Chapter 2 Chemical Sub-sector

2.1 Detailed Enterprise Survey

2.2 Simplified Enterprise Study

CASE STUDY C-01

Vinh Phu Battery - Cell Company

Survey Date: November 23, 1999

March 6,7,8,14 2000

1. General

1.1 Profile

Vinh Phu Battery - Cell Company is one of the national companies under VINACHEM, Ministry of Industry. The company profile is summarized in Table 1. The structure of the company is shown in Figure 1, and its layout is shown in Figure 2.

Table 1 Company Profile

Company Name:	Vinh Phu Battery-Cell Company
Ownership:	State owned
Address:	Lam Thao- Phu Tho
Director:	Mr. Hoang Quoc Vinh
Established:	1965
Began Operation:	1979 for batteries, 1995 for dry cells
Corporate Capital:	
Number of Employees:	502, including 100 in sales offices and also including 14 engineers
Main Products:	Batteries, Dry Cells

1.2 Status of Business

The main products of Vinh Phu Battery - Cell Company are various kinds of batteries and dry cells. The number of employees is around 500, including 100 employees who work outside the company selling their products through out the country. 14 engineers are also included in this figure, and they have is only one person in charge of environment and safety. The history of the factory is as follows:

1965 The company was established. The Vietnam-US war forced postponement of the implementation of factory construction.

1975 The battery production plant was actually constructed at a former Army base location.

1978 The battery case production facility was constructed. Both buildings for battery and battery case production were designed and constructed using Chinese technology.

1979 The full product line for the battery operation was completed.

1995 The dry cell production facility was constructed using Taiwanese equipment.

The market for batteries and dry cells is a little bit weak at present because of imported products from China with competitive prices and good quality. The production capacity and actual production for the year 1998 for their main product is shown in Table 2. The actual consumption of raw materials, utilities and additives in the year of 1998 are also shown in Table 2.

1.2.1 Production

The main product, batteries are produced at a capacity of 60,000kwh/y and the facility for their new product, dry cells, is designed to produce 8,000,000/y.

1.2.2 Debt

1.5 billion US$ of bank debt

Table 2 Production Amount(1998) and Designed Capacity

Product	Unit	Production	Designed Capacity
Batteries	KVA	51,000	60,000
Dry Cell (R20)	Pieces	4,000,000	10,000,000
Dry Cell (R6)	Pieces	2,000,000	8,000,000

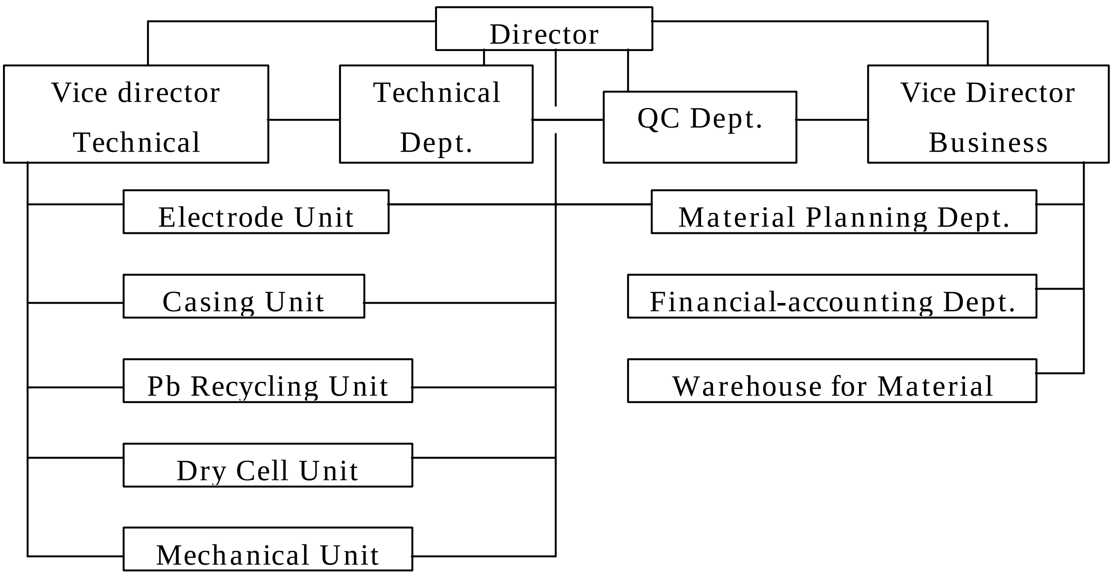


Figure 1 Organizational Chart of the Company

2. Production Technology

2.1 Process

The production technologies used for batteries and dry cells were mainly developed and established by the company.

The production line consists of 4 functions (shown in table 3) and the circumstances on their production technology are shown in Table 4.

Table 3 Production Line

	Name	Function
1	Electrode Unit	Electrode Production & Battery Assembling
2	Casing Production Unit	Produce Battery Casing
3	Synthesis Unit	Recycling & Lead Alloy Production, Assembling Domestic Batteries
4	Cell Production Unit	Manufacture Zinc Casing, Production & Assembling of Cell R20 and R6

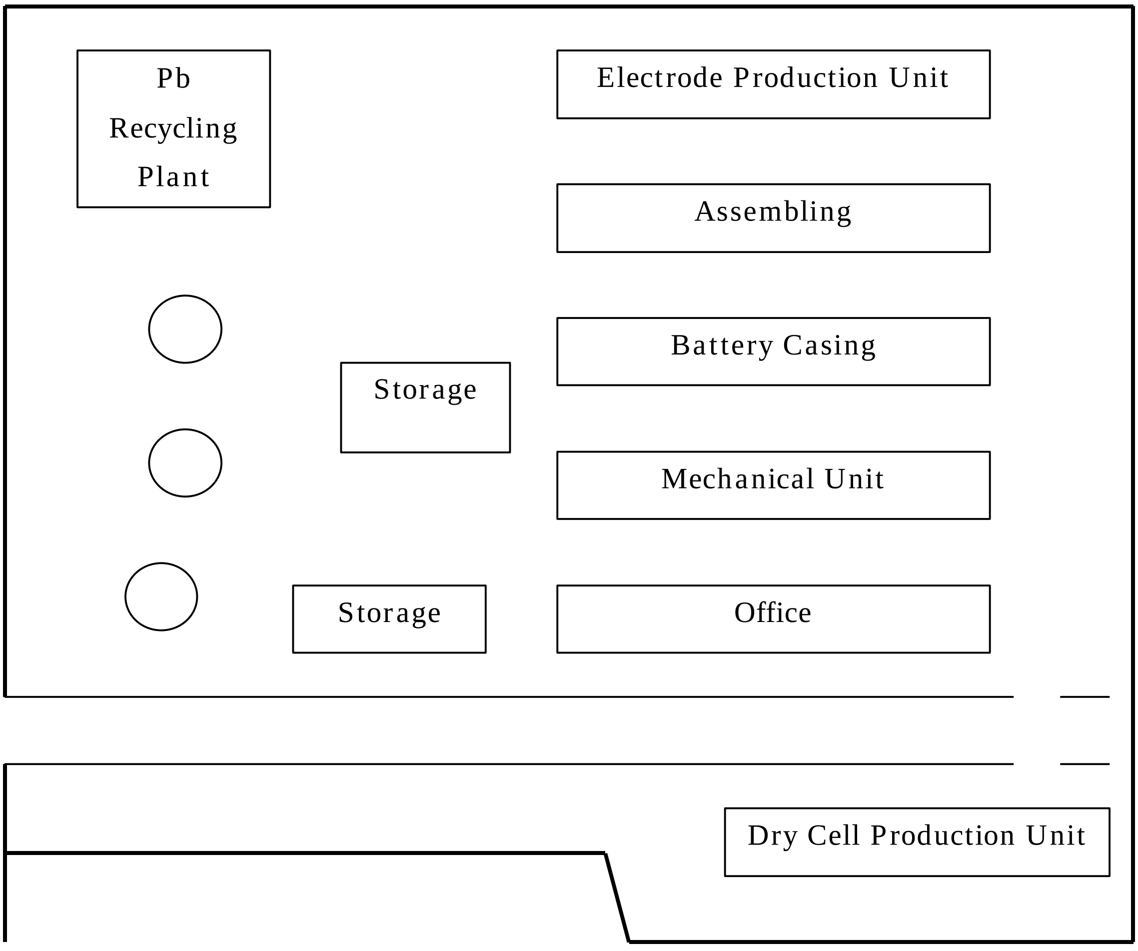


Figure 2 Factory Layout

Table 4 Production Technology

Production Chain Technology	Licenser	Year of Production	Date of Installation	Specification
Electrode Production	China	1975	10/1978	Frame casting, Surface treatment, Finishing, Drying & Cutting & Assembling 32 leaves/min.
Ebonite Casing Production	China	1975	10/1978	Material mixing, Refining
Plastic Casing Production	China	1994	5/1995	Standard resin, Drying, and Product finishing
Cell R20 & R6 Production (paper based)	China	1995	1996	Zn casing product, Mixing, Assembling, Carbon rod pitching, Bottom filling, and Paper filling, Packaging Productivity: 100 cells/min.
Cell R20 Production (without paper cover & threading)		1996	1998	Zn casing, Filling, Assembling, and Packaging Productivity: 100 cells/min.

Figure 3 shows electrode production and its assembly process based on data provided by the company, Figure 4 presents the ebonite battery case production process. Figure 5 shows the N-Pb-Sb recycling system, and Figure 6 shows the dry cell production process.

The company states that they do not utilize a continuous production process, but instead that the opt to use intermittent production.

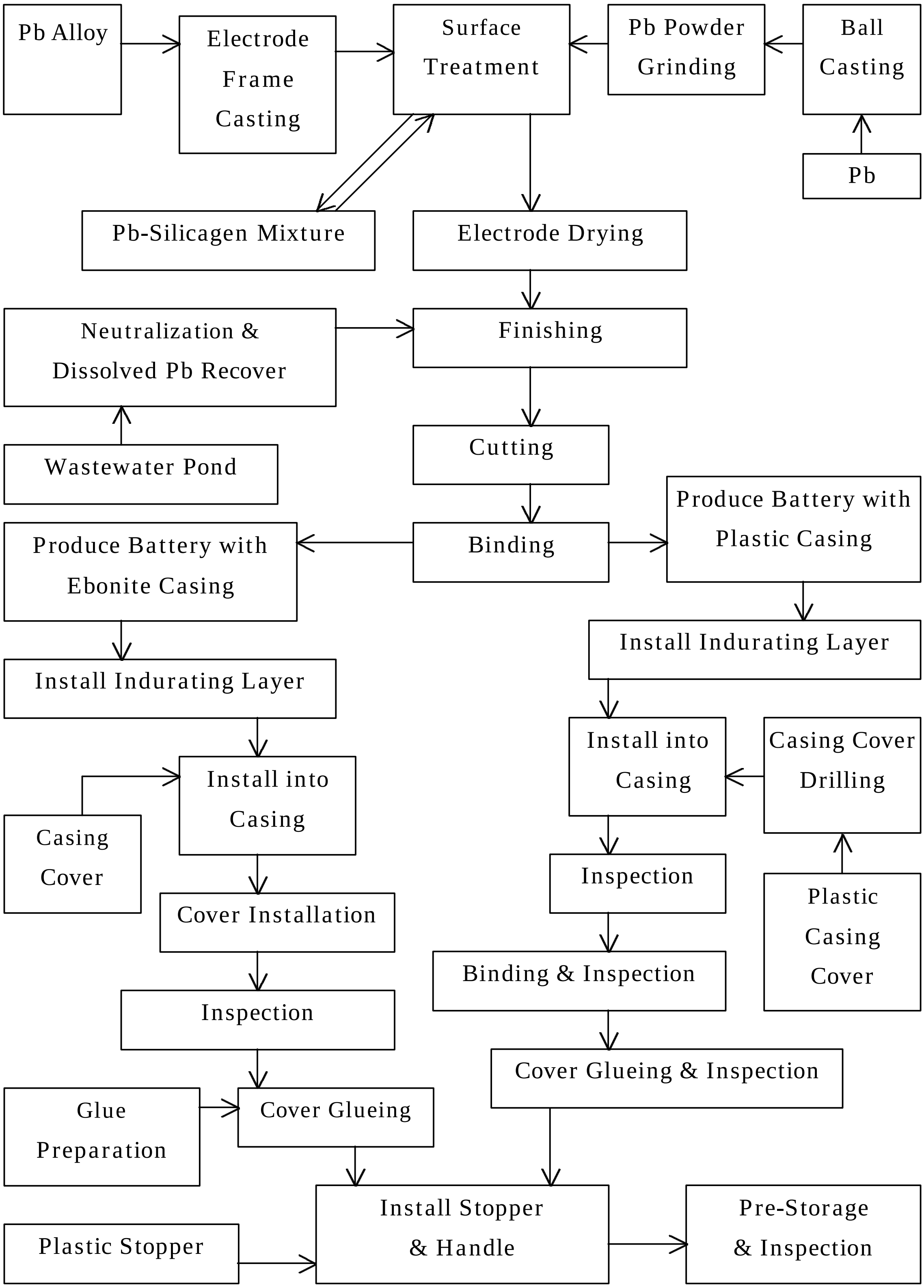


Figure 3 Electrode Production and Assembly Process

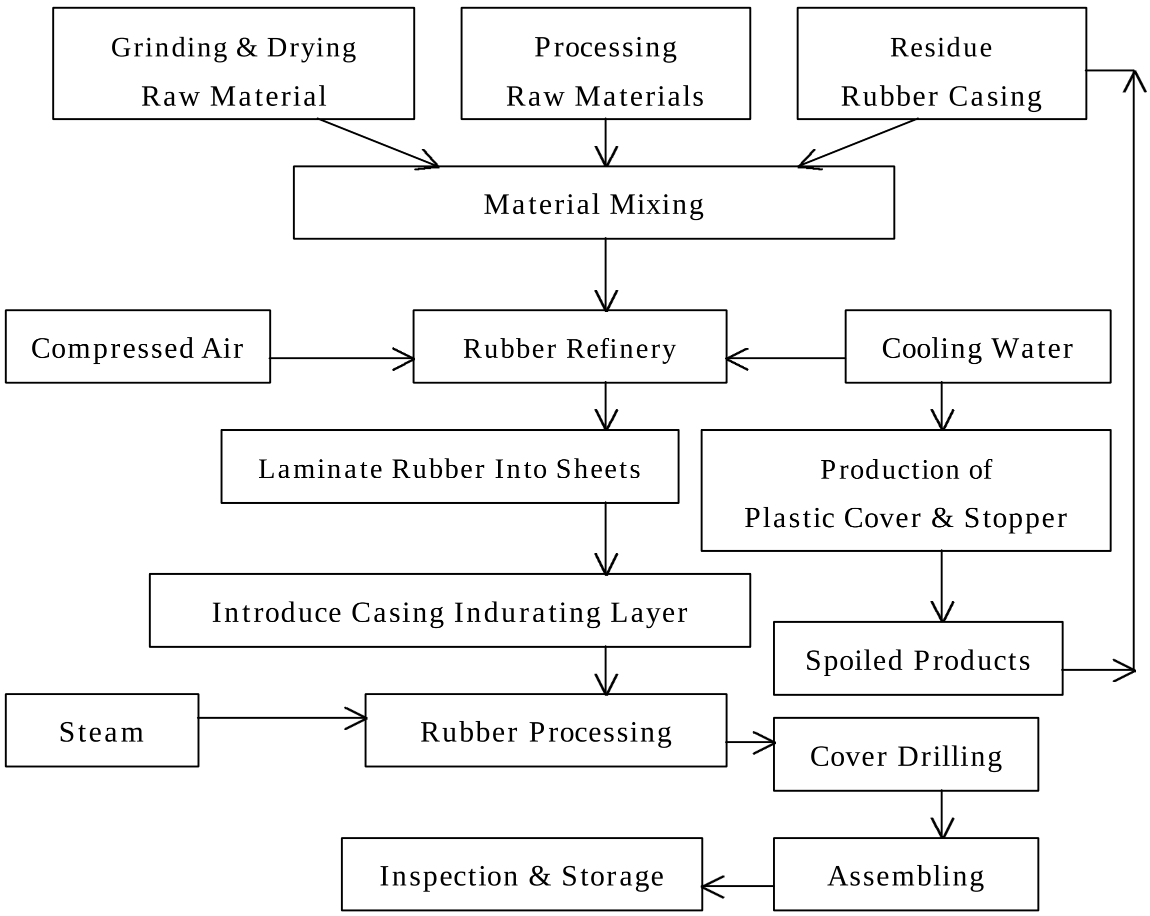


Figure 4 Ebonite Battery Case Production Process

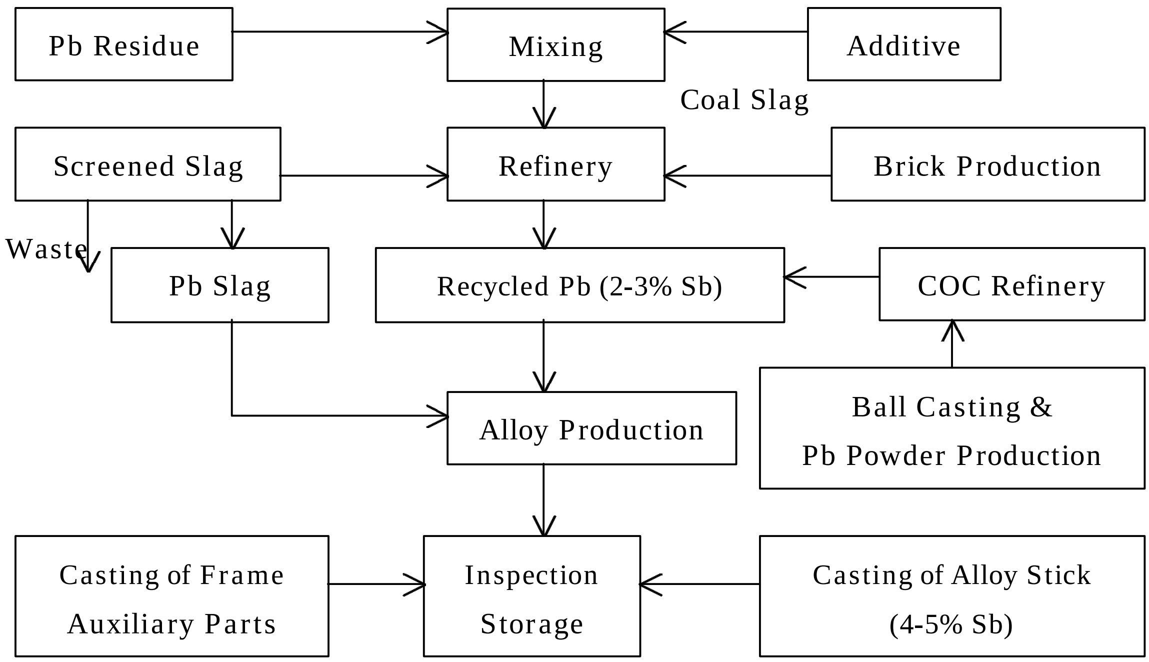
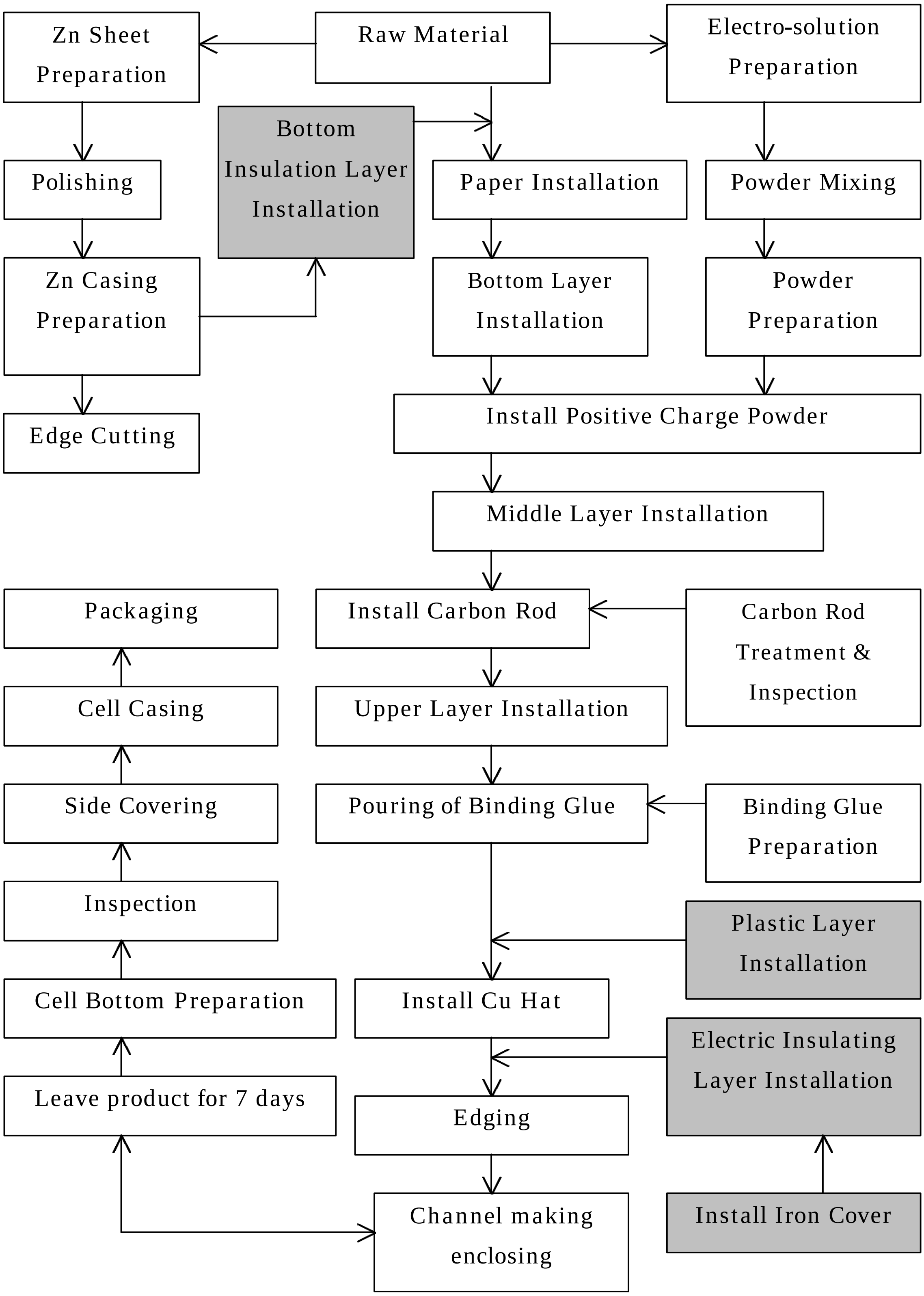


Figure 5 N-Pb-Sb Recycling Process



(*) Shaded Areas are used only for R20 production

Figure 6 Dry Cell(R6、R20) Production Process

2.2 Industrial Water Source

The company indicates that productivity, including the quality of the products, equipment, employee's health, the quality of wastewater, is closely related to the industrial water quality. ① Supply from Lam the Thao Superphosphate & Chemical Co. ② 2 Deep wells water, ③4 excavated wells water has been used as industrial water, however due to the end of the contract, ① has been stopped since August 1999.

Table 5 shows the specification of the industrial water used in the electrode and dry cell production process. In order to ensure the quality of water used in processing, they have set up ion exchanger machines at both processes.

Table 5 Specification for processing water used in the electrode and dry cell production process

Parameter	Specification	Parameter	Specification
Color	none	pH	7
Resistability (Ω)	≧ 30,000	Ion (Fe,Ca, Mg, Cl)	none

2.3 The Quality of Industrial Water(taken on March 7, 2000)

The result of the measurements using simple instruments is shown in Table 6. The samples were taken at the same time as the measurement, and they were analyzed by CECO , Table 7 shows the results.

As stated before, they do have ion exchange machines in electrode and dry cell units in order to secure enough amount and quality of processing water used for each unit, necessary amount of the water is 20m^3/d. However, both machines have some problems that are shown in Table 6 and Table 7.

Table 6 Quality Change

Parameter	Unit	No. of table	Electrode production		Dry cell production	
			Before treatment	After treatment	Before treatment	After treatment
pH		6	4.58	5.8	7.02	3.64
		7	4.59	5.84	7.02	3.64
Conductivity	ms/cm	6	0.26	0.29	0.26	0.54
		7	0.26	0.29	0.26	0.54

① The pH level before and after treatment is almost the same, but in all cases the after treatment level is farther out of the specification range.

② Conductivity level is not improved through treatment.

This means that the method they use to operate the ion exchange machine or their choice of ion exchange resin is inappropriate.

Table 7 Industrial Water Quality analyzed by CECO

Sampling Point		1	2	3	4	5
Item	Unit					
Time		10:37	10:51	11:17	11:08	11:00
Temp.	℃	22	22	22.2	24	22
pH		6.62	6.8	4.55	5.62	4.59
Conductivity	ms/cm	0.22	0.16	0.26	0.11	0.26
Turbidity	NTU	21	11	212	5	0
Oil content	mg/l	0.31	0.36	0.017	0.25	0.023
BOD_5	mg/l	6	5	2.7	3	3
COD	mg/l	12	11.2	8	8	7.2
DO	mg/l	5.8	4.1	3.2	4.4	3.3
SS	mg/l	22	14	1	8	4
SO_4	mg/l	78	33	126	29	126
T-nitrogen	mg/l	11	12.4	1.83	2.5	1.9
CN	mg/l	0.001	0.001	0.001	0.001	0.01
Phenol	mg/l	0.005	0.003	0.004	0.007	0.003
Residual Cl	mg/l	0.17	0.1	0.03	0.04	0.01
Pb	mg/l	0.0024	0.001	0.0005	0.0025	0.003
Ni	mg/l	0.02	0.016	0.012	0.0025	0.001
Cd	mg/l	0.0006	0.0004	0.0001	0.0004	0.0012
Mn	mg/l	0.4	0.2	0.8	0.3	0.47
Zn	mg/l	0.24	0.07	0.1	0.2	0.31
Color	Pt-Co	38	8	0	24	3
Fe	mg/l	0.65	1.26	1.42	0.98	0.41
PO_4^{3-}	mg/l	0.01	0.18	0.015	0.09	0.16
Ca^{2+}	mg/l	18.4	16.8	20	17.32	20
Mg^{2+}	mg/l	7.1	5.83	3.16	2.68	3.88
CO_3^{2-}	mg/l	2.2	1.3	0.8	1.12	0.1
Cl^-	mg/l	8.75	14.2	19.5	15.4	12.4

Sampling Point		6	7	8	9	
Item	Unit					
Time		11:43	11:52	13:20	13:50	
Temp.	℃	22	20.5	21	23.4	
pH		6.85	7.02	3.64	5.84	
Conductivity	ms/cm	0.27	0.26	0.54	0.29	
Turbidity	NTU	2	2	4	0	
Oil content	mg/l	0.01	0.17	0.08	0.12	
BOD_5	mg/l	4	3	9	4	
COD	mg/l	16.4	7.2	20.8	9.6	
DO	mg/l	5	5.7	6	3.3	
SS	mg/l	4	5	2	1	

Sampling Point		6	7	8	9	
Item	Unit					
SO_4	mg/l	51	53	2	106	
T-nitrogen	mg/l	1.45	2.1	2.4	1.8	
CN	mg/l	0.00	0.014	0.001	0.001	
Phenol	mg/l	0.001	0.004	0.0033	0.003	
Residual Cl	mg/l	0.02	0.04	0.06	0.02	
Pb	mg/l	0.0005	0.0006	0.0004	0.0023	
Ni	mg/l	<0.001	0.01	0.008	<0.01	
Cd	mg/l	0.001	0.0003	0.0003	0.0002	
Mn	mg/l	0.38	0.52	0.55	0.1	
Zn	mg/l	0.24	0.41	0.44	0.16	
Color	Pt-Co	17	16	8	4	
Fe	mg/l	0.15	0.32	0.3	0.4	
PO_4^{3-}	mg/l	0.83	0.19	0.28	0.1	
Ca^{2+}	mg/l	22	31.2	18	0.8	
Mg^{2+}	mg/l	4.04	9.72	4.37	1.46	
CO_3^{2-}	mg/l	0.08	0.0	0.0	0.0	
Cl^-	mg/l	7.32	5.33	113.6	10.6	

Table 8 shows the operating condition of the excavated well pump when the measurements and samples were taken.

Table 8 The Operating Condition of the Water Pump（excavated Well）

	No.1	No.2	No.3	No.4
Operation status	Not in operation	Not in operation	In operation	In operation
Operation frequency per day	Twice	Twice	Once	
Operating hours	1-2hrs.	1-2hrs.	2hrs.	3-4hrs.

2.4 Industrial Water Secure Plan

① Considering the quality and cost, the company has made plans to stop using water from the excavated well. The price of the excavated well water is much more expensive than the water from the Lam Thao Superphosphate & Chemical Co. (1,000 VND/m^3)

② From q quality prospective, instead of using excavated well water, water from deep well should be given priority for utilization. There is an existing deep well, located outside of the factory site, with a depth of 95m. This deep well is not able to provide enough water to meet their needs. The other well, located inside the factory has a depth of more than 100 m, and is also not able to cover the amount of water they need. The company is now constructing a new deep well and they are now looking for a suitable location.

③ Another option could be receiving water supply from Lam Thao Superphosphate & Chemical Co. However, the quality of their water is less than the quality of deep well water.

The transition of industrial Water is shown in Table 9, based on the data received wfrom the company.

Table 9　　Industrial Water Transition

	1998	1999	Future Plan
Battery Production (KVA)	40,000	32,000	60,000
Dry Cell Production (Pieces)	7,000,000	7,000,000	
Water from Lam Thao Superphosphate & Chemical Co. (m^3/y)	68,176	18,421	
Water from excavated wells (4 wells) (m^3/y)	48,000	48,000	
Water from deep wells (m^3/y)		33,450	
Total (m^3/y)	116,176	99,871	200,000

The total amount of water required is 120,000m^3/y at the rate of 55,000KWH/y production. The number of days operated is 330d/y. The following countermeasures are suggested:

① Necessary equipment : Centralized sedimentation tank→an ion exchange machine→neutralization tank

② Modify the plumbing system in the factory

③ Improve the plumbing ; replace the plumbing from the Lam Thao Superphosphate & Chemical Co. (2km x 4B)

2.5 Countermeasures for sulfur vapors in the electrode lead production process

In this process, a certain amount of sulfur disappears while the lead rods are placed in sulfuric acid for a 3 month time period.

① The existing absorption system is now stopped, however, blowers are placed in 2 rooms, one has 5 blowers and the other has 9 of them, and each blowers has the same capacity, 8m^3/sec. (5 kw. Its duct is made of PVC. The lid of the charging tank is also made of PVC.

② We recommended that the shape of the lid be changed and that the aisles surrounding the tank be enlarged in order to reduce the amount of water use for washing the floor around the tank.

In order to get a good idea of the condition of the working environment in the room, we requested CECO to make analysis, using a unit mg/m^3 、 of the density of sulfuric acid. Samples are taken 1.5**m** above the floor. The results of this analysis are shown in table 10.

Table 10 Sulfuric acid concentration（Working environment）(March 10,2000)

Sampling Point		1	2	3
Item	Unit			
Time		14:45	15:00	15:15
Height	M	1.5	1.5	1.5
H_2SO_4	mg/m^3	0.432	0.863	0.254

Remarks:

Sample No.1: Battery Production (middle position)

Sample No.2: Battery Production (end position)

Sample No.3: Electrode lead casting section (cast machine position)

2.6 Wastewater source

The amount of detrimental wastewater including heavy metals is 12-50m^3/d.

We counted three sources of wastewater.

① Lead powder preparation unit : Cooling water for the lead crushing process, and washing water for the cyclone and floors. This water is mixed and discharged through neutralization and sedimentation.

② Electrode production unit : Sulfuric solution spills over onto the floor because of gas generation during lead electrode preparation which takes 3 months. Washing water for the floor and lead electrodes are mixed and discharged to the wastewater pond after neutralization.

③ Dry cell production unit : Wastewater in the dry cell unit is discharged directly to the rice fields without any treatment.

The neutralization treatment utilizes lime, but there are no stirring devices. Neutralization and sedimentation ponds are made of concrete.

There are some different kinds of species of fish in the ponds which are used for checking the quality of industrial wastewater. We were informed that the industrial wastewater includes some toxic compounds like ammonia, sulfuric acid, Pb, zinc and etc.

Periodical checks on the wastewater have been performed once a year by CECO because the company has no quality control department and facilities. Actually, wastewater treatment is not performed at all for the purpose of environmental conservation.

① Lead powder production process：Cooking water from the lead grinding process and washing water for cyclones and floors is mixed. After the wastewater goes through a setting tank and a neutralization process, it is drained into rice fields.

② Electrode production process： While lead electrodes soak for 3 months in sulfuric acid, gas is generated. Since the gas causes sulfuric water to spill on the floor, floor washing is essential. Washing water for the floor and lead electrodes are one source of the hazardous wastewater. These two kinds of washing water are mixed and neutralized before being drain to a pond on the factory ground.

③ Dry cell production process：Wastewater from the dry cell production process is drained into rice fields without any treatment.

Lime is used as a neutralizer, however, no special agitation is used in the process. Neutralization and sedimentation tanks are made of concrete. Other wastewater from the silica-gel and battery case production process in addition to those stated before are mixed and drained into an excavated pond without treatment. Chart 7 shows the wastewater system and the points where samples were taken.

Wastewater measurement is implemented once a year by CECO（Chemical Engineering Corporation）because the company doesn't have the equipment to take measurements. Another simple measurement is implemented at the sample points 1、4、5、and 6 by using pH indicate paper every week. In addition to these measurements, an inspection is done by DOSTE, Phu Tho Province, once a year.

3. Management

3.1 General

ISO9000 and ISO14000 have not been applied in this company yet. The factory of this company is not so well managed from the view point of cleanliness of the working place and environmental aspects. However, top management has a concept and is considering what must be done by the company to improve these conditions. They explained that the site is supposed to be maintained to be clean to a level where there is no garbage in sight. The company is also putting that effort into growing tall and short trees, just like "a Factory in the Forest".

3.2 Unit Consumption of Raw Materials and Utilities

Table 11 shows the unit requirements of raw materials and utilities in the year 1998 provided by the company.

Table 11 Unit for raw materials and utilities(１９９８)

Material	Consumption (Tons/day)
Pure Lead (99.99%)	1.500
Lead Alloy (5%Sb)	1.643
H_2SO_4 (98%)	1.180
Natural Rubber	0.176
Sulfur Powder	0.053
$BaSO_4$	0.006
Coal (6x8)	0.618
Lime Powder	0.002
Bitumen	0.033
Carbon Powder	0.160
Zinc	0.610
Carbon Rod	0.153
Electricity (KW)	8,660
Natural Manganese	0.617
Electrolyzed Manganese	0.401

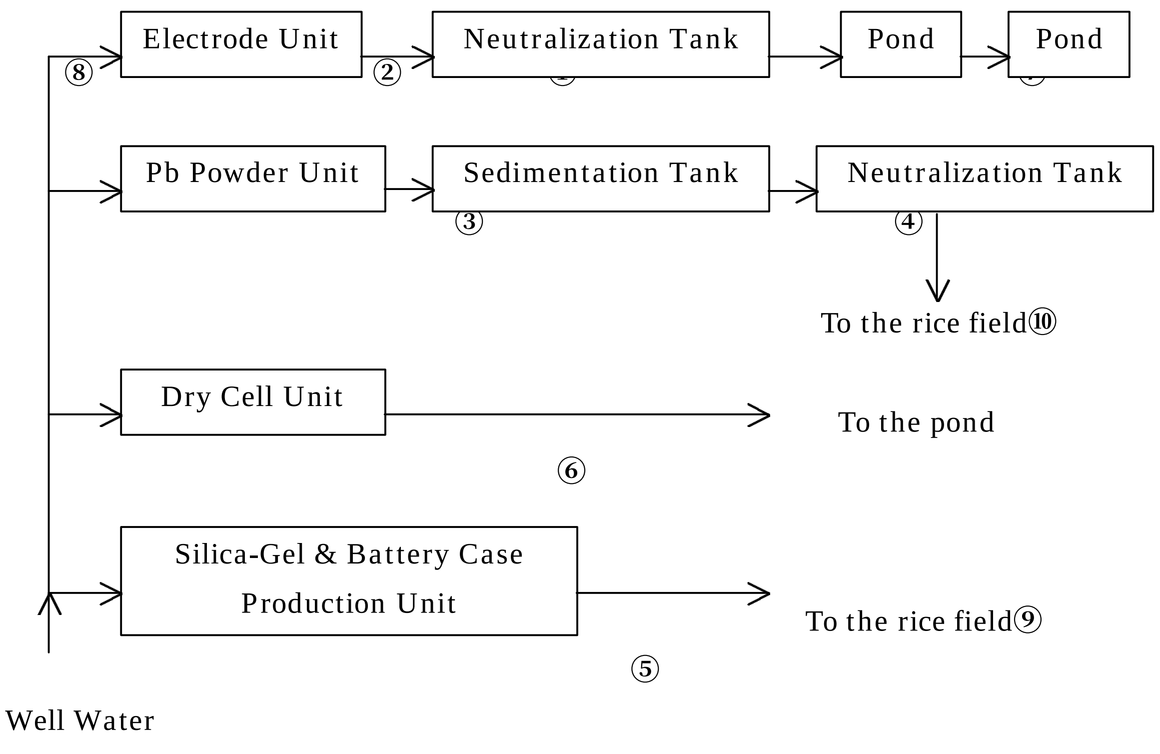


Figure 7 Water System

3.3 Environmental condition

Table 12 shows the equipment and exhaust density conditions. The present state of solid waste is shown in Table 13, and supply and wastewater conditions are shown in Table 14-17. All the charts were made based on data provided by the company.

3.3.1 Present condition of the atmospheric pollution

Table 12 shows the density of CO2, SO_2, and NO_2, and the location of where those gases are emitted.

Table 12 Air Pollution Conditions

Facility	Material used	Waste	Emission (mg/m^3)		Height of emission point (m)
			Designed	Actual	
Electrode frame casting facility	Pb alloy	CO SO_2 NO_2	40 0.5 0.4	0.417 0.562 0.073	12 12 12
Electrode finishing facility	D2, H_2SO_4	CO SO_2 NO_2	30 20 5	0.148 0.428 0.036	13.5 13.5 13.5
Rubber processing		CO SO_2 NO_2	30 20 5	0.253 0.218 0.047	12 12 12
Cell production facility	NH_4Cl, Mn, C powder, Graphite, Bitumen	CO SO_2 NO_2	30 20 5	0.186 0.236 0.053	5 5 5
Pb powder grinding facility	Pb	Dust	6	0.327	13.5

3.3.2 Present condition of Solid Waste

Table 13 Present Solid waste condition

Facility	Waste	Discharged amount (kg/d)	Discharged from	Treatment & usage
Pb alloy production (Sb+Pb)	Coal residue	50	Collected	Brick making
Rubber parts processing	Rubber	5	Collected	Recycling
Old battery recovery	Casing, Insulation	10	Collected	Treatment & Recycling

3.3.3 Present condition of supply and wastewater

Table14 Present Supply Water Conditions

Source of water	-Piped water from the Lam Thao Superphosphate Co. -Underground water in the company area -Surface water in the company area
Percentage of supply water	Pipe & underground water account for 70%
Volume of water intake	-Summer: 300m^3/d -Winter: 250m^3/d
Water consumption	-Process water: 12m^3/d -Domestic water: 40m^3/d -Industrial cleaning water: 3-5m^3/d -Cooling water: 170-180m^3/d

Table 15 Present Wastewater Conditions

Production unit	Discharge process	Discharge flow	Contaminants level
Pb powder production & electrode surface treatment units	-Cyclone treatment -Floor washing	5-7m^3/d	pH=6.2 SO_4=56 NH_3=0.36
Electrode finishing	-Making finishing solution -Floor washing	3-5m^3/d	pH=5.3 SO_4=110 NH_3=1.39 Pb=0.083

Table 16 Distinctive Waster Water features

Parameter	Unit	Waste stream			Vietnam standard 5945-1995
		Stream 1	Stream 2	Stream 3	
Temp.	℃	31.5	31.6	30.8	40
pH		6.7	5.3	6.2	5.5-9
DO	mg/l	4.5	5.6		
TSS	mg/l	6.05	7.0	5.0	100
TDS	mg/l	240	90	120	
Conductivity	ms/cm	0.29	0.17	0.23	
Turbidity	NTU	11	19	25	
Sulfate SO_4	mg/l	50	110	56	
NH_3	mg/l	0.55	1.39	0.63	1
Sulfate	mg/l	0.013	0.015	0.013	0.5
Zn	mg/l	0.02	0.2	0.2	2
Mn	mg/l	0.3	0.4	0.7	1
Fe	mg/l	0.13	0.9	1.04	5
BOD_5	mg/l	24	30	18	50
COD	mg/l	64	72	48	100
Pb	mg/l	0	0.038	0.033	0.05

Table 17　Current Wastewater Route Conditions

Industrial wastewater	-Drained to sedimentation tank, passes through treatment tank then joins with the storm water drainage into a biopond. Continuous discharge -Cooling water flow to recovery/circulating tank
Treatment facility	-One sedimentation system -Two pH adjustment tanks

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater quality

Table 18 shows the points where the samples are taken, and the contents of the sample points.

Table 18　Sampling points and Detail of samples

Sampling points	Detail of samples
1	Wastewater in the Neutralization Tank of electrode unit
2	Wastewater from Electrode Unit before the neutralization
3	Wastewater from the Sedimentation Tank of Pb Powder Unit before neutralization
4	Wastewater in the Neutralization Tank after Sedimentation
5	Wastewater from Battery product unit drain into rice fields
6	Wastewater from Dry Cell Unit drain into a little excavated pond
7	Waste water from the pond
8	Well Water
9	Wastewater from Silica-Gel and Battery Case Unit drain into rice fields
10	Wastewater from the rice field where water comes from Pb powder grinding unit
11	Water from a stream lower the rice field（upper the factory）

4.1.1 The results of the Nov/23/1999 measurements

The results of the samples analyzed by CECO are shown in Table 19.

Table 19 Wastewater Analysis Results (CECO)

Sampling Point		1	2	3	4
Parameter	Unit				
Time		11:55	11:30	11:45	11:54
Temp.	℃	22	22.7	22	25.7
pH		7.7	1.7	6.2	3.3
Conductivity	ms/cm	0.35	22	0.31	1.2
Turbidity	NTU	0.0	20	0.0	10
Oil content	mg/l	0.18	0.47	0.31	0.28
BOD_5	mg/l	18	10	7	69
COD	mg/l	24	24	17.6	144
DO	mg/l	8.3	8.0	8.6	7.5
SS	mg/l	1	14	2	10
SO_4	mg/l	118	1,776	128	228
T-Nitrogen	mg/l	76	6.4	7	8
CN	mg/l	0.005	0.004	0.001	0.004
Phenol	mg/l	0.007	0.003	<0.001	<0.001
Residual Cl	mg/l	0.02	0.08	0.08	0.07
Pb	mg/l	0.007	18.733	2.247	0.006
Ni	mg/l	0.002	0.394	0.431	0.001
Cd	mg/l	<0.001	<0.001	0.004	<0.001
Mn	mg/l	0.1	0.1	0.4	0.7

Sampling Point		5	6	7	8
Parameter	Unit				
Time		12:10	13:20	13:30	13:40
Temp.	℃	30	24	26	25.2
pH		6.6	6.7	8.5	7.1
Conductivity	ms/cm	0.37	1.9	0.21	0.35
Turbidity	NTU	80	30	10	1
Oil content	mg/l	0.19	0.42	0.05	<0.01
BOD_5	mg/l	48	85	32	4
COD	mg/l	120	128	88	11.2
DO	mg/l	6.8	8.1	7.6	5.8
SS	mg/l	34	209	19	3
SO_4	mg/l	224	51	54	5
T-Nitrogen	mg/l	6	80	75	1.85
CN	mg/l	0.002	0.025	0.001	<0.001
Phenol	mg/l	0.002	0.001	0.001	<0.001
Residual Cl	mg/l	0.00	0.01	0.07	0.08
Pb	mg/l	0.115	1.048	0.015	<0.001
Ni	mg/l	0.005	0.043	0.003	<0.001
Cd	mg/l	0.004	0.001	0.001	0.001
Mn	mg/l	0.3	11.7	0.00	0.32
Fe	mg/l	--	--	--	0.56

4.1.2 The results of the March 8th, 2000 measurements.

The analysis of these samples, carried out by CECO is shown in Table 20.

The sampling points numbers are the same as the numbers sampled on November 23rd 1999. However, sample 8 has been excluded because it was already discussed on page 2 and 3. Sampling points numbered 9 through 11 are newly measured this time, and the location of each of these sampling points is out side of the factory. Oil was observed at sample number 6 and 9.

Table 20 The Results of Wastewater Analysis (CECO)

Sampling Point		1	2	3	4	5	TCVN
Parameter	Unit						
Time		10:20	10:25	10:32	10:39	10:45	
Temp.	℃	21	21	20	21	29	40
pH		6.71	1.61	6.08	6.95	7	5.5-9
Conductivity	mS/cm	0.29	41	0.3	0.27	0.28	
Turbidity	NTU	9	78	12	1	10	
Oil content	mg/l	0.16	13.9	0	10	0.37	
BOD_5	mg/l	17	18.5	27	20	6	50
COD	mg/l	56	56	80	48	16	100
DO	mg/l	4.9	4.2	5.1	5.3	4.1	
SS	mg/l	10	394	96	8	11	100
SO_4	mg/l	74	1,168	68	66	47	
T-nitrogen	mg/l	6.2	7.5	6.2	7.6	5.6	60
CN	mg/l	0.001	0.036	0.0	0.0	0.0	0.1
Phenol	mg/l	0.008	0.001	0.0010	0.0016	0.001	0.05
Residual Cl	mg/l	0.07	0.5	0.07	0.05	0.04	2
Pb	mg/l	0.0386	0.508	2.87	0.004	0.172	0.5
Ni	mg/l	<0.01	<0.01	0.52	0.0015	0.004	1
Cd	mg/l	0.007	0.0082	0.006	0.001	0.003	0.02
Mn	mg/l	0.3	0.1	0.1	0.1	5.5	1
Zn	mg/l	0.63	1.76	0.3	<0.01	<0.01	2
Fe	mg/l	0.72	8.47	1.53	0.50	0.62	5

Sampling Point		6	7	9	10	11	
Parameter	Unit						
Time		11:02	10:55	11:25	11:32	11:40	
Temp.	℃	20	21	23	23	22	
pH		6.7	8.29	7.52	7	6.71	
Conductivity	mS/cm	0.85	0.24	0.29	0.3	0.32	
Turbidity	NTU	51	20	38	27	27	
Oil content	mg/l	0.32	0.2	0.26	0.33	0.4	
BOD_5	mg/l	22	25	42	22	17	
COD	mg/l	64	72	96	48	40	

Sampling Point		6	7	9	10	11	
Parameter	Unit						
DO	mg/l	1.2	7.3	5.8	5.1	4.5	
SS	mg/l	166	23	67	24	57	
SO_4	mg/l	75	64	86	63	126	
T-nitrogen	mg/l	36.9	3.12	3.50	4.5	6	
CN	mg/l	0.021	0.001	0.006	0.001	0.001	
Phenol	mg/l	0.01	0.021	0.014	0.001	0.01	
Residual Cl	mg/l	0.25	0.13	0.2	0.15	0.13	
Pb	mg/l	0.0183	0.002	0.01	0.008	0.0492	
Ni	mg/l	0.6	<0.01	0.005	0.01		
Cd	mg/l	0.0036	0.0086	0.0001	0.0082		
Mn	mg/l	<0.1	0.1	0.1	0.7		
Zn	mg/l	7.16	0.23	1.79	0.32		
Fe	mg/l	1.95	0.3	0.28	0.12		

4.2 Regulation Standards for Industrial Wastewater

According to the standards shown in Table 20, the following comments can be made about wastewater drained out side of the factory, sample 4 and 5 in the results shown in table 19 and 20.

< Sample No.4 >

① In table 20, the pH value is 3.3 which is out of the 5.5 – 9 range. However, in Table 22, the value is 6.95 which is in range.

② BOD_5 and COD exceed the standard value in table 20. However, in Table 22, each value meets the standards.

③ Oil content value is 10, which is way out of range of the standard value 1.

< Sample No.5 >

① COD exceeds the standard value in Table 20. However, in Table 22, the value is 16 which complies with the standards.

② The Mn value exceeds the standard value.

The following comparison is made between water quality in the pond, sample 6 and 7, and standards shown in Table 20:

< Sample No.6 >

① BOD_5 and COD exceed the standard value in Table 19 and 20. However, each value has been dropped to the standard.

② SS exceeds the standard value in both Table 19 and 20.

③ Pb content , 1.048, and Mn content, 11.7, exceed the standard value of 0.5 for Pb and 1 for Mn in Table 19. However, these values comply with the standard in Table 20.

④ The Zinc value , 7.16, exceeds the standard value, which is 2 in Table 20.

<Sample No.7>

None of the values in Table 19 and 20 exceeds the standards.

It should be concluded, from what has been shown above, that since the company does not utilize a continuous production process, but instead opts to use intermittent production, the value of the wastewater measurements will be different depending on what kind of process is being implemented at the time data is taken.

Thus wastewater management which suits each particular situation is required.

Wastewater out side of the factory site, the values of the wastewater samples taken from the rice field, sample points 9 and 10, the samples taken from the stream, and sample point 11 have been compared to the standards and analyzed as follows:

<Sample No.9 location> Down stream of sample point #5 where water is discharged from the battery case production process.

No values exceed the standard values.

<Sample No.10 location> Down stream of sample point #4 where water is discharged from the lead powder production process.

No values exceed the standard values.

<Sample No. 11> Down stream from the rice field

No values exceed the standard values.

Thus, there are no values that exceed the standard values for B rank wastewater in Table 23. However, some values exceed the standard values for A rank wastewater is regulated as domestic use water.

<Sample No.9>

① The measurement for BOD_5, 42, and COD, 96, exceed the standard values which are 20 for BOD_5, and 50 for COD.

② The value of Phenol, 0.014, exceeds the standard value, 0.001, for Phenol.

<Sample No.10>

① The BOD_5 measurement , 22, exceeds the standard value, 20 for BOD_5.

② The Zinc measurement, 1.79, exceeds the standard value, 1, for Zinc.

<Sample No.11>

①The Mn value, 0.7, exceeds the standard value, 0.2 for Mn.

5. Recommended Countermeasures for Improvement and associated cost

5.1 Countermeasures for production technology

5.1.1 Secure the water supply source

Industrial water quality is closely related to product quality, equipment, employee's health, and wastewater quality according to the company, as was mentioned in 2.2. There are three sources of industrial water:

① Supplied from the Lam Thao Superphosphate & Chemical Co., ② Deep well water and ③water from four excavated Wells, has been used as industrial water. However, due to the expiration of the contract, ①has not been utilized since August 1999.

As was stated in 2.4, the priority given to sources of industrial water and the reasons for prioritization are as follows:

(1) Taken quality and cost into consideration, the company is planning to stop using water from the excavated well. The cost of the excavated well water is much more expensive than the price of the water supplied from the Lam Thao Superphospate & Chemical Co. (1,000 VND/m^3)

(2) From a quality prospective, instead of using excavated well water, water from deep wells should be given priority for utilization. There is an existing deep well, located outside of the factory, that has a depth of 95m. However this deep well is not able to provide enough water to meet their needs. The other well, located inside the factory, has a depth of more than 100m, and is also not able to cover the amount of water they require. The company is now considering drilling a new, deep well and they are now looking for a suitable location.

(3) Another possible option for the company to consider would be receiving its water supply from the Lam Thao Superphosphate & Chemical Co.. However, the quality of their water is less than the quality of deep well water.

In some way, they need to secure enough industrial water to sustain full capacity operation and this is estimated to be about 200,000m^3/y for the full operation that will be required in the future.

5.1.2 Pre-treatment of industrial water and renewal of the water system

In order to provide high quality industrial water, it is necessary to install a pretreatment system, such as sedimentation and filtering. In addition, their water system, that has a lot of leakage needs to be renewed.

5.2 Countermeasure for management technology

5.2.1 Set up ion exchange machine and renovate existing water supply equipment

Pure water is essential for electrode and dry cell production. There are ion exchange machines in each production line to purify the water. However, as was stated in 2.3, those machines are inappropriate and sufficient treatment does not take place. Therefore, a new ion exchange machines or water purifying system is required and also the water system for the pure water coming from the new machine to the product lines needs to be renewed.

5.2.2 Countermeasures for sulfuric vapor steam at the electrode production process

As was stated in 2.5, electrodes need to be soaked in sulfuric acid for a while to charge before they are assembled as parts of wet cells. In this soaking process, gas is emitted. A ventilation system has been installed, but it is not functioning properly. The working environment in the factory is very bad, and sometimes it is hard for employees to breathe inside of this room.

Therefore, in concern for the employee's health, the ventilation system has to be renovated.

5.3 Countermeasure for wastewater treatment

As was explained on before,

① In the wastewater drained to rice fields around the factory, (taken from sample point 4 and 5.) Since the pH, SS, BOD_5, COD, lead, Mn values exceed the standard value, countermeasure must be taken as soon as possible. The countermeasures should be focused on installing a sedimentation tank, condensation and separation among treatments, and also initiating biotechnological treatment in order to meet the standard values.

② In order to get rid of lead and Mn from wastewater, the pH value has to be on the alkaline side, and they are needed to be settled out as an insoluble salt in an water. It is crucial to properly manage the pH value of wastewater. The operation of the neutralization tank has to be improved.

The reasons why wastewater from the factory does not satisfy the standards at times are because the treatment used for the wastewater is not sufficient and the production lines are not operated continuously at all the times. In order to fix the situation, the wastewater treatment system has to be developed and improved.

5.4 Estimation of costs for countermeasures

The estimated cost for these countermeasures, which experts from the Ministry of Industry, survey members, and the company already discussed, has been calculated by the company, and is shown in Table 21.

There are two choices for the industrial water source issue. The proposal in which a new well could be created costs 3,347 million VND. The other possibility that would be to buy water from the Lam Thao Superphosphate Co. costs 3,390 million VND. These figures are reflected in Table 21.

Table 21 Estimation Costs for Countermeasure

Million VND

No	Application Point	Countermeasures	Cost
1	Supplying water system	Two alternatives: 1. Upgrading the existing pipe line from Lam Thao Superphosphates company. 2. Preparation of new deep well system	② 1,310 1,267
2	Supplying water pre-treatment	sedimentation and filtration	② 260
3	Water pipe line to all workshops	Revamping and upgrading	① 443
4	Further treatment for process water	Installation of further treatment unit to produce pure water supplying to Battery and cells production (20 m^3/d)	② 180
5	Pure water supplying	Revamping and upgrading	① 50
6	Formation unit	Upgrading and revamping the H2SO4 vapor sucking system(14 units) including piping and construction	① 360
7	Waste water treatment	Neutralization including pH control system, sedimentation ponds, channels, piping	③ 457
8	Construction and erection		③ 330
	Total(depends on alternatives chosen)		3.347 **or** 3.390

Remarks:①Process Improvement (CP); ②Introduction of New Facility (CP) ;③EOP

6 Recommended Countermeasures for Improvement

6.1 Short-term Countermeasures

6.1.1

Determine which choice should be made in order to secure the industrial water supply as soon as possible.

6.1.2

After making this determination, start working on the countermeasures stated in Section 5.

6.1.3

Regarding SS, BOD_5 and COD values, these value need to be studied to determine the cause and to know the possibility of installing and adopting coagulation/separation type treatment or biological treatment.

6.1.4

Wastewater discharged from electrode production unit and Pb powder production unit should be decreased by dividing the wastewater line and by limiting the area washed when floors are cleaned.

6.1.5

Normal wastewater should be separated from abnormal, or dirty wastewater.

6.1.6

Introduce improvement changes such as the 5S activity, especially to improve the environment around the dry-cell unit.

6.1.7

Improve the quality of factory management by introducing statistical methods.

6.2 Mid-term and long -term Countermeasures

6.2.1

Introduce improved technology for the production system and environmental countermeasures from developed countries. An example of this would be to seek cooperation from a producer.

6.3 Schedule

Figure 8 shows industrial pollution prevention schedule. The company is obligated to carry out the measures following the schedule.

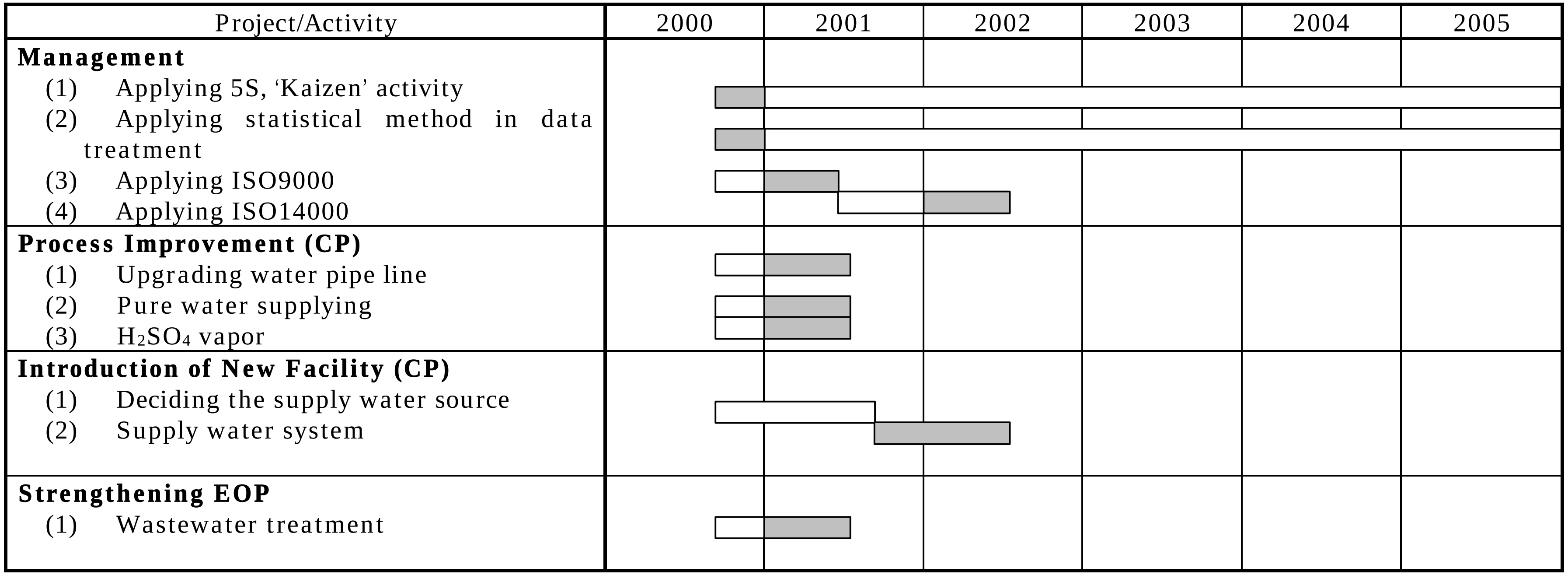


Figure 8 Action Plan (2000 to 2005)

CASE STUDY C-02

Lam Thao Superphosphate & Chemicals Company

Survey Dates: November 24, 1999

March 9-10, 13-14, 2000

1. General

1.1 Profile

Lam Thao Superphosphate & Chemical Company is one of the state-owned companies under VINACHEM, of the Ministry of Industry. The company profile is shown in Table 1, and the layout is shown in Figure 1.

Table 1 Company Profile

Company Name:	Lam Thao Superphosphate & Chemical Company
Ownership:	State owned
Address:	Lam Thao- Phu Tho Province
Director:	Mr. Nguyen Quoc Lap
Established:	1962
Corporate Capital:	
Number of Employees:	3,900 including 252 engineers
Main Products:	NPK, Superphosphates, H2SO4, Na_2SiF_6

The company was established in 1962 and production began at the same time. The enterprise produces sulfuric acid, single superphosphate, NPK fertilizer and Na_2SiF_6. The capacity of production has evolved and changed as follows:

	1962	1998	2001
sulfuric acid	40,000t/y	200,000t/y	240,000t/y
superphosphate,	100,000t/y	595,000t/y	750,000t/y
NPK fertilizer	-	90,000t/y	150,000t/y

New plant investment is 58 billion VND, 40% lower than surveyed. (The pay-out period is ten years) Technology was developed autonomously by the company, the equipment layout comes from Poland, automated machinery is from Japan (Yokokawa Electric), and the design was developed by CECO. Construction work is set to begin in April 2000 for this new, enlarged design and be completed around the end of the year. Production is scheduled to start in the first part of 2001.

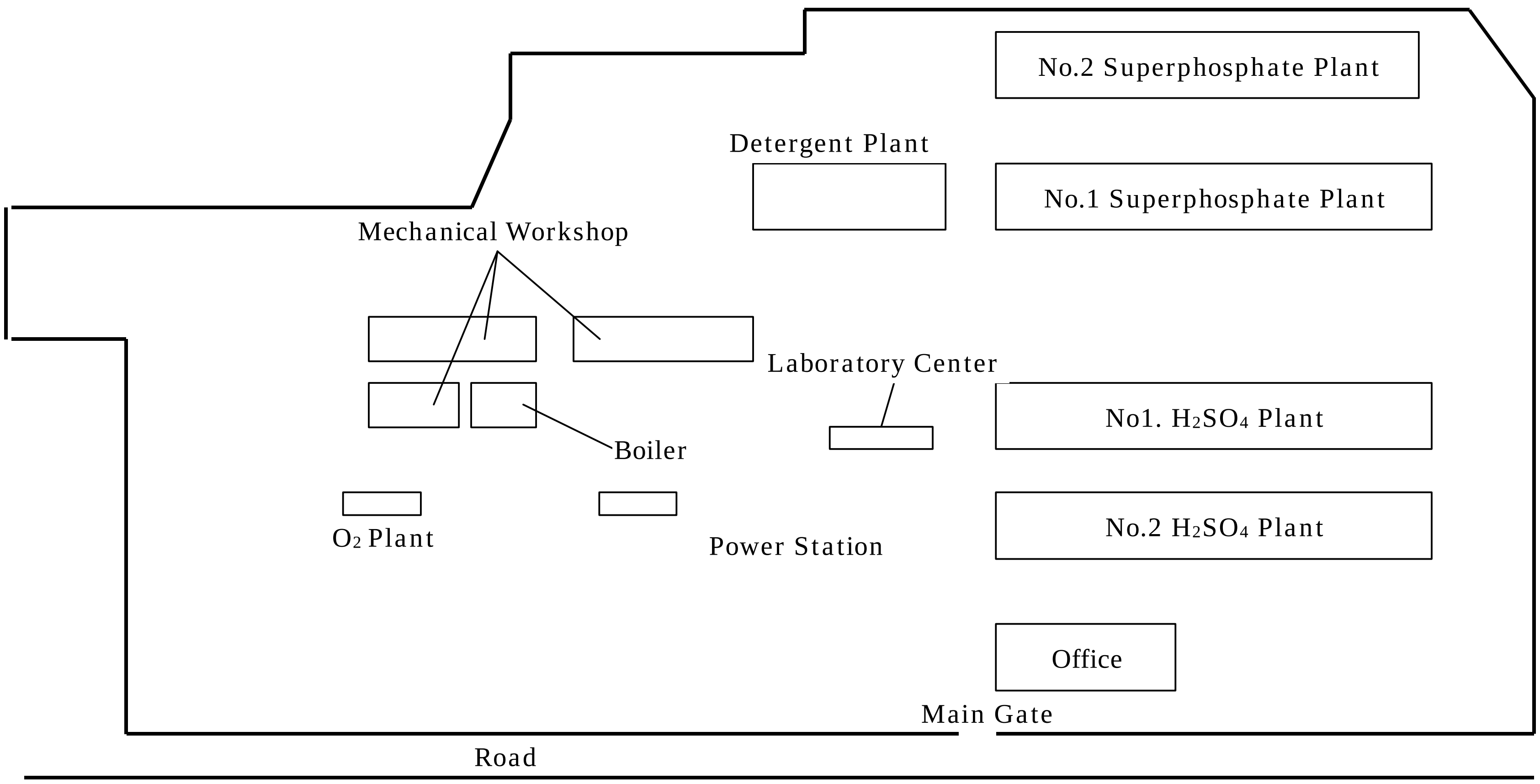


Figure 1 Factory Layout

1.2 Status of Business

1.2.1 Production

The expected demand for their products is very bright and more production capacity is needed for the future. However, prices of the products have not changed recently. When comparing the production graph below to production capacity shown above it can be seen that they are operating roughly at full capacity.

At present there is only 1 production line for H_2SO_4, and another line is expected to be installed for expansion of production capacity. Total production of their main products has grown almost 7 times in the past 37 years. Consumption of coal is 10,000 t/y and electricity is 6,000,000 kw/y.

Annual production and revenues are shown in Table 2

Table 2 Annual Production and Revenues in 1998

Product	1998		1999
	Production (Tons)	Revenue (million VND)	Production (Tons)
H_2SO_4	199,920	Internal Use	125,000
Single Superphosphate	593,600	365,160	638,000
NPK	85,171	85,171	125,000

1.2.2 Debt

Documents received from the company indicate that they hold minor debt with commercials banks, but 35,880 million VND in debt with the National Bank.

2. Production Technology

2.1 Process

Production technology used for their products, H_2SO_4 and single superphosphate fertilizer, was introduced from Russia. Production capacity was expanded several times due to improvements and modifications of facilities. However, there is no support from Russia at present. Annual maintenance takes 15 days.

2.1.1 Sulfuric Acid

Pyrite made in Phu Tho Province (Sulfur Content: 33%) and sulfur are the raw materials used for H_2SO_4 production (Purity : 99.5%). There are two trains, one utilizes a fluidized bed (installed in 1985) with 2 kinds of raw materials and another train uses only sulfur as a raw material (installed in 1995). The former process has a gas purification unit and the latter doesn't. Production of 100% H_2SO_4 from the former train was 122,960 tons and the latter was 76,960 tons in 1998. At the sulfuric acid plant surveyed, a double contact method has not been adopted. However, they are planning to adopt this method in the newly constructed plant. The conversion effectiveness of the reaction machine surveyed is 98.8% on average, and the effectiveness for sulfur is over 99.5%.

Since 1998 they have been working at lowering the utilization rate of pyrite and by the end of 2001 they are planning to stop using it altogether. They have a heat boiler with a capacity of 21t/h (vapor pressure: 25 atm) but, at present, they are not utilizing the vapor. However, they would like to utilize it for drying, etc. in the future. Figure 2 shows production process on both systems according to the data provided by the company.

2.1.2. Single Superphosphate

The technology in use is a drying method and there were 2 trains of roughly the same scale installed in 1962. Superphosphate fertilizer is produced by using apatite from Lao Cai Province as a raw material. Types, quality and consumption of apatite are shown in Table 3.

Table 3 Quality of Apatite and Consumption in 1999

Apatite	P_2O_5 Content (%)	Moisture Content (%)	Amount Used (1999)
Natural Apatite	33	12	255,000 Tons
Flotated Apatite	33	15	180,000 Tons

19 % is made up of P_20_5 in their product for both trains, of which 87% is water soluble P_2O_5 which can be used as a fertilizer. The content of F is 2%

2.2 Sources of Wastewater

400m^3/h of industrial wastewater is draining into the Kouga River, and in addition to this, 120m^3/h of wastewater generated from the washing process for dust coming out of the superphosphate production process is draining into nearby fields. Concerning wastewater analysis, pH is analyzed everyday, and COD, BOD_5, PO_4, SO_4, Cl, Oil, Conductivity, SS, TDS, and Turbidity are analyzed once every 2-3 months. The system graph of wastewater, confirmed on November 24, 1999, is the same as it appears in Figure 4. However, during the third field survey, upon re-confirmation of wastewater usage, the following misunderstandings became evident.

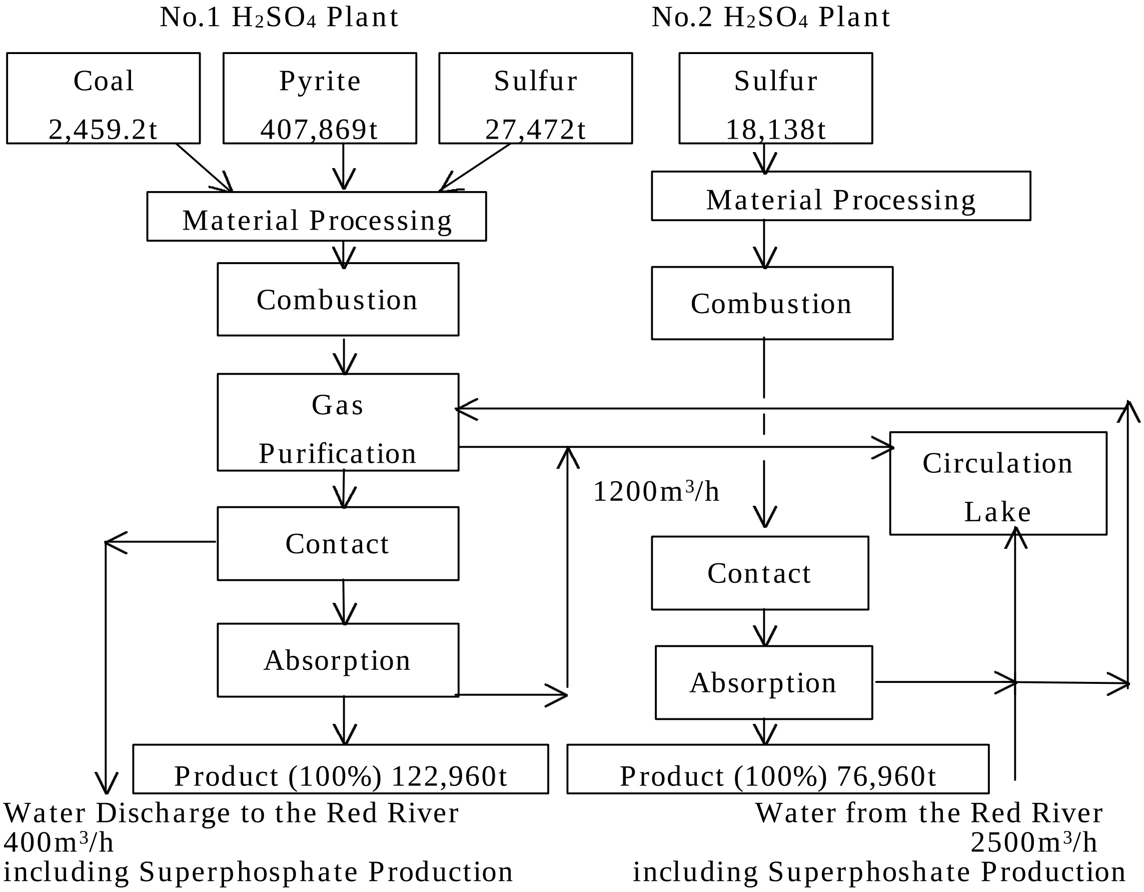


Figure 2 H_2SO_4 Production flow chart

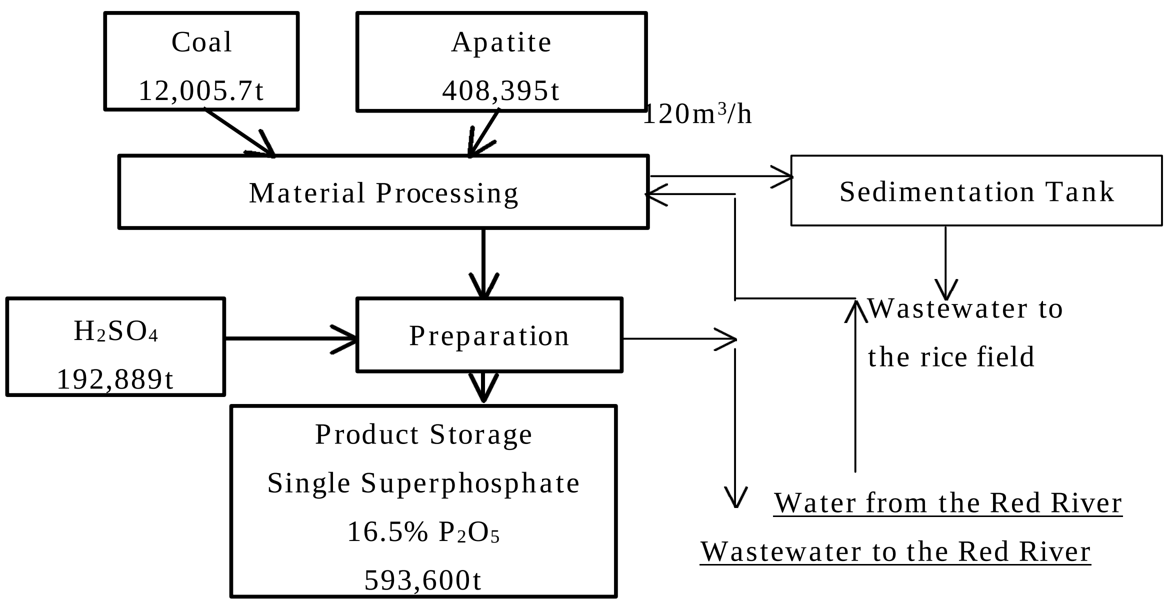


Figure 3 Super phosphate Production Flow Chart

① In the sampling that took place on November 24, 1999 in the second field survey, the location of survey point No. 7 (refer to Figure 4) was incorrect, and correctly should have been No.2, the exit to the Sulfur Plant (refer to Figure 5). Every morning at 8:00 A.M., Fe_2O_3 bunched up at the lower part of the thickener is blown in order to discharge it. However 2% of this includes sulfuric acid. Following this, it was thought that during the second field survey, that it was receiving some effect from the blowing.

② Furthermore, in the gas refining process of the same production process, there are a total of four moist-type, electric filters, and during lunch time every week, two hours are dedicated to cleaning one of these filters. Washing wastewater generated here (pumping ability 36-60m^3/h) includes 4%-5% sulfur.

We received this explanation from the company. So one of the sampling points that was used for sampling was in fact unsuitable for the purposes of this survey. At that point, we confirmed the wastewater system graph and made a decision on the sampling point. The result of this decision is exactly as it appears in Figure 5.

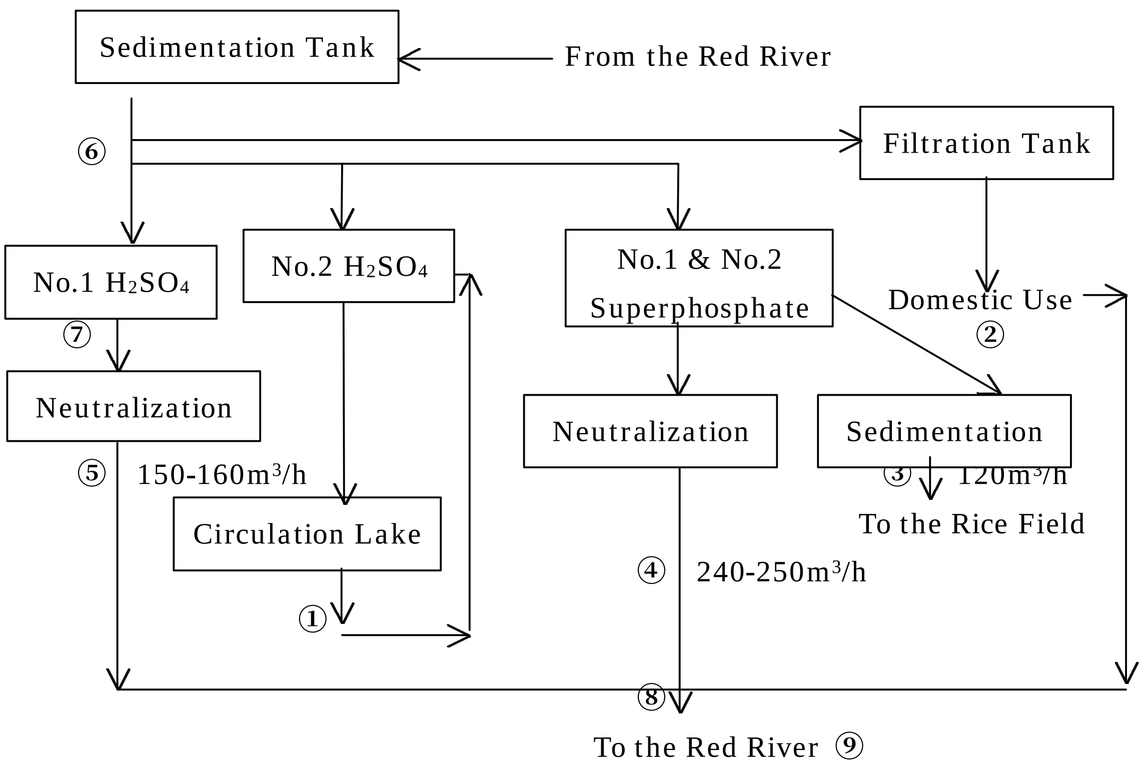


Figure 4 Water System

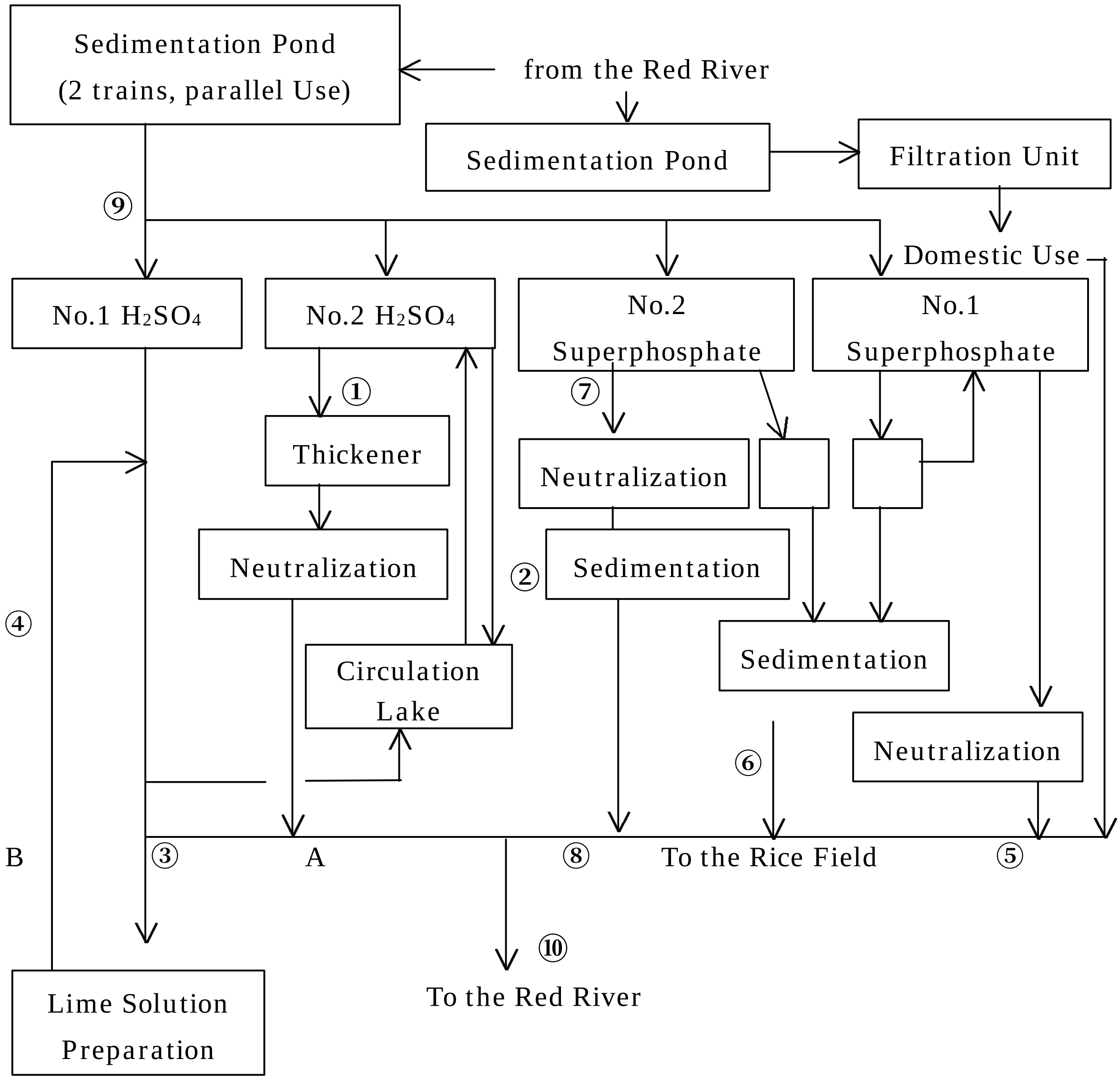
3. Management

3.1 General

Present environmental concerns of the company are gas emissions and wastewater discharge. Emissions of SO_2, SO_3 and HF gases have been decreased through technological improvements that have been made from the beginning of production. Also, sulfur dust from pyrites has been reduced by process improvement, and a P_2O_5 recovery system for apatite was installed in the factory.

According to the materials submitted by the company, a project for industrial waste is in process and is supported technically and financially by the Government of Japan, the Government of Viet Nam, MOSTE and DOSTE. The 3 objectives of this project are as follows:

1) Assessment on industrial waste and environmental conditions of the Company
2) Establishing countermeasures for such industrial waste
① Countermeasures for large, solid waste
② Countermeasures for waste gases (SO_2, SO_3 ,SiF_4).
③ Countermeasures for and recovery of dust
3) Establishing a system for wastewater containing HF and HF gas in the Single Superphosphate production unit



(Note) The area surrounded by dotted lines shows the Superposphate plant, the only plant where apatite is partially recycled.

Table 5 Water System and Sampling Points

3.1.1 Current Condition and Countermeasures for Waste Gas

The emission conditions of waste gases SO_2、SO_3、SiF_4 are summarized in Table 4.

Materials provided by the company describe the countermeasures for the above gases as follows;

① Countermeasures for SO_2

There are two emission points in the factory which exceed the SO_2 standard value regulated in Viet Nam. A few options for possible countermeasures include absorption through the use of a Na_2SO_4 solution, absorption by NH_3 and neutralization by Ca $(OH)_2$.

② Countermeasures for SO_3

The emission level is close to the regulated value, and the countermeasure suggested is to improve absorption efficiency by revamping the facilities.

③ Countermeasures for SiF_4

The emission from the No.1 train extremely exceeds the regulated value. Absorption is very difficult because SiO_2 covers the surfaces of the absorption column and lowers the efficiency. In order to solve this problem, a new technology needs to be applied in the future.

Table 4 Emission Conditions of SO_2, SO_3, SiF_4

Facility	Material Use	Waste	Discharge Volume (kg/h)		Discharge Height (m)
			Designed	Actual	
Acid Plant No.1 Contact Tower Absorption Tower	 SO_2 SO_3	 SO_2 SO_3	 133 6,527	 99.9 13,054	 60 60
Acid Plant No.2 Contact Tower Absorption Tower	 SO_2 SO_3	 SO_2 SO_3	 196 12.25	 245 24.5	 100 100
Superphosphate No.1 F Absorption	SiF_4	SiF_4	3.6	9.72	60
Superphosphate No.2 F Absorption	SiF_4	SiF_4	1.08	0.36	60

3.1.2 Current Condition and Countermeasures for Solid Waste

The condition of solid waste is summarized in Table 5.

Table 5 Condition of Solid Waste

Facility	Waste	Amount	Discharge Type	Treatment Status
Acid Production No.1	Fe2O3	70 t/d	Continuous	Sell & Store
Apatite Drying	Coal Slag		Continuous	Brick Making
Dust Treatment	Apatite Powder	30,000 t/y	Continuous	Superphosphate Production

Facility	Waste	Amount	Discharge Type	Treatment Status
Domestic	Domestic Waste	400 t/y	Periodically	Collect & Bury

The main solid waste generated by the company includes slugs of ferric oxide and coal, and apatite dust. However, most of the portion of ferric oxide is utilized for the production of cement and the rest is stored in the factory. In 2001, raw material utilized will be changed to sulfur only and the problem should be solved.

3.1.3 Current Conditions of Wastewater and Suggested Countermeasures

Required water is supplied and used from the Red River at 2,500m^3/h, 500m^3/h for domestic use and 2,000m^3/h for industrial use. Current conditions of wastewater are shown in Table 6.

Table 6 Current Condition of Wastewater

Waste Stream	Unit Production	Discharge Destination	Flow	Contaminant
1	Acid Production	Red River	400 m^3/h	Residue, pH
2	Acid Production	Circulating	1,200 m^3/h	Nil
3	Superphosphate Production	Pond	400 m^3/h	Apatite Residue

Stream No.2 is used for cooling water and the total volume of the water is 12,000m^3/h, which comes from the Red River. The quality of water in Stream No.1 and No.3 are shown in Table 7 and the drainage conditions are described in Table 8.

Countermeasures for wastewater problems are described as follows:
1) Wastewater is discharged into the Red River at about 400m^3/h and contains various pollutants.

①For wastewater discharged from the acid production plant: Treatment should be performed before being sent to the central wastewater treatment facility. This facility was originally installed to be the last treatment before final discharge to the Red River because the water contains solid substances such as ferric oxide and silica. The company is planning to replace the existing facilities.

② For Wastewater discharged from the absorption unit of HF in the superphosphate production unit: SiF_4 is used for production of Na_2SiF_6 and the process discharges wastewater containing HCl into the river. This is the main source of pollution in the wastewater in the company.

2) For rain water: It should be accumulated in a circulation pond for further utilization.

3) Domestic wastewater comes from the shower room and the kitchen room, but only the kitchen water has an adverse environmental impact. Biological treatment could be considered as a possible treatment for this water.

Table 7 Quality of Wastewater

Parameter	Unit	Waste Stream 1	Waste Stream 2
pH		5	6.5
Conductivity	ms/cm	1.7	0.24
SS	mg/l	160	950
TDS	mg/l	830	124
Turbidity	NTU	95	77
COD	mg/l	108	39
BOD5	mg/l	76	26
PO4	mg/l	7.2	2.6
SO4	mg/l	690	58
Cl	mg/l	0.7	4.8
Oil	mg/l	2.7	1.8

Table 8 Drainage Conditions

A) Different Types of Discharged Water	B) Industrial Wastewater System
- Separated industrial wastewater: 400m^3/h - Industrial wastewater combined with storm water: nil - Industrial wastewater combined with domestic water: 400m^3/h	- Circulating pond to minimize the volume of discharge (Working continuously) - On-site treatment at the Fluorine gas absorption unit of the Superphosphate production line (Batch Operation) - On-site treatment of wash acid from the acid production Unit No.1 (Batch Operation) – Treatment efficiency: Treatment will be more effective using automated operations in order to meet the allowable standard.

3.2 Consumption of raw materials and utilities

Table 9 is a summary of consumption of raw materials and utilities, and shows the cost of each of the products. (Statistics provided by the company.)

Table 9 Consumption on raw materials and utilities and their cost (1998)

Material Used	Amount	Cost
Acid Production	199,920 Tons	
Pyrite	75,635 Tons	407,869 VND/t
Sulfur	46,623.72 Tons	968,532 VND/t
Fuel Oil	368.880 Tons	1,727 VND/kg
Water	14,234,004 m^3	571 VND/m^3
Electricity	26,887,324 kwh	720 VND/kwh
Coal	2,459.2 Tons	398 VND/kg
Single Superphosphate	593,600 Tons	
Apatite	408,396.8 Tons	371 VND/kg
Acid	193,019 Tons	
Coal	12,005 Tons	
Water	1,290,002.5 m^3	
Electricity	15,175,274 kwh	

3.3 P_2O_5 balance

The company provided figures on average raw materials qualities (refer to Table 11). Table 10 shows the summary of the P_2O_5 balance in 1998 calculated by using these figures.

According to Table 10, the percentage of P_2O_5 lost is 1.07%. Other losses in wastewater were calculated to be 153t/y. This figure was calculated using the flow rate of all phosphorous, 42.5mh/l, at sample point 3, the volume of the discharged water, 120mh/l, the number of days that superphosphate lime is produced each year, 120 days, and the number of hours of operation in a day, 20 hours.

Thus, we can assume that most of the P_2O_5 loss is due to escaping dust. Actually, at the time of our observation of the production process, a large quantity of dust was coming from the apatite drying process to the grinding process, and through out the reaction process dust was coming off from machines and conveyor belts.

Table 10 Results of the trial calculation of the P_2O_5 balance

Item	Consumption & Production in 1998	Premises	P_2O_5
Apatite Natural Flotated	408,397t/y 248,241t/y 160,156t/y	P_2O_5:33% (dry base) Moisture:12% Moisture:15%	117,012t/y 72,089t/y 44,923t/y
Superphosphate	593,600t/y	P_2O_5:19.5% (wet base)	115,752t/y
P_2O_5 Balance	--	--	1,260t/y

Table 11 Apatite Quality

Parameter	Natural Apatite (February 2000)	Floating Apatite
P_2O_5 % (dry base)	32.3-33	35.53
SiO_2 %	10.87-12.3	
Fe_2O_3 %	2.2	
MgO %	2.2-2.4	
CaO %	42.3-42.4	
F %	2.0-2.2	
Al_2O_3 %	4.4-4.8	

In order to double check these figures, raw material samples, product samples, and sludge samples from the sedimentation tank samples were collected on March 10, 2000. These were sent to CECO for analysis. The results of this analysis are shown in Table 12.

Table 12 Results of composite analysis (CECO)

Sample		Apatite (Natural)	Apatite (Flotated)	Superphosphate (Product)	Settled Sludge
Item	Unit				
Time		12:20	12:20	12:06	12:30
P_2O_5	%	29.28	27.62	20.85	0.16
Al_2O_3	%	0.453	0.302	0.351	0.302
Fe_2O_3	%	1.77	1.42	1.03	0.15
MgO	%	3.0	3.0	2.0	0.8
CaO	%	42.0	42.0	28.0	27.4
Pb	%	0.0217	0.075	0.0188	0.0058
Cr	%	2.25×10^{-3}	1.75×10^{-3}	1.25×10^{-3}	$<10^{-3}$
Cd	%	$<10^{-4}$	$<10^{-4}$	4×10^{-4}	$<10^{-4}$
Mn	%	0.468	0.202	0.128	0.005
Ni	%	4×10^{-3}	3×10^{-3}	2×10^{-3}	$<10^{-3}$
As	%	9.91×10^{-4}	8.28×10^{-4}	8.29×10^{-4}	1.76×10^{-4}
Zn	%	0.0131	0.058	0.082	0.069

3.4 Fluorine material balance

Fluorine balance in 1998 was calculated under the same conditions as the preceding section. Supposing that the content of fluorine in apatite is 2.0%(dry base), the amount of fluorine in apatite comes to 7,092t/y. Because of the fact that the company didn't produce any Na_2SiF_6 in 1998, and their product, superphosphate lime, contains only half the amount of fluorine, it means that 3,546t/y of fluorine escapes and is lost to the air or the discharged water.

From the results of a trial calculation, we can conclude that most of the lost Fluorine, 33t/y, escapes into the air. This number was calculated using the following figures: ①Fluorine content at sample points #3 is 15.75mg/l and at #4 is 13.25mg/l in Table 15. The volume of water at sampling point #3 is 120m^3/h, and at sampling point #4 is 240m^3/h.②The number of operating days per year, and the number of hours in operation each day of the superphosphate production unit.

4. Industrial Wastewater and its Treatment

4.1 Wastewater quality

4.1.1 Samples taken on November 24th,1999

Figure 13 shows sample points and details. The results of wastewater quality measured by a simple analysis equipment is shown in table 14.

Table 13 Sampling points and the detail of samples

Sampling point	Sample
1	Recycled water from the No.2 Sulfur Plant
2	Blank test （service water）
3	Wastewater from the No.1 and No.2 Superphosphate plant tank discharge point（drained into the rice field）
4	Wastewater from the discharge point for the neutralization tank of the No.1 and No. 2 Superphosphate plants
5	Wastewater from the discharge point of the neutralization tank of the No. 1 Sulfur plant
6	Water from the discharge point of the irrigation water precipitation tank
7	Wastewater from the No. 1 sulfur plant （before neutralization）
8	Drainage water into the Koga River
9	Water from the Koga River 2 km downstream of the discharge point

Figure 14 shows the results of the water quality analysis of samples simultaneously taken and measured by CECO with a simple analyzing device.

However, concerning the Blank Test for purified water, there were no samples taken by CECO for analysis. Following this, in CECO's analysis report for sampling points 3 and above, these have been listed one by one, but in order to link them with Table 14, here in Table 13, we have adopted the use of sampling point numbers.

Table 14 Water Quality Analysis Results（CECO）

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		13:20		13:35	13:45	13:50
Temp.	℃	33		34	39	35
pH		8.3		8.1	11.9	9
Conductivity	ms/cm	0.23		0.3	5.0	0.37
Turbidity	NTU	180		230	2,370	139
Oil content	mg/l	0.4		0.42	0.44	0.35
BOD_5	mg/l	20.7		29	21.6	18
COD	mg/l	52		74.6	68	67
DO	mg/l	4.8		4.9	4.3	4.0
SS	mg/l	159		270	2,575	181
T-Nitrogen	mg/l	28		57.6	57.6	6.4
CN	mg/l	0.001		0.000	0.000	0.014
Phenol	mg/l	0.005		0.001	0.005	0.003
Residual Cl	mg/l	0.00		0.00	0.3	0.09
SO_4	mg/l	47		74	24	76
Mn	mg/l	0.20		0.00	32.2	0.00
Fe	mg/l	1.09		2.17	25.68	12.84
F	mg/l	4.15		15.75	13.25	0.07
T-P	mg/l	12.1		42.5	52.29	0.07
Sampling Point		6	7	8	9	
Parameter	Unit					
Time		14:10	13:23	14:40	15:00	
Temp.	℃	25	37	31	24	
pH		8.4	2.5	2.6	7.2	
Conductivity	ms/cm	0.21	4.4	3.1	0.2	
Turbidity	NTU	300	232	241	432	
Oil content	mg/l	0.01	0.32	0.37	0.01	
BOD_5	mg/l	13	21.8	54	16	
COD	mg/l	26	86.7	96	35	
DO	mg/l	7.4	0.1	4.5	6.0	
SS	mg/l	386	437.5	310	660	
T-Nitrogen	mg/l	5.75	6.5	19.8	7.5	
CN	mg/l	0.00	0.035	0.038	0.000	
Phenol	mg/l	0.005	0.007	0.005	0.005	

Sampling Point		6	7	8	9	
Parameter	Unit					
Residual Cl	mg/l	0.00	0.12	0.2	0.07	
SO_4	mg/l	6	536	152	11	
Mn	mg/l	0.12	0.00	0.8	0.2	
Fe	mg/l	2.8	34.08	3.12	5.84	
F	mg/l	0.06	0.07	2.43	0.37	
T-P	mg/l	0.09	0.14	5.86	0.48	

4.1.2 Samples taken on March 10, 2000

The sampling point numbers used this time (refer to Figure 5) and the content of the samples have been put together and organized with old sampling point numbers (refer to Figure 4) and their differences in Table 15. Also, the volume of the water at each of the sampling points used this time is shown in Table 16.

Table 15 Differences Between Past and Present Sampling Points

Sampling point No.'s used this time	Sampling point No.'s used last time	Differences between past and present
1		No.2 H_2SO_4 discharge point
2	1	Cooling circulation line (the content of the samples are the same)
3	5	No.1 H_2SO_4 discharge point
4		No.1 Fertilizer wastewater at the discharge point before neutralization
5		No.1 Fertilizer wastewater after neutralization
6	3	Dust treatment water at the discharge point of the precipitation tank for No.1 & No.2 Fertilizer before drainage into rice fields
7		Wastewater discharge point for No.2 Fertilizer (before treatment)
8	4	No.2 Fertilizer wastewater after treatment
9	6	Last time, in the end, samples were taken at the intake point of the precipitation tank. This time samples were taken at the pump discharge point at the precipitation tank exit.
10	8	Drainage exit for general wastewater drained into the Koga River
A	7	Last time what we intended to be No.2 H_2SO_4 actually turned out to be No.1 H_2SO_4. H_2SO_4.This time we only measured with a "Checker."
B		Lime Solution Preparation

Sample point A and B were only measured with a simple analyzing device

Table 16 Water Volume at the Sampling Points

Sampling Point Numbers	Water Volume
③	150-160m^3/h
A	180m^3/week
⑧	120m^3/h
⑥	180m^3/h
⑤	120m^3/h
Cyclone wastewater of the No.2 Superphosphate Plant	120m^3/h
Cyclone wastewater of the No.1 Superphosphate Plant	120m^3/h
Return from the precipitation take of the No.1 Superphosphate Plant	60m^3/h

Moreover, according to the explanation by the company, the intake entrance for domestic wastewater is 5km upstream of the paper manufacturing plant. The intake volume is 500m^3/h and the factory irrigation water intake volume does not exceed 2,000 m^3/h. The results of measurements taken this time with a simple analyzing device, and the results of the sampling done at the same time by CECO are shown in Table 17. Moreover, at the time the samples were taken, the above mentioned "purging," as well as cleaning of the wet-type, electric filter was not taking place.

At the time of the second field survey, we did not receive any information on the thickener "blow" for the No.2 H_2SO_4 and information on the cleaning of the moist electric filter. However, when we compare the results from the new No.1 to the old No. 7 and the new No. 10 to the old No. 8, it can be supposed that the cleaning of the moist electric filter was not taking place. Also, during the second field survey, we thought that we had measured after the precipitation treatment of irrigated wastewater. However, in actuality, we found we had measured before the precipitation treatment.

Table 17 Analysis Results on Water Quality（CECO）

Sampling Point		1	2	3	4	5
Item	Unit					
Time		10:57	11:03	11:11	11:29	11:35
Temp.	℃	35	29	27	27	26
pH		11.5	8.72	8.14	0.58	12.3
Conductivity	Ms/cm	2.4	0.24	0.22	100	7.7
Turbidity	NTU	3.4	35	36	103	213
Oil content	mg/l	0.015	0.31	0.31	0.35	0.34
BOD_5	mg/l	13	22	38	62	42
COD	mg/l	32	56	80	120	88
DO	mg/l	3.5	4.4	4.7	0.4	4.5
SS	mg/l	5	43	110	1,587	1,206
T-nitrogen	mg/l	4.8	21	5.7	48	42
CN	mg/l	0.028	0.001	0.003	0.026	0.001
Phenol	mg/l	0.004	0.003	0.002	0.002	0.001
Residual Cl	mg/l	0.17	0.24	2.19	1.03	1.98
SO_4	mg/l	325	48	33	175	90
Mn	mg/l	0.00	0.6	0.7	20	0.78
Fe	mg/l	12.5	1.12	13.5	16	1.77
F	mg/l	0.09	0.21	0.01	2.55	5.35
T-P	mg/l	0.2	0.3	0.02	38	20
Zn	mg/l	0.03	0.04	0.03	3.312	0.06
Cr	mg/l	0.01	0.02	0.62	0.37	0.01

Sampling Point		6	7	8	9	10
Item	Unit					
Time		11:50	12:13	12:25	12:54	13:15
Temp.	℃	25	22	43	21	29
pH		7.5	1.97	10	9.26	9.04
Conductivity	ms/cm	0.29	15	0.56	0.22	3.31
Turbidity	NTU	9	35	1	59	14
Oil content	mg/l	0.34	0.28	0.26	0.007	0.33
BOD_5	mg/l	112	124	42	10	37
COD	mg/l	344	336	112	24	80
DO	mg/l	5.1	4.6	2.9	5.8	4.5
SS	mg/l	258	298	163	98	266
T-nitrogen	mg/l	52	6.1	5.9	5.6	9.7
CN	mg/l	0.157	0.157	0.066	0.005	0.001
Phenol	mg/l	0.001	0.0024	0.002	0.003	0.003
Residual Cl	mg/l	0.24	0.3	0.12	0.4	0.27
SO_4	mg/l	33	218	30	36	78
Mn	mg/l	0.2	4.8	0.0	0.5	0.3
Fe	mg/l	1.1	17.3	6.5	2.1	1.2
F	mg/l	0.28	2.75	0.29	2.45	0.28
T-P	mg/l	11.75	1.45	0.03	0.02	0.02

Sampling Point		6	7	8	9	10
Item	Unit					
Zn	mg/l	0.25	0.09	0.00	0.0	0.1
Cr	mg/l	0.00	0.11	0.02	0.02	0.001

4.2 Regulation Standards for Industrial Wastewater

We have added Table 18 in order to compare the wastewater quality in public water areas (In Table 14 sampling point No.8 and in Table 17 sampling point No. 10), included in the water quality analysis results in Table 14 (samples taken on November 24, 1999) and Table 17 (samples taken on March 10, 2000), with Vietnam's industrial wastewater standards (Rank B).

We heard from the company that, "At the time the industrial wastewater standards were set, B rank seemed to be most applicable for our existing factories. However, for the newly constructed factory and the factory's new facilities, A rank is more applicable." As a result of this, and for reference, the A rank standard price is also added next to it in Table 18.

Table 18 Industrial Wastewater Discharge Standards

Parameter	Unit	Wastewater Discharge Standard		Parameter	Unit	Wastewater Discharge Standard	
		A	**B**			**A**	**B**
Temp.	℃	40	40	Mn	mg/l	0.2	1
pH		6-9	5.5-9	Ni	mg/l	0.2	1
BOD_5	mg/l	20	50	Organic P	mg/l	0.2	0.5
COD	mg/l	50	100	Fe	mg/l	1	5
SS	mg/l	50	100	Sn	mg/l		1
Mineral Oil	mg/l	ND	1	Hg	mg/l	0.005	0.005
Organic Oil	mg/l	5	10	T-Nitrogen	mg/l	30	60
As	mg/l	0.05	0.1	T-P	mg/l	4	6
Cd	mg/l	0.01	0.02	F Compounds	mg/l	1	2
Residual Cl	mg/l	1	2	Phenol	mg/l	0.001	0.05
Cr(VI)	mg/l	0.05	0.1	S Compounds	mg/l	0.2	0.5
Cr(III)	mg/l	0.2	1	CN	mg/l	0.05	0.1
Zn	mg/l	1	2				
Pb	mg/l	0.1	0.5				

Parameter	Unit	Wastewater Discharge Standard		Parameter	Unit	Wastewater Discharge Standard	
		A	B			A	B
Cu	mg/l	0.2	1				

Regarding the wastewater from sampling point No. 8 in Table 14, the values are 2.6、54mg/l、310mg/l、2.43mg/l for pH、SS, BOD_5 and fluorine compound respectively, and exceed the B rank of the industrial wastewater standard.

5. Recommended Countermeasures for Improvement and Their Cost

5.1 Countermeasures for production technology

5.1.1 Countermeasure for pH value in the No.2 sulfuric acid plant

At present because they are using pyrite in the washing process of the moist electric filter, and the thickener purging process, at the No.2 Sulfuric acid plant the Ph value is out of the acceptable range. However, they are planning to stop using pyrite in the near future. As one possible countermeasure could be used in the superphosphate plant.

5.1.2 Countermeasure for loss of P_2O_5 in calcium superphosphate plant

It is necessary for the company to strengthen their dust prevention and collection efforts from the apatite drying grinding process to the reaction equipment. They need to install a cover to prevent dust scattering, more absorption systems, and repair spots where leakage occurring.

5.1.3 Countermeasure for loss of fluorine in calcium superphosphate plant

They have stopped producing Na_2SiF_6 as a pesticide due to a decrease in demand, and now they are only selling off their remaining stock. Thus, it is essential to search for an effective way to utilize hydrogen fluoride, i.e. such as use as an alkylation enzyme or for use in the glass industry. Countermeasures for the moment could be increasing absorption packed tower installing venturi scrubbers, or making use of an alkaline solution. It is needed that form and separate insoluble salts by making fluorine ions react with calcium ions after determining the form of fluorine ion in the wastewater. In this case, pH value control becomes a very important issue.

5.2 Countermeasures for management technology

As stated in 5.1, wastewater pH control has to be improved.

5.3 Countermeasure for wastewater treatment

Taking countermeasures explained in above will lead to improved wastewater treatment.

5.4 Estimate for countermeasures

We requested an estimation from the company for the cost of countermeasures in part 3 which experts from MOI, members of survey team, and the company representatives discussed and summarized. Table 19 shows the estimate submitted by the company via MOI. The total estimation for these countermeasures is 15,040 million VND, and the estimate categorized by investment classification shown in Table 19.

Table 19 Estimation Costs for Countermeasures (Million VND)

I. Superphosphates plant No. 2

No	Application point	Countermeasures	Cost
1	Hammer mill	Replacement of material to improve life time, closing system	① 200
2	Flotated ore conveyer after drying	Closed hood and sucking system	② 200
3	Underground conveyer after hammer mill	Closed system, installation of dry and wet cyclones, sucking system for dust recover	② 500
4	Cyclone system for four drying systems	Engineering, manufacturing and erection of other dry and wet integrated cyclone system for the 4 dryers	② 400
5	Blowers and piping for the 4 drying systems	- Upgrading of blowers for the 4 dryers to improve efficiency - Leakage treatment	① 800 ① 800
6	Discharged point after dried flotated ore conveyer	Hood system	② 150
7	Ball dryer system No. I	Leakage treatment, piping replacement	① 200
8	Dust recovering cyclone system from ball mill No. 1	Addition of integrated cyclone for improvement of efficiency	① 200
9	Blowers and piping of ball mill system No. 1	Upgrading blowers, Leakage treatment, Pipe replacement	① 500
10	R/M receiving point of No.1 ball mill feed funnel from conveyer No. 13	Hood system, closed system for the feed funnel	② 150
11	R/M receiving point of conveyer No. 13 from conveyer No. 12	Closed system	② 150
12	Ball mill No. 2	Leakage treatment, upgrading pipe lines	① 200
13	Dust recovering system after ball mill No. 2	Addition of integrated cyclone system to improve dust recovering efficiency	① 200
14	Blowers for ball mill No. 2	Upgrading the blowers system	① 500

No	Application point	Countermeasures	Cost
15	Receiving point of bulk from conveyer No. 110	Hood and closed system	② 150
16	Fluorine absorption system	Addition of new absorbers or ejectors including pumps	③ 1.000
17	Waste water neutralization	- Revamping of W.W neutralization system - Addition of sedimentation system after W.W neutralization for respectively work - Installation of pH control system	③ 300 ③ 100 ③ 140
18	Recovering of fluorine gas on product conveyers	Hood and closed system then sent to fluorine absorbers	① 300
		Subtotal	7,140

II. Superphosphates plant No.1

No	Application point	Countermeasures	Cost
1	Hammer mills (4 sets)	Replacement of material to improve life time, closing system	① 400
2	Raw material conveyer to ball mill	Hood, Closed system redesign sucking system in order to recover dust	② 200
3	Ore contained bulk to feed ball mill	Closed system, addition of dust recovering system	② 100
4	- 4 cyclones integrated system and wet cyclones - Blowers for drying(4 sets) - Pipe line	- Additional installation of dry cyclone - Upgrading the 4 blowers	① 1,800
5	- 6 cyclones integrated system and dust recovering of 2 mills	Redesigning and revamping the cyclone system to improve efficiency	① 1,800
6	M/R Power containers & lifts	Closed system, addition of sucking system	② 200

No	Application point	Countermeasures	Cost
7	The piping for conveying powder to the formation chamber	Hood and closed system	② 200
8	The piping for M/R feeding	Hood, closed system	② 200
9	High pressure blowers and process pipe for ball mill	Closed system and replacement of pipe line	① 100
10	R/M receiving point of conveyer from screw 400	hood and closed system	② 200
11	Ball mill system	Replacement of material to improve life time, closing system	① 400
12	Fluorine absorption system	Addition of new absorbers or ejectors	③ 200
13	Fluorine gas sucking Blower	Replacement of new appropriate blower	③ 200
14	Circulation pump	Addition of new absorption pump and new sprayers	③ 100
15	H_2SiF_6 neutralization system	- Revamping existing facilities - Installation of new sedimentation pond - pH automatic control system for W.W - Installation of alarm system	③ 150 ③ 200 ③ 100 ③ 50
16	Recovering of fluorine gas on product conveyers	Hood and closed system then sent to fluorine absorbers	① 300
17	Discharge points of lifts	Hood and closed system	② 200
Subtotal			7,100

III. H_2SO_4 plant No. 2

No	Application point	Countermeasures	Cost
1	Periodical discharge points of high pH W.W	- Installation of container - Pump and piping system	③ 200 ③ 600
		Subtotal	800
		Total	15,040

Remarks:①Process Improvement (CP) ;②Introduction of New Facility (CP) ;③EOP

6. Suggestions for industrial pollution prevention

6.1 Short-term countermeasures

6.1.1 Keep the inside of the factory clean through the introduction of some improvement activities like 5S.

6.1.2 In order to introduce cleaner production, the management needs to have discussion and debate, not only with people in the production section, but also other sections as well. Management needs to take the lead in changing employee attitudes toward operating methods and the importance of maintenance.

6.1.3 Establish statistical process systems for collecting and analyzing data.

6.1.4 Exchange information with domestic companies in the same industry to improve international competitiveness.

6.1.5 Since the value of SS and BOD_5 in wastewater exceeds the standard, they need to take countermeasures to fix this problem as soon as possible. They need to examine the applicability of separation or utilization of biological treatment, after verifying the cause and discharge conditions of SS and BOD_5.

6.1.6 In order to improve sedimentation, the flow rate of wastewater in the drainage canal need to be reduced.

6.1.7 Utilize steam collected at sulfuric acid plant effectively.

6.2 Mid-term countermeasures

6.2.1 Apply for ISO9000 in the near future.

6.3 Action plans

Figure 6 shows the action plan for industrial pollution prevention measures. The company is expected to follow the schedule and take countermeasures for improvement.

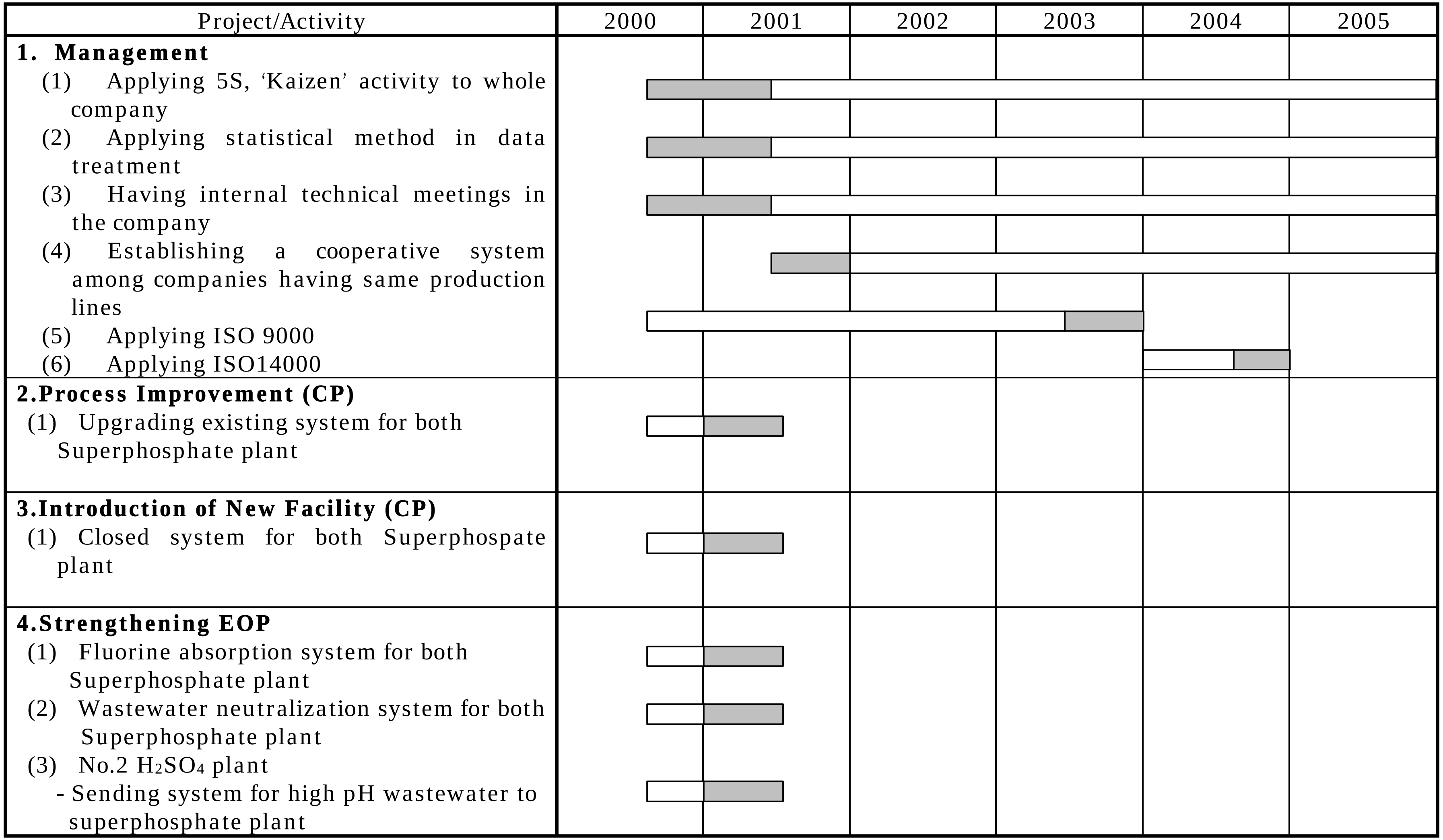


Figure 6 Action Plan (2000 to 2005)

CASE STUDY C-03

The Southern Fertilizer Company

Survey Date : December 3, 1999
February 25, 28, 29, 2000

1. General Outline

1.1 Company Profile

The company profile of the Southern Fertilizer/Long Thanh Superphosphate Factory is shown in Table 1 below.

Table 1 Company Profile

Company Name:	The Southern Fertilizer Company / Long Thanh Superphosphates Factory
Ownership:	State owned
Address:	Phuoc Thai- Long Thanh- Dong Nai
Vice Director:	Mr. Nguyen Thanh Thiep
Established:	1975
Corporate Capital:	
Number of Employees:	350 for this factory (including 20 engineers) 1,500 for whole company (including 150 engineers)
Main Products:	Single Superphosphate, H_2SO_4, Na_2SiF_6

The company was established in 1975 and has seven factories and one research center. Among these, six factories produce NPK fertilizer and one factory produces superphosphate and sulfuric acid. The revenue of the company started at around 20-30 billion VND/y, but has now reached 1,000 billion VND/y.

1.2 Business Conditions

The market for fertilizer is rather good in Viet Nam. MOI and top management have already approved the budget for expansion of a new production line for the Long Thanh Plant. The forecast for the fertilizer business in Viet Nam is promising, but main raw materials are generally imported from foreign countries. For example, potassium at 500,000t/y, as well as Urea at 1.7million t/y, are imported from

Canada. Sulfur and DAP at 600,000t/y are also imported from foreign countries. In the past, even NPK was imported, but now the production capacity of NPK fertilizer has reached very high levels in Viet Nam. Sulfur is imported from Canada for the raw materials needed for sulfuric acid. The company has no sulfur recovery system for exhaust gas.

The Southern Fertilizer company is involved in the following joint venture factories:

1. A JV with Nissho Iwai Corp. and Central Glass Co., Ltd. (30 % of the shares are held by the Southern Fertilizer Co.,) : NPK fertilizer 300,000t/y.
2. A JV with Mitsui Chemical Corporation (70% of the shares are held by the company) : NPK fertilizer 500,000t/y.
3. A JV with a Korean company : DOP, PVC (300,000t/y).

(1) Production

The superphosphate plant was installed in 1988 and a full production line was completed in 1991. The capacity of the main products are as follows:

Superphosphate in 1 plant ; 100,000 t/y

Sulfuric acid in 2 plants ; 40,000 t/y

Future projects related to production expansion are as follows:

One superphosphate plant with a capacity of 200,000 t/y has been designed by CECO, and a Taiwanese engineering company has been ordered to oversee the construction of the plant, which is estimated to begin in September, 2000.

The company is also, planning for a new sulfuric acid plant. The plant will adopt it's technology from a Taiwanese Company and it have a capacity of 40,000 t/y. Design work for the plant, which will take six months, was scheduled to be completed by June, 2000. However, because of procedural difficulties that hindered the start of the project, the completion of the design work will take between 1-2 months longer than expected. Construction of the plant itself will take 12 months and is scheduled for completion around July or August in 2001.

Actual annual production and revenues are shown in Table 2.

Table 2 Actual Production and Annual Revenue in 1998

Product	Capacity	Production	Revenue (x1000VND)
Single Superphosphate	100,000 t	100,063 t	85,762,848
Sulfuric Acid	40,000 t	35,196 t	5,654,719

(2) Debt

2. Production Technology

2.1 Process

(1) General

The production technology and facilities of the existing plant in this factory utilize domestic technology and the company commented that the level of this technology is rather old. As for environmental preservation technology, the new process they have for the removal of SO_2 in exhaust gas has brought about a decrease, from 1,600mg/m^3 to 500mg/m^3, in the SO_2 level in the exhaust gas and also, helped decrease energy use in the sulfur plant by 20%.

(2) Sulfuric Acid Production Technology

Figure 1, which shows the sulfuric acid production process, was made following the documents we received from the company.

As can be readily realized by observing Figure 1, the company is utilizing imported sulfur (recovered sulfur-99.45% purity) from Canada as a raw material. Following this, in cases where they are using pyrite as a raw material, because there are no different gas refining processes, no wastewater, and no solid waste either, it can be assumed that there are not many major problems. In addition, the oxidation rate of SO_2 to SO_3 is 98%, the absorption rate for sulfuric acid is 99.9%, and the conversion rate from sulfur to sulfuric acid is between 98.3% to 98.6%.

Moreover, the company is not adopting the double contact method for the conversion machine that converts SO_2 to SO_3, and in addition, they do not have sulfur recovery equipment.

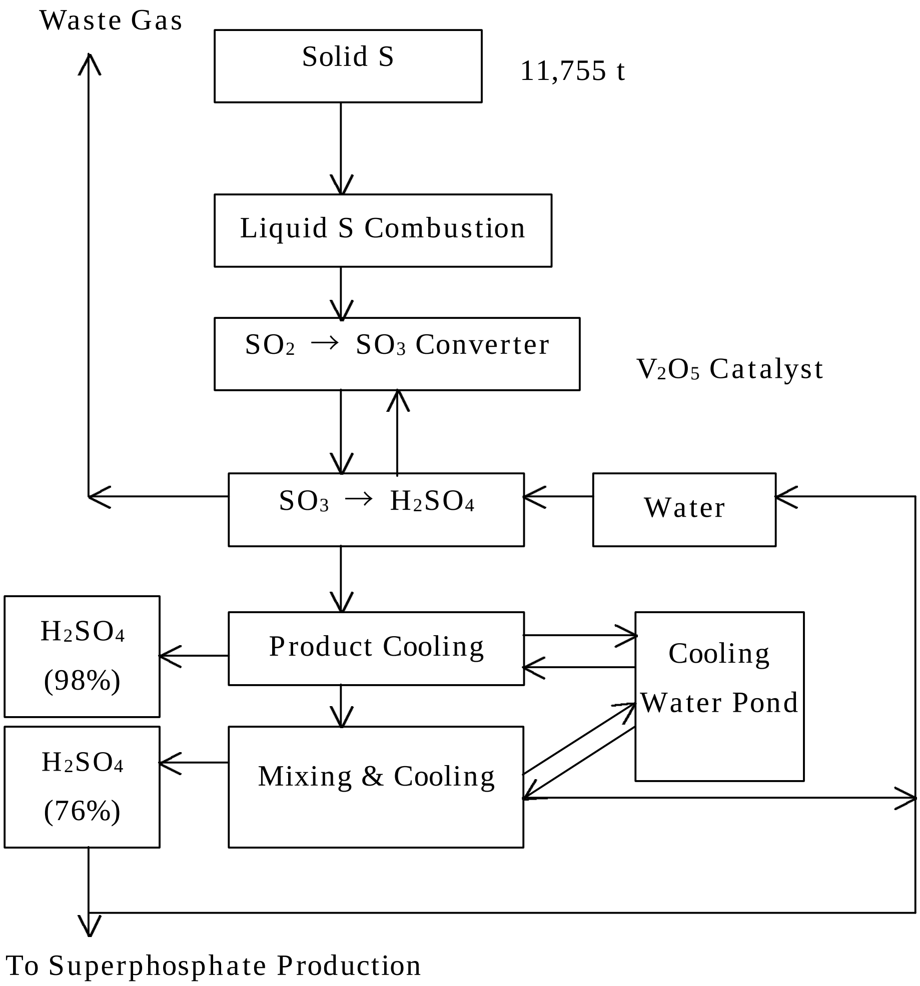


Figure 1 Sulfuric Acid Production Process

(3) Superphosphate Production Technology

Figure 2, the superphosphate production process, was constructed following documents received from the company. The company uses apatite made in Lao Cai Province, which is situated close to the national border with China, as a raw material. From the production region it is carried by railway to Hyphon, then from there it is transported by ship. One “lot” is between 5-10 tons per ship, and apatite is loaded at about a one ship per month pace. Because of this fact, the company carries out quality checks. The results of these checks, which were indicated in the documents we received from the company, are listed in Table 3.

Table 3 Apatite Qualities

Parameter	Analytical Result	Parameter	Analytical Result
P_2O_5 (%)	32-33	CaO (%)	44-47
Al_2O_3 (%)	1.2-1.7	F (%)	2-2.4
Fe_2O_3 (%)	1.5-2.5	Moisture (%)	8-13
MgO (%)	1.6-2	Particle size (mm)	<200
SiO_2 (%)	5-8		

After drying, apatite is grinded until the diameter of the grain reaches 0.75 μ, and then utilized. The percentage of P_2O_5 contained within the product is 20.1% on the whole. However, only 16.5% of the fertilizer is water soluble.

The unit consumption rate for one kilogram of product is 0.7kg for apatite and 0.32kg for sulfuric acid (for 100% sulfuric acid). The company takes sulfuric acid with a 75% density, dilutes it to 68%, and then utilizes it. In addition to this, the gypsum by-product that is generated is not separated.

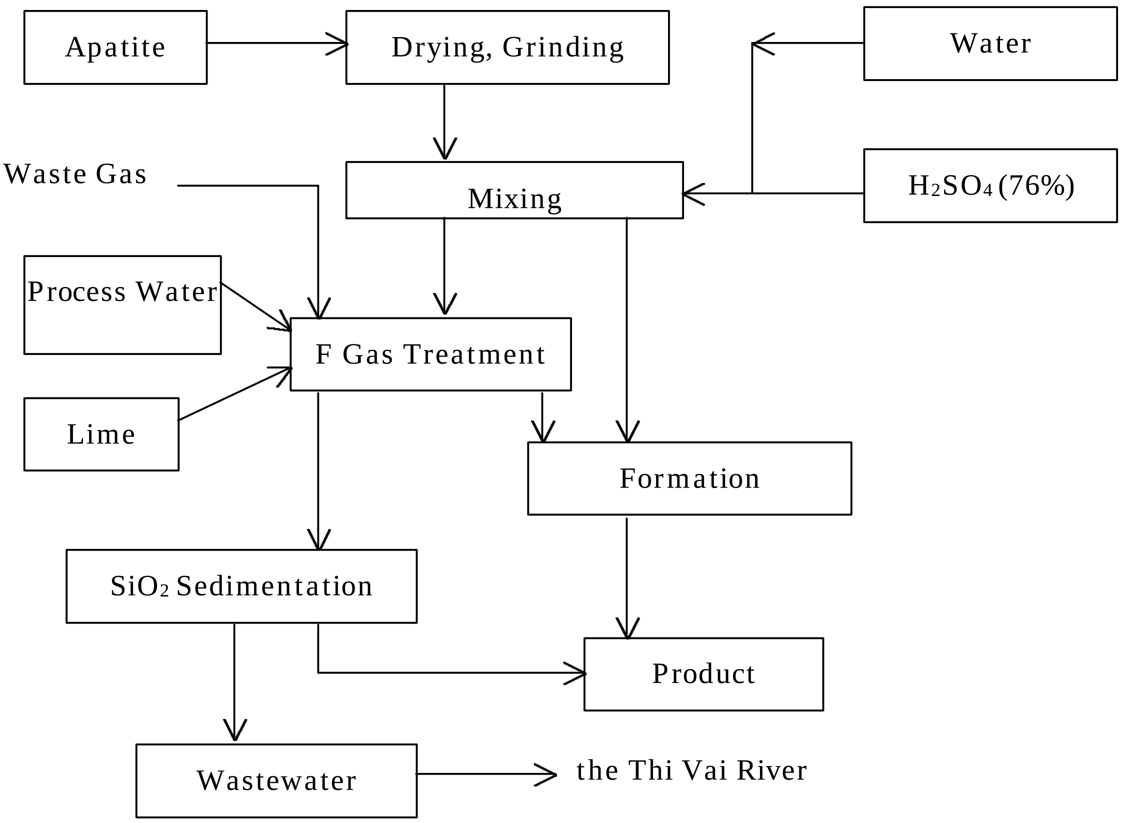


Figure 2 Superphoshphate production flow chart

2.2 Wastewater Sources

Environmental pollution is one of the problems facing the entire region around the company. Even at this company there are three important environmental pollution problems. These problems are listed below:

(1) Wastewater from two different kinds of factories.
(2) SO_2 and SO_3 exhaust gas.
(3) Dust generated in the apatite grinding process.

Recently, from 1997 through 1998, MOI and MOSTE made investments in dust collecting equipment for superphosphate plants. However, because of various problems such as corroding equipment, these machines are not operating effectively. In the case of superphosphates, wet, cyclone-type dust collecting equipment is thought to be the only type of equipment that is valid for use.

The SO_2 removal facilities developed by the Viet Nam Polytechnique University use a $Mg(OH)_2$ solution for absorption, and sulfur is recovered and sent to a sulfuric acid plant. However, the project is not complete at present because of financial problems.

For industrial wastewater, only the superphosphate fertilizer plant discharges wastewater at a volume of 15 m^3/hr. Two sulfuric acid plants do not discharge wastewater. Recycled cooling water, at a volume of 500m^3/hr, flows through a cooling water pond that has a capacity of 6,000m^3. The wastewater from the superphosphate plant is treated in a sedimentation pond and, depending on the case, is occasionally neutralized with calcium hydroxide.

However, they have no continuous neutralization treatment equipment and there are cases where very acidic wastewater with a pH of around 2.0 is discharged into the Thi Vai River. We were told that wastewater analysis for pH only are performed every day. However, the results of the pH measurements have seemingly not been put to good use.

Supply water is drawn from a deep well in the factory for industrial and domestic use.

The irrigation wastewater system and sampling points are shown in Figure 3.

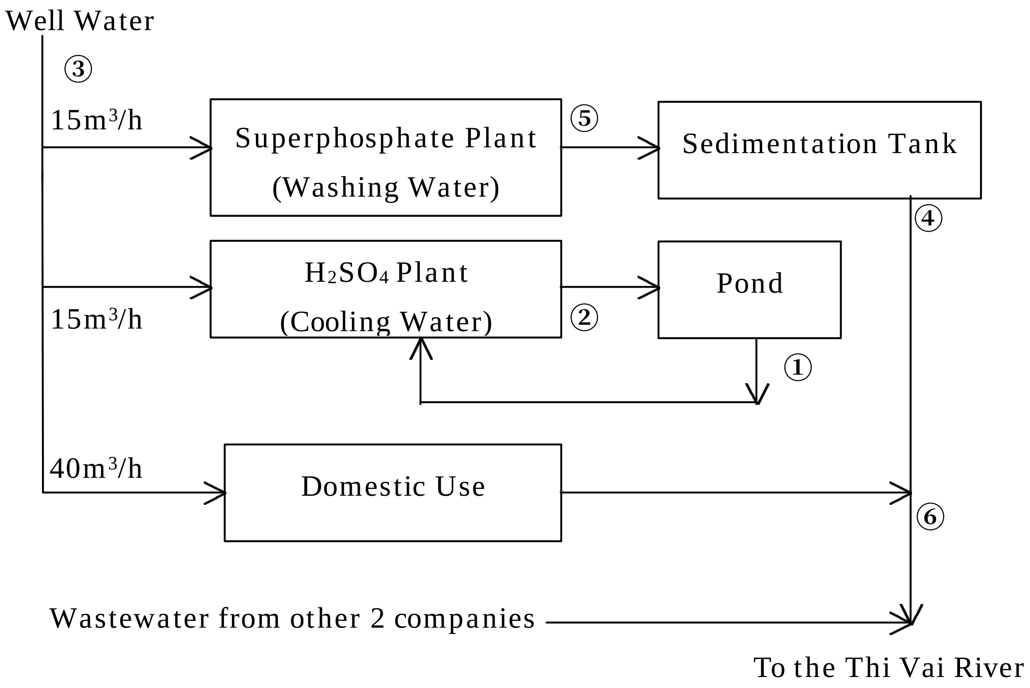


Figure 3 Irrigation Wastewater System and Sampling Points

3. Management

3.1 General

From a general observation, the management of the factory seems rather good because the factory site, facilities and equipment are well maintained.

3.2 Raw Material and Utility Consumption

Raw material consumption and utility consumption in 1998 are shown in Table 4.

3.3 P_20_5 Balance

If a trial calculation of P_2O_5 loss in 1998 is made using the total production of apatite in 1998, shown in Table 2, and the total consumption of apatite in 1998, shown in Table 4, the result are the figures shown in Table 5, and the loss rate comes to 10.3%.

Table 4 Raw Material and Utility Consumption in 1998

Material Used	Amount	Cost
Single Superphosphate		
Apatite (32%)	0.7 t	614,760 VND/t
H_2SO_4 (100%)	0.3218 t	540,625 VND/t
Steel Ball	0.15 kg	12,000 VND/t
CaO	3kg	630 VND/kg
Industrial Water	0.65 m^3	
Commercial Water	0.6 m^3	
Fuel Oil	9.35 l/t	1,600 VND/l
Electricity	28 kwh	770 VND/kwh
Sulfuric Acid		
Sulfur	0.334 t	1,040 VND/kg
Water Filter Agent	0.06 kg	19.050 VND/kg
Catalyst	0.15 l	82,000 VND/l
CaO	1 kg	630 VND/kg
Diesel Oil	0.45 kg	3,800 VND/kg
Electricity	85 kwh	770 VND/kwh
Na_2CO_3	0.3 kg	2,300 VND/kg
Industrial Water	1.8 m^3	
Additional Water for Circulating Water System	30 m^3	
Soft Water	1.5 m^3	8,000 VND/m3

Table 5 Trial Calculation of P_2O_5 Loss

Item			Amount of P_2O_5
Superphosphate	Production (t/y)	100,063	--
	P_2O_5 Content (%)	20.1	20,113t/y
Apataite	Consumption (t/y)	70,044	--
	P_2O_5 Content(%)	32	22,414t/y
Loss of P_2O_5	--	--	2,301.4t/y

Phosphate lost in wastewater is calculated following the analysis results in Table 8.

The premise for the trial calculation is just as it appears in Table 6.

Table 6 Premise for the Trial Calculation of P_2O_5 Loss

Item	Premise	Note
Volume of wastewater	15m^3/h	See Fig.3
Operation hours per day	16h/d	
Operation days per year	330d/y	
T-P content	114mg/l	See Table 9 (Sampling Point 4)
Molecular weight of P_2O_5	142	

It is thought that, because the amount of P_2O_5 loss in wastewater is 9t/y, that the majority of this has become dust. In actuality, a Dust Collector has been set up in the production process. However, because the collection efficiency rate is thought to be very low and the cover of the belt conveyor is not sufficient, it looks as if a large amount of dust is being scattered.

Moreover, while confirming the apatite analysis data, we took samples for the purpose of obtaining quality data on accumulated matter in the sedimentation tank and requested CECO to carry out the analysis. The results of that analysis are shown in Table 7.

Table 7 Analysis Results of Solid Samples (CECO)

Sample		Apatite*1	Superphosphate	Settled sludge
Parameter	Unit			
Date		29 February 2000		
P_2O_5	%	29.46	19.7	5.63
Al_2O_3	%	1.53	1.02	0.4
Fe_2O_3	%	4.55	3.03	1.7
MgO	%	4	12	0.65
SiO_2	%	10.34	6.86	1.88
CaO	%	36.4	28.0	0.3
Pb	%	1.38×10^{-2}	8.45×10^{-3}	5.13×10^{-3}
Zn	%	5.41×10^{-3}	8.02×10^{-3}	$<10^{-3}$
Cr	%	$<10^{-3}$	$<10^{-3}$	$<10^{-3}$
Cd	%	2.1×10^{-4}	2.5×10^{-4}	1.36×10^{-3}
Mn	%	0.324	0.274	0.005
Ni	%	0.01	0.015	$<10^{-3}$

Remarks:

＊1：powder after grinding

3.4 Fluorine Material Balance

Fluorine in the raw materials, due to the following reactions listed below, is collected and sold as Na_2SiF_6 (insecticide). However, at present it is impossible to anticipate what the profits from this operation will be.

$F + SiO_2 \rightarrow SiF_4$

$SiF_4 + H_2O \rightarrow H_2SiF_6$

$H_2SiF_6 + NaCl \rightarrow Na_2SiF_6 + HCl$

For these reactions, because of the relationship to cost, salt is used instead of caustic soda and a hydrochloric acid by-product is produced as a result.

Making a trial calculation of fluorine balance in 1998 using the composition of fluorine in apatite, 2%, and the volume of fluorine in wastewater (Table 9-Sampling Point No. 4), 15.72mg/l, the following figures results:

The composition of fluorine in apatite: 1,400 kg/y
The composition of fluorine in the wastewater: 1,243 kg/y

From these results it can be supposed that the majority of the fluorine is leaking into the wastewater.

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Qualities

4.1.1 Samples taken on December 3, 1999

Sampling point numbers and the content of samples are shown in Table 8. The results of measurements taken with a simple analyzing device are shown in Table 9, and the analysis results of the water qualities of the samples taken simultaneously by CECO are shown in Table 9.

Table 8 Sampling Points and Content of Samples

Sampling Point	Sample Content
1	Cooling water (taken from the pond) (the day before sampling, because of some kind of trouble, the pH level was low. Because of this we took another sample at ②)
2	Cooling water (Taken from the water channel that sends water from the process to the pond)
3	Well-water
4	Precipitation Tank Discharge Point
5	Wash water at the discharge point from the process exhaust gas washing process
6	(Precipitation tank intake wastewater) Drained water into the Thi Vai River (Taken at the drainage point in to the Thi Vai River)

Table 9 Water Quality Analysis Results (CECO)

Sampling Point		1	2	3
Parameter	Unit			
Time		11:15		11:25
Temp.	℃	37		34.5
pH		3.6		6.3
Conductivity	mS/cm	2.94		0.24
Turbidity	NTU	16		4
Oil content	mg/l	3		<0.01
BOD_5	mg/l	16		5
COD	mg/l	32		8.6
DO	mg/l	5.2		7.0
SS	mg/l	43		15
T-nitrogen	mg/l	4.37		3.1
CN	mg/l	0.093		<0.001
Phenol	mg/l	0.002		0.001
Residual Cl	mg/l	0.08		0.68
SO_4	mg/l	118.4		25
T-P	mg/l	42.2		0.07
Fe	mg/l	2.37		7.8
F	mg/l	3.7		0.009

Sampling Point		4	5	6
Parameter	Unit			
Time		11:30	11:45	12:04
Temp.	℃	31	33	31.5
pH		2.3	1.4	2.7
Conductivity	mS/cm	17.17	65.5	4.5
Turbidity	NTU	590	2,320	68
Oil content	mg/l	1.3	1.5	0.9
BOD_5	mg/l	18	69	144
COD	mg/l	24	132	316
DO	mg/l	6.2	5.2	5.4
SS	mg/l	467	5,128	255
T-nitrogen	mg/l	14.51	8.58	6.24
CN	mg/l	0.018	0.017	0.028
Phenol	mg/l	0.01	0.005	0.001
Residual Cl	mg/l	0.00	0.05	0.04
SO_4	mg/l	110	328	146
T-P	mg/l	114	119	64
Fe	mg/l	7.65	8.91	8.2
F	mg/l	15.72	16.07	3.72

Ther was some samall trouble at the plant on the day before we visited and pH control was inappropriate, so pH value at sampling point No.1 is very low.

4.1.2 Samples Taken on February 29, 1999

As was mentioned earlier, there appears to be no major problems in the sulfuric acid production process. Therefore, our measurements and analysis were concentrated on the superphosphate plant. Sampling point numbers and content of samples are shown in Table 10, and analysis results of samples taken by CECO are shown in Table 11.

Table 10 Sampling Point Numbers and Sample Content

Sampling Point Numbers		Sample Content
February 29, 2000	December 3, 1999	
1		Wastewater from the No.1 absorption tower
2		Wastewater from the absorption mixing tower
3	5	Wastewater from the intake point of the sedimentation pond
4	4	Wastewater from the discharge point of the sedimentation pond
5		Wastewater from the wet-type cyclone
6	3	Well water
7	--	Ba Ria Port (Thi Vai River)
8	--	Oil Port of the Phu My Integrated Power- Urea Factory (Thi Vai River)
--	1	Cooling water use pond of the sulfuric acid plant
--	2	Cooling water at the discharge point of the sulfuric acid plant
--	6	Drainage water into the Thi Vai River

Table 11 Water Quality Analysis Results（CECO）

Sampling Point		1	2	3	4	**TCVN**
Parameter	Unit					
Time		14:46	14:53	14:59	15:09	
Temp.	℃	28	37	29	30	40
pH		1.12	0.7	1.8	1.94	5.5-9
Conductivity	mS/cm	85	100	21	30	
Turbidity	NTU	120	249	23	38	
Oil content	mg/l	0.3	0.4	0.22	0.25	1
BOD_5	mg/l	96	74	60	22	50
COD	mg/l	240	200	130	48	100

Sampling Point		1	2	3	4	**TCVN**
Parameter	Unit					
DO	mg/l	4.7	0.7	4.1	3.7	
SS	mg/l	567	810	123	30	100
T-nitrogen	mg/l	3.2	3.0	3.0	3.5	60
CN	mg/l	0.31	0.069	0.001	0.001	0.1
Phenol	mg/l	0.02	0.02	0.025	0.025	0.05
Residual Cl	mg/l	0.25	1.21	0.09	0.1	2
SO_4	mg/l	925	950	250	200	
T-P	mg/l	0.92	0.38	0.32	1.58	6
Fe	mg/l	9.12	7.52	6.75	5.16	5
F	mg/l	7.375	4.875	5.875	6.25	2

Sampling Point		5	6	7	8
Parameter	Unit				
Time		13:18	15:31	16:20	16:55
Temp.	℃	33	27	29.8	29.3
pH		3.89	4.75	7.2	7.34
Conductivity	mS/cm	2.7	0.1	0.35	0.47
Turbidity	NTU	22	0	15	9
Oil content	mg/l	0.3	0.00	0.1	0.14
BOD_5	mg/l	370	9	140	124
COD	mg/l	1,120	19.6	276	264
DO	mg/l	4.4	5	4.7	4.5
SS	mg/l	478	2	10	13
T-nitrogen	mg/l	3.5	2.6	5.9	8.6
CN	mg/l	0.012	<0.001	0.001	0.002
Phenol	mg/l	0.03	0.001	<0.001	0.001
Residual Cl	mg/l	0.37	0.10	0.07	0.08
SO_4	mg/l	425	1	240	112
T-P	mg/l	2.56	0.01	0.03	0.04
Fe	mg/l	7.3	4.7	0.21	0.14
F	mg/l	4.75	0.06	1.65	4.5

4.2 Industrial Wastewater Standards

Vietnam industrial wastewater standards (B rank) are shown in Table 12. When the standard numbers are compared with numbers of the measurements of analysis results taken at sampling point number 4, shown in Table 10, on December 3, 1999, as well as the measurements of the analysis results taken on February 29, 2000 at sampling point number 4, shown in Table 12, just as they have been shaded in the tables:

① In the analysis results for Table 9, pH, SS, total phosphates, iron, as well as the density of fluorine compounds are exceeding the standard values.

② In the analysis results for Table 11, pH, fluorine compounds, as well as iron density, are exceeding the standard values, and SS, as well as total phosphate density, are satisfying the standards.

5. Countermeasures for Improvement and there Estimated Costs

5.1 Production Technology Improvement Policy

(1) Sulfuric Acid Plant Improvement Policy

It appears as if there are no major problem areas that need to be improved.

(2) Improvement Policy for P_2O_5 Loss at the Superphosphate Plant

As was mentioned earlier in Section 3.3, due to the low collecting efficiency rate of the Dust Collector and the insufficiency of the cover on one portion of the conveyor belt, a significant amount of phosphate is leaking out. Because of this, and according to a trial calculation, a 10% loss is anticipated. Following this, a thorough dust prevention policy, improvement of operating methods, and thorough conservation are required.

(3) Improvement of Fluorine Loss in the Superphosphate Plant

As was mentioned earlier in Section 3.4, there has been a depression in the amount of Na_2SiF_6 produced as an insecticide, and almost all of the fluorine is being lost. Because of this, the amount of absorption water going to the absorption tower, and the number of spray nozzles in use need to be increased. At the same time, in the long run, they must find a valid use for hydrogen fluoride, other than as an insecticide.

Short-term improvement measures that can be raised at this time include, establishing an absorption tower and a ventury scrubber facility, as well as utilizing alkaline solution as an absorbent . After elucidating the nature of the fluorine ion in the wastewater, and because of the reaction that occurs when it is made to react with calcium ion, it is necessary for them to generate and separate insoluble salt. In this case as well, pH control will become an important factor.

5.2 Improvement in Management Technology

The company needs to adopt improvement activities such as 5S activities, hold company wide meetings at fixed intervals regarding technical problems and the like, execute statistical control of data, as well as make other improvements. At the same time, in order to increase international competitiveness, it is also necessary for them to have periodic information exchanges with domestic companies in the same industry and execute mutual inspections.

Because of the fact that the pH level is especially low in the well water, which is the source of the irrigation water, it is assumed that it is necessary for the irrigation water to be treated.

5.3 Wastewater Treatment Improvement

As was mentioned earlier in Section 4.2, because it is exceeding the wastewater standards for numerous items, wastewater control needs to be strengthened for water volume, water quality, the drainage canal, and the like. In order to execute pH control and operation control of the sedimentation tank, and carry-out periodic removal of accumulated matter in the sedimentation tank, it is necessary for them to make improvements in equipment control, and construct a new sedimentation tank.

5.4 An Estimation of Countermeasure Costs

In order to execute the above listed three improvement items, which came about as a result of discussions between experts from the Ministry of Industry, survey team members, as well as the company, we requested an estimated calculation of the outline of the costs from the company. This outline was delivered via the Ministry of Industry to the survey team members and is shown in Table 12. The general, total cost of these countermeasures is 10,000,000,000 VND.

Table 13 Estimation Costs for Countermeasues

Million VND

No	Application Point	Countermeasures	Cost
1	Well water for all purposes	Installation of a new treatment system to deal with acidic situation	③ 1,500
2	Dust leakage from whole Superphosphates operation line.	Hood, closed system for piping, dryer, mill, cyclone, conveyers, blowers... to recover raw material in the form of dust. The lost estimation of R/M is around 4-7%	② 1,000
3	Fluorine absorption system	Revamping and upgrading equipment to improve productivity and fluorine absorption efficiency	③ 2,000
4	Waste water	Installation of new W/w treatment	③ 1,500
5	Main equipment	Upgrading equipment considered as application of Cleaner production to improvement environmental situation	① 2,000
6	Storehouses	Expansion and upgrading of storehouse	③ 2,000
	Total		10,000

Remarks:①Process Improvement (CP); ②Introduction of New Facility (CP) ;③EOP

6. Recommendations for Pollution Prevention

6.1 Short-term Countermeasures

(1) With top management as the initiating force, activities like 5S and other improvement activities need to be implemented.

(2) Carry-out data control using statistical methods.

(3) Hold periodic, company-wide meetings concerning technical problems and the like.

(4) In order to increase international competitiveness, execute periodic information exchange sessions and mutual inspections with domestic companies in the same industry.

(5) In order to avoid corrosion of machines made of carbon steel in the sulfuric acid plant, the pH problem in the re-cooling water pond needs to be improved immediately.

6.2 Mid-term Countermeasures

(1) Install a pond in front of the sedimentation tank for neutralization treatment, and at the same time, it would be desirable for them to execute suitable environmental control by continuously measuring pH values.

(2) After installing wastewater treatment facilities, in order to effectively remove heavy metals from the sedimentation tank, improvement in operations is also necessary. It is especially important to maintain and control pH values at the most suitable level.

(3) In the near future, it would be desirable for the company to obtain the ISO 9000 qualification. In order to do this, production equipment and the inside of the factory must be organized and cleaning must be thoroughly carried out. At the same time, it is necessary that document system organization for production data, product quality data and the like be carried out.

6.3 Action Plan

The action plan concerning industrial pollution prevention policies is shown in Figure 4. It is expected that the company will follow this schedule and execute these improvement measures.

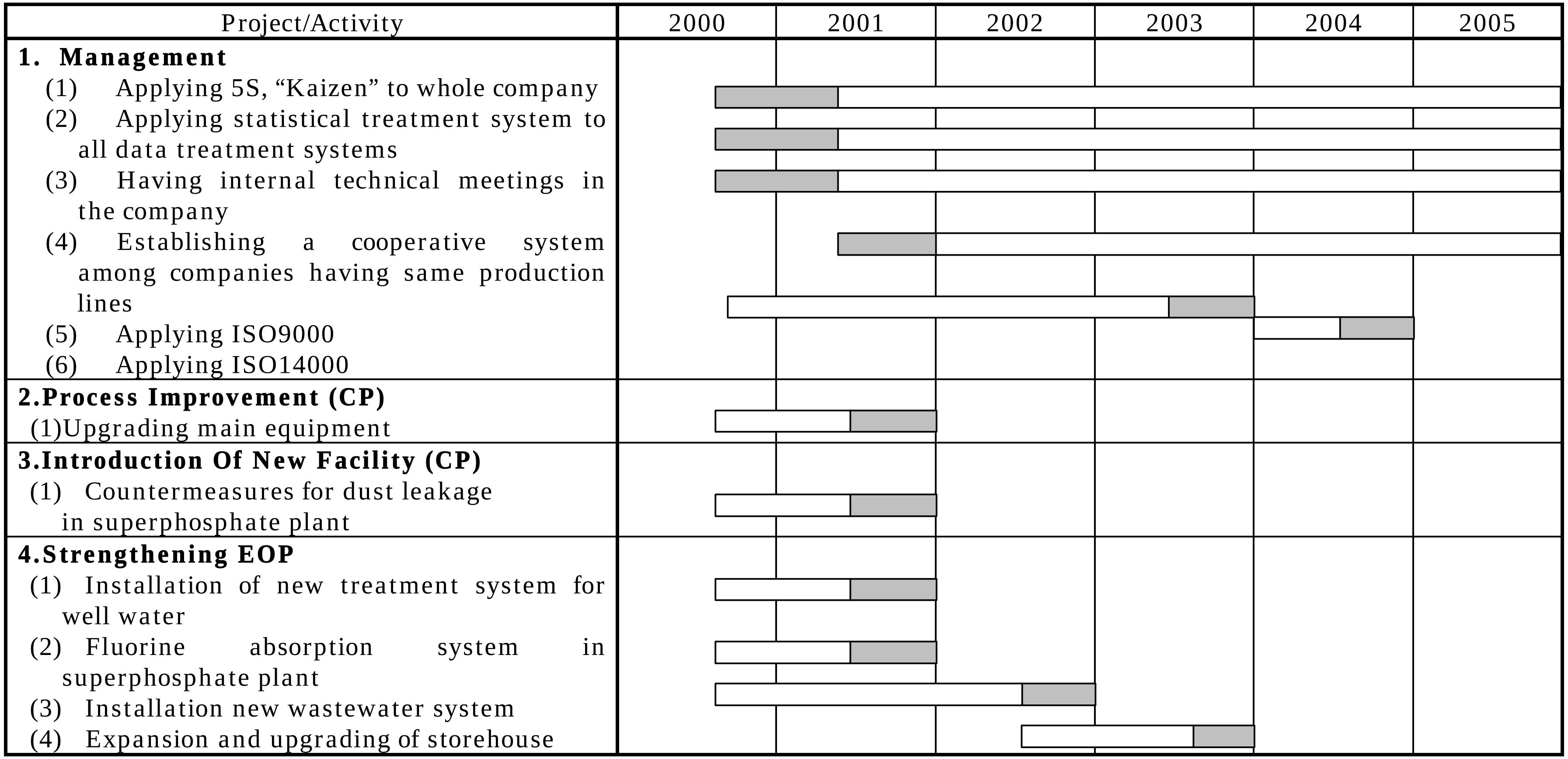


Figure 4 Action Plan (2000 to 2005)

CASE STUDY C-04

Vietnam Pesticide Company

Survey Date: December 6, 1999
March 1 through 3, 2000

1. General

1.1 Profile

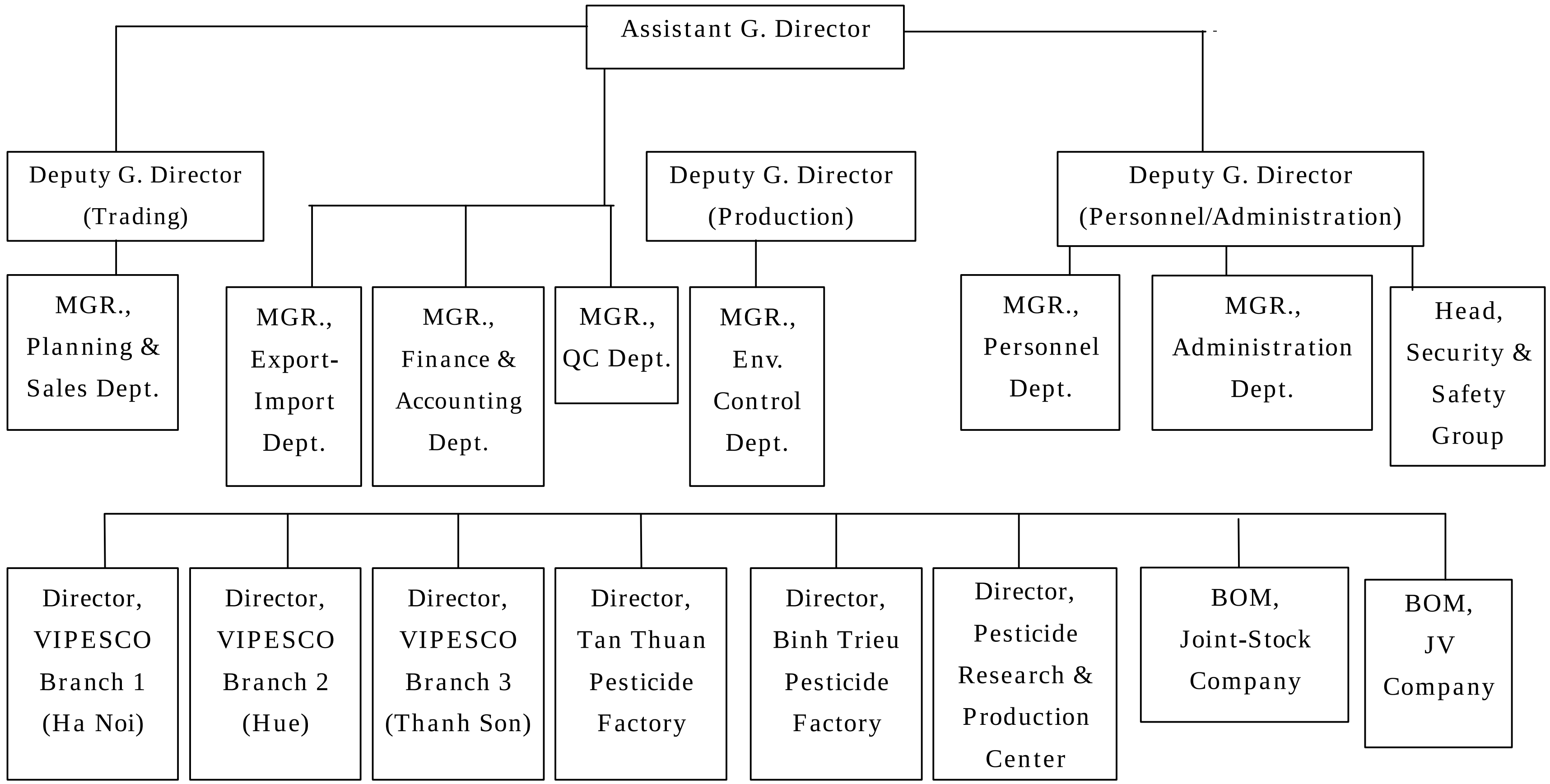
The profile of the Viet Nam Pesticide Company is shown in Table 1 and organizational chart of the whole company and organizational chart of this factory are shown in Figure 1 and 2 Figure 3 shows the factory layout.

Table 1 Company Profile

Company Name:	Viet Nam Pesticide Company （VIPESCO） Thanh Son Factory
Ownership:	State owned
Address:	102 Nguyen Dinh Chieu- Pre.- HCM City
Director General:	Mr. Nguyen Manh Tuyen
Established:	1976
Corporate Capital:	Fixed Property: 50 billion VND Floating Assets: 50 billion VND
Number of Employees:	1,353 (including 130 engineers & 50 researchers)
Main Products:	Kinds of Pesticide

VIPESCO was originally a small private company, but it was changed to its present day status a state-owned enterprise in 1976. Their headquarters are located in HCMC, and they have four 4 factories in the HCMC vicinity. They have 1 research center where research for chemical formulation carried only. There is a pilot plant inside the center as well. They have two other factories, one in Hanoi and one in Hue. They also have a research center in Osaka, Japan that functions as the research development arm of the company. This center also receives cooperation from Nihon-Noyaku, Japanese chemical company.

In addition to these, there are 3 JV enterprises, the first is with a Korean company called KOSVIDA up of a joint venture between KOSCO and DEAWOO of Korea, the second is Chinese company and, the third JV is with a Malaysian company. The company has 1000 VIPESCO employees, and 300 JV employees in 3 JV enterprises, including 50 researchers in the research center and 130 engineers in the factory.



Remarks: QC: Quality Control; Env.: Environment; MGR: Manager

Figure 1 Enterprise Organization Chart

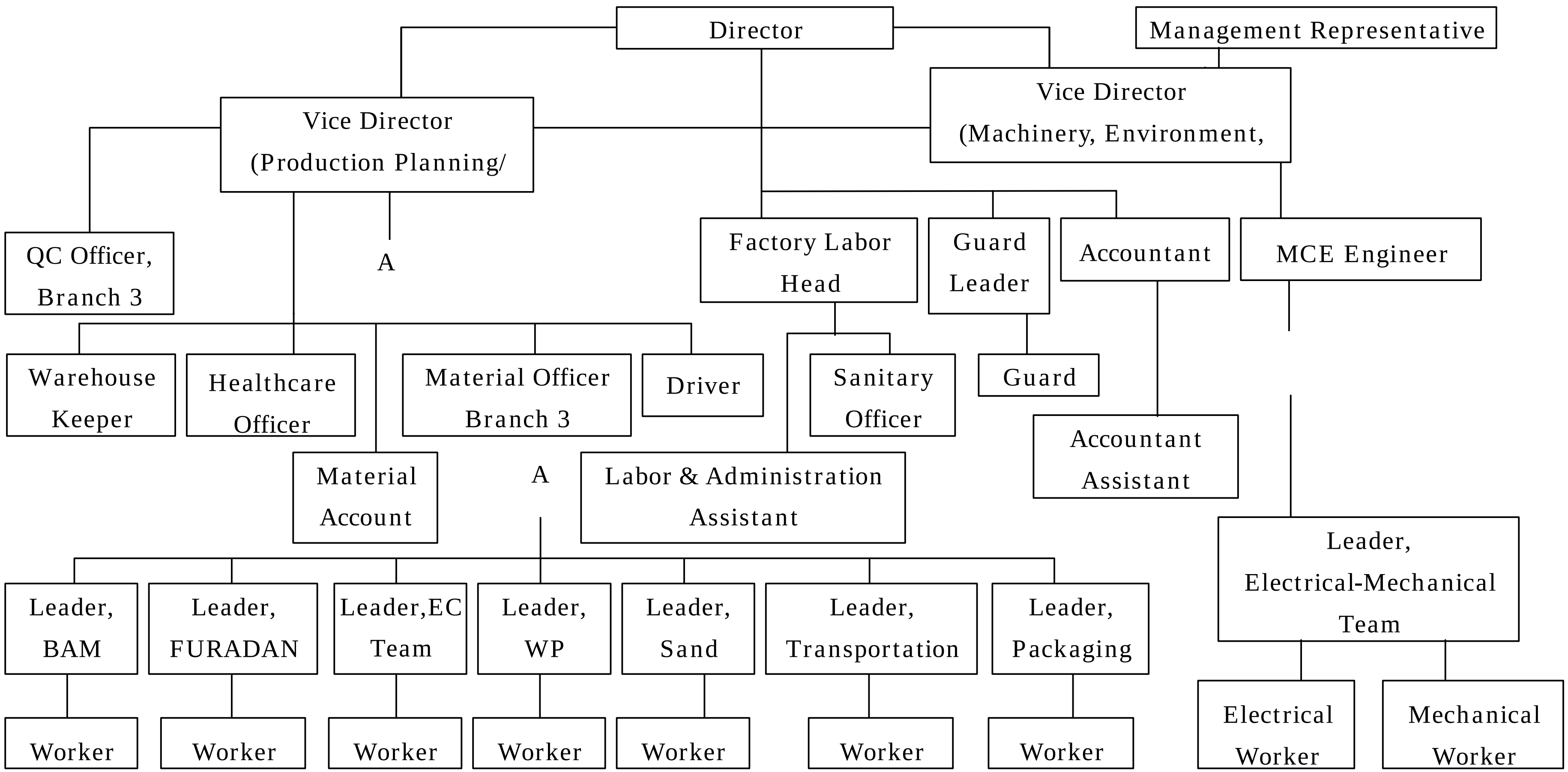


Figure 2 Factory

Remarks:

QC: Quality Control

MCE; Mechanical-Chemical-Environmental

EC: Emulsificable Concentrate

WP: Wettable Power

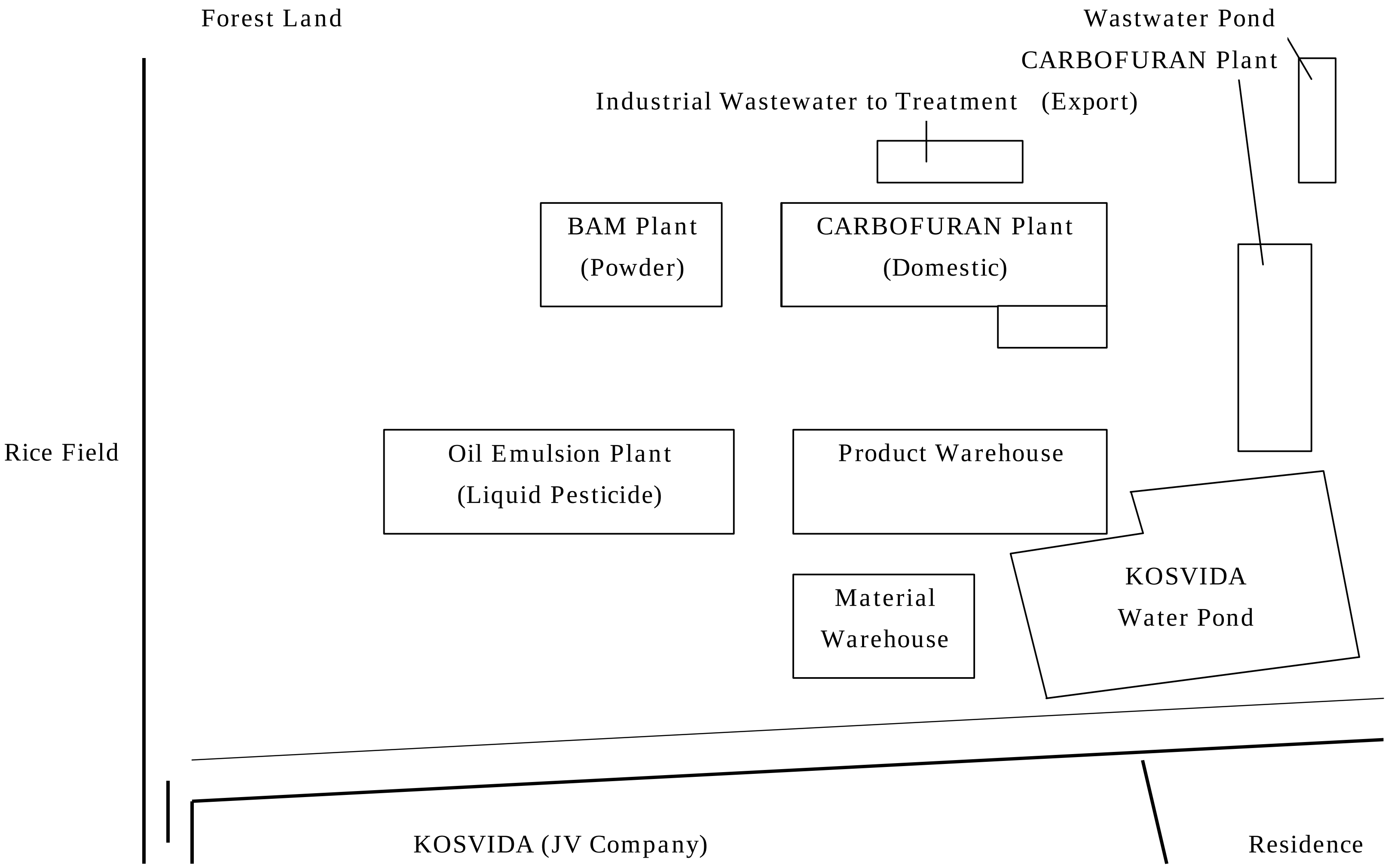


Figure 3 Factory Layout

1.2 Status of Business

The business has been successfully maturing over the past 5-6 years and VIPESCO is the biggest company among 127 rather small pesticide companies, including JV companies, with a 65 – 70% market share in Viet Nam market. Turnover of the company in 1999 is anticipated to be 30 million US$, with profits of 1 million US$. High quality products produced by VIPESCO have been distributed to each province in Viet Nam, and are also exported to Korea, Taiwan and other countries as well.

Since 1990, turnover of VIPESCO has increased by 10%/y and they have paid Government taxes and employees salaries without any subsides from the Government.

Their high quality products are internationally competitive but the only problem is with their price. This is because products from China and India flowing into market are 30-40% lower in price.

The factory covers an area of 4ha.

(1) Production

Raw materials for pesticide production, chemical formulation and chemical synthesis are imported from Korea, China and Malaysia, and VIPESCO is partially supported by companies from these countries in the technological area.

Actual annual production and revenues are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Production (t)	Revenue (x1000VND)
Viben-C	50	3,534,250
Newkasuran	60	3,300,000
Applaud Bass	21	1,880,550
Applaud Micp	23	1,533,295
Viben 50BTN	10	656,440
ViMicp 25BTN	116	2,610,000
Furadan 3H	3,619	29,346,470
ViBam 5H	3,383	31,129,423
Carbofuran 3G,5G,10G	649	9,021,100
Vi 2,4D 85BTN	79	2,711,912
Viphosat 488g/l	230	11,502,070
Thiodan 35ND	272	16,270,500
Vibasa 50ND	50	1,773,100
Fokeba	37	975,616
Vidithoate 40ND	29	690,722
Vinmonyl 72WP	2	166,166

Product	Production (t)	Revenue (x1000VND)
Sand	6,387.9	--
Kaolin	835.4	--
Monitor 50DD	70	1,883,840
Vectron 10SC	4.3	513,420
Vismit 5BR	3	15,000
Vibasu 10BR	2	21,250
Azodrin 50ND	13.9	755,131
Total	15,946.5	102,290,255

According to the explanation we received from the company, product structure, technology, start of operations and production capacity have been determined and are shown in Table 3.

In addition, an automated program for grain type pesticide is now in process, and it cost is 100,000 VND. The automated program is scheduled to be completed in 2010, and the total cost is estimated as 13,000,000 VND. This automated program is sponsored by the government, however, financially procurement for the program as a problem.

This factory doesn't have a boiler.

Table 3　Technology and Production Capacity

Product	Technology	Starting Operation	Capacity	Note
Powder	Japan	1985	3,000t/y	
Granule			20,000t/y	2 trains
Liquid	Taiwan	1999	1,500t/y	1 train

(2)　Debt

According to materials we received from the company, the company has a total of 31,550,008,218VND in foreign loans and a bank loan of 20,000,000,000VND.

2. Production Technology

2.1 Process

(1) Outline

Production processes for liquid and solid pesticide are shown in Figure 4 and 5. Both production processes utilize batch production.

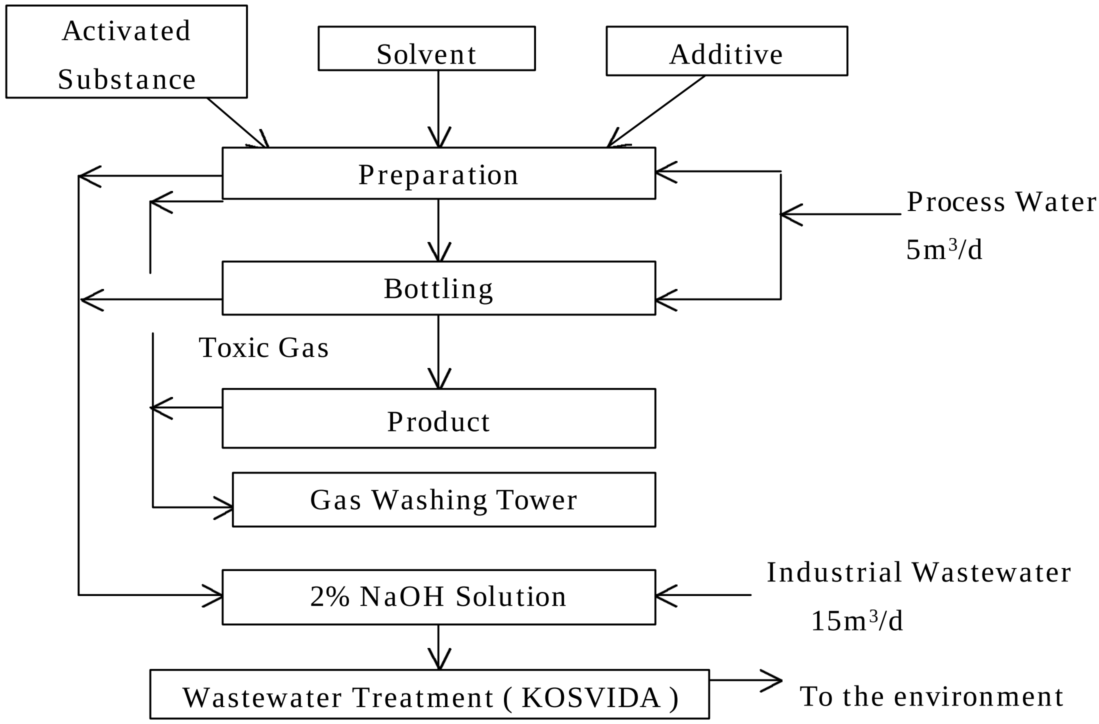


Figure 4 Liquid Pesticide Production Process

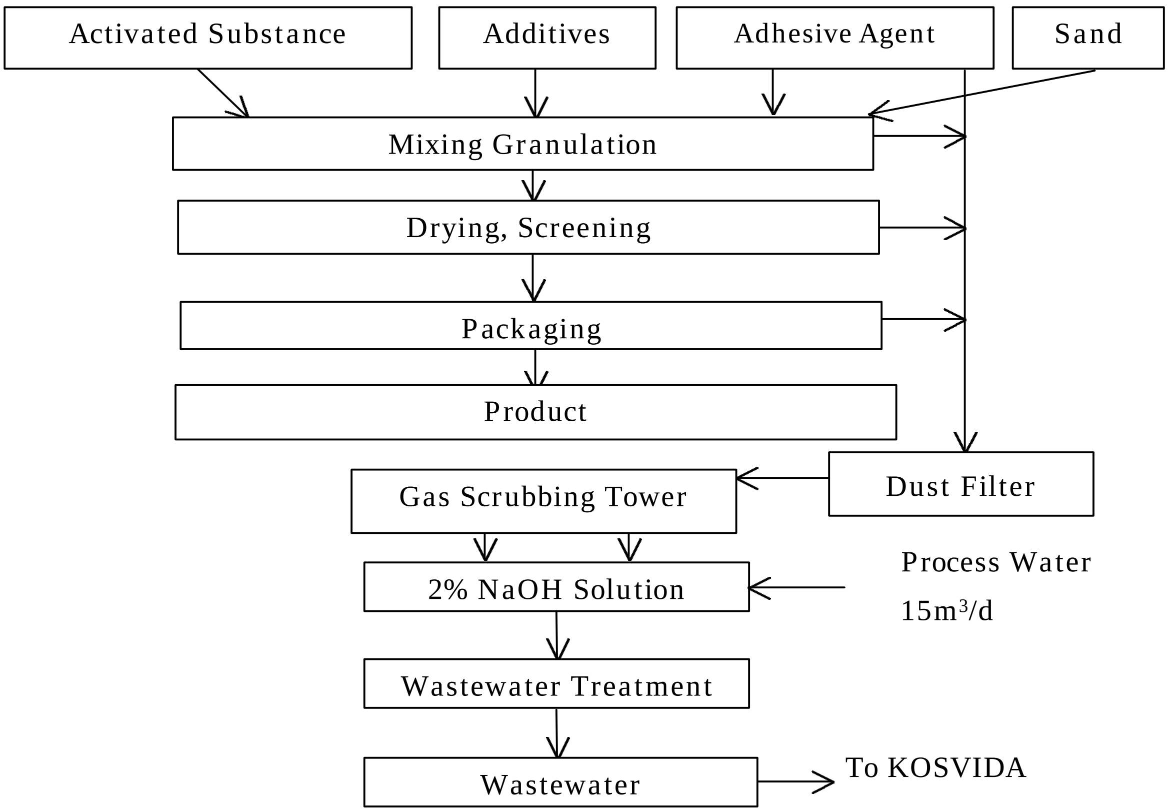


Figure 5 Solid Pesticide Production Process

(2) Raw materials leakage and Countermeasures for foul odors

We examined in detail of their carbofuran facility for export production as a representative example of all facilities. If we observe closely, leakage of raw materials carbofuran, grain products and other products occur in 13 parts of the process, such as the rotating part of granulating or drying machines, transport use conveyor belts in used all processes, the packing process and the like. However, most of the leaked materials are collected in a drum and spills on the floors are cleaned with a vacuum cleaner and collected at the end of each shift. Floors are washed with water once every 2 or 3 months. The loss rate in the beginning use was 4 to 5 %, but is gradually decreased to the rate of 0.2% at present. Thus, because we believe that this is a big problem, we don't see any problems in raw materials or products loss, besides the foul odors in process. Regarding the foul odor, there are many open areas in the processes, like where raw materials are added, and it is crucial to seal and close all the processes.

Some oil leakage was also found.

2.2 Wastewater resources

Wastewater from this factory is categorized into 2 parts, wash wastewater from machine and floor washing, and exhaust gas wash water that contains 2% caustic soda solution NaOH from the grain type pesticide production process.

As the use of mercury, cadmium, chrome as pesticides is banned by the law, only manganese, zinc, lead need to be concerned with as far as heavy metals go for the wastewater issue. The ministry of Agriculture carried out analysis on these heavy metals and the company received proof from the ministry that these heavy metals in the wastewater is very low.

Wastewater is sent to the nearby KOSVIDA facility and goes through activated sludge process at a rate of 3～5m^3/6 month. The pH rate of circulating water only is checked regularly and when necessary, caustic soda is added and the water is neutralized.

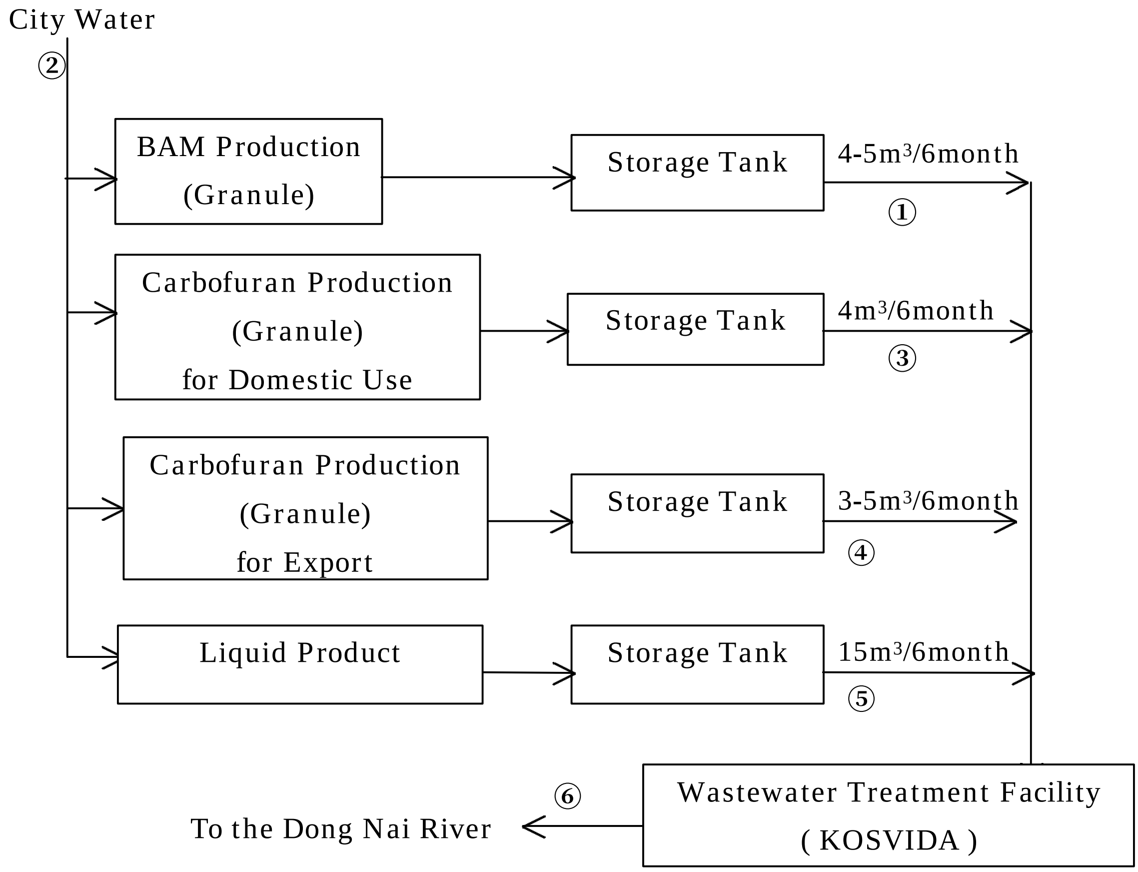


Figure 6 Water System

Since they doubled the production capacity at DOSVIDA, the activated sludge process now full operation. The company autonomously undertook treatment experiment activated sludge has been done, and the experiment results of this has been disclosed.

At present, the capacity of the activated sludge process equipment in KOSVIDA is 300m^3/d, and the composed of the wastewater mixing, pH adjustment, aeration, activated sludge treatment, sedimentation and thickener processes. The wastewater from this factory is treated along with wastewater from KOSVIDA with this equipment.

Treated wastewater drains into the Dong Nai River, which is one of the tributaries of the Sai Gon River. Moreover, since the Sai Gon River is badly contaminated with domestic and industrial wastewater, Ho Chi Min City prefers that water from river not be used for domestic or industrial purposes. The amount of wastewater from the dust washing process for three grain type products is 5m^3/batch, 15m^3/batch from the caustic soda washing process for the three grain type products, as well as 15m^3/batch is from the wastewater of liquid product equipment and floor washing. The water system and sampling points areas shown in Figure 6.

3. Management

3.1 General

Basically the management condition of the factory seems to be satisfactory and the factory, facilities and equipment are maintained in a good, clean condition.
The company obtained the ISO9002 certificate in Dec.1999 and has already made an application for ISO14000.

There are four problems concerning the environment and they are as follows:

(1) Dust from powder chemical products: A bug filter was installed to help protect workers' health.

(2) Wastewater which contains carbamate compounds: The company utilized 3 kinds of treatment utilized, a chemical type treatment, a large sedimentation pond and biological treatment which makes use of activated sludge.

(3) A large number of toxic chemicals; Treatment is very difficult and further investment is necessary.

(4) Foul smelling chemicals

In order to avoid environmental problems, they are in the middle of conducting a feasibility study on the possibility of constructing a new factory in the new industrial zone south of HCMC land moving all their HCMC area factories and research center into it. The plan has received the approval of MOI. However, it is estimated it will require a 10 million US$ investment, 300 hectares of land and a 6 month moving period. Another problem they are facing are expensive land rental fees in HCMC.

3.2 Unit Consumption of Raw materials and Utility

The consumption amount of raw materials and utilities in 1998, which has provided by the company, is shown in Table 4 and 5.

Table 4 Raw Materials Consumption (1998)

Material Used	Consumption (tons)	Cost (mill. VND)
Activated Substance	926.00	
Solvent	247.00	
Sand	12,721.70	
Kaolin	1,769.00	
Additives	112.30	
Water	36,838	
Fuel Oil	87.05	
Electricity (kwh)	345.800	
Total		89,422.255

Table5 Unit Consumption of Raw Materials and Utilities and Revenues

	Product	Production (*1)	Material Used								Total Cost	Total Revenue
			Activated Substance	Solvent	Sand	Kaolin	Additives	Water (*2)	FO	Electricity		
		(t)	(t)	(t)	(t)	(t)	(t)	(t)	(t)	(kwh)	(mill. VND)	(mill. VND)
1	Viben- C	50	28.5			14.5	7				3,110.55	3,534.25
2	New Kasuran	60	17.3			33.1	9.6				3,029.80	3,300.00
3	Applaud Bass	21	6.4				9.3				1,441.80	1,880.55
4	Applaud Mipc	23	6.2				4.6				1,299.50	1,533.30
5	Viben 50BTN	10	5.3			3.7	1				605.96	656.44
6	ViMipc 25BTN	116	30.9				17.5				2,410.93	2,610.00
7	Furadan 3H	3,619.00	145.1		3,465.00				10.13		26,219.60	29,346.47
8	ViBam 5H	3,383.00	202	34	2,265.00	882	8.8				10,544.80	13,129.42
9	Carbofuran 3G,5G,10	649	42.9				0.4				8,566.80	9,021.10
10	Vi 2,4D 85BTN	79	79		603.8				0.32		2,539.38	2,711.91
11	Viphosat 488g/l	230	153.4				23	53			8,980.12	11,502.07
12	Thiodan 35ND	272	94.5	154.3			23.2				14,527.52	16,279.50
13	Vibasa 50ND	50	26.3	20.2			3.5				1,632.95	1,773.10
14	Fokeba	37	9.3				1.8				742.96	945.616
15	Vidithoate 40ND	29	12.1	14.6			2.3				734.391	690.722
16	Vimonyl 72WP	2	2.1			0.3	0.2				143.328	166.166
17	Sand	6,387.90			6,387.90				76.6	95,800		
18	Kaolin	835.4				835.4				20,000		
19	Monitor 50DD	70	50	20							1,743.49	1,883.84
20	Vectron 10SC	4.3	4.3								390.1648	513.42
21	Visumit 5BR	3	0.2								15.852	15
22	Vibasa 10BR	2	10								21.22	21.25
23	Azoridin 50Nd	13.9	926	3.9			0.1				721.146	755.131
	Total	15946.5	1851.8	247	12721.7	1769	112.3	36838	87.05	115800	89,422.26	102,269.26

Remarks:

*1: Production amounts of sand and Laolin are included in total production.

*2: Total water consumption is included domestic water consumption.

“The trial calculation of all kinds of loss that occurs in the pesticide production process (for the end of 1999)” was provided by the company and is shown in Table 6. Looking at this we can see if the company has been managing this loss well on a daily basis.

Table 6 Trial Calculation of all Kinds of Loss occurs in the Pesticide Production Process (for 1999)

Product	Usage	Item			Loss Rate (%)
Liquid	Domestic	Emulsion	Material & Solvent		0.2
			Packaging	Glass Bottle 100cc (Malaysia)	0.2
				Glass Bottle 100cc	1
				Bottle 480cc	2
				Aluminum Covers	0.5
				Plastic Cover, Box	0.3
				Label	0.4
				Tape	1
				Aluminum Packaging	1
		Foaming	Material etc.		0.3
			Packaging	Same as Emulsion	
	Exporting		Material & Additive		0.5
			Packaging	Same as Emulsion	
Powder	Domestic		Material	Raw Material	4
				Powder Material	0.3
				Surfactant, etc.	0.3
			Packaging	PE Packaging	0.5
				OPP packaging	1
				Paper & Craft Packaging	0.5
				Aluminum Packaging	0.3
Granule	Domestic		Material		0.3
			Packaging	Packaging Materials	0.5
	Export		Material	Carbofuran 3G	1
				Carbofuran 5G	1.2
				Carbofuran 10G	2.5
				Cartap 4G	1
				Diazinon 10G	0.5
				Surfactant	0.5
			Packaging	Packaging Materials	1

Auxiliary Material

No.	Material	Loss
1	Powder used to make glue for boxing	2kg/100boxes
2	Thread used for craft paper sewing	0.12kg/40bags
3	Paper used to make craft bags	0.48kg/40bags
4	Glue for labels	
	PVA glue (for glass bottles)	
	- 480cc bottles	0.1kg/t-product
	- 100cc, 250cc bottles	0.2kg/t-product
	4000H glue (aluminum and plastic bottles)	
	- 480cc bottles	0.9kg/t-product
	- 100cc, 250cc bottles	0.6kg/t-product

Estimation of quantity tape needed for boxes

Product	Box Dimension	No. of bottle	No. of one roll	Note
Liquid	465 x 320 x 220	24 bottles of 480cc	73	
	405 x 260 x 270	80 bottles of 100cc	80	
	415 x 260 x 170	24 bottles of 250cc	80	
	395 x 300 x 378	40 bottles of 480cc	83	
	393 x 315 x 373	40 bottles of 500cc	83	Vifosat
	435 x 345 x 258	20 bottles of 1000cc	77	Vivadamy
	535 x 260 x 145	1200 packs of 10cc	65	
Granule	335 x 260 x 145	10 boxes of 1kg	93	
	505 x 328 x 145	20 boxes of 1kg	69	
Powder	530 x 400 x 208	100 packs of 100g	66	
	430 x 340 x 280	50 packs of 200g	76	
	500 x 350 x 252	70 packs of 200g	70	

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Table 7 shows the sampling points and content of samples.

Table 7 Sampling Points and Content of Samples

Sampling Points	Content of Samples
1	Wastewater from the BAM Unit
2	Intake Water
3	Wastewater from the domestic use carbofuran production process
4	Wastewater from the export use carbofran production process
5	Wastewater from the liquid pesticide production process
6	Wastewater from discharge point out of the KOSVIDA company

(1) Samples taken on Dec.6,1999

Analysis done by CECO on samples which were taken simultaneously to these measurements is shown in Table 8.

The reasons have not been determined yet, but we can see the following peculiar results:

①Sample 1 has a brownish-white color, sample 3 is black, and sample 4 is slightly brown in color ②conductivity and concentration of salt is high.

Table 8 Water quality analysis results（CECO）

Sampling Point		1	2	3
Parameter	Unit			
Time		11:15	11:20	11:25
Temp.	℃	26.5	27	27
pH		8.8	7.2	6.3
Conductivity	mS/cm	5.5	0.15	18.25
Turbidity	NTU	1,112	6	392
Oil content	mg/l	0.21	<0.01	0.32
BOD_5	mg/l	405	4	795
COD	mg/l	680	8	1,680
DO	mg/l	4.5	5.8	5.6
SS	mg/l	3,960	1	1,620
T-nitrogen	mg/l	43.37	0.68	68.02
CN	mg/l	0.613	<0.001	0.386
Phenol	mg/l	0.012	<0.001	0.54
Residual Cl	mg/l	12.25	0.02	4.38
SO_4	mg/l	1,150	5	4,000
Fe	mg/l	30.63	0.05	10.75
Cr（VI）	mg/l	3.37	0.001	1.0
Cu	mg/l	18.75	0.01	7.625
Cd	mg/l	<0.001	<0.001	<0.001
Hg	mg/l	0.018	<0.001	<0.001
Zn	mg/l	15.77	<0.001	4.07

Sampling Point		4	5	6
Parameter	Unit			
Time		11:35	11:40	12:03
Temp.	℃	26.5	26.5	31
pH		8.8	8.9	7.1
Conductivity	mS/cm	1.56	0.59	15.39
Turbidity	NTU	26	31	40
Oil content	mg/l	0.25	0.37	0.19
BOD_5	mg/l	162	160	193

Sampling Point		4	5	6
Parameter	Unit			
COD	mg/l	360	360	320
DO	mg/l	6.5	4.2	5.6
SS	mg/l	137	160	59
T-nitrogen	mg/l	8.58	34.01	12.5
CN	mg/l	0.01	0.016	0.003
Phenol	mg/l	0.045	0.007	0.003
Residual Cl	mg/l	0.86	0.24	0.13
SO_4	mg/l	164	64	131.2
Fe	mg/l	1.06	0.65	0.52
Cr（Ⅵ）	mg/l	0.43	0.08	0.01
Cu	mg/l	1.15	0.25	0.09
Cd	mg/l	<0.001	<0.001	<0.001
Hg	mg/l	<0.001	<0.001	<0.001
Zn	mg/l	1.11	<0.001	<0.001

(2) Samples taken on March. 3, 2000

Table 9 shows the results of analysis done by CECO on sample which were taken simultaneously to the simple measurement.

The reasons are not clear yet, but we can see the following two peculiar results: ①sample 1 has yellowish-brown color, sample 3 has blackish-brown color, and sample 4 also has a blackish-brown color.

Table 9 Water Quality Analysis Results（CECO）

Sampling Point		1	2	3
Parameter	Unit			
Time		9:30	9:37	9:44
Temp.	℃	26	27	31
pH		8.61	6.7	10.3
Conductivity	mS/cm	3.3	0.12	2.3
Turbidity	NTU	1,324	0.0	856
Oil content	mg/l	0.42	<0.01	0.45
BOD_5	mg/l	602	4	659
COD	mg/l	1,080	8.8	1,400
DO	mg/l	2.8	4.7	2.1
SS	mg/l	1,490	0.0	600
T-nitrogen	mg/l	31.5	1.6	71
CN	mg/l	0.196	<0.001	0.0096
Phenol	mg/l	0.05	0.001	0.4
Residual Cl	mg/l	5.64	1.54	2.19
SO_4	mg/l	925	19	1,175
Fe	mg/l	22.85	0.12	8.67
Cr	mg/l	1.22	0.00	0.55

Sampling Point		1	2	3
Parameter	Unit			
Cu	mg/l	8.58	0.00	3.2
Cd	mg/l	0.0034	<0.001	0.0017
Hg	mg/l	0.008	<0.001	<0.001
Zn	mg/l	2.76	0.008	2.92

Sampling Point		4	5	
Parameter	Unit			
Time		9:50	10:00	
Temp.	℃	27	28	
pH		8.88	9.02	
Conductivity	mS/cm	1.5	0.64	
Turbidity	NTU	233	68	
Oil content	mg/l	0.25	0.29	
BOD_5	mg/l	211	172	
COD	mg/l	440	320	
DO	mg/l	4.6	3	
SS	mg/l	105	433	
T-nitrogen	mg/l	6.5	11.5	
CN	mg/l	0.019	0.016	
Phenol	mg/l	0.05	0.04	
Residual Cl	mg/l	0.87	0.4	
SO_4	mg/l	150	100	
Fe	mg/l	1.81	1.08	
Cr	mg/l	0.54	0.18	
Cu	mg/l	1.09	0.55	
Cd	mg/l	0.006	<0.001	
Hg	mg/l	<0.001	<0.001	
Zn	mg/l	0.55	0.07	

4.2 Industrial Wastewater Standards

Table 10 shows industrial wastewater standards (rank B) which apply to the factory.

Table 10 Industrial Wastewater Standards（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

When comparing the results of measurements on sampling point 6, where wastewater is discharged into public water in Table 8 (Dec, 1999) and Table 9 (March, 2000), with industrial wastewater standard in Table 12, we see that standards values for BOD5 and COD are being exceeded. Also, not for wastewater being discharged into public water areas, but for wastewater from all production lines in this factory, the density of BOD5 and COD, is high. A reasonable countermeasure for these problems could be utilization of an activated sludge process.

5 Countermeasures and their estimated cost

5.1 Countermeasures for Production Technology

Raw materials loss is well managed and they are sufficiently collecting and re-using materials, so there are no major problems. However, for countermeasures for the foul smell coming from the processes needs to be implemented, and process needs to be completely sealed, and the ventilation system needs to be strengthened.

5.2 Countermeasure for management technology

They have already received ISO9002 certification and are using statistical methods for data analysis. Therefore, there are no particular improvement areas relating to “Management” that need to be implemented.

5.3 Countermeasures for wastewater treatment

As is clearly shown in Table 8 and 9, the activated sludge process equipment in KOSVIDA is operating working fully at present as a result of their doubling production capacity. The concentration of BOD5 and COD values in all wastewater, which is used as an index for organic pollutant, is high. New activated sludge process equipment needs to be installed, and they are already examining this issue.

5.4 Estimation of Cost for countermeasures

Table 11 shows the estimated cost for countermeasures which specialists from MOI, survey team members, and the company discussed. The company provided us with this information via MOI. The total estimated cost is 18.8 billion VND.

Table 11 Estimation Costs for Countermeasures

IMPLEMETATION STAGE

1. Countermeasure for implementing cleaner production

1.1. Upgrading and complete the existing production lines to overcome leakage causing environmental pollution

No.	Production plant	Cost estimated (million VND)
1	Exported Carbofuran plant	169
2	Domestic Carbofuran plant	179
3	Powder pesticide plant (WP)	159
4	Liquid Pesticide plant (EC)	33
5	VIBAM Plant	210
6	Sand Processing plant	60
Total		810

Remarks: See detail in the Annex 1.

1.2. New granulation equipment and investment in automatic packaging system for granule products.

No.	Item	Cost estimated (million VND)
1	Granulation equipment (Nauta type) and auxiliary equipment	500,000 USD x 14,000 = 7,000
2	Automatic Packaging Plant for Granular products; include: - Housing - Equipment	6,822 300 6,522
Total		13,822

Remarks: See detail in the Annex 2.

2. Environmental protection:

2.1 Investment for gas and wastewater treatment for the whole branch aiming at environmental protection.

No.	Item	Cost estimated (million VND)
1	Invest in gas and wastewater treatment similar to that of KOSVIDA Joint Venture (KOREAN equipment)	280,000 USD x 14,000= 3,920
2	Installation cost	20,000 USD x 14,000 = 280
Total		4,200

Remarks: See detail in the Annex 3.

TOTAL IMPLEMETATION COST

Item	Description	Cost estimated (million VND)
1.1	Upgrading the production plant toward Cleaner production	810
1.2	Granulation equipment and automatic packaging system for granular products	13,822
2.1	Invest in environmental protection: biological wastewater treatment system	4,200
	Total	18,832

Remarks:

Item No.1: Process Improvement (CP)

Item No.2: Introduction of New Facility (CP)

Item No.3: EOP

EXPORTING CARBOFURAN PLANT

No.	Problem to be solved	Countermeasure	Cost estimated (million VND)	Notes
1	Material leakage in the feeding area	Use close operating system	20	
2	Material leakage before mixer	Closed box and sucker	4	
3	Leakage of the intermediate product after mixer	Enclosed box and sucker	10	
4	Leakage of semi product and oil at the bottom lift 1	Enclosed box	10	
5	Leakage of semi product and oil along the body of lift 1	Replace joint and tightening	10	
6	Leakage of semi product and oil at the beginning of the conveyor bell	Close system, sucker and oil receiver	5	
7	Leakage of semi product at the middle of the conveyor bell	Close system for product recovery	5	
8	Leakage of semi product and oil just before dryer	Close system, sucker, and oil receiver	5	
9	Leakage of product and oil at the bottom of lift 2	Enclosed box	5	
10	Leakage of the product at the top of lift 2	Close system and sucker	5	
11	Leakage of product at the screener	Close system and sucker	20	
12	Leakage of product after the screener	Close system and sucker	20	
13	Leakage at the packaging area	Close system or packaging machine	50	
Total			169	

DOMETIC FURADAN PLANT

No.	Problem to be solved	Countermeasure	Cost estimated (million VND)	Notes
1	Material leakage in the feeding area	Use close operating system	20	
2	Material leakage before mixer	Closed box and sucker	4	
3	Leakage of the intermediate product after mixer	Enclosed box and sucker	20	
4	Leakage of semi product and oil at the bottom lift 1	Enclosed box	10	
5	Leakage of semi product and oil along the body of lift 1	Replace joint and tightening	10	
6	Leakage of semi product and oil at the beginning of the conveyor bell	Close system, sucker and oil receiver	5	
7	Leakage of semi product at the middle of the conveyor bell	Close system for product recovery	5	
8	Leakage of semi product and oil just before dryer	Close system, sucker, and oil receiver	5	
9	Leakage of product and oil at the bottom of lift 2	Enclosed box	5	
10	Leakage of the product at the top of lift 2	Close system and sucker	5	
11	Leakage of product at the screener	Close system and sucker	20	
12	Leakage of product after the screener	Close system and sucker	20	
13	Leakage at the packaging area	Close system or packaging machine	50	
Total			179	

POWDER PESTICIDE PLANT (WP)

No.	Problem to be solved	Countermeasure	Cost estimated (million VND)	Notes
1	Open material transport facility, dust and smell generated in the transporting process and feeding operation	Enclose the transport facility, additional sucker for feeding area	3	
2	Leakage at rotating joints of the Ribbon mixer and lift	Closed box , replace the spare parts and packing	10	
3	Smell generating from the vessel body of the Super Micron Mill	Replace the vessel, enclose the leakage point	120	
4	Leakage and smell at the joints and soft pipe (rotating valve, vibration, etc.)	Enclose, replace packing that can withstand vibration	10	
5	Leakage at the Dust filter SP 36	Repairing	8	
6	Dust generated at the product effluent point (to packaging area)	Close system, sucker and oil receiver	8	
	Total		159	

LIQUID PRODUCT PLANT (EC)

No.	Problem to be solved	Countermeasure	Cost estimated (million VND)	Notes
1	Smell generated as the product is transferred in the bottles from bottling area to capping area	Additional sucker	3	
2	Gas and product leakage at the pumps that used to feed material and transfer product to container of the stirring vessel group	Replace the pump, replace packing material of the joints with solvent resistance material	30	
Total			33	

VIBAM PLANT

No.	Problem to be solved	Countermeasure	Cost estimated (million VND)	Notes
1	Dust generation at the feeding area for sand and kaolin	Change the feeding system (lift, bunker with load cell, etc.)	120	
2	Dust generation at the outlet under mixing vessel	Additional sucking system, increase sucking capacity, pressure, install dust cover	10	
3	Dust generation at the screening process	Enclose the screening system, upgrading the sucking system	10	
4	Dust generation at the product outlet into product container and at the packaging area	Enclosing the outlet system, improve packaging process, use automatic weighting, install sucking system	70	
Total			210	

SAND PROCESSING PLANT

No.	Problem to be solved	Countermeasure	Cost estimated (million VND)	Notes
1 2 3 4 5 6	Dust in material feeding area Dust in the screening area Dust at the transition point from the lift to the drying machine Leakage from the Joint parts Leakage from the body of the centrifuge pump Leakage at product outlet	Upgrading the equipment and the sucking system in the plant	60	
Total			60	

Annex 2

Installing new equipment and facility

AUTOMATIC PACKAGING PLANT

(For granular product)

1. Construction of housing

300 million VND

- Cost to treat the foundation, roofing, ventilation for 540 m^2:

300 million VND

2. Equipment

6,522 million VND

- Imported equipment (two packaging system) from Japan or Western Europe:

210,000 USD x 2 x 14,000 = 5,922 million VND

Specification on packaging equipment:

- Packaging type: 1-5 kg/pack
- Capacity: 20- 60 pack /minute
- Packaging material: PP, OPP, PE, AL in roll type

- Domestic equipment:

- 4 containing vessels 10m^3 with stand:
  40 million/vessel x4 = 160 million VND
- 4 conveyor belt
  35 million/belt x4 = 140 million VND
- Sucking system 300 million VND

Annex 3

Investment in Environmental Protection

SPECIFICATION ON GAS AND WASTEWATER TREATMENT SYSTEM

1. Capacity: 30 m^3/day

2. Treatment requirement for wastewater influent:

+ COD: 1,500 mg/l
+ BOD: 500 mg/l
+ Total pesticide residue: 500 mg/l
+ pH 9-10
+ Inorganic salt: 2%

3. Specification for pumping system and press filter system:

+ Flow capacity: 200 m^3/day
+ Press filtration capacity : 0.5 m^3/day

4. Requirement for wastewater effluent:

+ Meet standard level B according to TCVN 5945 - 1985.

6. Proposals for Pollution Prevention

6.1 Short Term Countermeasures

Conduct more frequent, autonomous, periodical checks on wastewater to strengthen environmental management. (At present, there is an inspection of wastewater by the authorities every 6 months.)

6.2 Mid and Long Term Countermeasures

After obtaining the ISO9000 certificate, the company should prepare an application for ISO 14000. In order to do so, they need to enforce cleaning and organization inside of the factory, and consolidate and organize environmentally related documents.

6.3 Action Plan

Figure 7 shows the action plan for industrial pollution prevention measures. The company is expected to follow the schedule and take the necessary improvements.

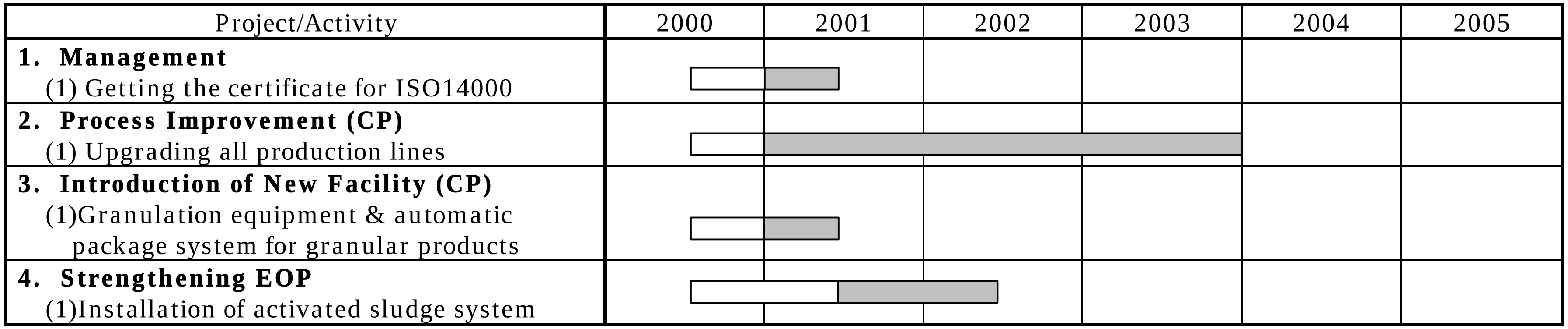


Figure 7 Action Plan (2000 to 2005)

CASE STUDY C-05

Ha Bac Nitrozennous Fertilizer and Chemical Company

Survey Date : November 19, 1999

1. General

1.1 Profile

Ha Bac Fertilizer & Chemical Company belongs to VINACHEM(Viet Nam Chemical Corporation) . The factory profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Ha Bac Nitrogenous Fertilizer & Chemical Company
Ownership:	State-owned
Address:	Bac Giang Town- Bac Giang Province
Director:	Mr. Hoang Van Tien
Established:	1960
Corporate Capital:	
Number of Employees:	2,960 including 300 engineers
Main Products:	Urea fertilizer, Liq. Ammonia, Electric Power

Production for nitrogen, oxygen, liquefied ammonia and electricity started in 1965 and urea in 1975.

1.2 Status of Business

(1) Production

Ammonia is consumed in the company and also sold to others. Craft paper is exported to Taiwan to be used in the manufacturing of bills. Liquefied gases such as nitrogen, oxygen, CO_2, and dry ice and calcium carbonate are produced in the factory. Bottled water, alcoholic beverages such as wine and champagne are produced in their subsidiary company. The market for urea fertilizer and its derivatives are very weak at present because of low prices, and the operation load of the production plant is very low compared with its nominal capacity. The only place that is maintaining a high operation rate is the electrical power generation plant. The company also sells electricity to the state-owned electricity company. There are 3 electricity generation plants, each having 6,000kwh capacity steam turbines, and 5 boiler plants, each of which have a 35t/h capacity feed with coal granules. The pressure of the steam is 35 atm. The production capacity of the main product, urea, was designed at 100,000t/y and expansion of production enabled actual production to reach 130,000t/y.

Production capacity and annual production in 1998 are shown in Table 2.

Table 2 Production Capacity and Annual Production

Main Product	Unit	Production (1998)	Designed Capacity
Electric Power	Mwh	125,000	85,000
Liquid Ammonia	Tons	39,000	65,000
Urea Fertilizer	Tons	64,000	100,000
Activated Carbon	Tons	180	200
NPK Fertilizer	Tons	7,000	20,000
Craft Papaer	Tons	1,850	5,000

(2) Debt

2. Production Technology

2.1 Process

The process and production technology were mainly supplied by the Peoples Republic of China in the past years. The gasification plant was licenced by Lurgi(Holland), the urea plant was licenced by Stamicarbon, the ammonia plant and other plants were supplied by the Republic of China. The ammonia plant has a capacity of 65,000t/y when operated under the operating conditions of 500°C, at 300atm.

The CO_2 removal plant uses an MEA absorption process. The CO and CO_2 removal unit of the ammonia plant utilize a copper carbonate solution.

There are future plans for the expansion of ammonia and urea production, but the schedule depends on the demand of these products. Urea production Process is shown in Figure 1.

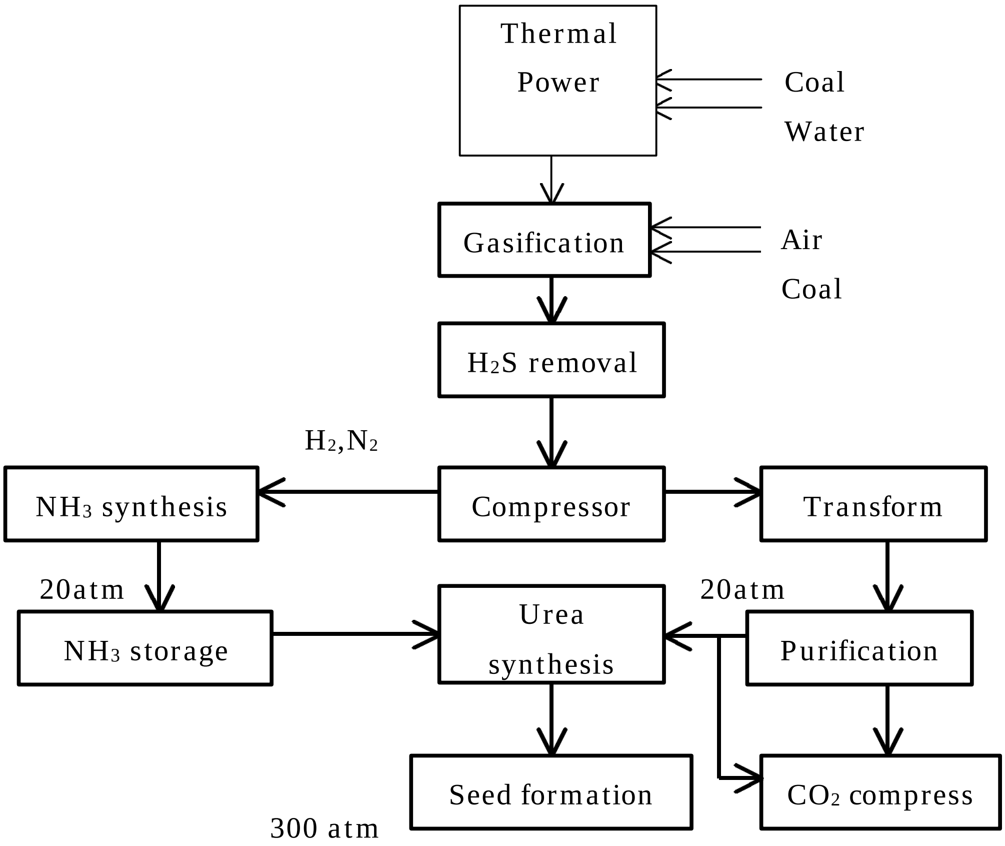


Figure 1 Urea Production Process

2.2 Wastewater Source

Industrial water is drawn in from the Thuong river and the intake of water is installed almost 1 km upstream of the factory and its outlet for waster water. Though the nominal volume of industrial water is designed at 12,000 m^3/hr, present intake stays only at 8,000m^3/hr because of the low production rate. The present total volume of wastewater is around 7,500 to 8,000 m^3/hr, including 4,000m^3/hr from the urea plant which contains ammonium and shows a high pH value. The main pollution of the wastewater comes from the exhaust of the gas purification plant and its wastewater of 100m^3/h contains cyanide ions, chlorine ions and sulfur. Three big ponds for sedimentation have been installed and follow one water channel with 100,000m^3 capacity.

Water system and balance are shown in Figure 2.

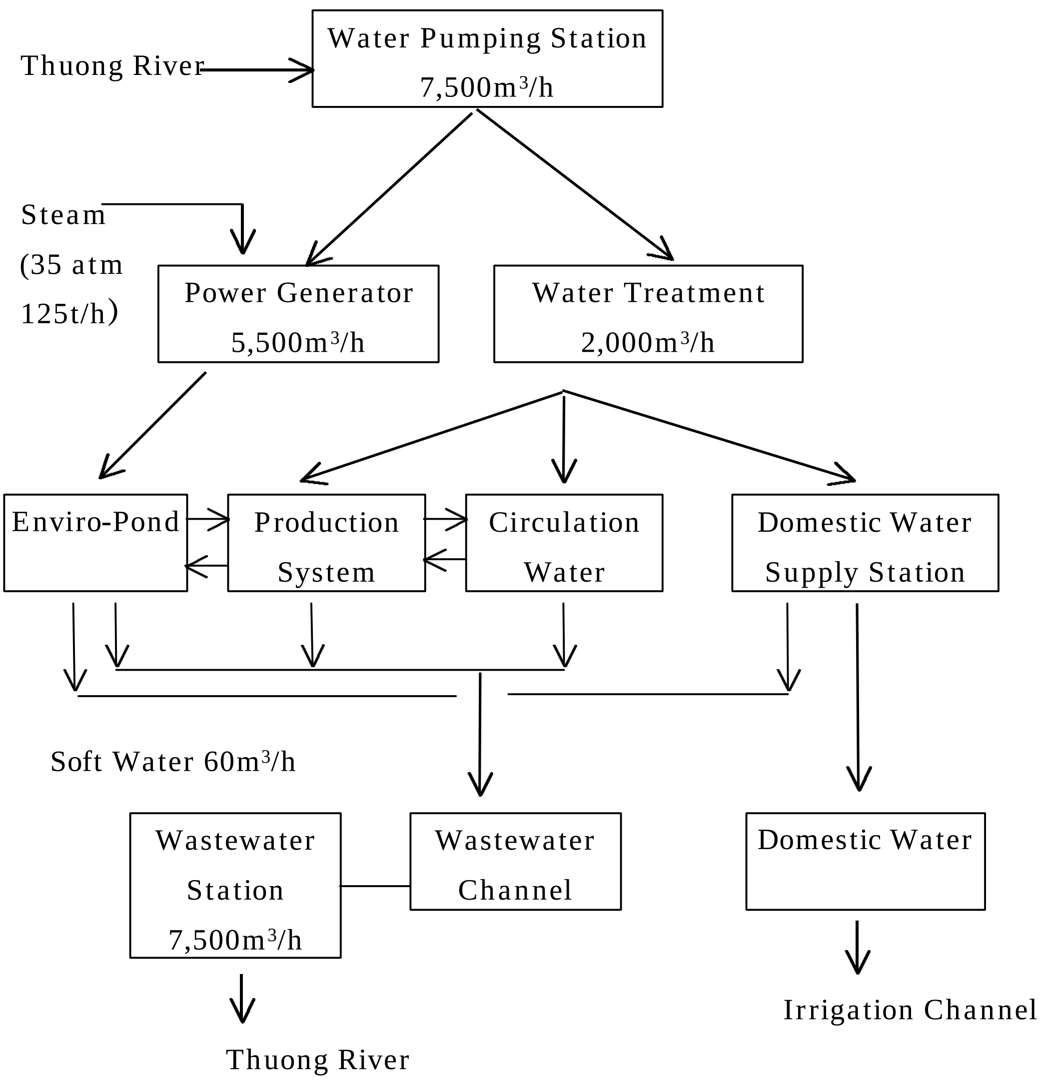


Figure 2 Water System and Water Balance

3. Management

3.1 General

ISO 9000 and ISO 14000 are not applied in this company yet, but the latter is now under the program in INEST. The factory of this company is well managed, maintaining a clean site with no garbage in sight and has trees growing all around it just like a factory in a forest.

3.2 Unit Consumption of Raw Materials

Unit consumption of raw materials for each product, additives and utilities with annual consumption in 1998 are shown in Table 3.

Table 3 Unit Consumption and Annual Consumption in 1998

Material Use	Unit	Consumption
1. Energy		
Coal-Powder	Tons	198,600
Fuel Oil	Tons	581
H_2SO_4	Tons	205
NaOH	Tons	18
Soft Water	10^3m^3	1,100
Cooling Water	10^3m^3	51,000
Electricity	Kwh	20,000
2. Ammonia		
Coal	Tons	60,500
Electricity	Mwh	52,800
Steam	Tons	234,000
Cooling Water	10^3m^3	4,500
MEA	Tons	32
3. Urea Fertilizer		
Liquid Ammonia	Tons	37,800
Electricity	Mwh	9,000
Cooling Water	10^3m^3	14,000
Uresoft-150	Tons	20

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Aperiodical check on the wastewater is performed once every 15 days and the results of the analysis are evaluated continuously.

The expansion of chemical wastewater treatment plant to a capacity of 40,000m3/d has been suspended because of the weakness of the market.

discharged wastewater, because flow direction changed, influenced by tides in spite of the far distance, 70 km, from the sea.Table 4 shows sampling points.

Table 4 Sampling Points

Sample #	Sampling Points
1	Wastewater from the Pond to the Canal
2	Process Water
3	Wastewater from processes
4	Wastewater from Power Plant
5	Wastewater from Urea Plant(4,000m^3/h)
6	Wastewater after the Pond
7	Wastewater in the Canal
8	Outlet to the River
9	Intake Water from the River(1km upstream from the discharge point)
10	River Water (500m downstream from the discharge point)

The results of analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 5.

Table 5　Wastewater Quality　（CECO）

Sample Point		1	2	3	4	5
Parameter	Unit					
Time		14:00	14:10	14:20	14:30	14:40
Temp.	℃	39	26	32	31	59
pH		7.27	7.8	7.23	7.03	9.1
Conductivity	mmS/cm	0.95	0.24	0.95	0.25	1.52
Turbidity	NTU	48	10	79	1,028	11
Oil content	Mg/l	0.31	0.03	0.21	0.47	0.14
BOD_5	Mg/l	17	4	10	6	8
COD	Mg/l	35.2	6	25.6	12.4	14.4
DO	Mg/l	4.8	8.2	5.6	6.6	2.6
SS	Mg/l	76	6	111	2,500	16
T-Nitrogen	Mg/l	107.64	2.25	12.45	4.68	71.21
CN	Mg/l	0.20	0.004	0.20	0.006	0.004
Phenol	Mg/l	0.015	0.006	0.052	0.04	0.005
Residual Cl	Mg/l	0.12	0.47	0.16	0	0.12
Cr (Ⅵ)	Mg/l	0.03	0.05	0.01	0.03	0.001
Cu	Mg/l	0.029	0.014	0.02	0.04	0.001
Fe	Mg/l	0.52	0.36	0.99	0.4	0.3

Sample Point		6	7	8	9	10
Parameter	Unit					
Time		14:50	15:00	15:10	15:20	15:30
Temp.	℃	31	32	32	27	26
pH		8.1	8.89	9.31	8.62	8.25
Conductivity	mmS/cm	0.65	0.29	0.35	0.26	0.26
Turbidity	NTU	30	17	68	22	79
Oil content	Mg/l	0.27	0.33	0.2	0.04	0.16
BOD_5	Mg/l	9	17.8	15.8	4	5
COD	Mg/l	24	29.6	26.4	6	6.4
DO	Mg/l	6.5	6.8	6.6	7.8	8.2
SS	Mg/l	35	126	114	25	27
T-Nitrogen	Mg/l	8.68	17.8	19.2	2.19	6.8
CN	Mg/l	0.01	0.15	0.045	0.004	0.006
Phenol	Mg/l	0.002	<0.001	0.001	0.007	0.012
Residual Cl	Mg/l	0.13	0.22	0.13	0.56	0.39
Cr (Ⅵ)	Mg/l	0.002	0.012	0.01	0.05	0.05
Cu	Mg/l	0.016	0.01	0.01	0.016	0.019
Fe	Mg/l	0.44	0.53	0.5	0.48	0.5

4.2 Regulation Standards

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 6.

Table 6 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(Ⅵ)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(Ⅲ)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

By comparison between the result of analysis shown in Table 5(Sampling Point No.8) and Standard shown in Table 6, value for pH and SS exceed the standard.

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Conduct a study to reinforce the neutralization and sedimentation process, especially in order to decrease pH and SS.

(2) Conduct a study for the treatment and utilization of solid waste, like sludge.

5.2 Mid- Term and Long Term Countermeasures

(1) Maintain equipment against rusting through periodical effective painting.

CASE STUDY C-06

Trang Kenh Chemical & Calcium Carbide Company

Survey Date : November 22, 1999

1. General

1.1 Profile

Trang Kenh Calcium Carbide & Chemical Company is one of the national companies under VINACHEM. The factory profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Trang Kenh Calcium Carbide & Chemical Company
Ownership:	State owned
Address:	Minh Duc- Thuy Nguyen- Hai Phong
Director:	Mr. Bui Huy Hoang
Established:	1940's as JV sponsored by Japanese Co. (80%) and French Co. (20%) and then became a State owened company.
Corporate Capital:	
Number of Employees:	273 including 15 engineers
Main Products:	Calcium Carbide, Soft Calcium Carbonate

The plant for the main product, calcium carbide, has a capacity of 10,000t/y to 12,000t/y after improving the process and expanding from the original designed capacity of 2,000t/y.

1.2 Status of Business

(1) Production

The actual production of carbide for 1998 stayed at only 2,160 t/y. The main products of Trang Kenh Calcium Carbide & Chemical Company are calcium carbide, acetylene, and black acetylene. The company is now planning an investment to install a new product line using Taiwanese technology for calcium carbonate with a capacity of 2000 t/y, and the total capacity will be 6,600 t/y in the beginning of year 2000. The annual production and the revenues in 1998 are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Unit	Production	Revenue (VND)
Calcium Carbide	Tones	2,160	7,058,445,000
Acetylene Gas	m^3	10,673	486,494,400
Acetylene Black	Tones	21,922	4,921,650,000
Soft Powder ($CaCO_3$)	Tones	--	--
Total			12,466,589,400

There was 1 electricity generating plant in the factory, but it had been already shut down and instead, electricity is purchased from outside at the price of 730 VD/kwh. The electricity cost share is almost 60% of the total production cost, and cost improvement is an urgent issue for the company. The factory has an annual maintenance from Nov. 20, 1999 to Dec. 20, 1999 and as no plant was in operation today, the production condition could not be evaluated. The plant was said to be scheduled for operation from the beginning of the new year, 2000.

(2) Debt

2. Production Technology

2.1 Process

The production technology and original plant for calcium carbide were supplied by the Denka Corporation of Japan, and even now the business relationship between them and Denka corp. still exists and they cooperate to exchange information on calcium carbide production.

Calcium carbide, Acetylene, and Acetylene Black production processes are shown Figure 1,2, and 3 respectively.

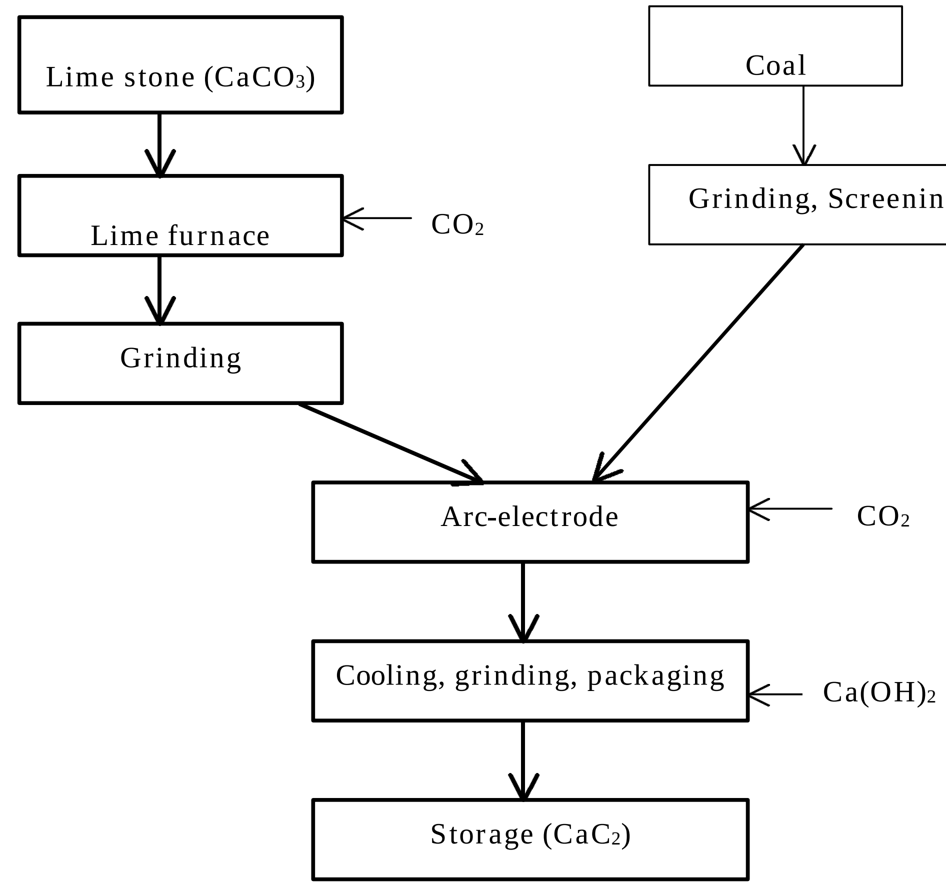


Figure 1 Calcium Carbide Production Process

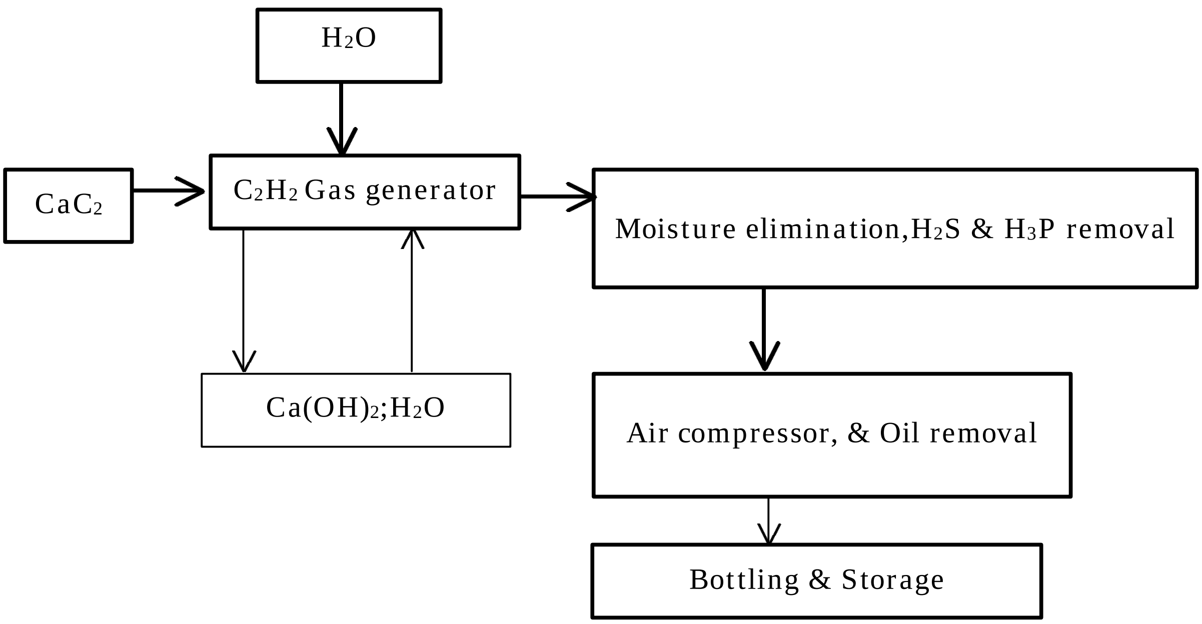


Figure 2 Acetylene Gas Production Process

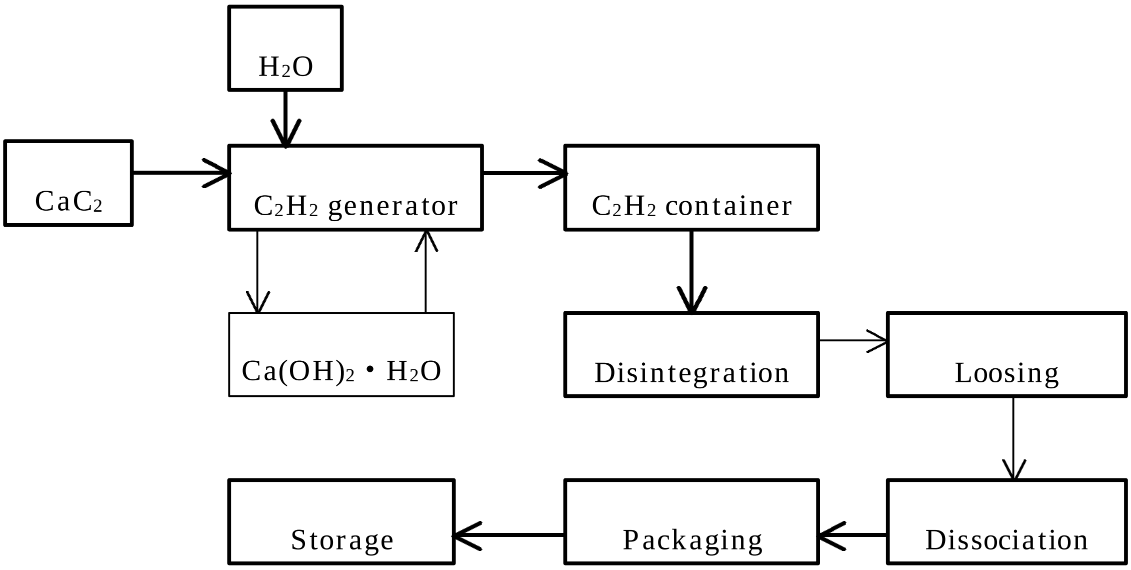


Figure 3 Acetylene Black Production Process

2.2 Wastewater Source

Industrial water is supplied by a well utilizing deep underground water through a sedimentation holder with 200 m^3/d and all wastewater is sent to a pond with a capacity of 28,800m^3(120m×80m×3m). Pond water is recycled completely to the facilities and no wastewater is displaced to the river or in public drains. This means the company has no problems for their wastewater so far. The only problem regarding wastewater is the discharge of a large amount of residue from calcium carbide and black acetylene.

Water system and sampling points are shown in Figure 4.

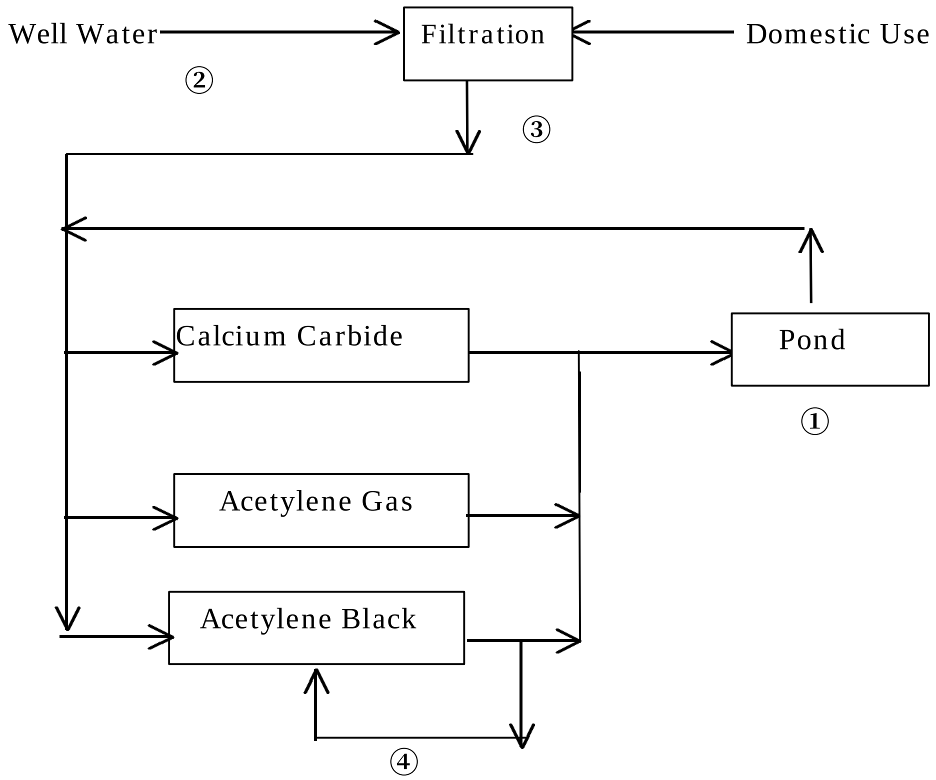


Figure 4 Water System

3. Management

3.1 General

EIA is applied by the MOI Environmental Center, but the ISO system has not been applied yet in this company. Environmental aspects are considered in the long term, but present facility is not enough for environmental evaluation in Viet Nam. Investment costs for environmental facilities in Viet Nam are too expensive for them to bear at present, and almost all investors hesitate to invest in their factory because of their economic aspect.

The factory of this company seems not to be well managed, as facilities are not maintained and the site is not kept clean. However, we need to consider that the raw materials and products are basically powder solid and are scattered easily during treatment.

3.2 Annual Consumption and Cost

The annual consumption and cost in 1998 are shown in Table 3.

Table 3 Annual Consumption and Cost in 1998

Material Use	Unit	Amount	Cost (VND)
Calcium Carbide			
Coal	Tones	1,751,461	655,746,998
Lime Stone	m^3	2,475	54,450,000
Bre Resin	Tones	134,513	215,220,800
Coal	Tones	203,299	234,958,800
Lead	Tones	80,650	68,955,750
Steel Plate	Tones	35,581	185,021,200
Electricity	Kwh	8,847,714	5,931,660,260
Acetylene Gas			
Calcium Carbide	Tones	6,127	211,485,000
Water	m^3	5,000	5,150,000
Electricity	Kwh	18,255	15,699,300
Acetone	Kg	1,560	17,160,000
Acetylene Black			
Calcium Carbide	Tones	9,844	3,913,741,312
Water	m^3	29,000	30,000,000
Electricity	Kwh	45,072	38,761,920

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Table 4 shows Sampling Points.

Table 4 Sampling Points

Sample number	Sample
1	Wastewater from the Pond
2	Underground Water before treatment
3	Underground Water after Filtration
4	Recycled Water from Acetylene Black Production

The results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 5.

Table 5 Wastewater Quality （CECO）

Sampling Point		1	2	3	4
Parameter	Unit				
Time		11:20	11:30	11:40	11:50
Temp.	℃	25	26	26	25
pH		7.8	7.5	7.8	11.8
Conductivity	mmS／cm	0.46	0.36	0.37	2.1
Turbidity	NTU	80	38	10	98
Oil Content	mg／l	0.2	0.0	0.0	1.4
BOD_5	mg／l	14	2	0	76
COD	mg／l	18	7.2	3.6	110

Sampling Point		1	2	3	4
Parameter	Unit				
DO	mg/l	7.2	7.6	7.8	6.5
SS	mg/l	36	4	1	59
T-nitrogen	mg/l	49.6	17.6	14.3	19.8
CN	mg/l	0.000	0.000	0.000	0.000
Phenol	mg/l	0.001	0.000	0.000	0.000
Residual Cl	mg/l	0.04	0.04	0.02	0.01
Fe	mg/l	0.16	1.03	0.38	0.27

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Have periodical checks on the quality of recycling water especially from acetylene black.

5.2 Mid- Term and Long Term Countermeasures

(1) Maintain the facility from aging through periodical effective painting.

CASE STUDY C－07

Viet Tri Chemicals Company

Survey Date : November 25, 1999

1. General

1.1 Profile

Viet Tri Chemical Company is one of the State-Owned companies under VINACHEM, Ministry of Industry. The factory profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Viet Tri Chemical Company
Ownership:	State-Owned
Address:	Tho Son- Viet Tri City- Phu Tho Province
Director:	Mr. Dao Quang Tuyen
Established:	1961
Corporate Capital:	
Number of Employees:	555 including 30 engineers (10 chemical engineers)
Main Products:	NaOH, HCl, Detergents, Liquefied Cl_2

The main products of Viet Tri Chemical Company are NaOH, HCl, liquefied chlorine, $CaCl_2$ and detergents. Capacity of NaOH production has expanded 3 times to 6,000t/y since starting and will be expanded two fold to satisfy demand in the northern region. They produced PVC and pesticide before 1990 and stopped the production because of economic and environmental problems. However, there is a possibility to re-start production depending on the market, and in such a case, modification of facilities will be needed. Another factory 3km apart from this main factory produces $CaCl_2$ and 2 types of detergents of which raw material, LAS is imported from Korea. There is no expansion plan for detergent, because of many competitors in Viet Nam.

1.2 Status of Business

Business of their products is still weak especially for NaOH and chlorine because of competition with Chinese products and a price-free market which is not controlled. Cost of their products are rather high and this is caused by small scale production and old fashioned equipment, beside expensive electricity. Demand for electricity in Viet Nam is increasing and the price went up from 5 cents/kw to 6-7 cents/kw recently, and 2.5 cents/kw in China and 4 cents/kw in Japan, they said.

(1) Production

Production Capacity, Annual Production and Revenues in 1999 are shown in Table 2.

The company has been obliged to produce their product at a low operation rate, because of the market condition.

Table 2 Production Capacity, Annual Production and Revenues

Product	Production (t/y)	Capacity (t/y)	Revenue (Million VND)
NaOH (as 100%)	5,000	6,000	
HCl (31%)	10,200	14,000	
NaOCl	2,750	8,000	
Liq. Cl_2	977	1,500	
Washing Powder	1,515	5,000	
Washing Paste	5,187	14,000	
Na_2SiO_3	2,681	5,000	
$CaCl_2$ (at least 96%)	1,150	2,000	
Total			64,105.898

(2) Debt

The company's debt is 4,700 million VND as the short term loan.

2. Production Technology

2.1 Process

The production technology for NaOH is the diaphragm process introduced from China and titan is used for the material of electrodes. Figure 1 shows caustic soda production process, and Figure 2 shows detergent and silicate production processes. The technology for detergent is domestic by local consultant.

2.2 Wastewater Resource

They use intake water from the Red River water after going through the sedimentation pond. In 1995 a recovery system of industrial wastewater was introduced to the company and 70% of wastewater, the total amount is 12,000m^3/d, was recovered successfully decreasing the amount discharged into the river. Industrial wastewater is treated by neutralization with no stirring and sedimentation, and the neutralization facilities are very simple, but work well now.

After this neutralization treatment, wastewater is discharged to the Red River with domestic wastewater. They are planning to recycle all wastewater in 2 years.

Another factory producing detergents discharges wastewater at only 30 m^3/d and has no problems. The company performs the analysis of pH for industrial wastewater on 3-4 points every day. The wastewater system and sampling points are shown in Figure 3.

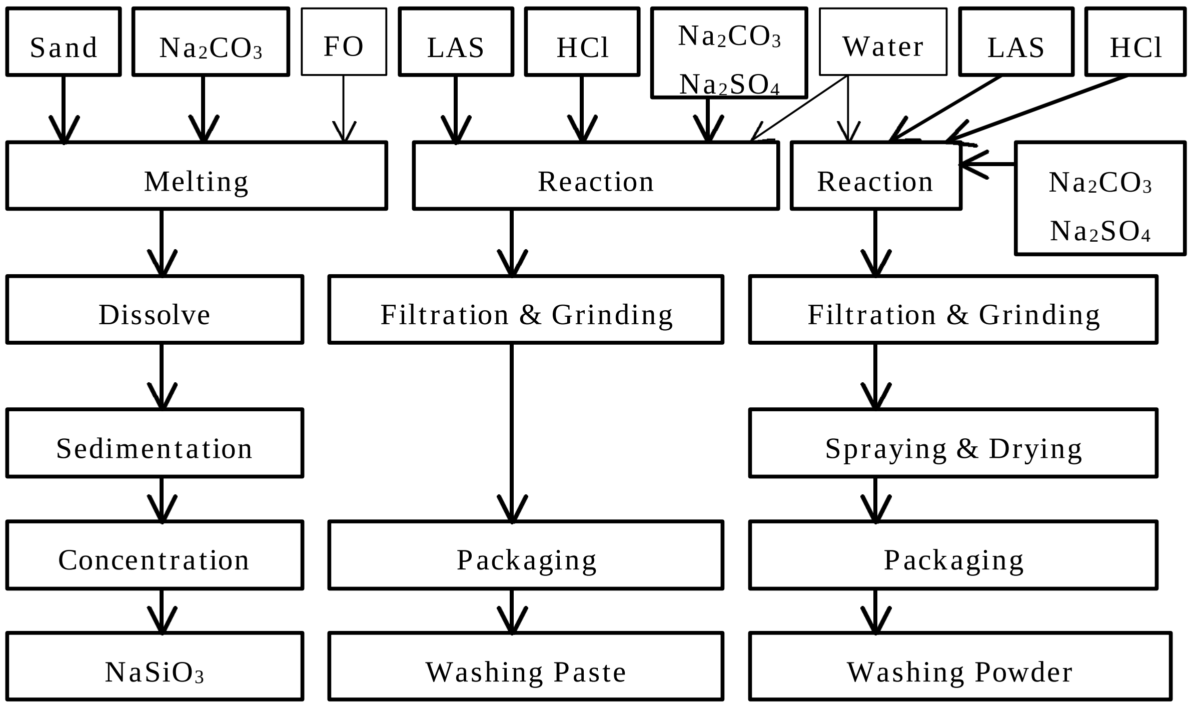


Figure 2 Sodium silicate , Detergent Production Process

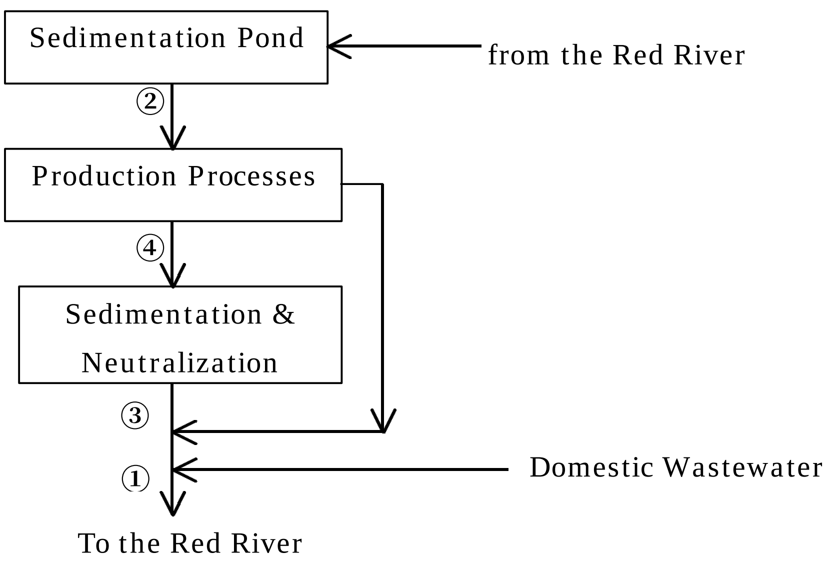


Figure 3 Water System and Sampling Points

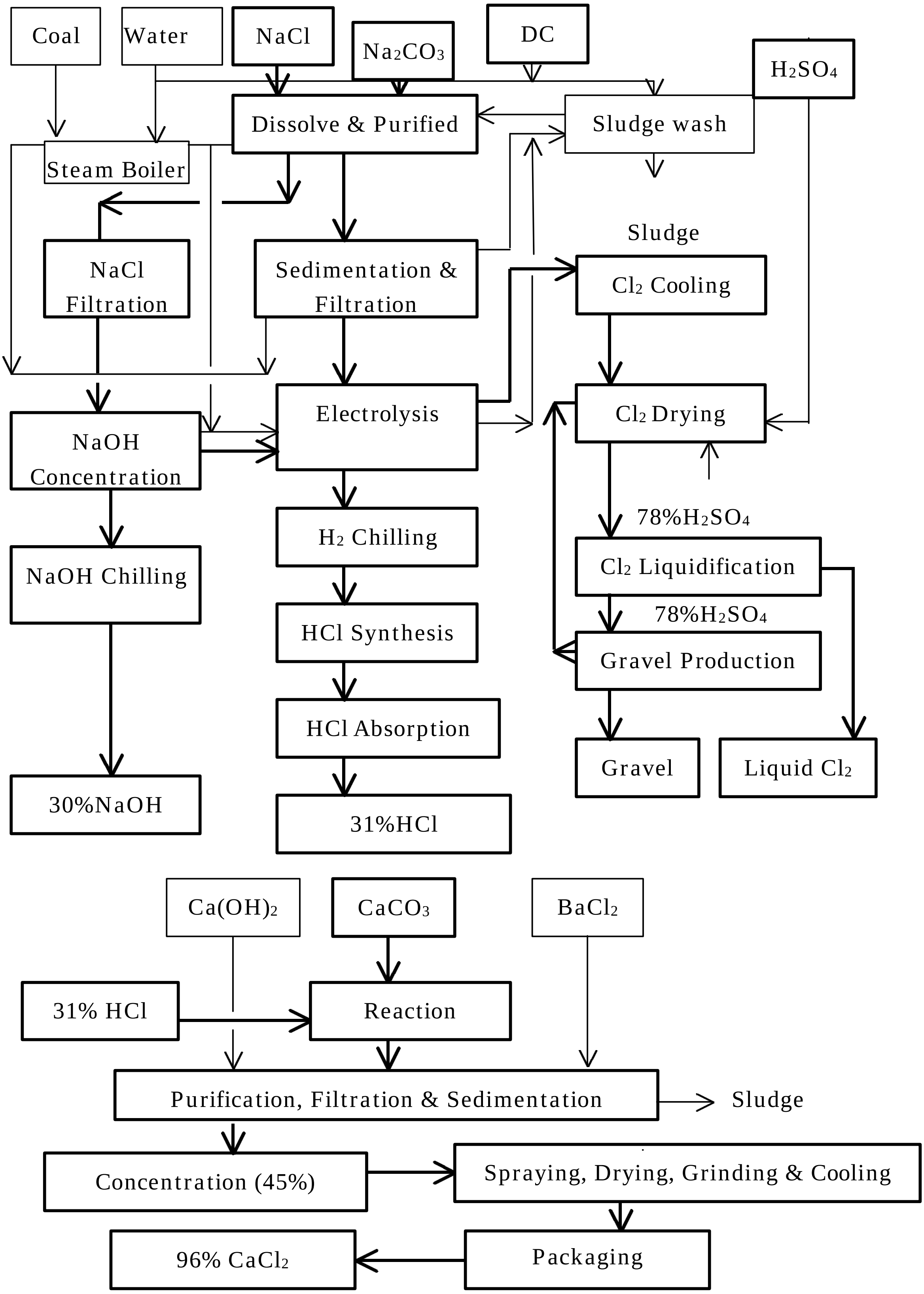


Figure 1 Caustic Soda and Chlorine Production Process

3.Management

3.1 General

After an environmental conference was held in Viet Tri district in 1992, the management decided to change the factory to be cleaner than ever, and the activities to plant trees and to put nests for doves were implemented.

Management of the factory is well performed and the concept on improvement for production and future plans very clear and concrete. The facility, building and equipment are being maintained in very good and beautiful condition.

The top management thinks that their factory is too small scale, too old and the cost of electricity is too expensive to survive the competition, so they eagerly want to renovate the factory soon.

Environmental impact of gas and solid waste is quite low and the main problem is wastewater discharged to the Red River. A recovery system of industrial wastewater was introduced in 1995.

Unit consumption of raw materials for each products, additives and utilities with annual consumption in 1998 are shown with its cost in Table 3.

Table 3 Annual Consumption and Cost in 1998

Material Used	Amount (kg)	Cost (VND/kg)	Total Use (Tones)
NaOH			
NaCl	1,812	550	9,066
$NaCO_3$	12.4	1,785	69.394
$CaCl_2$	13.96	2,500	69.8
Asbestos	0.167	69,607.7	0.8358
Steam	7,500	244,000	37,129
HCl			
Cl_2 Gas	328	360	3,347.233
Liq. Cl_2			
H_2SO_4	1.4	1,511.4	1.36
NH3	1.33	3,000	1,010
NaOCl			
Cl_2 Gas	78	360	214
NaOH	96	3,100	264
Na_2SiO_3			
Na_2CO_3	217	1,785	548
SiO_2	350	126.1	941
Detergent			
LAS	100.02	11,459	670.554
Na_2CO_3	78.02	1,785	922.930
NaCl	24.6	550	165.200
HCl	26.31	800	176.34
Na_2SO_4	147.53	975.5	988.775
Na_3P_5O10	10.04	6,396	673.17
NaOH	4.96	3,100	33.307
$CaCl_2$			
HCl	3,003.6	800	3,319
$CaCO_3$	1,338	112.9	1,479

According to company materials, consumption of utilities are as follows;

Industrial water：2,187,244m^3

Domestic water：53,948m^3

Electricity：15,142,833kwh

Coal：7,690t

Fuel oil：279.116t

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Sampling points and numbers are shown in Table 4. The results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 5.

Table 4 Sampling Points and Numbers

Sample Numbers	Sampling Points
1	Wastewater discharged to the Red River
2	Intake Water from the Red River after Treatment
3	Wastewater after Treatment
4	Wastewater before Treatment

Table 5 Wastewater Quality （CECO）

Sampling Point		1	2	3	4
Parameter	Unit				
Time		10:50	11:00	11:07	11:12
Temp.	℃	37	27	35	27
pH		7.0	7.8	5.7	1.9
Conductivity	mmS/cm	3.5	0.27	3.6	12
Turbidity	NTU	380	30	20	44
Oil content	mg／l	0.35	0.00	0.27	0.32
BOD_5	mg／l	52	15	72	97
COD	mg／l	142	28	168	344
DO	mg／l	3.9	3.6	3.4	3.6
SS	mg／l	1,122	67	9	69
T- nitrogen	mg／l	28.6	16.8	30	28
CN	mg／l	0.004	0.000	0.006	0.01
Phenol	mg／l	0.002	<0.001	0.003	0.003
Residual Cl	mg／l	0.2	0.00	0.2	0.7
SO_4	mg／l	38	11	12	10

4.2 Regulation Standards

Regulation Standards of Industrial Wastewater (Rank B) in Viet Nam are shown in Table 6. in order to compare to the value at sample point 1 in Table 5 where wastewater is discharged to the public areas.

Table 6 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
PH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(Ⅵ)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(Ⅲ)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

According to the comparison between the results of the analysis on sample No.1 which is discharged water to the river and TCVN value, BOD5, COD and SS exceed the regulated standard value. On the other hand, process wastewater before being mixed with domestic wastewater exceeds only BOD5 and COD. This fact indicates that excess SS is the result of domestic wastewater. So, if they aimed for a 100% water recycle system in 2 years, they should install a biological treatment facility such as activated sludge treatment, for domestic wastewater.

5. Recommendation for Pollution Prevention

5.1 Short term recommendation

(1) Take action to have a study for countermeasures on decreasing BOD5, COD and SS as soon as possible. However, first thing to do is to accelerate reduction, recovery and recycle of wastewater.

(2) Consider recovering 100% wastewater by recycling, the company should install an activated sludge treatment system for their domestic waste water.

(3) Discharged water to the Red River seems to contain chlorine because of

its odor, and chlorine content should be studied in detail. However, data in Table 5 does not show that is exceed the regulated standard value.

5.2 Mid- Term and Long Term Countermeasures

(1) Improve the productivity by cutting variable costs through expansion of production and introduction of new effective technology.

CASE STUDY C-08

Sao Vang Rubber Company

Survey Date : November 26, 1999

1. General

1.1 Profile

Sao Vang (Gold Star) Rubber Chemicals Company is one of the State-owned companies under MOI, specializing in producing tires and rubber products for vehicles and industrial use. The factory profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Sao Vang Rubber Company / Ha Noi Factory
Ownership:	State owned
Address:	231 Nguyen Trai- Thanh Xuan- Ha Noi
Director:	Mr. Nguyen Duy Dang
Established	1960
Corporate Capital	
Number of Employees:	2,100
Main Products:	Rubber Tire & Derived Goods

The main products of Sao Vang Rubber Chemicals Company are tubes and tires for automobiles and tractors, tubes and tires for motorcycles and bicycles, conveyor belts and V-belts of different sorts, rubber hoses and other rubber technical retail products. The number of employees is 2,100, however, the number of employees was 260 at the time of establishment in 1960. The initial production capacity of tires for bicycles was 30,000 tires/y.

The demand for tires and the development of the company was so fast, so as to increase the production capacity. At the end of the 1980's, the production capacity became 31 times the initial capacity, for example;

① bicycle tires; 4,000,000-5,000,000tires/y

② car tires; 60,000-70,000sets/y

③ rubber pipe; 1,000,000m/y

④ rubber products and other technical products for industrial use

The main factory is located in Hanoi. There is a factory producing intermediate rubber products in Vinh Phu province and another factory producing tires for bicycles in Thai Binh province.

1.2 Status of Business

The market of rubber products in Viet Nam is big and the demand is expanding, so the production facility runs at its full capacity. Also employees work overtime everyday at present. The business outlook of the company for the future is quite bright and investment is planned for future expansion of car tires for which production capacity is to be 500,000sets/y at the year of 2003, and was approved by top management. The new facility will be installed in Vinh Phu province.

1.2.1 Production

The actual production for 1998 for their main product and revenues are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product Type	Unit	Production	Revenue (1000VND)
Air Plane Tire	Product	822	1,817,000
Car & Truck Tire	Product	100,601	61,596,535
Car & Truck Tube	Product	84,457	4,279,525
Car & Truck Carpet	Product	9,593	489,405
Motorbike Tire	Product	453,872	24,261,567
Motorbike Tube	Product	1,090,234	16,428,017
Bicycle Tire	Product	6,780,358	102,131,120
Bicycle Tube	Product	7,839,982	39,172,821
Rubber Boot	Pair	16,437	384,205
Curoa (all type)	Product	8,223	83,116
Rubber Pipe (all type)	M	5,155	314,444
Technical Rubber	Kg	--	8,516,709
Battery Cell	Product	28,570,000	27,256,567

According to this data, the main product, tires for cars were produced at almost 100,000sets/y and tires for bicycle 6,800,000tires/y in 1998.

The main raw material, natural rubber, is purchased from Southern Viet Nam and is sulfurized for various products.

As for the boiler system, 5 coal boilers(made in China and Taiwan) and 1 oil base boiler(made in Germany) are operated at a capacity of 36t/hr steam generation, but the actual operation rate is about 40% now. Two of the coal base boilers will be replaced by oil base boilers of German technology in the near future.

1.2.2 Debt

12.6 billion VND to the bank, Dong Da Bank of Commerce at the end of 1998.

2. Production Technology

2.1 Process

The production technology and facilities for tires and rubber products were initially introduced from China in 1960's and the expansion of production capacity was attained by buying equipment from China and Taiwan under their technical support. The production technology was changed from a hand made base to a mechanical base in the 1990's. The technology by Inoue Rubber Co., Japan is applied to the production of bike tires. New technology does not use zinc in the production process.

Figure 1 shows rubber processing process.

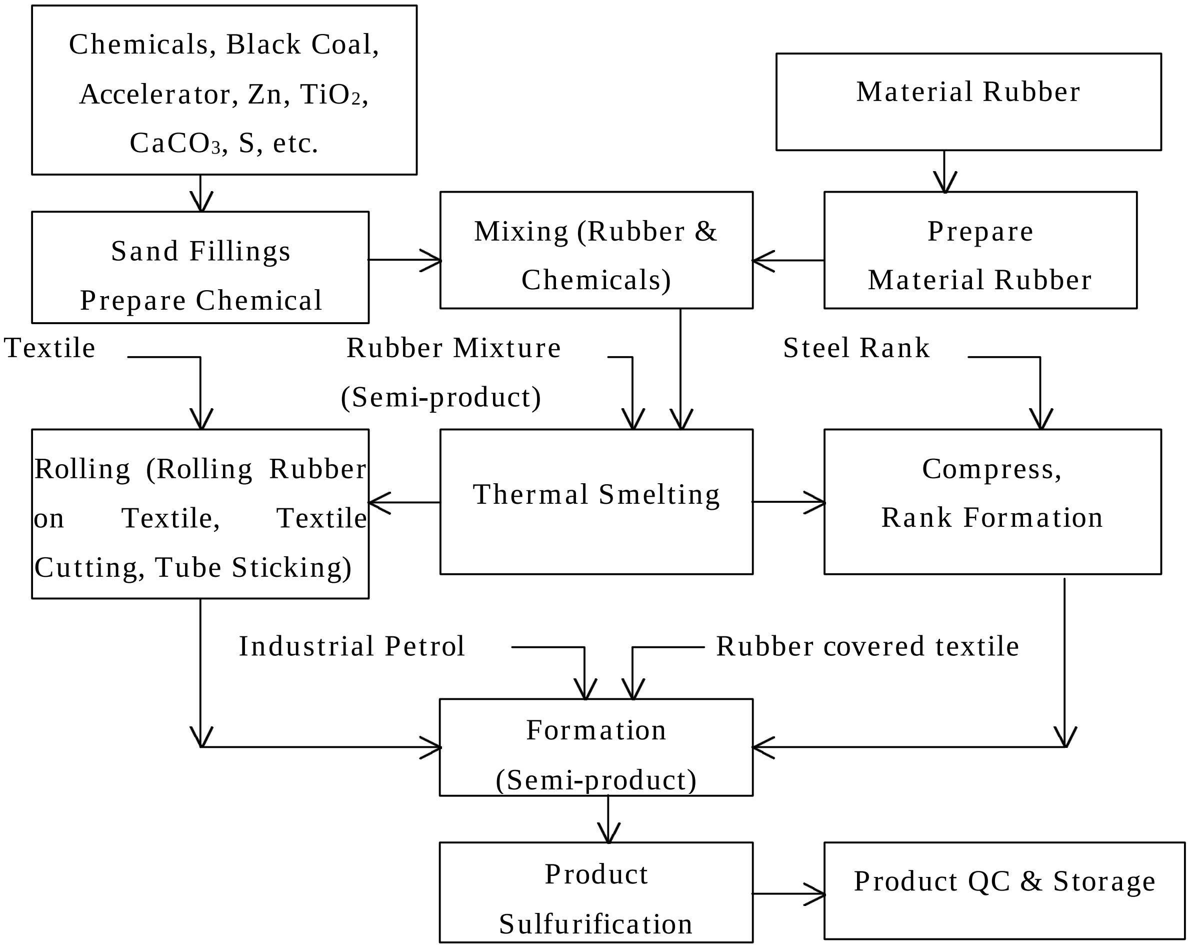


Figure 1 Rubber Processing Process

2.2 Wastewater Source

Main concern for the environment is not the wastewater issue in rubber production, but dust and toxic organic solvents. The organic solvent was changed from benzene to industrial petroleum to decrease its toxic influence.

The industrial water is supplied from a deep well in the factory at 200 m^3/h for boiler feed water and supplemental water for cooling water and domestic use. There is no data on the amount of steam condensate.

Before 1996 they had no recovery system and water was wasted at 6,000m^3/d. Recycled water is used as cooling water. After a circulating system was applied for minimizing the wastewater, it is now estimated at only about 200m^3/d. The quality of all wastewater is within standards and the main concern is SS and volatile substances. They would like to increase recycling water rate from 40% to 90% in the future.

A periodical check on wastewater has not been performed since 1996 after the wastewater project in the company finished its work, and EIA was performed in 1996 only. So no recent data for wastewater exists and the wastewater treatment is not actually performed for environmental conservation.

The wastewater seems not to be seriously polluted at present, but the oil contamination on the surface of wastewater can been seen. Oil leakage was observed on the ground in the factory, especially a large amount around the boiler facility, near the mechanical machine facility, from knock out vessels and from cars used for logistics.

Water System and Sampling Points are shown in Figure 2.

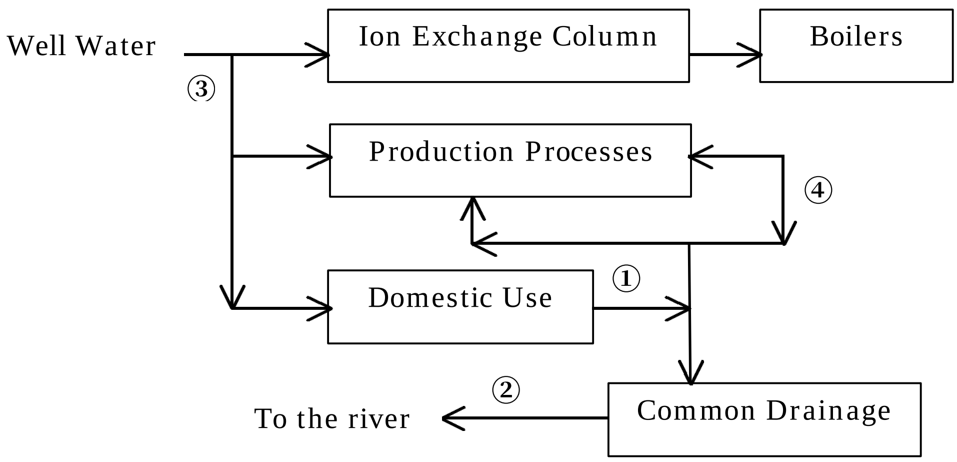


Figure 2 Water System and Sampling Points

For drainage as common channel is utilized by 3 enterprises, Sao Vang Rubber Co., LEVER HASO and their subsidiary company, Ha Noi Detergent Company.

3. Management

3.1 General

At the same time they innovated technology in the 1990's, the management system was also renovated for an open market. The factory of this company seemed well managed actually from the view point of the production system.

From the aspect of environmental improvement, the technology and management have been renewed, especially during the period from 1993 to 1999, as 100,000,000VND was invested to renew technology and equipment. The technology in production is now quite advanced and part of the production line is automated.

Work for ISO9002 is now taking place for application on January 2000, and the company also has an idea to apply for ISO 14000 in the future.

The environment is considered and well managed, and also the working standards are well satisfied are a good influence for the community. The factory is located in a shopping and urban area and the Government invested to apply a closed system for prevention of dust and toxic gas emissions. Part of the production line and equipment were moved to the countryside in Thai Binh Province, 100km south of Hanoi. This was because the production facility had generated pollution in the past and was requested to move to another province.

3.2 Unit consumption

Actual consumption of raw materials for each products, additives and utilities with annual consumption in 1998 are shown in Table 3.

Table 3 Unit Consumption and Annual Consumption in 1998

Material Used	Purpose of Use	Amount (t)	Cost (1000VND)
Rubber	Main material	5,080	40,640,000
Calcium Carbonate	Filling	2,500	2,020,000
Barium Sulfate	Filling	125	93,750
Bentonite	Filling	170	149,600
Black Coal	Filling	1,000	5,600,000
Sulfur	Surfurification	125	395,000
Iron Oxide	Coloring agent	30	190,500
Taitanium Oxide	Coloring agent	5	150,000
Anti-aging Agent	Prevent rubber aging	65	2,925,000
Accelerator	Accelerate sulfurification	50	1,750,000
Flexon Oil	Rubber softner	200	1,020,000
Stearic	Rubber softner	120	1,166,400

Material Used	Purpose of Use	Amount (t)	Cost (1000VND)
Paraffin	Framing additive	60	330,000
Pine Oil	Softner	70	525,000
Pine Resin	Softner	40	280,000
Dissolvable Powder	Separating agent	60	180,000
Industrial Fat	Softner	10	135,000
Industrial Petrol	Dissolve solvent	230	1,633,000
Textile	Resistance enhancer	620	33,699,480
Textile	Resistance enhancer	25	1,007,975
Textile	Water proofing	60	180,000
Steel	Car & Bicycle Tire	720	8,106,480
Lubricant	Equipment lubricating	270	270,000
Diesel	Car & Truck consumption	2	7,000
Fuel Oil	Use for oil based boiler	3,600	6408,000
Furnace Coal	Use for coal based boiler	15,000	4,800,000
Electricity	Production & Domestic use	16,800,000kwh	13,000,000

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Sampling points and numbers are shown in Table 4. The results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 5.

Table 4 Sampling Points and Numbers

Sample number	Sampling Points
1	Wastewater Outlet to the Common Drainage
2	Wastewater in the Common Drainage (3 companies)
3	Well Water
4	Wastewater from Production Processes in the Circulation Line

Table 5 Wastewater Quality （CECO）

Sampling Point		1	2	3	4
Parameter	Unit				
Time		10:20	10:22	10:37	10:45
Temp.	℃	38.5	32.4	29	31.3
pH		7.1	8.5	7.1	8.2
Conductivity	mmS/㎝	0.9	0.1	0.8	0.68
Turbidity	NTU	66	74	52	39
Oil content	mg／l	0.2	0.32	0.00	0.17
BOD_5	mg／l	78	270	1	12.5
COD	mg／l	220	452	7	36
DO	mg／l	2.4	4.5	7.8	4.2
SS	mg／l	61	71	3	3

Sampling Point		1	2	3	4
Parameter	Unit				
T-nitrogen	mg／l	8.4	13.7	3.8	4.5
CN	mg／l	0.009	0.006	0.000	0.001
Phenol	mg／l	0.007	0.005	<0.001	<0.001
Residual Cl	mg／l	0.03	0.05	0.00	0.00
S Compounds	mg／l	67	30	0.00	3

4.2 Regulation Standards

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 6.

Table 6 TCVN 5945-1995（ Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(Ⅵ)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(Ⅲ)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

According to the comparison of the data for Sampling point No.1 in Table 5 and TCVN in Table 6, the value of BOD5、COD and sulfur compounds exceed the regulation.

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Take countermeasures for BOD5,COD and sulfur compounds soon.

(2) Adopt the activated sludge treatment for the high BOD5 wastewater after studying the present condition of domestic wastewater and reducing it, if necessary.

(3) Prevent sulfur compounds flowing into drainage from the contaminated floor.

(4) Conduct a periodical check on the quality of wastewater and include quality check on industrial wastewater in EIA starting next time.

(5) Countermeasure to stop the oil leakage from equipment ,facilities and cars. Also for oil leakage removal from ground and equipment.

(6) Reduce the volume of industrial wastewater to the river by recovery.

5.2 Mid- Term and Long Term Countermeasures

(1) Install an oil separator before discharging wastewater of the drainage to the river.

(2) Apply for ISO14000 in the near future. In order to apply, it is necessary that the periodical EIA, more active environmental management including environmental committee should be implemented.

CASE STUDY C-09

Van Dien Fused Magnesium Phosphate Fertilizer Company

Survey Date : November 29, 1999

1. General

1.1 Profile

Van Dien Sintering Superphosphate and Chemical Company is one of the State-owned companies under MOI, specializing in producing fused magnesium phosphate fertilizer and NPK fertilizer. The factory profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Van Dien Fused Magnesium Phosphate Fertilizer
Ownership:	State owned
Address:	Van Dien- Thanh Tri- Ha Noi
Director:	Mr. Nguyen Quoc Viet
Established	1960
Corporate Capital	
Number of Employees:	526 (27 engineers)
Main Products:	Fused Magnesium Phosphate Fertilizer, NPK, Cement

The main products of Van Dien Sintering Superphosphate and Chemical Company are fused magnesium phosphate fertilizer, NPK combination fertilizer and cement. When the company was established, the initial production capacity of fused magnesium phosphate fertilizer was 20,000 t/y by vertical furnaces and was increased to 90,000 t/y by the introduction of 5 vertical furnaces in 1975.

The strong demand for fused magnesium phosphate fertilizer has enabled the company to develop their production capacity to 180,000t/y in 1999. Also the demand for fertilizer for this is still very high and increases in production capacity are planned more and more, but they have no concrete figures for expansion yet at present.

The capacity of the main product, fused magnesium phosphate fertilizer, was attained by improving the technology and changing facilities, which consisted of the furnaces, reactors and other equipment. Especially, the 5 furnaces were replaced with 3 new ones with new technology in order to reduce raw materials and energy for production by 30% compared with conventional technology. If the conventional technology was still in use now at 180,000t/y production, solid waste from the process should be 5,000 to 6,000t/y, but actually the byproduct was completely recovered and fed to the process as a main raw material. This improvement had a big effect on the economy and environment of the existing process and it caused to a considerable reduction in their production cost. Fuel is another factor that causes high costs and pollution to the environment. Coal costs are so high for production and it contains a higher amount of sulfur. Coal generates much sulfur dioxide and carbon dioxide. So they made efforts to take countermeasures to reduce the consumption of coal. For example, by only introducing a vertical furnace it caused the unit consumption ratio of coal to drop from 0.62 t-coal/t-product to 0.19 t-coal/t-product. Also, the consumption ratio of electricity improved from 145kw/t-product to 60 kw/t-product (electricity cost was cut almost 65% to 70%). This improvement made it possible to reduce total cost of the product by about 60%. At the same time they made efforts to improving product quality, and got customers from Japan in the beginning of the 1990's. Area of the factory is 10 hectares. Expansion in the past was attained by improvement of efficiency, because the available area is too small for them to expand more.

1.2 Status of Business

They need to improve production capacity more because their product demand is getting bigger, however, an expansion of production capacity is not planned at present.

(1) Production

Annual Production and Revenues in 1998 are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Production	Revenue (Billion VND)
Fused Magnesium Phosphate Fertilizer	139,144 Tons	115.432
NPK Compounded Fertilizer	9,270 Tons	10.835
Cement & Other Products		0.478
Total		126.745

(2) Debt

No description

2. Production Technology

2.1 Process

The production technology and facilities for main products were initially transferred through Japan, China and Korea in 1950's and introduced to the enterprise in 1960.

Fused calcium superphosphate production process is shown in Figure 1.

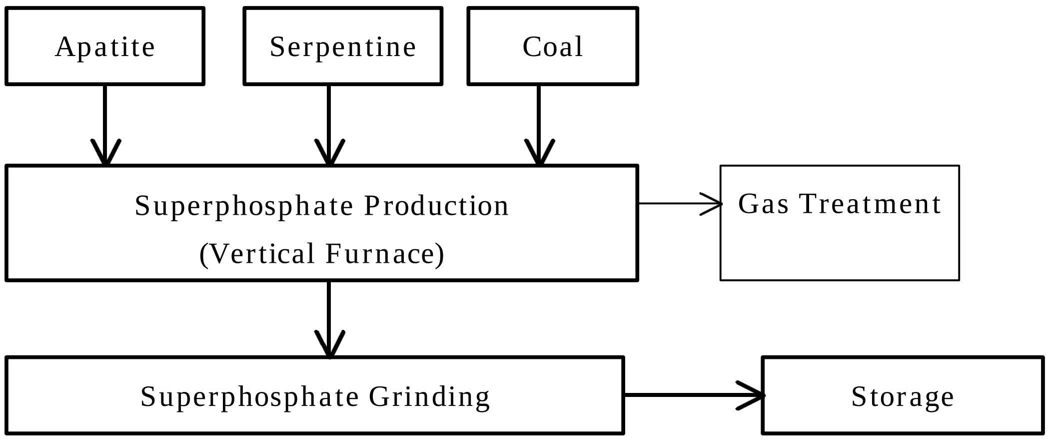


Figure 1 Fused Calcium Superphosphate Production Process

2 .2 Wastewater Source

In spite of increasing the capacity of production, the volume of wastewater has been decreased and the quality of wastewater improved apparently after having implemented a wastewater treatment system similar to one of phosphate companies in Japan. The circulation system of water enables wastewater discharge to be decreased to 2/3 of original amount and 100% of wastewater will be recovered in the near future by minimizing water usage.

Water supply comes from underground pumping at present, but they have been warned by authorities that their descending land will be a big problem in Hanoi because of excessive consumption of underground water in the near future.

The volume of discharged water is 2,000 m3/d from each furnace and is sent to the To Lich River. An amount of 4,000 m3/d is utilized through recycling in the company.

Water system and the sampling points are shown in Figure 2.

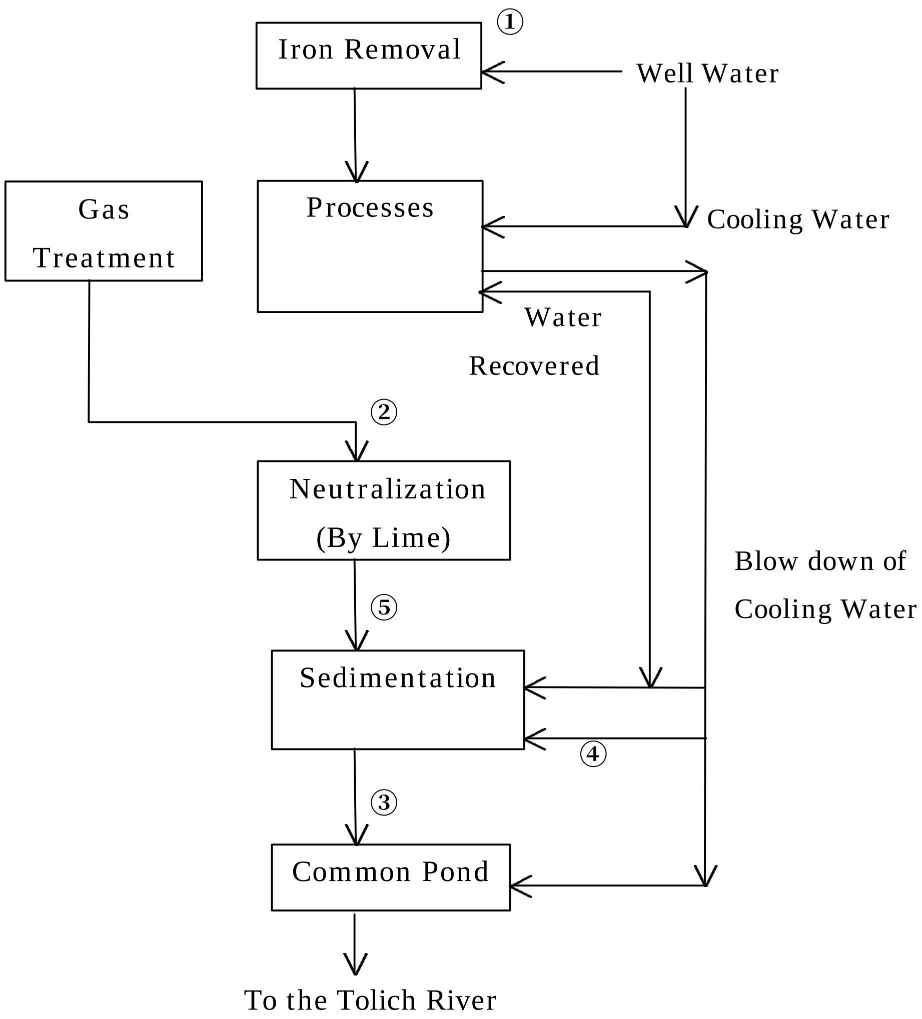


Figure 2 Water System and Sampling Points

3. Management

3.1 General

The company has Targeted the 3 main objectives, product quality 1st, environmental conservation 2nd and economic improvement 3rd ,as the basic principles of the company.

The company is now just applying for ISO9002 and it seems that they will get ISO9000 certification in 2001. However, an application for ISO14000 is not planned at the moment.

3.2 Unit Consumptions

The following is a comparison of 3 types of furnaces, unit consumption of raw materials for each product, and additives and utilities in 1998 are shown in Table 3.

① Unit Consumption of Raw Materials

Though 3 technologies have the same unit consumption, electric furnaces and horizontal furnaces need fine raw materials, so there is an added cost for crushing. On the other hand, high vertical furnaces consume raw materials with a size 10-90 mm in diameter and fine materials should be arranged into the shape and size of a cake.

② Unit Consumption of Fuel Oil and Electricity

Electric furnaces : Unit consumption of electricity is 900+74 kw/t-product and unit price of electricity is 770 VND, so the electricity cost is 749,980 VND/t-product.

Horizontal furnaces : Unit consumption of fuel oil and unit price of oil, 3600 VND/l will result in fuel costs of 468,000 VND/t-product. In the same way, electricity cost is 119,550 VND/t-product. Total cost is 587,350 VND/t-product.

High Vertical furnace : Electricity cost is 50,050 VND/t-product and coal cost is 153,600 VND/t-product (Unit price : 640 VND/t). Total cost is 203,650 VND/t-product.

The vertical furnace is the most economical among the 3 type of furnaces. Anyway, waste treatment for exhaust gas, wastewater and solid waste is necessary for the 3 processes. The data of horizontal furnace was supplied by Hinode Co., Japan in 1993.

Table 3 Unit Consumption in 1998

Material	Electric Furnace	Horizontal Furnace	High Vertical Furnace
Apatite Serpentine Additive	1.25 t/t-product	1.25 t/t-product	1.25 t/t-product
Electricity for Thermal reaction	800-900 kw/t-product		
Electrode	5 kg/t-product		
Electricity for Machine	74 kw/t-product	155 kw/t-product	65 kw/t-product
Fuel Oil		130 l/t-product	
Coal			0.23 t/t-product
Powder Coal No.4 for Semi product drying		0.1 t/t-product	

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Results of the analysis by the Institute of Chemical Industry in on December 9th 1998 are shown in Table 4.

Table 4 Results of the analysis by the Institute of Chemical Industry

Parameter	Unit	Vietnam Standard	Results	
			Sample 1	Sample 2
pH		5.5-9	8.46	7.46
COD	mg/l	100	49	28
BOD_5	mg/l	50	15.6	10.2
SS	mg/l	100	120	100
Pb	mg/l	0.5	0.04	0.07
Mn	mg/l	1	0.71	0.51
Fe	mg/l	5	3.48	2.28
T-nitrogen	mg/l	60	5.6	7.0
P_2O_5	mg/l	6	2.9	Undetectable
F	mg/l	2	2.32	1.98

Sample 1: Wastewater in the drainage of the company

Sample 2: Pond Water next to the living area of the company workers

Company stated that there is no problem on exhaust gas because they wash HF in the exhaust gas, however, opposite statement was given by Mr. Do Thanh Bai from Institute of Chemical Industry.

Table 5 shows sampling points.

The results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 6.

Table 5 Sampling Points

Sample Number	Sampling Points
1	Intake water before treatment
2	Wastewater after furnace(Smelter)
3	Wastewater after treatment
4	Cooling Water
5	Wastewater after neutralization

Table 6 Wastewater Quality （CECO）

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		10:05	10:10	10:30	10:50	10:55
Temp.	℃	22.3	48.7	41	41	42
pH		7.15	7.51	7.29	7.5	2.7
Conductivity	mms/cm	0.42	0.69	0.7	0.6	0.3
Turbidity	NTU	10	51	29	80	239
Oil content	mg/l	0.02	3.5	1.6	0.52	0.25
BOD_5	mg/l	3	7	27	7.5	18
COD	mg/l	12	32.9	120	19	64
DO	mg/l	8.3	2.2	2.7	2.4	1.9
SS	mg/l	24	77	39	42	465
T-nitrogen	mg/l	4.56	10.14	12.48	14.66	16.24
CN	mg/l	0.000	0.000	0.001	0.000	0.000
Phenol	mg/l	<0.0001	0.00	<0.001	<0.001	<0.001
Residual Cl	mg/l	0.00	0.00	0.01	0.05	0.03
SO_4	mg/l	0.00	19	40	3	118
Mn	mg/l	0.00	0.1	0.6	0.5	3
Fe	mg/l	1.94	1.24	0.63	1.85	12.68
T-P	mg/l	0.03	5.41	1.72	1.64	67.5
Pb	mg/l	0.00	0.071	0.658	0.02	18.86
F	mg/l	0.052	12.5	8.15	0.17	23.3

4.2 Regulation Standards

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 7.

Table 7 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater	Parameter	Unit	Wastewater
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2	Cu	mg/l	1
Pb	mg/l	0.5			

By comparing data for sampling point No.3 in Table 6 and relating data in Table 7, the value of the temperature of the water, COD, lead and fluorine compounds exceed regulations.

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Take action for establishing countermeasures on temperature of discharged wastewater, COD, lead and fluorine compounds as soon as possible.
For COD and lead, more analysis on correlation between the operation condition and the quality of wastewater are necessary. As the concentration of fluorine compounds shows high value, fluorine compounds should be removed as an insoluble calcium salt under the strict pH control.

(2) Create a closed system for wastewater in the near future.

(3) Install closed drainage for prevention of injuries of workers by hot water and acidic wastewater.

5.2 Mid-Term and Long Term Countermeasures

(1) Conduct a study to reduce noise in the factory through the analysis of noise sources on frequency and strength of noise. Then, take adequate countermeasures to reduce noise depending on the quality and level of noise.

(2) Apply for ISO14000 in the near future In order to apply, it is necessary that the periodical EIA, more active environmental management including environmental committee should be implemented.

CASE STUDY C-10

LEVER HASO JV Company

Survey Date : November 30, 1999

1. General

1.1 Profile

Lever Haso is one of the JV venture companies invested in by Unilever, one of the worlds biggest consumer products company. As one of 3 joint venture companies of Unilever, Lever Haso was formed by Unilever and MOI, the Government of Vietnam in Jan., 1995. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	LEVER HASO JV Company
Ownership:	JV between State owned company and private company
Address:	233 Nguyen Trai- Thanh Xuan- Ha Noi
Director:	Mr. Pham Van Trac
Established	1995 (starting operation in 1996)
Corporate Capital	
Number of Employees:	200 (excluding 100 seasonal employees)
Main Products:	Powder Detergent, Body Wash, Shampoo, Wash Milk

Their 4 main products are detergent powder, body wash, shampoo and washing milk. 1 year after establishment, production started in 1996, and after 2 more years, the operation generated profits and paid taxes to the Government. The company has already applied for ISO9000 and is now trying to apply for ISO14000.

The organization of the company consists of 1 director, 1 vice director, 3 units of production, R&D department, maintenance department, energy department and administrative department. At present the company has a good relationship with the Local Government and is complying with all laws and regulations.

The Unilever group in Viet Nam was chosen as the No.1 production company in 1999 and their products by Lever Viso, Lever Haso and Elida P/S were honored as Top 10 Products in Viet Nam in 1999.

1.2 Status of Business

The market for home and personal care in Viet Nam has been very good for

Lever Haso. Their revenue in 1998 reached 17.3 mil. USD, 14 times more than before they formed the joint venture. In 1999, a 20% increase is expected in comparison with the figures for 1998.

The capacity of the main products comply with present demand, but expansion of capacity is expected to increase 20% annually in the future. Because of the limitation of land area there, they can not install any more new facilities, but exchanging intermediates for products enables them to increase production levels.

(1) Production

One of the raw materials for powder detergent, LAS, is supplied from the JV company with Japan in Viet Nam. Annual production of main products in 1998 is shown in Table 2.

Table 2 Annual Production in 1998

Product	Production (t)
Shampoo	3,197
Scented Soap	1,723
Detergent Powder	18,990
Total	23,910

(2) Debt

2. Production Technology

2.1 Process

The production technology and facilities for the main product were transferred from Unilever, UK. All production processes for all products seems to have already introduced Cleaner Production and are maintained in good condition.

Basically, all production systems are operated automatically and high productivity and high quality has been attained. The production line is operated by 3 shifts, 24hrs/d and packaging unit operators wear clean uniforms, masks and caps. The equipment in the production line is made of stainless steel to keep the product quality higher. The floor in the production building is kept clean everywhere except in the powder packaging unit, which is polluted by gray dust caused by a neighboring factory. There was slight leakage at the LAS tank yard.

Soap, powder detergent, and shampoo production processes are shown Figure 1,2 and 3 respectively.

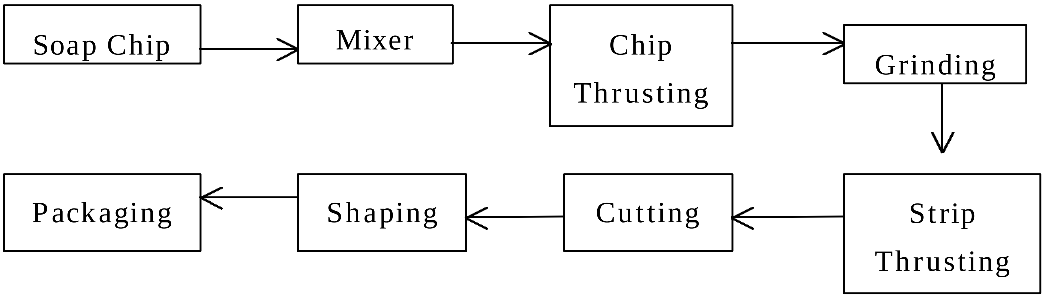


Figure 1　Soap Production Process

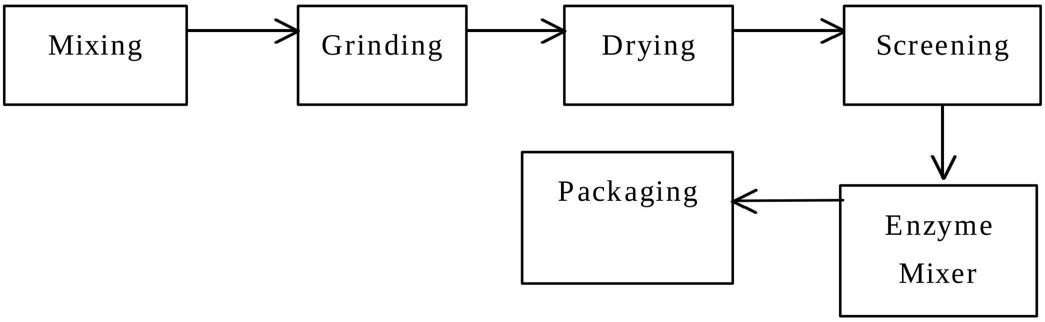


Figure 2　Powder Detergent Production Process

Figure 3　Shampoo Production Process

2.2　Wastewater Source

There is no industrial discharge from the company to public drainage, and only 40m^3/d domestic wastewater is discharged to the Tolich River, one of the most polluted river in Hanoi City. Supply water is introduced from common water pond outside and 100m^3/d (3,000m^3/M) is consumed for domestic water, boiler feed water and process water. Industrial use of water is only 60m^3/d which is consumed as boiler feed water, cooling water and washing water in processes, but all wastewater from the processes s circulated through sedimentation treatment pond and recycle water storage tank. These circulating facilities for reducing and reusing wastewater were completed at the end of 1998.

Water system and sampling points are shown in Figure 4.

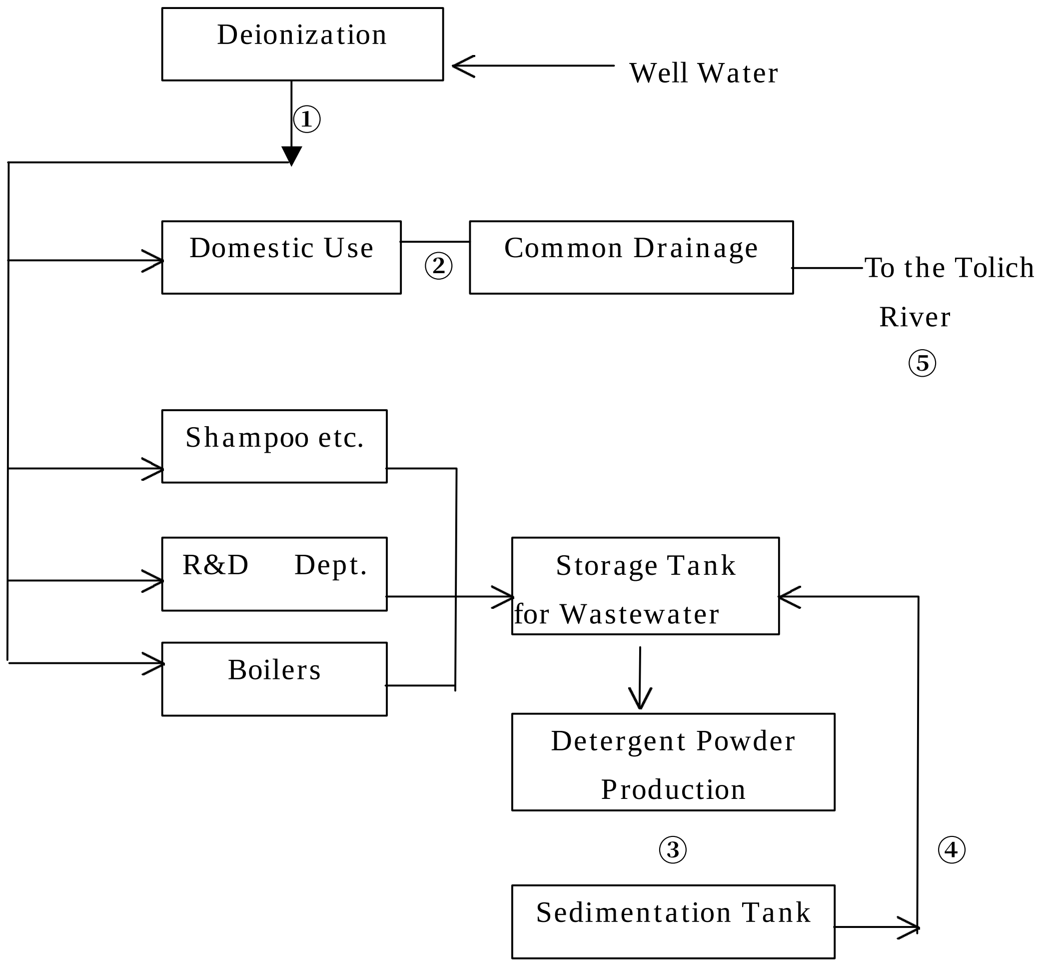


Figure 4 Water System and Sampling Points

3. Management

3.1 General

The management system of the company is just the same as advanced companies in developed countries. They have an environment and safety organization consisting of a Vice director, Heads of each related Department and representatives of a labor union. They have environmental audits annually by the parent company UK, and also have information exchange with parent UK company on the various subjects. There are high level of Environmental manuals for operation. The activities for activation of the company, Total Productive Management/Maintenance, 5S activity and Kaizen (improvement) activity are performed through all the factories there. These activities make company productivity high and ensure a clean environment, safe working conditions, stable production & quality control.

They already have ISO9000 certification, and ISO 14000, which they are getting ready for, will be certified in the beginning of 2000.

3.2 UnitConsumption of Raw Materials and Utilities

Unit consumption of raw materials for each product, additives and utilities in 1998 are shown in Table 3.

Table 3 Unit Consumption and Cost in 1998

Material Used	Amount	Cost (VND)
Shampoo		
Emal	19,508 kg	328,844,000
Silicone	2,350 kg	1,239,400,000
Fragrance	500 kg	125,132,000
Scented Soap		
Soap Chip	336,300 kg	3,767,500,000
Fragrance	2,830 kg	315,478,000
Detergent Powder		
LAS	3,744,326 kg	38,540,058,985
Silicate	5,577,819 kg	4,264,232,661
STPP	2,890,700 kg	18,700,600,000
NaOH	1,485,000 kg	2,730,900,000
Fragrance	48,000 kg	7,860,663,000
Utilities		
Water	10,219 m3	40,876,000
Electricity	1,234,868 kwh	929,403,804
Fuel Oil & Diesel Oil	1,234,950 kg	2,259,876,150

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

The quality analysis is performed 1/week on domestic wastewater discharge on BOD5, COD, SS and AD (Active Detergent) by relative institute of MOSTE (STIMMEQ). The latest results of the analysis in Nov. 1999 show BOD5-20.9mg/l, COD-61.0mg/l and SS-46.6mg/l. All pollution items are analyzed annually in the EIA. No heavy metals are used in the production process. Results of the analysis by the STIMMEQ are shown in Table 4.

Table 4 Results of analysis on domestic wastewater by the STIMMEQ

Parameter	Unit	Results
BOD5	mg/l	20.9
COD	mg/l	61.0
SS	mg/l	46.6

Sampling points and their numbers are shown in Table 5 and the results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 6.

Table 5　Sampling Points

Sample Number	Sampling Points
1	Intake water after Treatment(Well water)
2	Discharged Domestic Wastewater to the Common Drainage
3	Industrial Wastewater after Treatment
4	Industrial Wastewater before Treatment
5	River Water(the To Lich River)

Table 6　Wastewater Quality　（CECO）

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		10:06	10:35	10:45	10:50	11:50
Temp	℃	23	23	24	23	23
pH		7.7	11.9	9.2	7.8	7.7
Conductivity	mmS/㎝	1.0	2.7	2.9	0.55	4.3
Turbidity	NTU	60	67	80	3	59
Oil content	mg／l	0.43	2.2	0.5	0.00	1.2
BOD_5	mg／l	94	920	1,100	0	350
COD	mg／l	120	1,400	1,800	4	520
DO	mg／l	2.6	6.0	1.3	5.1	0.7
SS	mg／l	46	57	93	3	56
T-nitrogen	mg／l	26.52	19.35	14.12	8.76	26.95
CN	mg／l	0.002	0.003	0.000	0.000	0.013
Phenol	mg／l	<0.001	0.008	0.005	<0.001	0.15
Residual Cl	mg／l	0.6	0.4	0.1	0.0	0.0
SO_4	mg／l	7	688	240	0	9
T-P	mg／l	0.34	0.16	0.19	0.01	1.52
As	mg／l	<0.001	0.006	<0.001	<0.001	0.09
LAS	mg／l	843	2,785	1,132	15	372

4.2　Regulation Standards

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 7.

Table 7　TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(Ⅵ)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(Ⅲ)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

As there is no industrial wastewater from this company, only domestic wastewater is polluted and its value of pH, BOD5 and COD exceed the regulations for industrial wastewater described in Table 6. However, these problems will be solved if they adopt a closed system for all wastewater from the company in December, 1999.

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Clean up the floor with detergent powder in packaging unit.

(2) Maintain the equipment and facilities installed outdoors and clean the rusting and small liquid leakage.

(3) Install a guard bridge above piping to avoid injury and accident for workers in the storage tank yard.

5.2 Mid- Term and Long Term Countermeasures

(1) Apply for ISO14000 in the near future. Environmental management has been implemented in this company so far, and the environmental condition is excellent. So they can apply soon after completion of closed system of

domestic wastewater.

6. Notice

Lever Haso seems to be one of the most advanced companies in the chemical industry in Viet Nam from the point of view of Cleaner Production and Environmental Conservation. The company is recommended to be one of the model companies in Vietnamese industry.

CASE STUDY C-11

Hai Phong Tia Sang Battery Company

Survey Date : December 1, 1999

1. General

1.1 Profile

The company profile for Hai Phong Tia Sang Battery Company is summarized in Table 1.

Table 1 Company Profile

Company Name:	Hai Phong Tia Sang battery Company
Ownership:	State owned
Address:	Ton Duc Thang- Hai Phong City
Director:	Mr. Nguyen Duy Sy
Established	1960
Corporate Capital	
Number of Employees:	275 (20 engineers)
Main Products:	Battery

Tia Sang Battery Company is one of the State-owned companies under MOI. The company produces various kinds of batteries for domestic use and has been expanding capacity, process technology and quality of its products. However, they don’t produce any dry cell batteries and they have no plan to produce them in the future.

1.2 Status of Business

Business for batteries is not so strong now and the operation rate of the plant in 1998 is about 80% of production capacity. However, they have to keep up with competition through expansion and improvement of existing facilities, especially in regards to product quality.

(1) Production

Battery production in the beginning in the 1960’s was 2,000 batteries/y and electricity consumption was 12,000kwh/y. However, production reached 178,000 batteries/y and electricity consumption rose to 1,656,000 kwh/y in 1998.

They are struggling to improve quality, including the life of the battery and to lower the cost of their product.

They purchases raw materials, PbO at 10,000 VND/kg and H_2SO_4 at 2,000 VND/kg. H_2SO_4 is transferred from Lam Thao Superphosphates and Chemical Co., at a transportation rate of 300,000 VND/5,000 kg using a 5 T-pickup. There is a storage tank for their H_2SO_4 near Hai Phong.

The ebonite casing is a little bit of a problem for consumers compared to plastic casing and the market share of plastic casing reaches 60% because the appearance is better than ebonite in spite of better strength and similar quality and cost.

The actual production for 1998 for their main product is shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Production (Product)	Revenue (x1000VND)
Staring Battery	54,000	22,680,000
Motorbike Battery	120,000	8,400,000
Specialized Battery	4,000	3,600,000
Total	178,000	34,680,000

(2) Debt

There is no description.

2. Production Technology

2.1 Process

The production technology used for batteries is an integration of domestic and foreign (Chinese, Korean and Russian) technology. The equipment for production was imported from Taiwan and Korea. At first, the ebonite casing was used for batteries, but they have made an investment to produce a new type of casing which is made of plastics. Battery production process is shown in Figure 1.

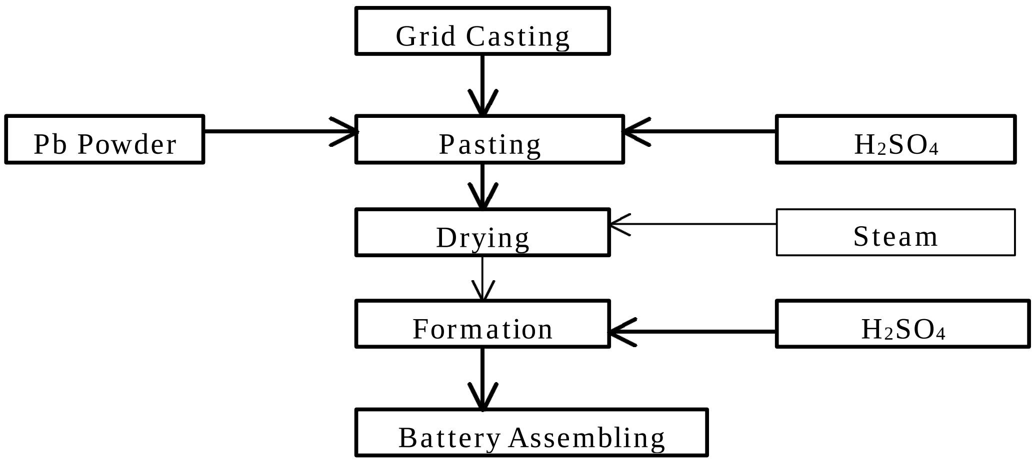


Figure 1 Battery Production Process

2.2 Wastewater Source

In accordance with the increase in production, the volume of wastewater, especially cooling water, has increased. The production facility is washed once a day and effluent water contains $PbSO_4$. They recover 4 kg $PbSO_4$/day.

There is a big industrial wastewater treatment facility for neutralization, lime bed ponds sized 2 m-in width, 15 m-in length and 1 m-in depth in 4 rooms' of a concrete vessel. However, the actual procedure is not appropriate and pH of wastewater in not improved after even being sent to the huge lime bed. This means heavy metals like Pb can not be precipitated as salt for removal from wastewater, so the method which utilizes a lime bed is requested to be improved as soon as possible.

Results of analysis for heavy metals had no problems in the past, and recent results for Fe were 5.0 mg/l and 1.4 mg/l, and for Cd 0.5 mg/l and 0.48 mg/l.

Supply water is 210 m^3/d of city water and part of it is used for the ebonite casing unit at 50 m^3/d, for the battery assembling unit at 5 m^3/d, for the battery production line at 72 m^3/d and for boiler feed water at 23 m^3/d. Wastewater from these units are treated through a lime stone bed facility, common pond in the factory, and discharged to the Re River. Periodical quality analysis of wastewater is implemented annually by Hai Phong Agency under DOSTE, Ha Noi. Only a pH check using pH testing paper is performed daily by the company.

The water system for intake water and wastewater are shown in Figure 2.

3. Management

3.1 General

The management of the factory seems to be good, especially for the maintenance of the equipment, building and other facilities.

3.2 Annual Consumption of Raw Materials and Utilities

The actual consumption of raw materials, utilities and additives in 1998 as well as cost are also shown in Table 3.

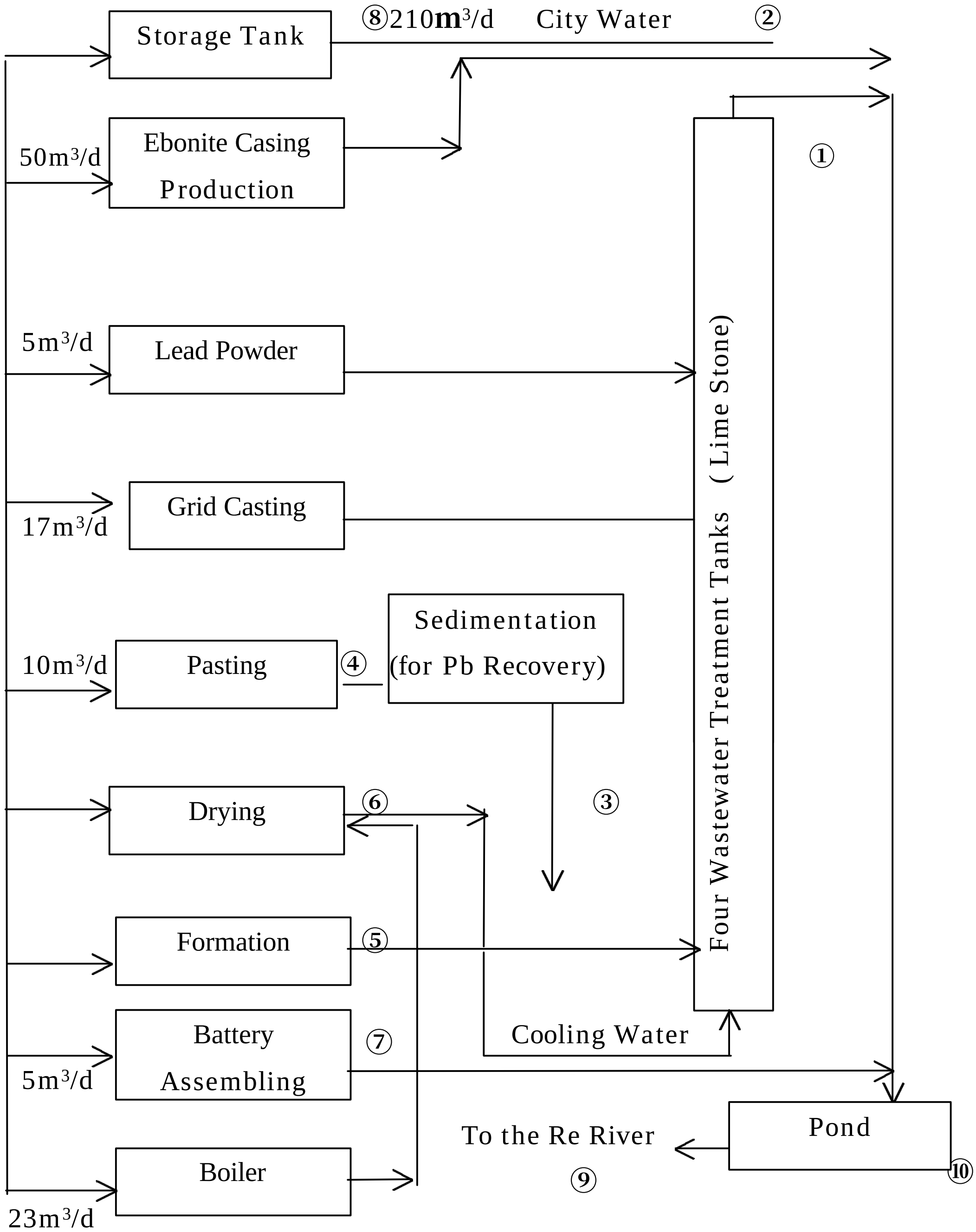


Figure 2 Water System and Sampling Points

Table 3　Annual Consumption and Cost in 1998

Energy	Amount	Cost
Oxygen	500 bottle	33,000 VND/bottle
Gas	16 Tones	6,500,000 VND/Tone
Electricity	1,656,000 kwh	870 VND/kwh
Coal	750 Tones	530,000 VND/Tones

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Sampling points and numbers are shown in Table 4.

Table 4　　Sampling Points

Sample Number	Sampling Points
1	Outlet of Wastewater Tank
2	Outlet of Ebonite Casing Unit
3	Wastewater after Pb Recovery
4	Wastewater before Pb Recovery
5	Wastewater from Formation Unit
6	Cooling Water from Drying Unit
7	Wastewater from Assembly Unit
8	Intake Water (before the Tank)
9	River Water (The Song Re)
10	Wastewater befor the Pond

The results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team is shown in Table 5.

Table 5　Wastewater Quality　(CECO)

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		10:45	10:50	10:56	11:05	11:13
Temp.	℃	27	30.1	28.8	26.7	24
pH		3.4	7.5	6.9	6.0	1.9
Conductivity	mmS/㎝	1.83	0.45	0.41	0.37	4.3
Turbidity	NTU	11	7	51	790	19
Oil content	mg/l	0.1	0.15	0.25	0.25	0.15
BOD_5	mg/l	16.5	42	24	54	4.5
COD	mg/l	45	135.4	62	160	26
DO	mg/l	6.0	5.8	6.5	4.3	6.4
SS	mg/l	33	17	162	16,680	190

Sampling Point		1	2	3	4	5
Parameter	Unit					
T-nitrogen	mg／l	8.12	11.32	14.18	14.57	7.33
CN	mg／l	0.002	0.001	0.001	0.006	0.016
Phenol	mg／l	0.001	0.005	<0.001	0.00	0.001
Residual Cl	mg／l	0.04	0.02	0.02	0.05	0.07
SO4	mg／l	1,016	51	86	98	440
Fe	mg／l	6.02	0.19	0.37	2.06	2.55
Cr(VI)	mg／l	0.02	0.01	0.01	0.01	0.000
Pb	mg／l	4.727	0.923	32.5	1,194.12	520.07

Sampling Point		6	7	8	9	10
Parameter	Unit					
Time		11:20	11:26	11:30	11:40	11:35
Temp.	℃	33.5	26.8	44.4	23	27.6
pH		6.5	8.7	7.56	7.9	3.9
Conductivity	mmS/cm	0.39	0.49	0.46	1.3	1.9
Turbidity	NTU	11	15	5	116	10
Oil content	mg／l	0.18	0.1	0.00	0.03	0.05
BOD_5	mg／l	3	11	0.0	32	16
COD	mg／l	14	36	4.3	91	49
DO	mg／l	5.7	4.8	7.3	5.6	5.2
SS	mg／l	31	28	32	147	17
T-nitrogen	mg／l	9.86	8.72	15.46	14.59	11.43
CN	mg／l	0.001	0.00	0.001	0.001	0.026
Phenol	mg／l	0.005	0.003	0.005	0.00	0.001
Residual Cl	mg／l	0.04	0.015	0.01	0.04	0.08
SO_4	mg／l	47	42	41	54	40
Fe	mg／l	0.43	0.11	0.12	0.49	4.68
Cr(VI)	mg／l	0.000	0.01	0.01	0.01	0.00
Pb	mg／l	0.064	0.031	0.014	0.132	0.717

4.2 Regulation Standards

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 6.

Table 6 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	Mg/l	50	Organic P	mg/l	0.5
COD	Mg/l	100	Fe	mg/l	5
SS	Mg/l	100	Sn	mg/l	1
Mineral Oil	Mg/l	1	Hg	mg/l	0.005
Organic Oil	Mg/l	10	T-Nitrogen	mg/l	60
As	Mg/l	0.1	T-P	mg/l	6
Cd	Mg/l	0.02	F Compounds	mg/l	2
Residual Cl	Mg/l	2	Phenol	mg/l	0.05
Cr(VI)	Mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	Mg/l	1	CN	mg/l	0.1
Zn	Mg/l	2			
Pb	Mg/l	0.5			
Cu	Mg/l	1			

Discharged wastewater from the company, Sample No.10, shows higher data on Pb and lower data on pH than the regulation standards. This means there is an inappropriate operation of the neutralization pond and sedimentation pond because the pH is almost neutral even at the inlet of the sedimentation pond (Sample No.4) and at the outlet of another one (Sample No.3). Therefore, the lead concentration is especially high, 32.5 mg/l, at the outlet.

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Improve the pH control system for wastewater from the unit and keep pH on the alkaline side to precipitate Pb salt efficiently.

(2) Improve the operation and equipment used in the huge neutralization pond for packing lime stone so as to enable a sufficient reaction of Pb with $CaCO_3$ on the surface of lime stone. Through this reaction, hindering CO_2 will be removed. In order to attain such targets the velocity of wastewater flow should be increased by using buffer plates in the water stream of the pond, by narrowing the stream, or by pouring in pressurized jet water.

(3) Prepare another kind of neutralization agent like $Ca(OH)_2$ or wasted caustic soda for efficient wastewater treatment.

5.2 Mid- Term and Long Term Countermeasures

(1) Apply for ISO 9000 in the near future. In order to apply, the factory and facilities should be maintained cleanly and orderly, and documentation system for production and quality control should be completed orderly.

CASE STUDY C-12

The Hanoi Battery Company

Survey Date : December 02, 1999

1. General

1.1 Profile

Ha Noi Battery Company is one of the state-owned companies under VINACHEM, the Ministry of Industry. The Company Profile is shown in Table 1.

Table 1 Company Profile

Company Name:	Ha Noi Battery Company
Ownership:	State-owned
Address:	Van Dien- Thanh Tri- Ha Noi
Director:	Mr. Nguyen Xuan Cuong
Established	1960
Corporate Capital	
Number of Employees:	653 (including 30 engineers)
Main Products:	Different kinds of Batteries

The Hanoi Battery Corporation is one of the state-owned companies which produce only conventional dry cell batteries, but they have produced many kinds of dry cells so far. The company was established in 1960 and will have a 40 year celebration soon. In the beginning stages of the company, there was no problem in the company with environmental issues, because they were surrounded only by fields, but nowadays, due to an increase in the population moving into the community near the factory, many places were contaminated by domestic and industrial waste. However, the company has complied with the law on the environment and taken environmental protection countermeasures even though their company is a state-owned one.

The company explained that MOI would not invest in environmental projects without business profits from the state-owned enterprises, and that an investment for environmental improvement should not be considered in the short term. As the cost of investment for environmental facilities is included in their product prices, the government of Viet Nam probably does not do this. They undertook a Japanese supported project on environmental management a few years ago, the second of it's kind for them, and they seem to be following the same path as chemical factories in Thailand.

They are conscientious of their responsibility to comply with environmental laws and regulations of Viet Nam and that the Government should make efforts for sustainable development for long term issues even though financial resources are limited.

1.2 Status of Business

The market for dry cells in Viet Nam has been rather good for their industry over the past 40 years, enough for them to have increased production capacity. However, recently the business situation is changing to a free market, and besides the many producers entering the industry, low priced products from China and high quality products from Japan have flown into this country. The excessive supply is forcing them to lower their production rate to 75%.

(1) Production

The present capacity of dry cells is 150,000,000 cells/y, but the expected production in 1999 is 90,000,000 cells/y. The original capacity in 1960 was 5,000,000 cells/y and the capacity reached 20,000,000 cells/y in 1990, but no further expansion of capacity is expected at present. However a new production line for improvement is going to be tested by Chinese engineers from Shang Hai.

Actual annual productions and revenues in 1998 are shown in Table 2.

Table 2 Annual Production sand Revenues in 1998

Battery Product label Rabbit	Production (Cell)	Revenue (VND)
Electro-paste Cell (R14, R20, R40)	63,760,000	68,330,000,000
Pasted Paper Cell (R6p)	24,300,000	11,300,000,000
Alkali Cell (LR6)	13,000	32,000,000
Total	88,073,000	79,662,000,000

There are 3 boilers in the factory, but only 1 boiler in operation consumes boiler feed water at 0.5t/d.

(2) Debt

2. Production Technology

2.1 Process

The production technology and facilities for dry cells consists of 3 process technologies; ① Dry cells using MnO_2, ② Electro-Paste, ③ Soda Alkali Cells using paper technology which is the base technology of the company and also is a rather new one developed and used by the company since 1994. ①and②are rely on Chinese technology.

The management has future plans to introduce new technology from Japan by a target date of 2005, especially for their key paper technology.

The cost of production is rather competitive so far compared even with Chinese products. The main concern at present is their product quality. Consumers buy high quality dry cells rather than low ones in spite of their expensive price. The top policy of the company is to attain 4 objectives.

① Implement advanced and new technology
② Attain high quality, the same as Japan
③ Lower costs and prices to the same level as Chinese products
④ Environmental conservation

As for expansion of business, discussions were held for establishing a joint venture company with Hitachi Maxell Co., Ltd and Fuji Battery Co., Ltd for rechargeable dry cell production but an agreement has not been reached. The company is also thinking about Ni-MH(Metal Hydrate) cell production to comply with the demand for mobile phones but it costs too much to construct a new facility at present market conditions.

2.2 Wastewater Resources

Wastewater from the company is estimated at 830 m3/d of which 150 m3/d is industrial wastewater. A new wastewater treatment facility is just under construction and will be starting operations within 1 month. The process was designed by CECO and the equipment has been constructed by a domestic chemical construction company.

The main treatment process consists of neutralization, flock processing and a sedimentation unit. Wastewater is discharged to the Kim Nguu River almost with no treatment and analysis is said to be performed regularly, once every 3-4days but no results were shown to us.

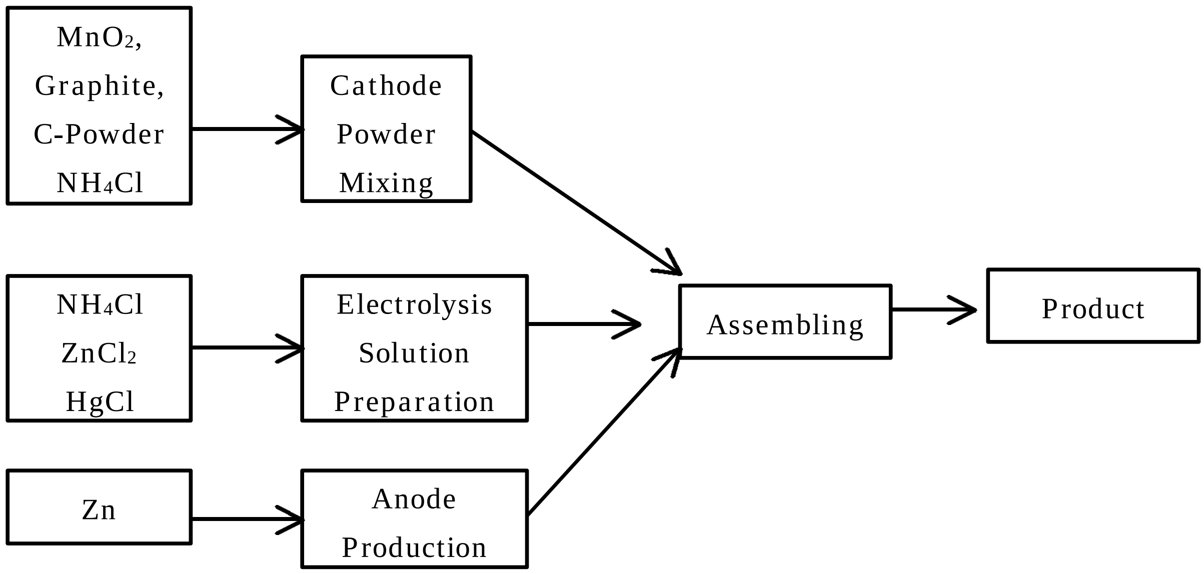


Figure 1 Dry Cells Production Process

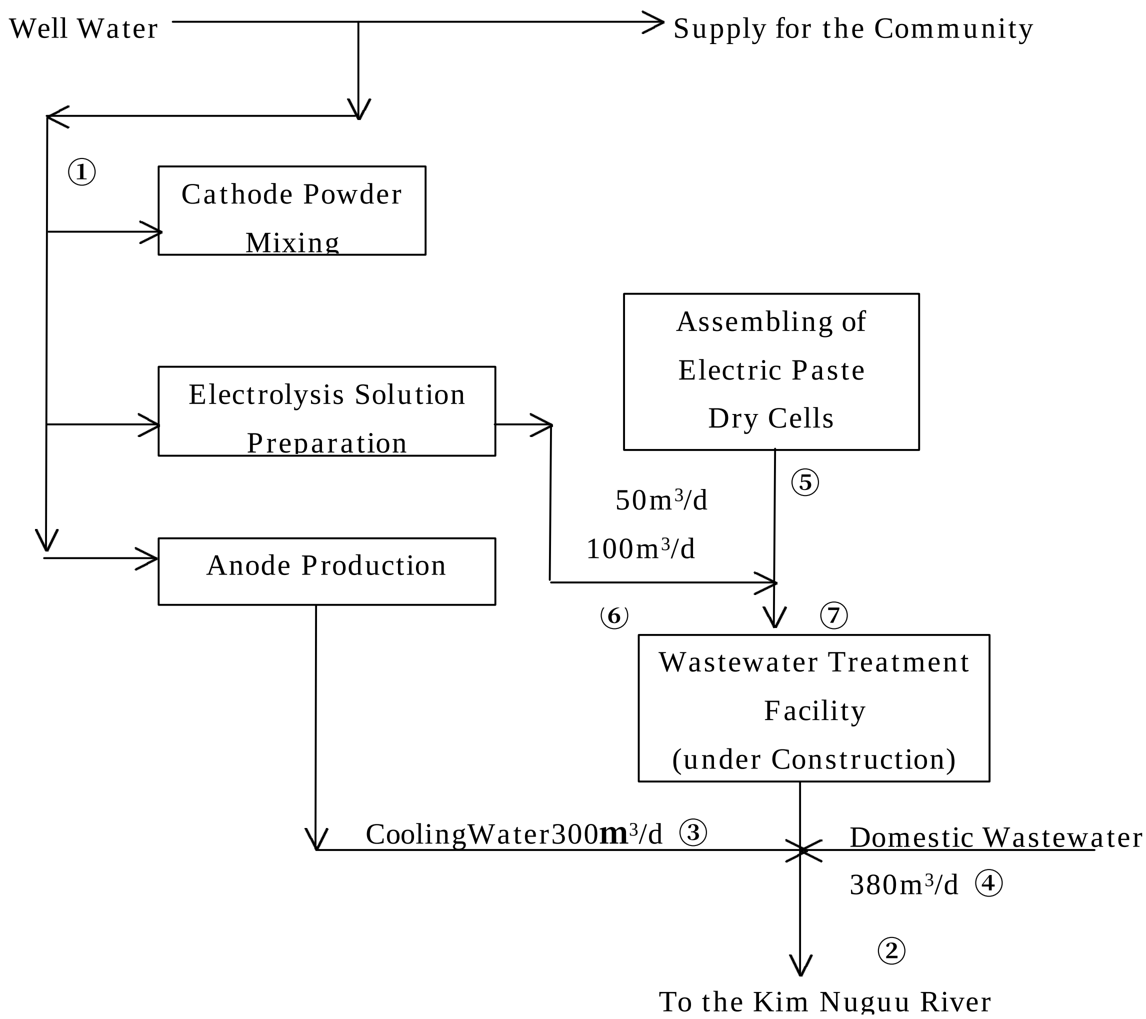


Figure 2 Water System and Sampling Points

The factory indicated that the latest EIA was performed by CECS in 1996. The main concern of wastewater quality is the content of heavy metals and ammonium ion contained in the raw material preparation unit. Supply water is drawn from a deep well with pump capacity 160m^3/h in the company. Water system and sampling points are shown in Figure 2.

3. Management

3.1 General

The company is now preparing an application for ISO 9000 in the year 2000 and is also looking for a consultant from overseas.

3.2 Annual Unit Consumption and Cost

Annual unit consumption of raw materials for each products, additives and utilities with annual consumption in 1998 are shown in Table 3.

Table 3 Annual Unit Consumption and Cost in 1998

Electro-paste Cells		Pasted Paper Cells		Alkali Cells	
Material Used	Amount	Material Used	Amount	Material Used	Amount
Natural MnO_2	1,203 t	Synthesis MnO_2	45 t	MnO_2 Alkali	12 t
Synthesis MnO_2	501 t	Acetylene Black	15 t	Graphite	2.1 t
Acetylene Black	146 t	$ZnCl_2$	4 t	KOH	1.5 t
Graphite	148.5 t	NH_4Cl	3 t	Zinc Powder	0.3 t
NH_4Cl	416.5 t	Pasted Paper	4 t	CMC	0.05 t
Carbon Rod	300 t	Carbon rod	28 t	Distilled Water	22.31 t
Starch	150 t	Zn	223 t	Ethanol	9.6 t
$ZnCl_2$	24 t	Bitumen	7 t	Epoxy	0.3 t
$HgCl_2$	0.34 t	Pine Resin	2 t	Bitumen	0.3 t
Pine Resin	25 t	Paraffin	5 t	Label & Packing Paper	2.5 kg
Paraffin	50 t	Label Paper	35 t	Electricity	470 kwh
Zn	1,200 t	Electricity	234,000 kwh		
Bitumen	30 t	Fuel Oil & Diesel Oil	50 t		

Electro-paste Cells		Pasted Paper Cells		Alkali Cells	
Label Paper	167 t				
Water	900 m^3				
Coal	90 t				
Fuel Oil & Diesel Oil	80 t				
Electricity	703,000 kwh				

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Sampling points and each number are shown in Table 4. The results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 5.

Table 4 Sampling Points

Sampling Points	Sample
1	Intake Water(Well Water)
2	Wastewater Discharged
3	Cooking Water
4	Domestic Wastewater
5	Wastewater from Electrolysis Solution Preparation Unit
6	Wastewater from Electrolysis Solution Preparation
7	Wastewater after mixing No.5 and No.6

Table 5 Results of the Analysis（CECO）

Sampling Point		1	2	3	4
Parameter	Unit				
Time		10:00	10:05	10:10	10:20
Temp.	℃	23.5	24	26.5	25
pH		7.6	7.2	7.7	7.8
Conductivity	MmS/cm	0.32	0.62	0.32	0.38
Turbidity	NTU	1	25	3	25
Oil content	mg/l	0.00	0.15	0.07	0.12
BOD_5	mg/l	3	76	21	86
COD	mg/l	16	124	30	124
DO	mg/l	7.2	6.9	5.4	5.1
SS	mg/l	2	56	14	71
T-nitrogen	mg/l	4.02	6.78	5.37	14.59
CN	mg/l	0.000	<0.001	<0.001	<0.001
Phenol	mg/l	<0.001	0.002	0.001	0.002
Residual Cl	mg/l	0.02	0.08	0.03	0.09

Sampling Point		1	2	3	4
Parameter	Unit				
SO_4	mg/l	1	2	0	3
Mn	mg/l	2.84	10.76	2.94	2.78
Fe	mg/l	1.67	1.42	1.58	1.69
Cr(VI)	mg/l	0.01	0.04	0.01	0.02
Pb	mg/l	<0.001	0.002	<0.001	<0.001
Ni	mg/l	<0.001	0.002	<0.001	<0.001
Cd	mg/l	<0.001	0.001	<0.001	<0.001
Zn	mg/l	0.02	8.7	1.28	17.4
Hg	mg/l	$<10^{-5}$	$1.78*10^{-3}$	10^{-5}	$8.49*10^{-3}$

Sampling Point		5	6	7	
Parameter	Unit				
Time		10:25	10:30	10:55	
Temp.	℃	23.5	26.5	24.5	
pH		6.8	7.2	7.0	
Conductivity	MmS/cm	6.7	2.1	1.2	
Turbidity	NTU	265	37	56	
Oil content	mg/l	0.1	0.12	0.25	
BOD_5	mg/l	287	205	272	
COD	mg/l	436	289	328	
DO	mg/l	5.9	5.5	6.3	
SS	mg/l	267	53	77	
T-nitrogen	mg/l	16.36	8.19	13.74	
CN	mg/l	<0.001	<0.001	<0.001	
Phenol	mg/l	0.004	0.003	0.002	
Residual Cl	mg/l	0.12	0.05	0.04	
SO_4	mg/l	2	0.0	4	
Mn	mg/l	6.21	17.69	12.33	
Fe	mg/l	0.07	0.88	0.19	
Cr(VI)	mg/l	0.19	0.04	0.00	
Pb	mg/l	0.002	0.001	0.001	
Ni	mg/l	0.001	<0.001	<0.001	
Cd	mg/l	0.002	0.001	0.001	
Zn	mg/l	49.8	39.3	39.7	
Hg	mg/l	$30.9*10^{-3}$	$16.81*10^{-3}$	$24.73*10^{-3}$	

4.2 Regulation Standards

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 6.

Table 6 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

Hatching columns for Sample No.2 in Table 5 show values that exceed regulations for BOD_5, COD, Mn and Zn.

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) After installing wastewater treatment facilities, the effect these facilities have should be strictly evaluated and the pH control should be performed under optimum conditions in order to remove the precipitate of heavy metals efficiently.

(2) Decrease the volume of wastewater used for washing water for containers of raw materials, washing water for assembly unit, and floor and cooling water for the dry cell assembly line.

(3) Recover all cooling water, estimated at 300m3/d and having almost the same quality as supply water, from the deep well. The amount should be about 30% of the total water usage of the company.

(4) Clean up oil leakage on the floor and ground.

5.2 Mid-term and Long Term Countermeasures

(1) Prepare an application for ISO 14000 after receiving the certificate for ISO

9000. In order to apply for ISO 14000, it is necessary that the periodical EIA, the activity on the environmental management, committee system, manager system should be implemented in the near future.

CASE STUDY C-13

LIX Detergent Company

Survey Date : December 07, 1999

1. General

1.1 Profile

Profile of the LIX Detergent Powder Company / HCMC Factory is shown in Table 1.

Table 1 Company Profile

Company Name:	LIX Detergent Powder Company / HCMC Factory
Ownership:	State owned
Address:	Linh Trung- Thu Duc- HCM City
Director:	Mr. Pham Cong Nhan
Established	1970
Corporate Capital	
Number of Employees:	301 in this factory, 320 in Ha Noi Branch 26 engineers among them in total
Main Products:	Detergent Powder, Paste, Solution

The company was established in 1972 and has two factories, a head office/factory in HCMC and a branch office/factory in Hanoi which was constructed in 1992.

1.2 Status of Business

The sales of their products had been increasing and in good condition up until 1997, but the business environment suddenly changed, caused by the entrance of the JV companies, Liva Haso, Liso and P&G into the market in 1998. The competition among them is very serious and they want the government to construct an appropriate market for domestic companies.

Strict rules for orderly markets should be applied to JV companies and their production amount should be regulated.

The product quality is almost the same and causes no problems for competition. However, the big problem lies in the price of the product. After the JV companies took off in 1998, the price fell below cost, because of use of imported LAS. The JV companies sold their products bundling 1 free package in with 3 other packages. So the profits of domestic companies dropped lower than in the past 3 years. However, state-owned companies have to cope with this situation and further investment is needed to update their technology, to increase their productivity and to realize lower prices for their products.

They have been exporting a portion of their products to Iraq, Taiwan, Cambodia, Singapore, New Zealand and to the Madagascar Islands.

Production trends and revenues of the company are shown in Table 2

Table 2 Production Trends and Revenues

	Unit	1993	1997	1998
Production	t /y	10,405	36,275	26,508
Revenue	Billion VND	72,467	223,981	128,114

(1) Production

Production capacity and technology for powder detergent, paste detergent and liquid detergent are shown in Table 3.

Table 3 Production Capacity and Technology

Product	Technology	HCM Factory	Ha Noi Factory	Total
Powder Deterget	Italy Domestic (Total)	15,000 t/y 30,000 t/y 45,000 t/y	-- 15,000 t/y 15,000 t/y	15,000 t/t 45,000 t/y 60,000 t/y
Paste Detergent	Domestic	6,000 t/y	14,000 t/y	20,000 t/y
Liquid Detergent	Domestic	1,500 t/y	3,000 t/y	4,500 t/y

Powder detergent is produced through continuous operation, but paste detergent and liquid detergent are produced through batch production. Raw material, LAS, is purchased from domestic companies, for example TICO, rather than importing from abroad. No heavy metals are used in production.

Unit consumption of raw materials for each product, additives and utilities with annual consumption in 1998 and the first and second quarter in 1999 are shown with its cost in Table 4.

Table 4 Production Capacity and Production in 1998 and in 1999

Production	Designed Capacity (t/y)	1998 (t)	1st quarter 1999 (t)	2nd quarter 1999 (t)
Powder Detergent	15,000	10,221	1,565	2,103
Paste Detergent	6,000	501	83	113
Dish Washing Liq.	1,000	83	19	29
Washing Liq.	500	31	1	5

(2) Debt

There is no description.

2. Production Technology

2.1 Process

Information on production technology supplied by the company is shown in Table 5.

Table 5 Production Technology

Production-line Technology	Licenser	Year of Technology Invention	Time of Operation	Summary of Technical Specification
Detergent Powder (PX1) Spraying, Drying, & Packing	Italy	1972	1972	-Mixing Material with Water -Spraying & Drying Powder -Manual Packing with PE or OPP Bag -Capacity:15,000 t/y
Detergent Powder (PX2) Spraying, Drying, & Packing	Viet Nam	1998	1999	-Mixing Material with Water -Spraying & Drying Powder -Manual Packing with PE or OPP Bag -Capacity:30,000 t/y
Paste Detergent Production	Viet Nam	1994	1994	-Mixing Material with Water -Packing with PE Bag -Capacity:6,000 t/y
Dish Washing Liquid Production	Viet Nam	1997	1997	-Mixing Material with Water -Packing with PE Bag -Capacity:1,500 t/y

Paste and powder detergents production processes are shown Figure 1 and 2 respectively.

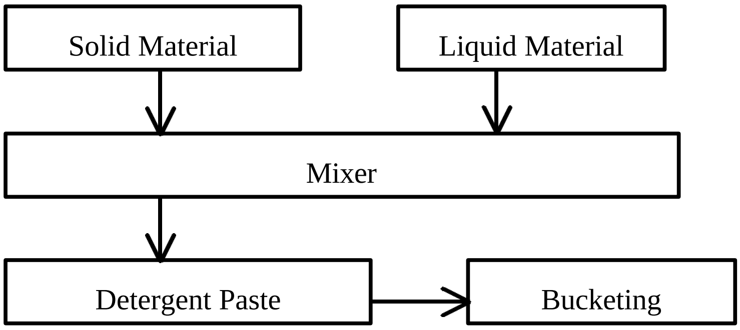


Figure 1 Paste Detergent Production Process

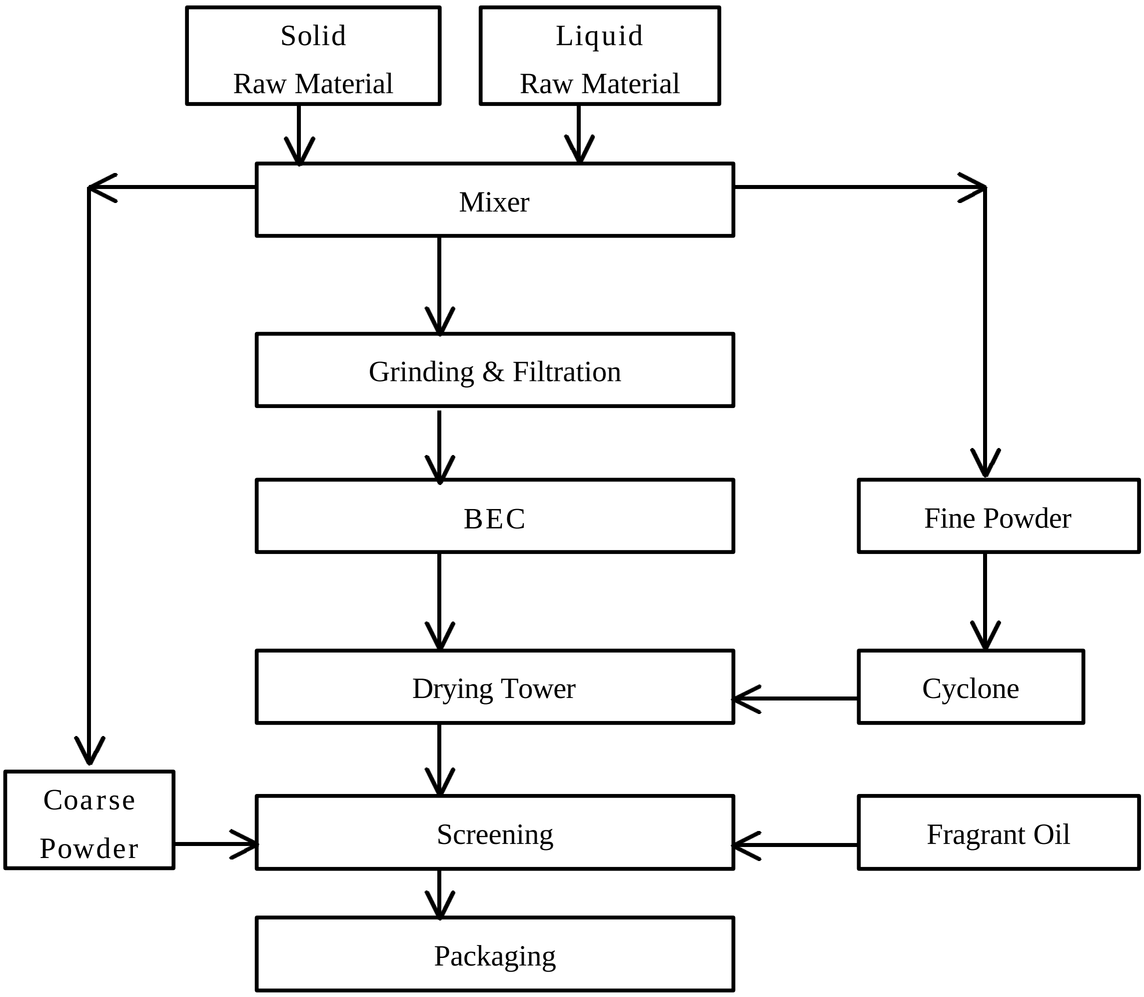


Figure 2 Powder Detergent Production Process

2.2 Source of Wastewater

Wastewater is discharged from washing facilities of exhausted gas from a cyclone for product detergent recovery. The amount of wastewater is estimated at 45 m^3/d.

Wastewater from industrial use is gathered and treated in aeration and sedimentation facilities and passes through screens to remove suspended solids. All wastewater is recycled to the production plant and no water is discharged outside.

Water is supplied from a deep well at a maximum rate of 200m^3/h and a minimum of 100m^3/h. Usually the rate of the intake water is 150m^3/h, 45m^3/h for industrial use and 105m^3/h for domestic use.

The wastewater system and sampling points are shown in Figure 3.

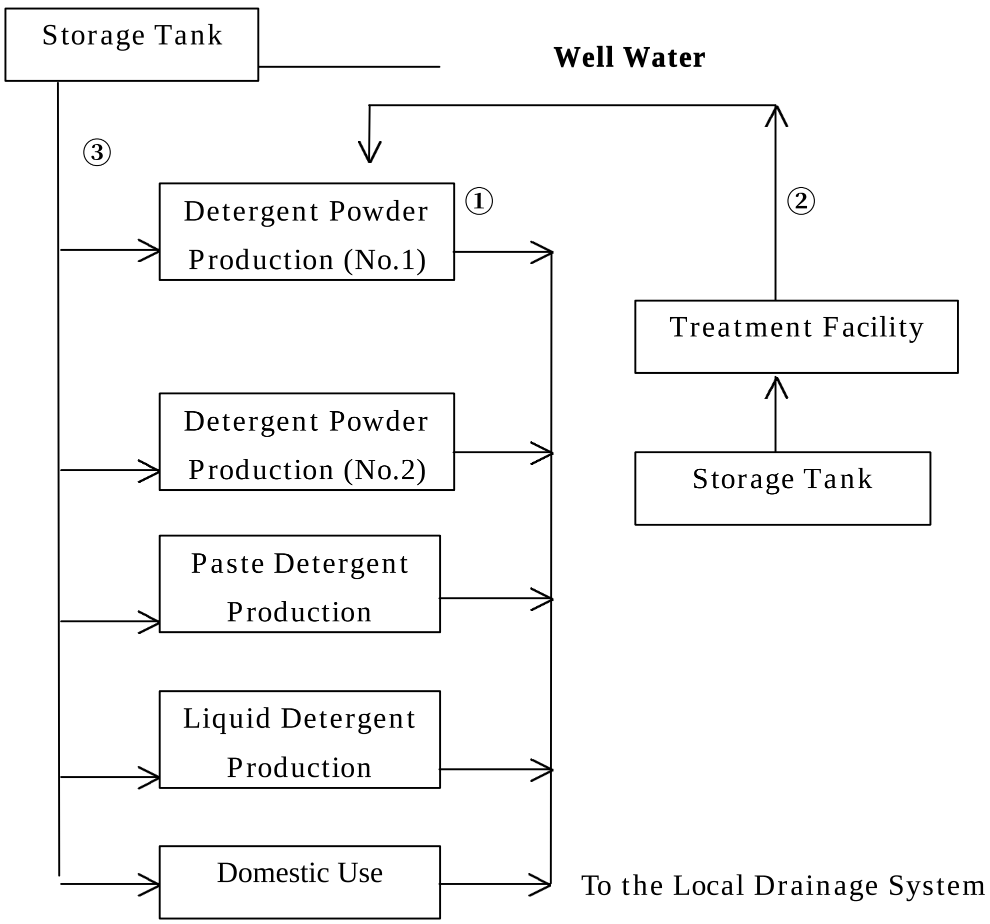


Figure 3 Water System and Sampling Points

3. Management

3.1 General

There is some environmental impact from gases like SO_2, CO_2, CO and dust caused by using fuel oil (Sulfur content ; 2.28%) at 60 l/1mt of product in the drying unit only. Fuel oil consumption is about 35 mt/d for drying. There is a scrubber for washing gases for preventing air pollution and the dust is recycled to the process after washing. There is almost no solid waste, but foul odors come from neighborhood hog raising farms. The company is in the process of applying for ISO 9000.

3.2 Annual Consumption of Raw Materials and Utilities

Annual Consumption of Raw Materials and Utilities in 1998 are shown in Table 6.

Table 6 Annual Consumption and Cost in 1998

Material Used	Form	Purpose	Amount (t/y)
LAS	Liquid	BG, KG Production	1,170
Sodium Silicate	Liquid	BG, KG Production	5,060
NPE 90E	Liquid	NRC Production	0.8
CDE	Liquid	NRC Production	0.66
Liquid $Al_2(SO_4)_3$	Liquid	KG Production	22
Fuel Oil	Liquid	Spraying, Drying	631
Rubber Milk	Liquid	Box Adhesion	7
Aromatic Substance	Liquid	BG, KG, NRC Production	29.4
SLESS	Liquid	NRC Production	6.5
Sodium Sulfate	Solid	BG, KG, NRC Production	4,200
Soda Ash	Solid	BG, KG, NRC Production	1,250
STS	Solid	BG Production	108
CMC	Solid	BG Production	35.4
STPP	Solid	BG, KG Production	582
Whitener (1)	Solid	BG, KG Production	1.4
Whitener (2)	Solid	BG, KG Production	4.4
NaCl	Solid	KG, NRC Production	20
Caustic Soda	Solid	NRC Production	1.2
$CaCO_3$	Solid	KG Production	14

4. Industrial Wastewater Treatment and Discharge

Sample numbers and Sampling points are described in Table 7. And the results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 8. As it was stated in section 2.2, all process waster is recycled in the factory and no water is discharged to outside.

Table 7 Sample Numbers and Sampling Point

Sample Number	Sample Point
1	Wastewater from Powder Unit No.1
2	Recycling Water
3	Well Water

Table 8 Wastewater Quality （CECO）

Sampling Point		1	2	3
parameter	Unit			
Time		10:33	11:00	11:15
Temp.	℃	28	27	27
pH		9.7	10.2	6.9
Conductivity	mmS/㎝	2.2	8.41	0.008
Turbidity	NTU	104	49	0
Oil content	mg／liter	0.10	0.07	<0.01
BOD_5	mg／liter	650	367	1
COD	mg／liter	1,200	1,040	4.8
DO	mg／liter	6.7	6.4	6.6
SS	mg／liter	216	36	0
T-nitrogen	mg／liter	6.24	4.68	3.12
CN	mg／liter	0.011	0.007	<0.001
Phenol	mg／liter	0.013	0.01	<0.001
Residual Cl	mg／liter	0.84	0.39	0.01
SO_4	mg／liter	725	6,375	0.00
T-P	mg／liter	21.58	6.12	0.06
Las	mg／liter	2,058	1,326	0.00

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Take countermeasures to control oil leakage from production equipment in house and the oil storage tank unit outdoors and maintain the clean condition of the factory.

(2) Check the quality of recycling water in order to maintain the quality of circulating water and products for finding the improving points continuously.

(3) Take countermeasure to save product loss in the packaging unit. Especially, procedure for measuring work of products and packaging work should be improved. For example, install a cover and dust collector to the packaging facilities.

5.2 Mid-term and Long Term Countermeasures

(1) Install automatic packaging equipment precisely in order to control productivity by reducing product loss, decreasing personnel cost, and improving environmental conditions.

(2) Prepare application for ISO 14000 after receiving the certificate for ISO 9000. In order to apply for ISO 14000, it is necessary that the periodical EIA, the activity on the environmental management, committee system, manager system should be implemented in the near future.

CASE STUDY C-14

The Southern Rubber Industry Company

Survey Date: December 08, 1999

1. General

1.1 Profile

The Southern Rubber Industry Company is one of the State-owned company under VINACHEM, Ministry of Industry. The factory profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Southern Rubber Industry Company / Hoc Mon Factory
Ownership:	State-owned
Address:	180 Ng. T. Minh Khai- Pre. 3-HCM City
Director:	Mr. Le Binh Thuan
Established	1969 ; in 1976, joined CASUMINA
Corporate Capital	
Number of Employees:	700 including 30 engineers for this factory
Main Products:	Tires, Rubber Gloves, Rubber Tubes

The company was established in 1960 by a French owned company related to Michelin, one of the biggest tire producers in the world. The company changed over to a state-owned company with several subsidiary enterprises in 1976 as CASUMINA. There are 6 enterprises in CASUMINA, 4 factories and 2 joint venture enterprises in Southern Viet Nam. One of 2 JV enterprises is jointed with YOKOHAMA Tire Co., located in the Tan Binh Rubber factory.

Their main products are tube tires and tubeless tires for industrial use and for motorcycles & scooters, bicycle tires & tubes, tires & tubes for tractor/light, truck/fork lift, and other rubber products.

1.2 Status of Business

Turnover of the company was 10 million US$/y in 1998 and has been increasing at 5-10%/y over the last 5 years. The company has been exporting their products to Western countries and Eastern Asian countries at 3 million US$/y.

(1) Production

The mixing unit for motorcycle tires and car tires among the three main production units has a strong environmental impact, especially for wastewater. The lubricant oil from mixing machines is constantly spilling out and going into wastewater facilities. The consumption amount of lubricant oil is estimated at 1,000l/every month. They recover waste oil from wastewater facilities and sell it to a recycling trader.

Some portion of the raw materials for rubber products are imported from Japan, JSR Co., and Nippon Zeon Co. There are 2 boilers and a diesel generator.

Actual annual production and revenues are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Production	Revenue(VDN)
Bicycle Tires	1,145,588	15,465,438,000
Bicycle Tubes	4,493,758	22,468,920,000
Baby Tires	1,516,358	22,745,370,000
Baby Tubes	51,834	356,421,000
Motorbike Tires	340,119	1,530,535,500
Motorbike Tubes	1,616,530	2,3,439,685,000
Total		86,066,369,500

(2) Debt

Total debt is 20,000 million VND,which includes 560 million VND with a commercial bank and 300 million VND with the National Bank.

2. Production Technology

2.1 Process

Figure 1 shows tires production process.

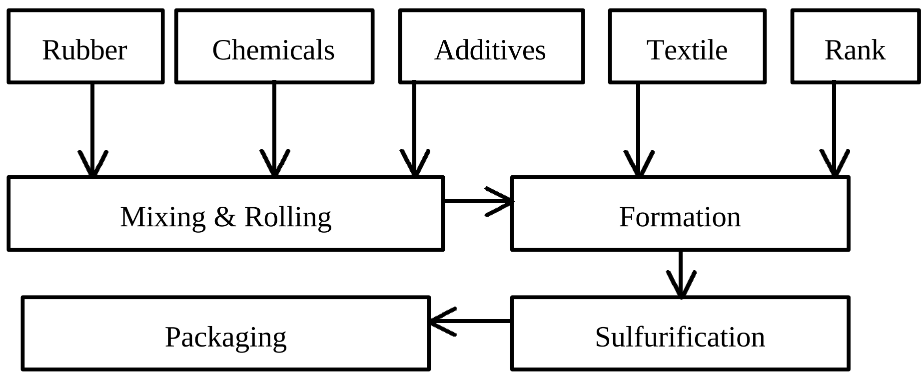


Figure 1 Tires Production Process

2.2 The Source of Wastewater

Water is supplied to totally from a deep well at 2,400m^3/d and more than 90% of it is used for cooling water for intermediate and end-products and 10% is for domestic use. There are 3 wells in the factory, and 2 of them are rather old, containing much Fe and a low pH of about 4.5. So they use only one new well and well water is treated by removing Fe, neutralization with lime, sedimentation by $CaSO_4$ and filtration through activated carbon.

Industrial wastewater mixed with water from the subsidiary company is treated by an oil separator which has 2 rooms for heavy oil and light oil, and at a sedimentation facility before being discharged into the Tham Luong River which flows into the Sai Gon River 30km down stream. The physical wastewater treatment system with skimming facilities for oil removal was designed by an environmental technical company in Viet Nam.

Though the wastewater from these companies is mainly used for cooling and is rather clean, it actually seems to contain oil even downstream of the separator where grease can still be observed on the surface of the river. The causes of the oil spill are leakage of lubricant oil from rotating machines, of fuel oil from boiler on facilities and of waste oil from oil drums onto the road.

An analysis of the wastewater is carried out annually.

The water system and sampling points are described in Figure 2.

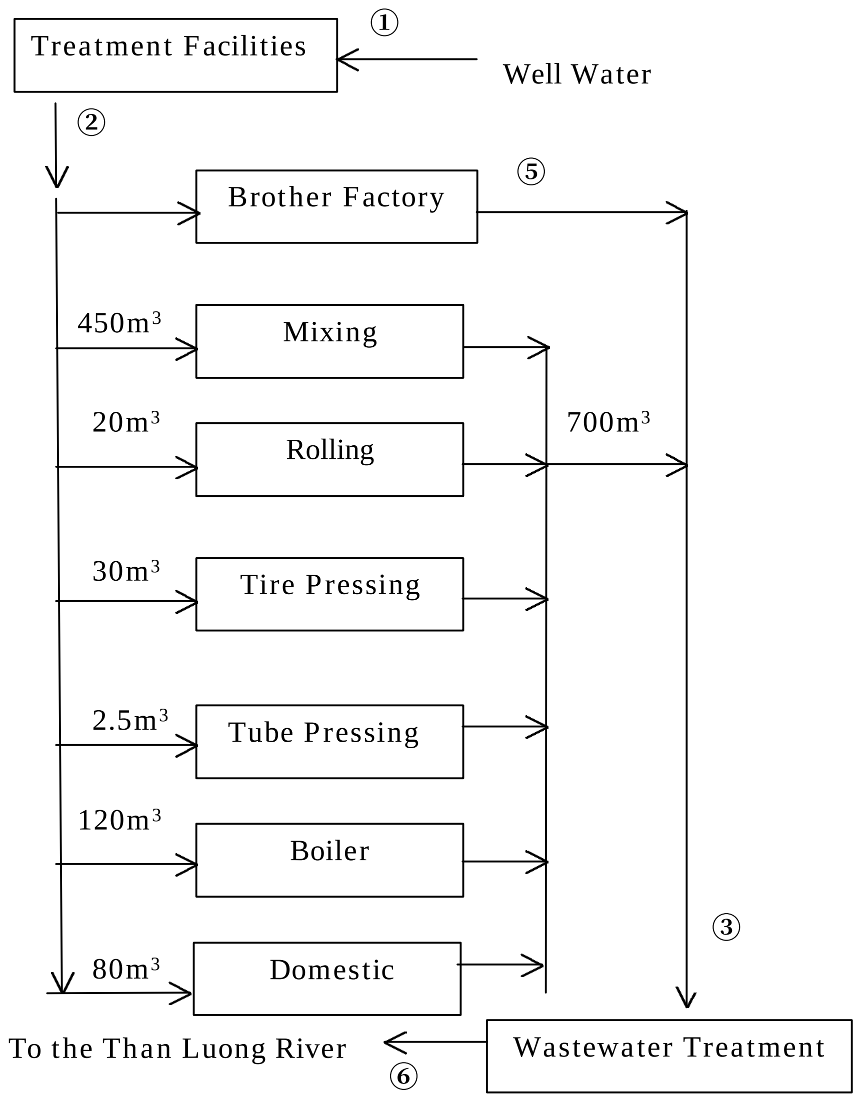


Figure 2 Water System and Sampling Points

3. Management

3.1 General

The company received the certificate of ISO 9002 as CASUMINA in May, 1999, but they have no plans to apply for ISO 14000 as of yet.

3.2 Annual consumption of raw materials and utilities

Annual consumption of raw materials for each product, additives and utilities with their costs in 1998 are shown in Table 3.

Table 3 Annual Consumption and Cost in 1998

Material Used	Amount (kg)	Cost (VND)
Bicycle Tires		
Rubber	982,914	9,829,140,000
Chemicals	137,470	2,749,400,000
Rank	950,838	10,459,218,000
Textile	985,205	57,141,890,000
Filling	439,905	1,759,620,000
Industrial Vehicle Tires		
Rubber	1,304,067	13,040,670,000
Chemicals	818,833	16,376,660,000
Textile	721,786	41,863,588,000
Filling	621,706	2,486,824,000
Steel Rank	300,238	3,302,618,000
Utilities		
Water (m^3)	210,000	
Fuel Oil (l)	1,258,000	1,645 VND/l
Electricity (kw)	5,039,560	

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Sample numbers and sampling points are shown in Table 4, The results of the analysis by CECO for wastewater sample taken at the same time as the JICA Team are shown in Table 5.

Table 4 Sample numbers and Sampling Points

Sample number	Sampling Points
1	Intake water before treatment
2	Intake water after treatment
3	Wastewater before treatment
4	Wastewater after treatment
5	Cooling water from another company
6	River water

Table 5 Wastewater Quality （CECO）

Sampling Point		1	2	3
Parameter	Unit			
Time		10:10	10:20	10:40
Temp.	℃	29	29	32
pH		6.7	7.1	7.3
Conductivity	MmS/cm	0.11	0.15	0.16

Sampling Point		1	2	3
Parameter	Unit			
Turbidity	NTU	10	0	6
Oil content	mg／l	0.00	0.00	0.14
BOD_5	mg／l	9	4	19
COD	mg／l	32	8	29
DO	mg／l	6.7	7.1	6.5
SS	mg／l	7	0	6
T-nitrogen	mg／l	2.32	2.11	7.41
CN	mg／l	<0.001	<0.001	0.008
Phenol	mg／l	<0.001	<0.001	0.002
Residual Cl	mg／l	0.16	0.02	0.06
SO_4	mg／l	13	11	16
Fe	mg／l	5.625	0.07	0.24

Sampling Point		4	5	6
Parameter	Unit			
Time		10:45	12:30	11:35
Temp.	℃	33	30.5	29.8
pH		7.2	7.7	7.0
Conductivity	MmS/cm	3.6	0.15	0.39
Turbidity	NTU	10	6	80
Oil content	mg／l	0.16	0.22	0.20
BOD^5	mg／l	11	15.2	101
COD	mg／l	19	32	360
DO	mg／l	6.7	6.3	1.3
SS	mg／l	5	4	263
T-nitrogen	mg／l	7.33	4.68	12.40
CN	mg／l	0.005	0.002	0.004
Phenol	mg／l	<0.001	0.002	0.015
Residual Cl	mg／l	0.07	0.08	0.8
SO^4	mg／l	15	14	39
Fe	mg／l	0.20	0.22	2.08

4.2 Regulation Standards for Industrial Wastewater

In order to check result of analysis for sample 4, wastewater discharge to a river, with regulation standards, Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 6.

The quality of the river water seems to be the worst, its color is black and its smell is strong and bad. The condition of the Tham Luong River is said not to have changed over the last 20 years. This is because of discharge of industrial wastewater from many enterprises, such as a textile factory and food processing factory, as well as discharged domestic wastewater. In order to improve this terrible condition, it is necessary to take action for countermeasures to improve wastewater from each factory and remove bottom soil in the river.

Table 6　TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Remove oil spillage on the floor, on the road of the mixing unit and on the boiler unit.

(2) Recover oil leakage, and lubricant oil from the mixing machine through installing oil receiver and oil recovery piping system.

(3) Take countermeasure to stop oil leakage from the equipment in the mixing unit and from the boiler feed oil storage tank unit through reinforcement of periodical maintenance.

(4) Reduce cooling water consumption by recycling after checking the quality of the water.

These countermeasures will result in a decrease of water discharge, water consumption, maintenance cost and lubricant oil purchasing.

(5) Strive for more cooperation between the environmental department and the production department for improving equipment, productivity and environmental conditions.

5.2 Mid- term and Long Term Countermeasures

(1) Prepare an application for ISO14000 in the near future. In order to apply for ISO 14000, it is necessary that the periodical EIA, the activity on the environmental management, committee system, manager system should be implemented in the near future.

(2) Not only this factory is the cause of polluted water in the river, however, very bad condition such as black colored water, foul odors, hasn't been changed for 20 years. This is caused by many textile factories, and food processing factories along the river, and domestic wastewater from the houses in this neighborhood.

As countermeasure for this, Restoration and Cleaning of the Tham Luong River with strong cooperation among the Central Government, Local Government, the enterprises and local inhabitants are necessary.

CASE STUDY C-15

Southern Vietnam Basic Chemicals Company / Tan Binh Chemical Factory

Survey Date : December 09, 1999

1. General

1.1 Profile

The Tan Binh Chemical Factory is a factory belonging to the South Vietnam Basic Chemicals Company, a state-owned company, that produces basic chemicals.

The company profile is summarized in Table 1

Table 1 Company Profile

Company Name:	Southern Basic Chemical Company / TAN BINH Chemical Factory
Ownership:	State owned
Address:	22 Ly Tu Trong-Pre.1- HCM City
Director:	Mr. Nguyen Do Ky
Established	1917
Corporate Capital	
Number of Employees:	210 including 8 engineers
Main Products:	H_2SO_4, $Al(OH)_3$

The company has 4 factories and 1 research facility. The company was established in 1917 and the production of sulfuric acid, aluminum hydroxide and aluminum sulfate was started with technological support from a Taiwanese company.

Production ability for sulfuric acid was 12,000t/y at the beginning, however, it reaches 18,000 t/y now. The selling price has been stable, and the production rate has been growing satisfactory. We would like to improve production amount with increasing productivity, not with installing more production lines.

Also, in order to strengthening environmental management, we would like to suggest them to plan to get ISO 9000 certification in 2000.

1.2 Status of Business

(1) Production

Revenue of the company and price of their products are almost stay in these days.

The production amount is as follows:

Table 2 Trend of Production of Main Products

Product	1989 (t)	1997 (t)
H_2SO_4	12,000	18,000
$Al(OH)_3$	3,500	5,000

The increase in production capacity has been attained by innovations in their processes.

There are 3 main production plants.

① $Al(OH)_3$ production plant

② H_2SO_4 production plant

③ $Al_2(SO_4)_3$ production plant

There are 2 boilers with capacities of 7.2 t/h(Fuel oil base) and 4t/h(Waste heat base of H_2SO_4 production plant). They do not use any heavy metals in the production.

Actual annual Production and Revenues are shown in Table 3.

Table 3 Annual Production and Revenues in 1998

Product	Unit	Capacity	Production	Revenue (VND)
H_2SO_4	Tons	18,000	19,837	16,886,413,000
$Al(OH)_3$	Tons	5,000	5,368	7,999,738,100
$Al_2(SO_4)_3$ single	Tons	6,000	5,410.95	9,171,169,375
$Al_2(SO_4)_3$ compound	Tons	249	249	407,487,500
Plastic Can	Cans	20,000	16,411	294,355,000
Thio-sulfate	Tons	128.05	128.05	576,675,000
Pure Acid	kg	100,000	35,013	353,018,001
Total				35,688,855,976

(2) Debt

2. Production Technology

2.1 Process

The production process of $Al(OH)_3$ is a Bayer Process and generates solid waste and wastewater from a cooling unit. The H_2SO_4 production generates SO_2, SO_3 and quite a small amount of wastewater from a cooling unit in which water is recycled now.

Wastewater from both processes are mixed into one channel before being discharged. The $Al_2(SO_4)_3$ production unit generates no wastewater.

Renovation of production technology is needed for improving productivity and more environmental protection is requested for gas emission and wastewater discharge into the community.

Figure 1 shows aluminum hydroxide production process, Figure 2 shows sulfuric acid production process, and Figure 3 shows aluminum sulfate production process.

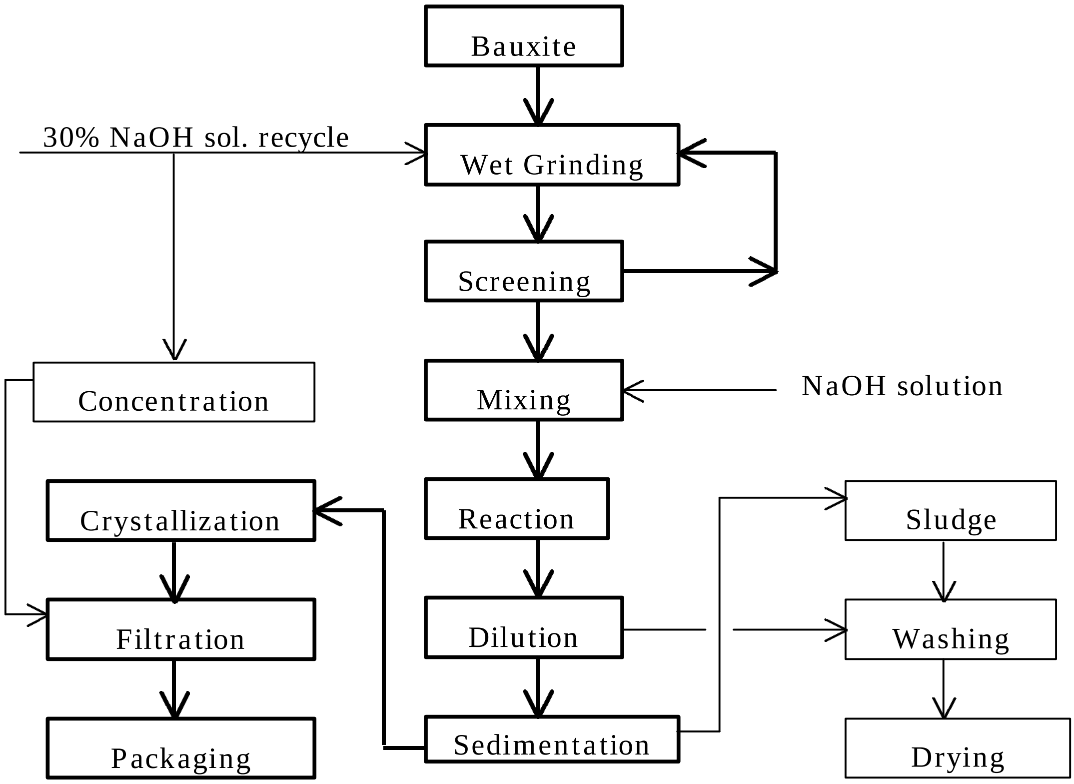


Figure 1 Aluminum Hydroxide Production Process

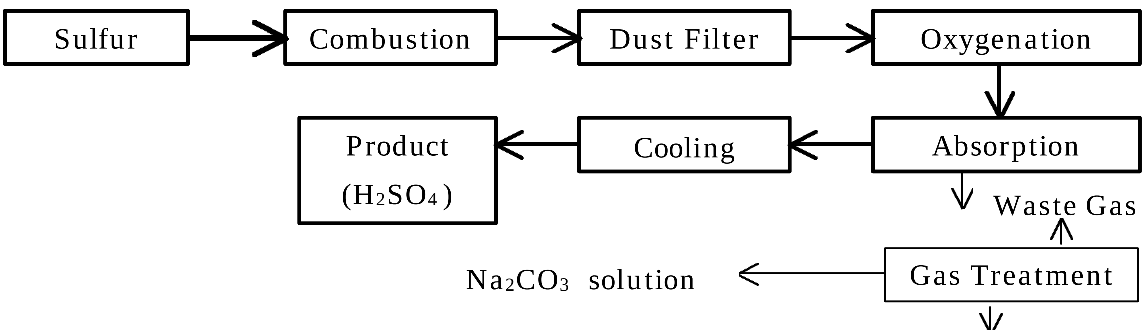


Figure 2 Sulfuric Acid Production Process

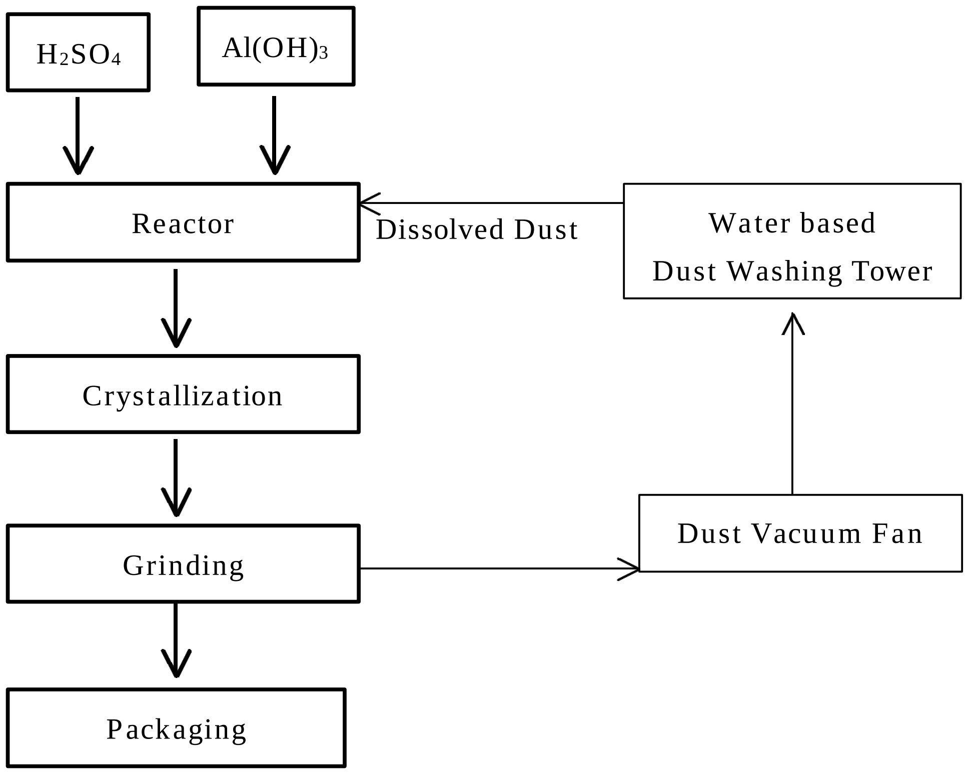


Figure 3 Aluminum Sulfate Production Process

2.2 The Source of Wastewater

The capacity of supply water from a deep well is about 1,680 m^3/d and water consumption is almost the same amount as the supply water. For domestic use the volume is; 192m^3/d, for boiler feed water; 96m^3/d and for industrial use as cooling water: 1,400m^3/d.

Well water shows strong acidity with a high Fe concentration and a metal-like odor. In addition, clothes are smeared after washing. This water is not adequate for drinking and the factory installed treatment facilities for neutralization, Fe removal and filtration. Boiler feed water is treated through the ion exchange unit.

Domestic wastewater is discharged independently to the Tham Luong River. Industrial wastewater is basically, recycled efficiently. For example, steam condensate is reused as boiler feed water and is also partly used for mixing with wastewater from the $Al(OH)_3$ plant. Also wastewater from the H_2SO_4 plant is recycled to its process as cooling water and utilized for neutralization with wastewater from the $Al(OH)_3$ plant. The H_2SO_4 production unit has a recycled cooling water system relating to the intake water unit, and it includes a softening treatment.

Furthermore, wastewater from the $Al(OH)_3$ plant is mixed with wastewater from the washing facilities of H_2SO_4 cans. The company explained that all of this wastewater is treated before being discharged to the Tham Luong River after checking its pH at a volume of around 1,000m³/d. They also explained that periodical analysis of well water and wastewater is undertaken themselves, weekly.

The water system is described in Figure 4.

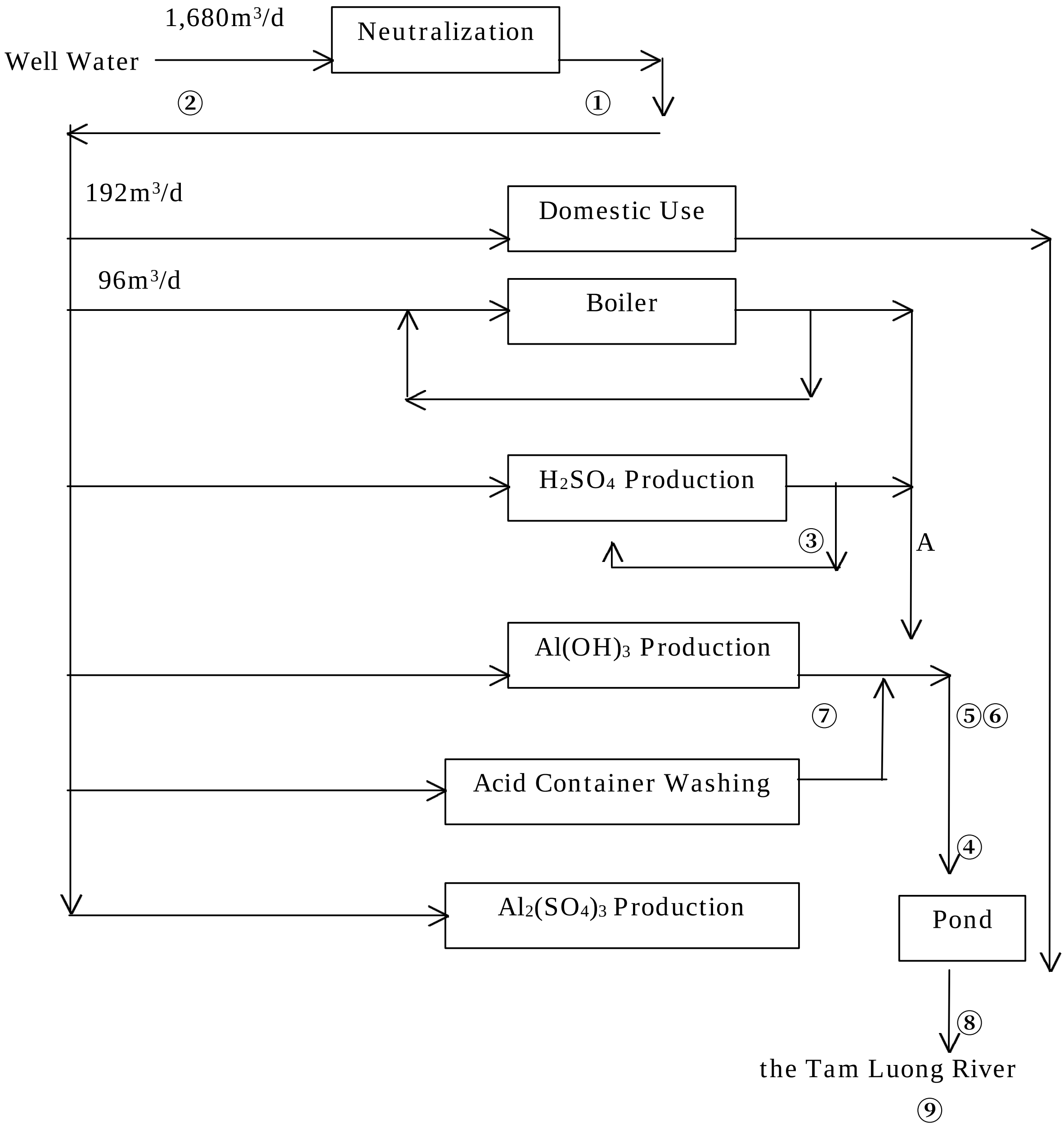


Figure 4 Water System and Sampling Points

3. Management

3.1 General

The company believesthat environmental consideration should be taken into account carefully by the top management of the company. EIA was performed by MOSTE in 1994 and environmental improvements have been implemented for waste gas and wastewater in recent years. As for the waste gas, the concentration of SO_2 and SO_3 is within the standard levels.

Domestic solid waste is generated from their kitchen and offices at 20-30kg/d. Industrial solid waste comes mainly from sludge and residue in the wastewater treatment facilities. These solid wastes are packed in containers and sent to the dumping area of the city by the Ho Chi Minh City Hygiene Company.

3.2 Unit consumption of Raw Material and Utilities

Annual consumption of raw materials for each product, additives and utilities with their costs in 1998 is shown in Table 4.

Table 4 Annual Consumption and Cost in 1998

Material Used	Unit	Amount	Cost (VND)
Acid Product			
Sulfur	Tones	0.337	404,400
V_2O_5	Liter		
Diesel Oil	Liter	0.240975	1,084.39
Electricity	Kwh	61.6225	53,611.58
$Al(OH)_3$ Product			
Bauxite	Tones	1.704575	603,414.55
Soude	Tones	0.08415	287,533.23
Filter Textile	M2	0.0535	214.00
Powder	Kg	2.1775	2,535.50
PP Bag	Bag	20	50,000.00
Fuel Oil	Liter	318.0975	508,956.00
Electricity	Kwh	214.045	186,219.15
Single $Al2(SO_4)_3$			
$Al(OH)_3$	Tones	0.337875	632,961.51
H_2SO_4	Tones	0.5332	460,046.03
PP Bag	Bag	21	52,500.00
Electricity	Kwh	29.076	25,296.12
Compounded Al2(SO4)3			
Al(OH)3	Tones	0.3137	587,673.03
H2SO4	Tones	0.4675	403,359.94
PP Bag	Bag	21	52,500.00
Electricity	Kwh	29.1295	25,342.00

Unit consumption of raw materials and utilities are shown in Table 5.

Table 5 Unit Consumption of Raw Materials and Utilities

Name	Consumption
Bauxite	1.7 t/t-$Al(OH)_3$
Sulfur	0.34 t/t-H_2SO_4
Caustic soda 100%	70 kg/t-$Al(OH)_3$

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Table 6 shows sample numbers and sample points. The results of the analysis by CECO for wastewater samples are shown in Table 7.

Table 6 Sampling Points

Sample number	Sampling Points
1	Supply Water after Treatment
2	Supply Water before Treatment
3	Wastewater from H_2SO_4 Production Unit
4	Wastewater before Discharging to the river (Inside the Factory)
5	Wastewater from $Al(OH)_3$ Production Unit mixed with Washing Water for Acid Container
6	Wastewater from $Al(OH)_3$ Production Unit mixed with Washing Water for Acid Container(30min after the sample 5 was taken)
7	Wastewater from $Al(OH)_3$ Production Unit
8	Wastewater just before Dischargint to the river (Outside the Factory)
9	River Water (500m Upstream from the Discharge Point)

There was some trouble and fluctuation in the factory while we were there, so there is a difference between the data, sample number 5 and 6, during the 30 minute interval that sampling took place . However, the causes were not known at that time.

Table 7 Wastewater Quality (CECO)

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		10:20	10:30	10:40	10:50	10:55
Temp.	℃	32	29	36.5	34	29
pH		7.6	6.1	3.5	2.9	2.4
Conductivity	mmS/cm	0.43	0.35	0.55	3.9	7.8
Turbidity	NTU	1	8	4	14	42
Oil content	mg/l	<0.01	<0.01	-	0.12	0.14
BOD_5	mg/l	5	6	-	36	14
COD	mg/l	15	36	-	96	44
DO	mg/l	6.6	5.4	-	3.7	4.3
SS	mg/l	6	14	5.4	147	35

Sampling Point		1	2	3	4	5
Parameter	Unit					
T-nitrogen	mg/l	2.73	6.21	-	12.2	11.31
CN	mg/l	<0.001	<0.001	-	0.006	0.023
Phenol	mg/l	<0.001	<0.001	-	0.001	0.015
Residual Cl	mg/l	0.02	0.06	-	0.01	0.09
SO_4	mg/l	20.7	64	-	171	624
Fe	mg/l	0.13	12.32	-	10.6	16.56

Sampling Point		6	7	8	9	
Parameter	Unit					
Time		11:20	10:30	11:40	11:52	
Temp.	℃	30	33.1	35	27	
pH		11.9	6.7	3.9	7	
Conductivity	mmS/cm	6.8	0.39	1.5	0.26	
Turbidity	NTU	33	117	1	35	
Oil content	mg/l	0.18	0.20	0.28	0.13	
BOD5	mg/l	24	20	24	68	
COD	mg/l	70	56	64	138	
DO	mg/l	3.1	6.5	3.2	3.8	
SS	mg/l	119	113	18	79	
T-nitrogen	mg/l	6.24	8.11	4.89	5.62	
CN	mg/l	0.01	0.02	0.07	0.03	
Phenol	mg/l	0.012	0.010	0.010	0.012	
Residual Cl	mg/l	0.022	0.08	0.05	0.017	
SO_4	mg/l	750	82	300	14	
Fe	mg/l	16.58	12.08	11.92	3.6	

4.2 Regulation Standards for Industrial Wastewater

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table8.

According to the comparison of data between sample No.8 in Table 7 and in Table8, pH and Fe concentrations exceed the regulation standards.

Table 8 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Take countermeasures for the pH and Fe concentrations that exceed the regulation standards. This is because low sedimentation performance is due to low a pH value. As Fe can forms an insoluble salt under alkaline condition in wastewater, and pH control is very important in this case.

(2) Stabilize the operation of both plants, the ones for H_2SO_4 production and aluminum hydroxide, because the fluctuation of operating conditions results in a loss of raw materials, energy and additives, and also is a cause of the higher emission of pollutants.

(3) Avoid sending acidic washing water from the H_2SO_4 cans to the drainage directly. It is recommended to recover H_2SO_4 or to neutralize it before sending it to the drainage.

(4) Clean up the factory more than now for further environmental and safety improvement.

(5) Apply for ISO9002 as soon as possible. In order to apply, the factory and facilities should be maintained cleanly and orderly, and the documentation system for production and quality control should be completed orderly.

5.2 Mid- Term and Long Term Countermeasures

(1) Install a neutralization treatment pond with a pH control system and measure and evaluate pH continuously. The results should be fed back to the operation and this results the development of productivity and better environment.

6. Notes

This factory needs a more detailed survey to determine ways improve its productivity and environmental conditions. They seem to have renovated their plant with a cooperative attitude and also have the capability to prepare for the necessary data for a further survey for this project.

CASE STUDY C-16

Southern Vietnam Basic Chemicals Company / Bien Hoa Chemical Factory

Survey Date : December 10, 1999

1. General

1.1 Profile

The Bien Hoa Chemical Factory is one of the factories belonging to the South Vietnam Basic Chemicals Company which is state-owned and produces basic chemicals. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Southern Basic Chemical Company Bien Hoa Chemical Factory
Ownership:	State owned
Address:	Bien Hoa I Industry, Dong Nai Province
Director:	Mr. Nguyen Do Ky
Established	1962
Corporate Capital	
Number of Employees:	286 including 30 engineers
Main Products:	NaOH, Liquid Cl_2, HCl, Sodium Silicate

The company produces caustic soda, liquefied chlorine, hydrochloric acid, sodium silicate for detergent additives, sodium hypochlorite and calcium hypochlorite.

1.2 Status of Business

(1) Production

New production facility was introduced from Italy in 1996. The production capacity of caustic soda of 100% concentration is 10,000 t/y and production in 1998 was 7,500 t/y. Just before introducing the new facility in 1995, the production was 4,000 t/y for 100% concentrated caustic soda. The causes of the decrease in total production to a level less than its capacity were unfavorable ①market situation and ②financial conditions, but the production plant has been operating at a 100% rate since last August. The product is mainly sent to the domestic market and only a small amount of caustic soda and liquefied chlorine is exported to Cambodia.

Only solid caustic soda is imported.

Actual annual production and revenues are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Production (Tons)	Revenue (VND)
NaOH (32%)	23,700.000	27,302,400,000
HCl (32%)	16,710.000	18,381,000,000
Liquid Cl_2	908.870	5,998,542,000
Sodium Silicate	4,388.000	2,121,709,200
Bleaching Liquid	2,720.140	680,035,000
Total	48,427.010	54,483,686,200

(2) Debt

There is no description.

2. Production Technology

2.1 Process

The production technology used for caustic soda is not a mercury process but a membrane process, so the only heavy metal contained in the wastewater is Fe. Two Boiler facilities with a capacity of 2t/hr in the existing plant in this factory were introduced from China and Japan. The fuel oil is fed to the boiler as fuel.

Figure 1 shows solicic acid production process, Figure 2 shows bleaching solution production process, and figure 3 shows caustic soda, hydrochloric acid, and liquid chlorine production processes.

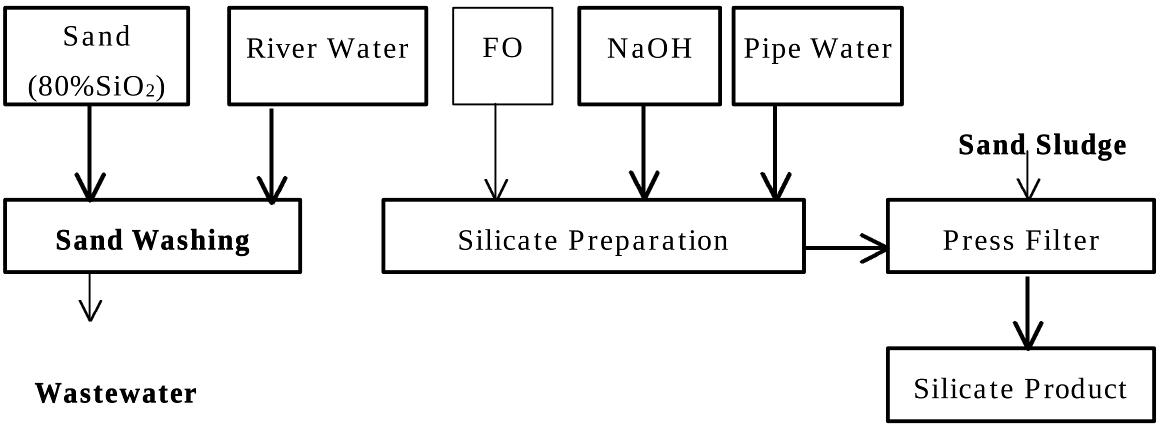


Figure 1 Silicic Acid Production Process

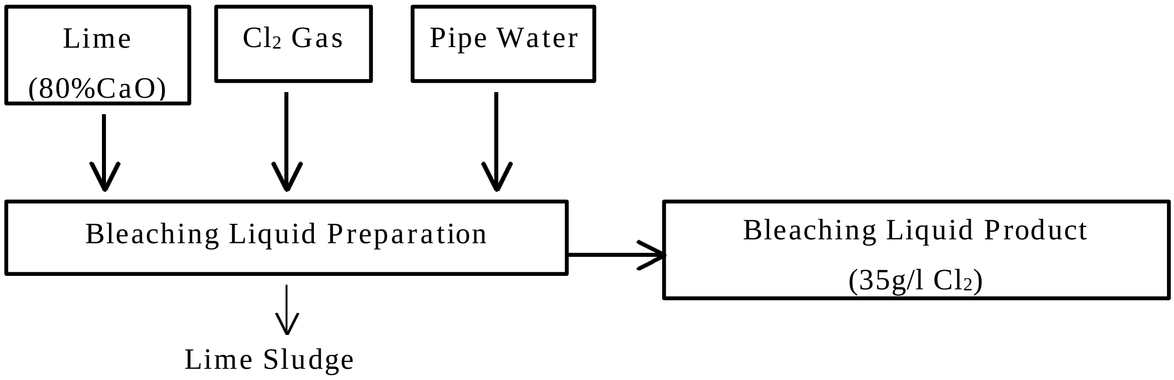


Figure 2 Bleach Production Process

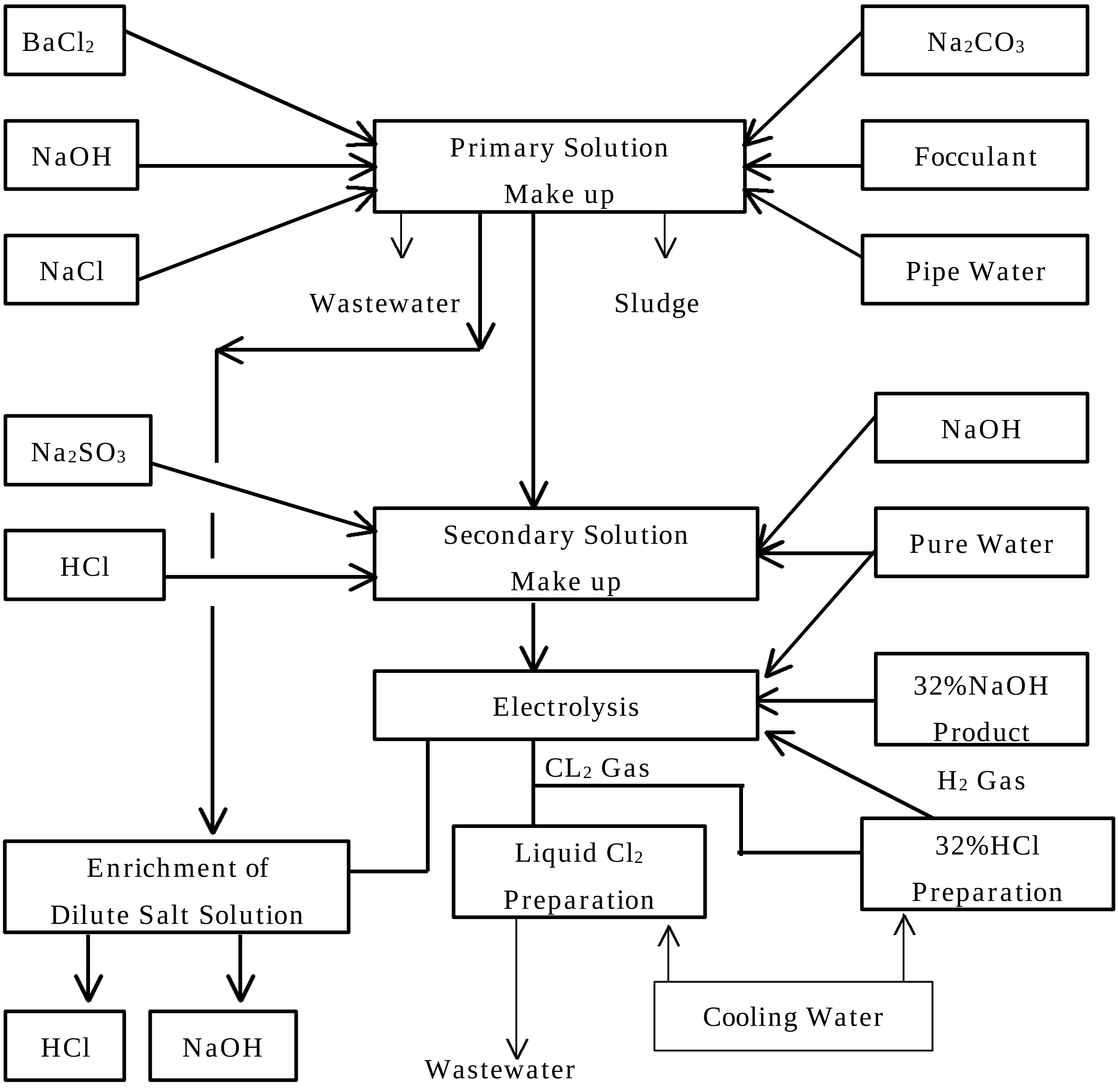


Figure 3 Caustic Soda, Hydrochloric Acid and Liquid Chlorine Production Process

2.2 Wastewater Source

Their supply water has two sources, city water and river water from the Dong Nai River.

City water is utilized for pure water production, production for silicate compounds, hypochlorite and electrolite solution. The total volume of city water is $19m^3$/hr. River water is utilized for washing and cooling of equipment at a volume of $25m^3$/hr.

The only treatment for the supply water is at an ion exchanging facility for making pure water. Total water discharge from the factory is $34m^3$/hr and this mainly consists of washing water for their equipment and floors, and also includes a small amount of domestic water. Analysis on wastewater is performed daily, and on pure water for the boiler weekly at their laboratory.

Environmental pollution is one of the major problems of the whole industrial area and this factory also has pollution problems with its wastewater.

As for industrial wastewater, the wastewater flowing from the factory to the sedimentation pond has a very low PH value, but no neutralization treatment has been introduced so far, and they are now studying ways to introduce an automatic neutralization facility in the near future.The water system is described in Figure 4.

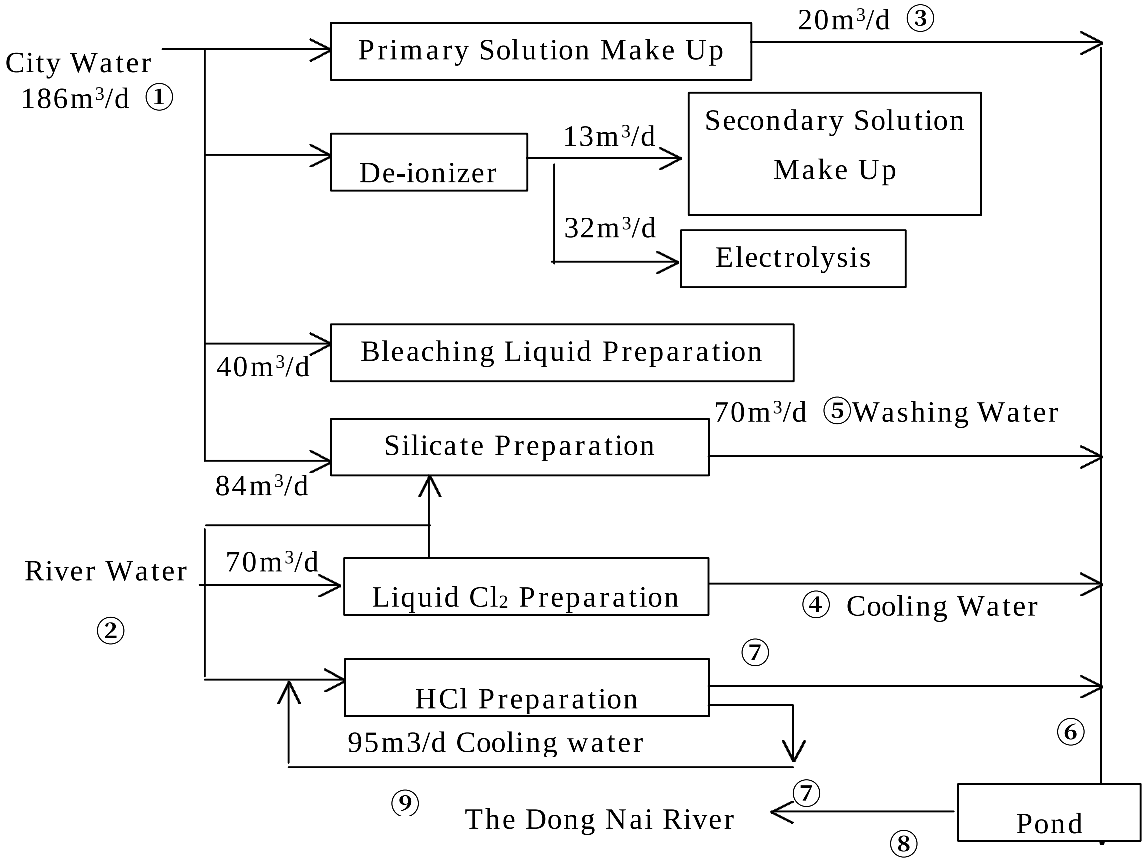


Figure 4 Water system and Sampling Points

3. Management

3.1 General

From the general observation the management of the factory seems rather good because of the well maintained factory site, facilities and equipment.

They are now applying for ISO 9000 and expecting the certification in the year 2000. However, there is no plan at present to apply for ISO 14000.

3.2 Unit Consumption of Raw Material and Utilities

Table 3 shows unit consumption of raw material and utilities in 1998.

Table 3 Unit Consumption in 1998

Material Used	Unit	Amount	Cost
NaOH (32%)			
NaCl (93%)	Tons	13,442.370	505,000 VND/t
NaOH (32%)	Tons	869.350	992,000 VND/t
Na_2CO_3 (98%)	Tons	103.120	1,900,000 VND/t
HCl (30%)	Tons	727.034	950,000 VND/t
$BaCl_2$ (85%)	Tons	283.775	2,900,000 VND/t
Na_2SO_3 (95%)	Tons	12.700	11,000,000 VND/t
Fuel Oil	Tons	640.780	1,600,000 VND/t
Electricity	kwh	18,402,477.000	779 VND/kwh
De-ionized Water	m^3	14,653.250	34,312 VND/m^3
City Water	m^3	45,504.000	3,100 VND/m^3
HCl (32%)			
Cl_2 Gas	Tons	5,409.199	2,311,042 VND/t
Fuel Oil	Tons	4.435	1,600,000 VND/t
Electricity	kwh	1,038,393.000	830 VND/kwh
Pipe Water	m^3	23,787.500	3,100 VND/m^3
De-ionized Water	m^3	3,334.280	34,312 VND/m^3
Liquid Cl_2			
Cl_2 Gas	Tons	999.757	2,311,042 VND/t
H_2SO_4 (97%)	Tons	56.004	900,000 VND/t
Electricity	kwh	345,756.000	830 VND/kwh
Sodium Silicate			
Sand	Tons	1,798.740	80,000 VND/t
NaOH (32%)	Tons	2,481.696	1,232,553 VND/t
Fuel Oil	Tons	212.135	1,600,000 VND/t
Pipe Water	m^3	21,940.000	3,100 VND/m^3
Electricity	kwh	127,905.300	830 VND/kwh
Bleaching Liquid			
Cl_2 Gas	Tons	217.611	2,311,042 VND/t
CaO (70%)	Tons	634.290	600,000 VND/t
Pipe Water	m^3	13,600.700	3,100 VND/m^3
Electricity	kwh	75,494.00	830 VND/kwh

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Sampling points and numbers are shown in Table 4.

Table 4　Sampling Points and Sample Numbers

Sample number	Sampling point
1	City Water (One of resource water)
2	River Water(One of resource water)
3	Wastewater from Primary Solution Preparation (we can not take sample because of no continuous flow)
4	Wastewater from Liquid Cl_2 Preparation(Cooling water)
5	Wastewater from Sodium Silicate Preparation(Washing water)
6	Wastewater before the pond
7	Wastewater from Acid Production (Cooling Water)
8	Wastewater after the Pond (discharge to the river)
9	River water (We can not find out the convenient place for taking samples)

We could not take sample at sampling point 3 because of no continuous flow.

Also, we tried to take sample at sampling point 9 as a general river water sample, however, we could not take sample because a suitable point for the condition was not found.

The results of the analysis by CECO for wastewater samples are shown in Table 5.

At sampling points No.4, No.6 and in the pond, oil was observed on the surface of water. However, no oil was observed at sampling point No.8. The pH value was very low, 2.1 and 2.4 respectively, at the upstream and downstream of the pond.

Table 5　Wastewater Quality　(CECO)

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		10:55	10:40	-	10:00	10:34
Temp.	℃	26	27	-	28	26
pH		7.2	8.0	-	7.4	10.8
Conductivity	mmS/cm	0.05	0.25	-	0.05	2.0
Turbidity	NTU	1	15	-	24	760
Oil content	mg/l	<0.01	0.04	-	0.10	0.15
BOD_5	mg/l	2	13.4	-	8	37
COD	mg/l	3.4	47.6	-	11.2	60.8
DO	mg/l	6.9	6.1	-	6.6	4.4
SS	mg/l	4	22	-	18	1,784
T-nitrogen	mg/l	2.9	6.2	-	6.6	4.3

Sampling Point		1	2	3	4	5
Parameter	Unit					
CN	mg/l	<0.001	<0.001	-	0.004	0.018
Phenol	mg/l	<0.001	<0.001	-	0.005	0.001
Residual Cl	mg/l	0.12	0.07	-	0.06	0.84
SO_4	mg/l	1.3	11	-	1.0	0.0
Fe	mg/l	0.08	0.29	-	0.53	0.34

Sampling Point		6	7	8	9	
Parameter	Unit					
Time		10:24	10:18	10:30	-	
Temp.	℃	28	29	28	-	
pH		2.1	4.3	2.6	-	
Conductivity	mmS/cm	7.3	0.21	0.22	-	
Turbidity	NTU	40	19	30	-	
Oil content	mg/l	0.17	0.15	0.13	-	
BOD_5	mg/l	26	9	9	-	
COD	mg/l	52.4	11.2	23.2	-	
DO	mg/l	5.4	5.8	6.4	-	
SS	mg/l	644	29	45	-	
T-nitrogen	mg/l	7.2	4.56	6.46	-	
CN	mg/l	0.006	0.001	0.016	-	
Phenol	mg/l	0.001	<0.001	0.003	-	
Residual Cl	mg/l	0.09	0.19	1.46	-	
SO_4	mg/l	40	25	25	-	
Fe	mg/l	6.08	1.18	2.92	-	

4.2 Regulation Standards for Industrial Wastewater

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 6.

Wastewater discharged to public water area, Sample No.8, shows that pH exceeds the regulated standard value (rank B).

Table 6 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD_5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(Ⅵ)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(Ⅲ)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Take countermeasures for neutralization of low pH water by adding alkaline chemicals into the sedimentation pond continuously.

(2) Remove oil in the wastewater found in certain drainage using absorbing mats.

5.2 Mid- Term and Long Term Countermeasures

There are no special recommendations.

Case Study C-17

Industrial Gas and Welding Electrode Company

Survey Date : December 13, 1999

1. General

1.1 Profile

The Industrial Gas and Welding Electrode Company is a State-owned company. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Industrial Gas & Welding Electrode Company / BIEN HOA Industrial Gas Factory
Ownership:	State owned
Address:	Bien Hoa Industrial Zone, Dong Nai Province
Director:	Mr. Dao Van Tong
Established	1968
Corporate Capital	
Number of Employees:	400 including 32 engineers (Whole Company) 61 including 5 engineers (Bien Hoa Factory)
Main Products:	Oxygen, Acetylene, Nitrogen

The company was established in 1968 and consists of 5 factories, 2 in HCMC, 1 in Bien Hoa, 1 in Can Tho and 1 in Nha Trang. The main products of the company are oxygen, nitrogen, acetylene welding materials and electrode products. The number of employees in the whole company is 400 people, including 32 engineers and, in Bien Hoa factory, there are 64 employees, of who 5 are engineers. The total area of the factory is 2.7 hectares.

1.2 Status of Business

The facility is rather old, but production has grown 5 -7 %/each year and market share is almost 50 -60% in the South. Recently, foreign companies including joint ventures with domestic companies and those with 100% foreign capital are developing there market share, so they need to improve productivity and quality of their products through this survey.

A new production line is under construction in Bien Hoa factory, of which capacity is 3 times the existing one for O_2, N_2 and its liquefied products.

There are several competitor companies, a domestic company and a JV company in the North, and a JV company with a Japanese company – Nippon Sanso, Tomoe Shokai and Nissho Iwai – and a JV company with a German company in the South.

Demand of oxygen is increasing for medical and industrial use.

Electricity is the main cost for the product at 33 -36% of total product cost and electricity consumption will increase from the present 770kwh/d to 800kwh/d. Transportation costs are not estimated. In Bien Hoa factory there are 2 production lines for producing industrial gases. The production in 1999 is expected to be lower than the capacity.

(1) Production

Table 2 Production Capacity of the Air Separation Plant

Product	Existing Facility	After Expansion
Oxygen (Nm^3/h)	145	300
Liquid Nitrogen (l/h)	200	900
Argon Gas (Nm^3/h)	-	6
Acetylene (Nm^3/h)	70	

Annual production capacity and production amounts for 1998 and 1999 are shown in Table 3.

Table 3 Production Capacity and Amount

Product	Unit	Capacity	Production (1998)	Production (1999)
Oxygen	Nm^3/y	5,600,000	4,368,000	744,000
Acetylene	Nm^3/y	1,000,000	188,000	60,000
Nitrogen	Nm^3/y	200,000	137,000	74,000

Actual annual Production and Revenues are shown in Table 4.

Table 4 Annual Production and Revenue in 1998

Product	Capacity	Production	Revenue (VND)
Oxygen	5,600,000 m^3	4,368,000	19,656,000
Acetylene	1,000,000 m^3	188,000	7,144,000
Liquid Nitrogen	200,000 m^3	137,000	1,370,000
Welding Electrode	3,000 t	1,160	7,846,000
Bottle Checking		22,700	4,000,000
Valve Repairing		33,000	
Industrial Services			
Total			40,016,000

(2) Debt

There is no description.

2. Production Technology

2.1 Process

The existing plant was designed and constructed by Chinese technology, and the equipment as well was supplied by China. The new plant has also been designed and constructed by China.

Figure 1 shows Oxygen and nitrogen production processes, and Figure 2 shows acetylene production process.

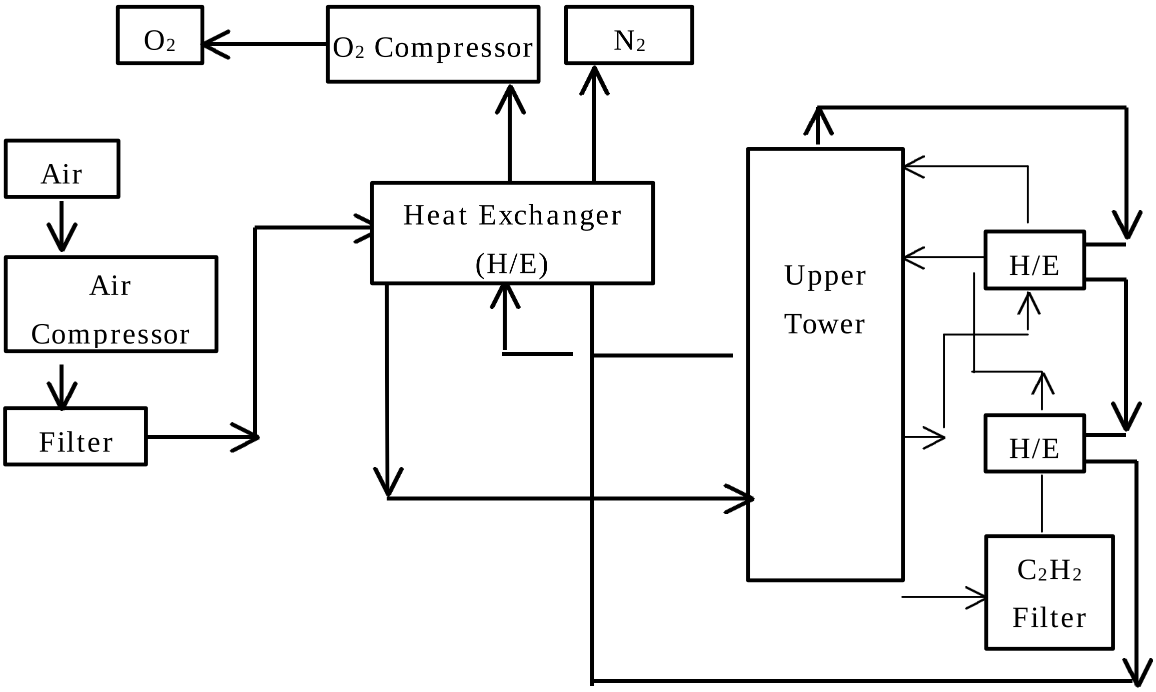


Figure 1 Oxygen and Nitrogen Production Process

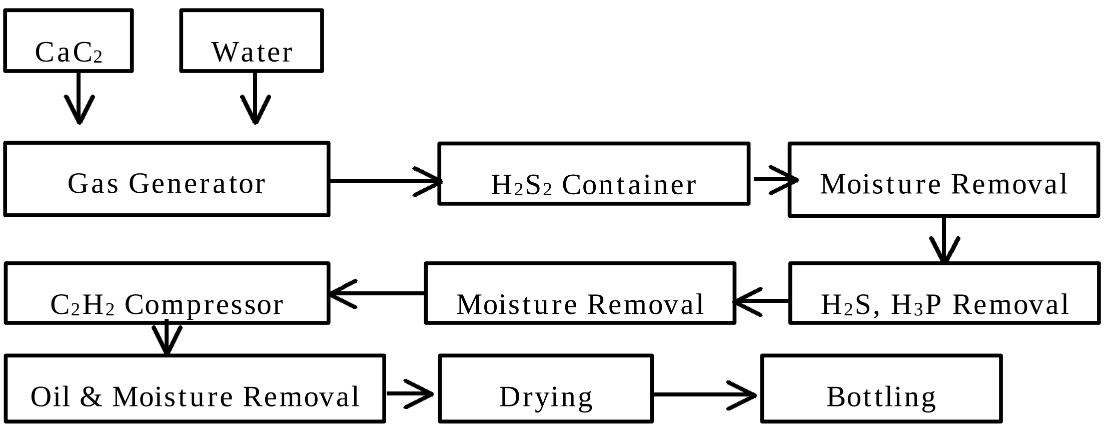


Figure 2 Acetylene Production Process

2.2 Wastewater Sources

Supply water has two sources, from city water which flows through piping from Dong Nai River and deep well water. The water consumption volume of city water is 8,000m^3/y and deep well water is also 8,000m^3/y. Total water usage for domestic, cooling of oxygen and other industrial use is 21,000 Nm^3/y, and only 12,600 Nm^3/y(60%) is discharged outside. A quality analysis inspection is performed every year.

There is a sedimentation pond with 2 channels for wastewater for the purpose of separating solid waste from wastewater. Not only the factory, but the Bien Hoa industrial area No.1 has environmental problems with wastewater and solid waste. Ind. area No.1 has a surface drainage system which discharges wastewater to the Dong Nai River. Industrial wastewater is mixed with residential wastewater and is discharged to the Dong Nai River, but the water supply source is the same Dong Nai River. Water system and sampling points are shown in Figure 3.

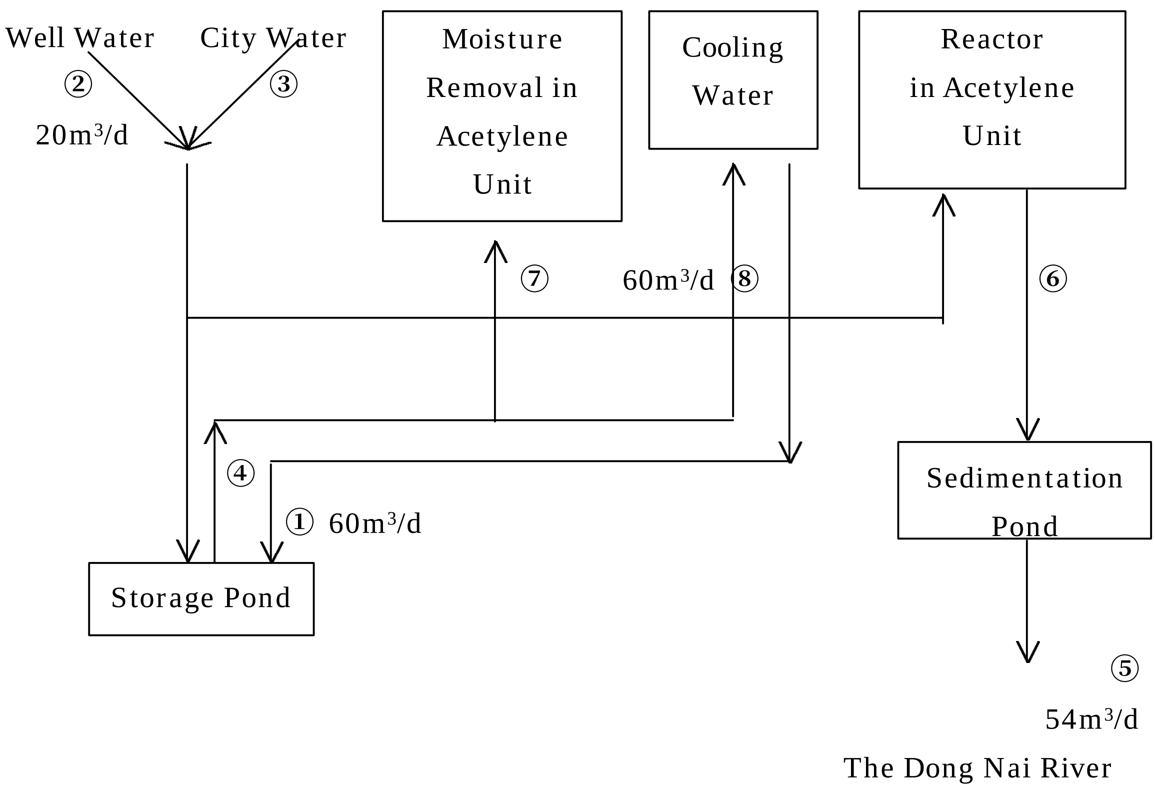


Figure 3 Water System and Sampling Points

The production technology for caustic soda is not a mercury process, but a membrane process, and so the only heavy metal contained in the wastewater is Fe. Two boiler facilities with a capacity of 2t/hr in the existing plant in this factory were introduced from China and Japan. The fuel oil is fed to the boiler as fuel.

3. Management

3.1 General

From the general observation the management of the factory seems rather good because the factory site, facilities and equipment are well maintained.

They started to study ISO 9000 in order to obtain it. After that they plan to challenge ISO 14000.

Wastewater and solid waste come along the production of acetylene have a big impact to environment. A Production level of 60,000Nm^3/y of acetylene requires 6,261,000kg/y CaC_2 raw materials and discharges 522,000 l/y of $Ca(OH)_2$ (1kg-CaC2 generates 2 l-$Ca(OH)_2$)and 320t/y of CaC_2 residue. The composition of CaC_2 residue after reaction is shown in Table 5.

Table 5 Composition of CaC_2 Residue

Parameter	Content (%wt.)
Calcium Carbide	24.6
CaO	12.5
MgO	0.5
$Fe_2O_3 + Al_2O_3$	3.5
S	0.2
C	1
$FeSiO_4$	4

The data mentions considerable amount of CaC_2 is contained the reaction residue.

3.2 Annual Consumption of Raw Material and Utilities

Raw material of acetylene, Calcium kabaite, is imported from China.

Annual consumption of raw materials for each product, additives and utilities with their costs in 1998 are shown in Table 6.

Table 6 Annual Consumption and Cost in 1998

Material Used	Amount	Cost (VND/unit)
Oxygen/Nitrogen		
Solid Soude	20 t	3,810,000
Perlite Insulator		
Copper Wire	0.0051 t	40,000,000
Ammonium Chloride	0.150 t	4,000,000
Ammonium Hydroxide	0.300 t	6,000
Lubricant	8.0 t	9,727
Electricity	9,906,000 kwh	770
Water	36,000 m^3	3,100
Acetylene		
Calcium Carbide	6,000 t	5,136,000
Calcium Chloride	4.0 t	4,300,000
Acetone	15.0 t	7,910,000
Water		
Electricity	54,000 kwh	1,020
Electrode Product		
Ferro-manganese	35.0 t	12,199,000
Rutile	100.0 t	3,636,000
Ilmenite	50.0 t	636,000
Feldspar	40.0 t	1,182,000
Kaolin	17.0 t	825,000
CaCO3	7.0 t	961,000
Wood Chip	11.0 t	2,400,000
Iron Oxide	3.0 t	7,909,000
Titanium Oxide	1.0t	31,905,000
Silicate	4.0 t	1,812,000
Tale Powder	70 t	1,340,000
Steel	730 t	4,200,000
Electricity	230,000 kwh	820

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

Sampling points are shown in Table 7, and the result of the analysis by CECO for wastewater is shown in Table 8.

Table 7　Sampling Points

Point Number	Flow rate (m³/d)	Sample
1	60	Recycled Cooling Water from the Storage Pond
2	10	Well Water（1/2 of consumption amount）
3	10	City Water（1/2 of consumption amount）
4	60	Wastewater to the Storage Pond
5	54	Wastewater after Sedimentation
6	54	Wastewater from Acetylene Reactor
7	little	Wastewater from Humidity Removal
8	60	Cooling Water from Processes

Table 8　Wastewater Quality （CECO）

Sampling Point		1	2	3	4
Parameter	Unit				
Time		11:31	11:22	11:24	11:50
Temp.	℃	27	28	28	27.8
pH		8.0	5.0	5.0	9.7
Conductivity	mmS/cm	0.12	0.09	0.09	0.09
Turbidity		8	1	1	14
Oil content	mg/l	0.09	<0.01	<0.01	0.14
BOD5	mg/l	8	3	2	7
COD	mg/l	16	5.6	3.8	14
DO	mg/l	5.8	5.4	6.4	5.8
SS	mg/l	19	6	3	11
T-nitrogen	mg/l	7.5	2.3	1.3	6.5
CN	mg/l	0.001	<0.001	<0.001	<0.01
Phenol	mg/l	0.002	<0.001	<0.001	0.13
Residual Cl	mg/l	0.02	0.01	0.02	0.05
SO4	mg/l	3	1	0.71	6
S	mg/l	4.5	2.3	4.5	45.8
T-P	mg/l	0.52	0.04	0.017	0.43

Sampling Point		5	6	7	8
Parameter	Unit				
Time		12:00	11:43	11:39	11:30
Temp.	℃	28	28	27	28.5
pH		11.98	5.0	7.8	7.8
Conductivity	mmS/cm	7.96	0.09	4.78	0.14
Turbidity		1,080	1	301	21
Oil content	mg/l	0.17	<0.001	0.10	0.08
BOD5	mg/l	118	2	391	20
COD	mg/l	340	3.8	648	68
DO	mg/l	3.4	6.4	4.0	5.4

Sampling Point		5	6	7	8
Parameter	Unit				
SS	mg/l	3,336	3	732	60
T-nitrogen	mg/l	29.3	1.3	324	8.4
CN	mg/l	0.079	<0.001	0.121	0.003
Phenol	mg/l	0.008	<0.001	0.03	0.09
Residual Cl	mg/l	1.85	0.02	1.72	0.09
SO4	mg/l	15	0.71	86	5
S	mg/l	349.5	4.5	0.83	0.08
T-P	mg/l	6.71	0.07	0.12	0.27

The quality of well water and city water are almost the same.

The sedimentation pond was filled with CaC_2 residue and wastewater was not treated in the pond because the back fill of residue caused new wastewater to pass over the surface of the pond so no sedimentation could take place. The color of wastewater from the acetylene reactor was grayish because it contained much CaC_2 residue.

4.2 Regulation Standards for Industrial Wastewater

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table9. Discharged water from the company, Sample No.5, shows that pH, BOD_5, COD, SS, sulfur compounds and total phosphor exceed regulated standard values.

Table 9 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD5	Mg/l	50	Organic P	mg/l	0.5
COD	Mg/l	100	Fe	mg/l	5
SS	Mg/l	100	Sn	mg/l	1
Mineral Oil	Mg/l	1	Hg	mg/l	0.005
Organic Oil	Mg/l	10	T-Nitrogen	mg/l	60
As	Mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Countermeasures need to be taken for wastewater discharge from the company as soon as possible. (Refer the following items)

(2) Neutralize wastewater before sedimentation using alkaline chemicals. However, if there are other sources of alkaline wastewater it is preferable to neutralize that wastewater in a common treatment pond.

(3) The sedimentation pond is full of solid waste and that waste needs to be removed. The sedimentation pond should be divided into two ponds, and they should be utilized for removing precipitate in turn.

(4) Clean up the factory, especially concentrating on safety aspects.

(5) Install portable acetylene gas detector or a stationary one for prevention of fires and explosions.

5.2 Mid- Term and Long Term Countermeasures

(1) Install a common wastewater treatment system in industrial zones.

(2) Apply for ISO 9000. In order to apply, the factory and facilities should be maintained cleanly and orderly, and the documentation system for production and quality control should be completed orderly.

CASE STUDY C-18

Tay Ninh Rubber Company

Survey Date : December 14, 1999

1. General

1.1 Profile

Tay Ninh Rubber Company is one of the Local Government owned companies of Ho Chi Minh City. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Tay Ninh Rubber Company
Ownership:	Local Government owned
Address:	Go Dau- Tay Ninh Province
Vice Director:	Mr. Le Khac Minh
Established	1908 as a French Company, then in 1975 established as Tay Ninh Rubber Company
Corporate Capital	
Number of Employees:	2,250 including 20 engineers
Main Products:	Rubber Materials

The plantation was started in 1908 before the French governed the country. The total area of the plantation was developed to 4,000ha in 1975. The Government of Viet Nam took over the plantation and the Tay Ninh Rubber Company was established in 1975. At present, the area has been expanded to 7,300ha and the number of employees is 2,300, including 60 university graduates, with 20 engineers in the chemical, mechanical and agricultural field. 100 technicians are also included in this figure. The company has 3 enterprises in 3 plantation locations, a head-quarters and a factory in Tay Ninh district and a factory in 25 km north from their head quarters in the Ben Cui district. There are three types of rubber products, block rubber from milk (latex) produced at 3,000t/y, block rubber from cup lump at 2,000t/y and latex concentrate at 2,000t/y.

The production capacity of rubber products is shown in Table 2.

Table 2 Production Capacity of Rubber Products

Product	Factory in Tay Ninh	Factory in Ben Cui	Total
block rubber from latex	3,000t/y	3,000 t/y	6,000 t/y
rubber from cup lump	2,000t/y	--	2,000 t/y
latex concentrate	2,000t/y	--	2,000 t/y

1.2 Status of Business

Their production rate is rather low and their main markets are China, South East Asian countries and the USA. There are some difficulties with domestic competition in terms of quality. They have almost the same quality as imported products, but are 60 to 200 US$ cheaper in price. So Tay Ninh Rubber company needs to stabilize the quality of their products. As for production costs, their product cost is similar to the products made in Thailand, especially for tree costs and labor costs. Future expansion will be depend on cost factors, especially equipment cost, labor cost and the cost of investment. The traditional chemical industry in Viet Nam is not big in scale and in the future an environmental friendly industry should be developed.

(1) Production

The main products of the company are SVR3L, SVR5 and market preferable products SVR10 and SVR20. Production of the latter 2 products will be increased from 20% to 75% for tire use. However, because of the limitation of available land area, they have no future expansion plan at present. Their main additives, formic acid in 30l cans is imported from Germany and NH3 in 30l cans is transported by train from Ha Bac district. Formic acid is substituted for acetic acid depending on each products' market price.

Actual annual Production and Revenues are shown in Table 3.

Table 3 Annual Production and Revenues in 1998

Product	Amount (t)	Revenue (1,000 VND)
From the plantation's material	**5,768.720**	**52,017,913**
SVR3L	3,666.000	30,017,626
SVR5	34.435	249,266
SVR10	67.894	589,581
SVR20	728.258	5,482,743
Specialized	0.467	3,497
Skim	121.732	622,268
Latex Concentrates	1,148.973	14,307,932

From outside material	**9.667**	**71,460**
SVR20	9.667	71,460
Process for other material owner	**1,055.827**	
SVR3L	238.580	
SVR5	15.181	
SVR10	339.567	
SVR20	462.499	
Total	**6,834.214**	
SVR3L	3,950.541	
SVR5	49.616	
SVR10	407.461	
SVR20	1,200.424	
Specialized	0.467	
Skim	121.732	
Latex Concentrates	1,148.973	

(2) Debt

A certain amount of debt has been introduced from the bank through the government and USA funds so far, but the company has been requested to pay back the debt in advance in spite of its original 10year pay back period.

2. Production Technology

2.1 Process

Figure 1 shows the rubber processing from pure latex process, figure 2 shows rubber processing process from cup lump and Figure 3 shows concentrated latex production process made from natural latex.

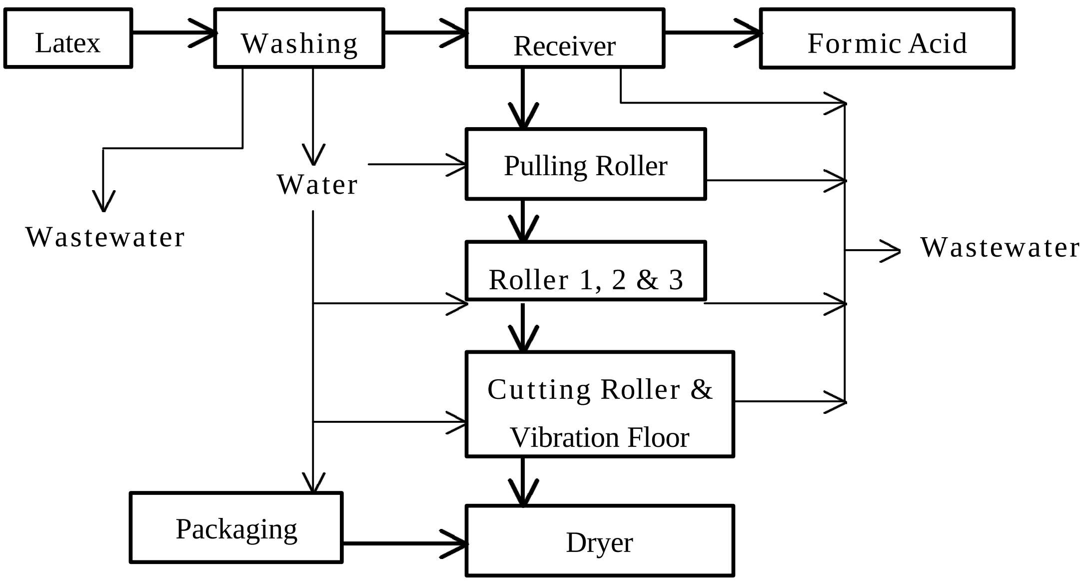


Figure 1 Rubber Production Process from Pure Latex

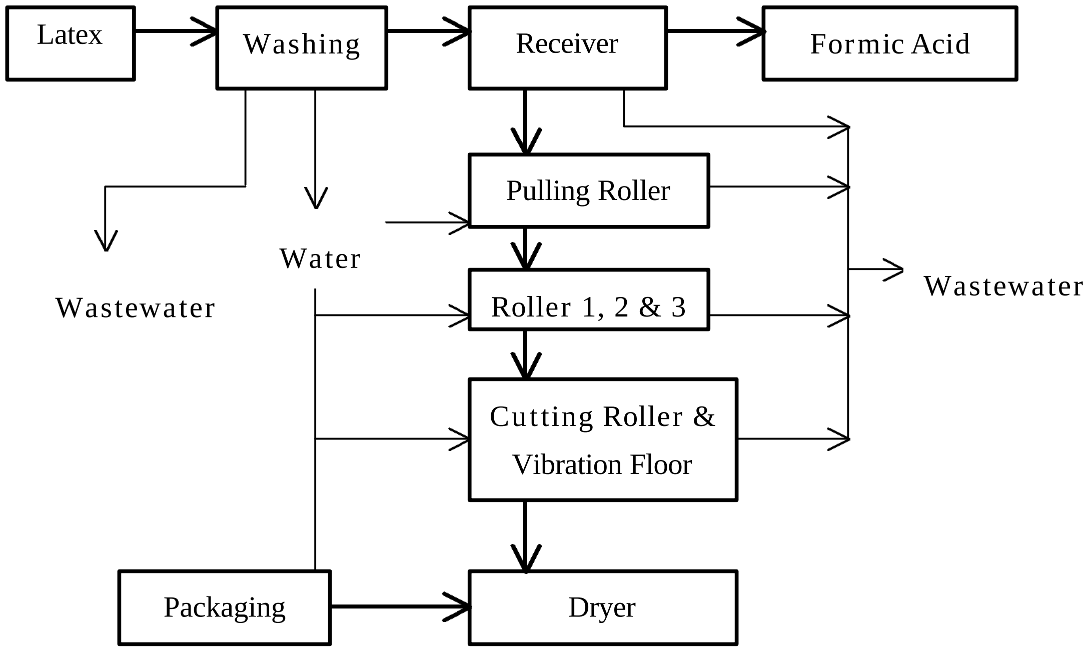


Figure 2 Rubber Processing Process from Cup Lump

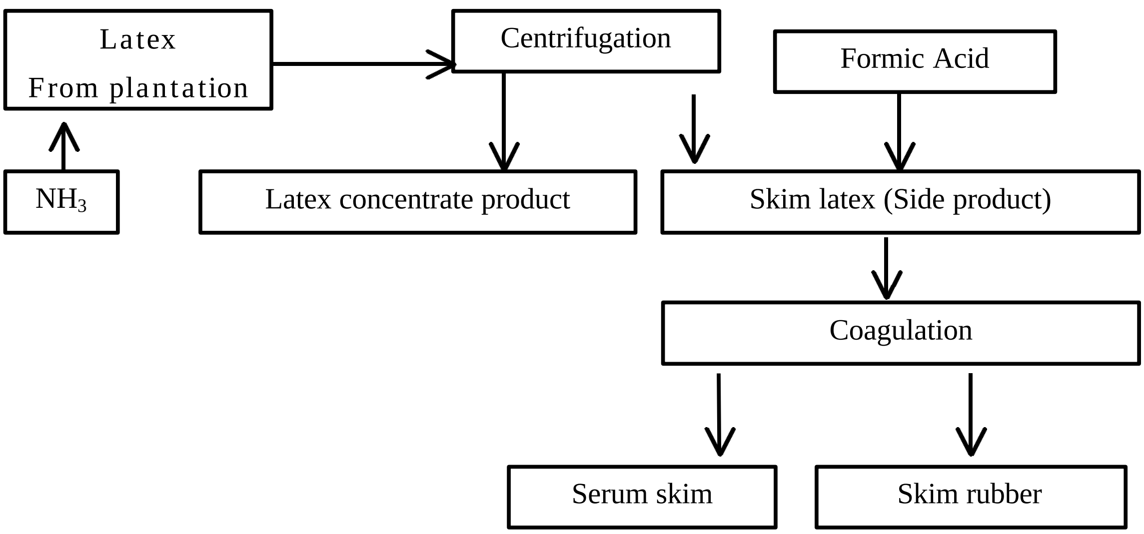


Figure 3 Concentrate Latex Production Process

2.2 Wastewater Source

The supply water sources are deep well and river water (The Vam Co Dong River). Pump capacity for each types of supply water is 50m^3/h and 30 m^3/h respectively. River water is used for washing water of the 1st half block rubber unit and well water is used for the 2nd half unit.

The company discharges 500m³/d of industrial wastewater through a biological wastewater treatment system that was renovated because of some unsuitability problems in the past, and now the system runs well with light loads so far.

Water system and sampling points are shown in Figure 4.

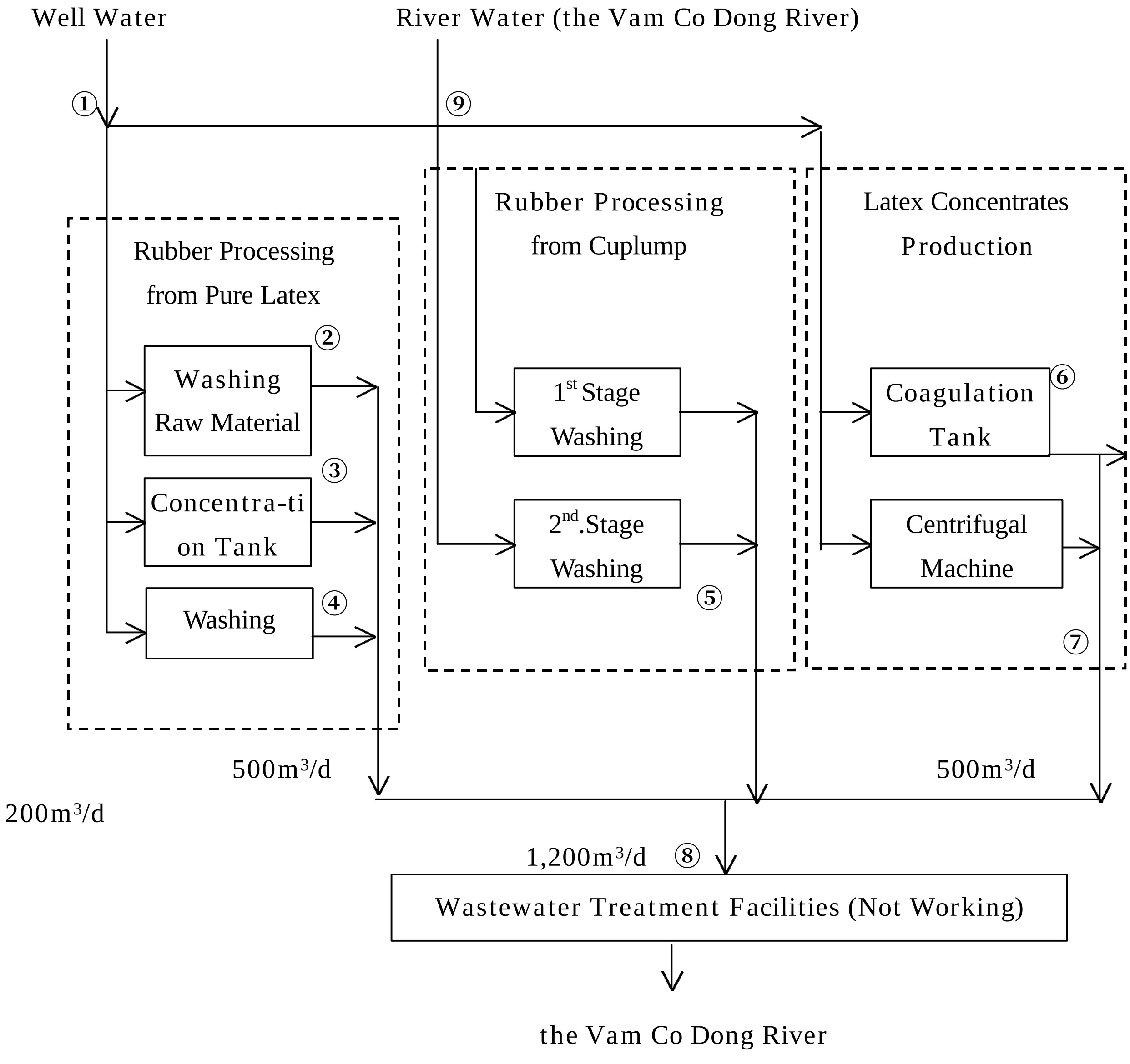


Figure 4 Water System and Sampling Points

3. Management

3.1 General

The main environmental problems of the company are gas emissions, foul odors and wastewater. They are preparing to apply for ISO 9000 under the supervision of French consultant and expect to be certified in the middle of 2000, but ISO 14000 is not under consideration yet.

3.2 Annual Consumption of Raw Materials and Utilities

Annual consumption of raw materials for each products, additives and utilities with their cost in 1998 are shown in Table 4.

Table 4 Annual Consumption and Cost in 1998

Material Used	Amount	Cost / Unit (VND)	Cost (VND)
SVR3L,5			170,220,000
Formic Acid	3.6kg/t x3.955=14,240kg	10,216	145,476,000
NH3, 20% solution	0.4kg x3,955=1,582kg	2,135	3,378,000
Sodium Bisulfide	0.6kg x3,955=2,373kg	8,522	20,223,000
Sulfuric Acid	0.08kg x3,955=316kg	3,616	1,143,000
SVR10,20			850,816,000
No Chemicals			
Water for Pure latex	3,955t x 25m^3/t=98,875m^3	350	34,606,000
Water for Cuplump	1,608t x35=56,280m^3	350	19,698,000
Water for Skim Latex	1,271t x20=25,420m^3	350	8,897,000
Electricity	971,165kw	811	487,615,000
Latex Concentrates			185,774,000
NH3 Gas	12kg x1,149=13,788kg	10,665	147,049,000
NH3 Solution	16.2kg x1,149=18,1387kg	2,135	38,725,000
Skim Rubber			311,588,000
Formic Acid	250kg x122=30,500	10,216	311,588,000

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

They often checked the quality of the wastewater in the past because the wastewater treatment did not work well at that time. The results of the analysis for industrial wastewater in 1997 are shown in Table 5.

Table 5 Result of Analysis for Industrial Wast Water in 1997

Parameter	Latex Concentration Unit	Block Rubber Unit
pH	4.2	5.7
BOD_5	3,580	1,750
COD	6,572	2,740
SS	390	240
N, NH_3	700	66

Sampling points are shown in Table 6. And the results of the analysis by CECO for wastewater sample taken at the same time as the JICA team are shown in Table 7.

Table 6 Sampling Points

Sample Number	Sampling Points
1	Well Water
2	Wastewater from Raw Material Washing (no continuous flow)
3	Wastewater from the concentration Tank
4	Washing Water (There is no wastewater)
5	Washing Water from Rubber Processing from the Cup Lump
6	Wastewater from the Coagulation
7	Wastewater from Latex Concentrates Production
8	Wastewater Discharge to the River
9	River Water

Table 7 Wastewater Quality （CECO）

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		13:10	-	12:54	-	13:02
Temp.	℃	29	-	28	-	30.5
pH		7.6	-	5.4	-	7.9
Conductivity	MmS/cm	0.17	-	2.5	-	0.28
Turbidity	NTU	0	-	852	-	44
Oil content	mg/l	<0.01	-	0.21	-	0.22
BOD_5	mg/l	4	-	1,495	-	183
COD	mg/l	8	-	2,720	-	320
DO	mg/l	6.4	-	5.1	-	6.3
SS	mg/l	1	-	583	-	173
T-nitrogen	mg/l	3.2	-	1,684	-	151
CN	mg/l	<0.001	-	0.16	-	0.016
Phenol	mg/l	<0.001	-	0.002	-	0.015
Residual Cl	mg/l	0.03	-	3.64	-	1.06
SO_4	mg/l	0.56	-	95	-	13

Sampling Point		6	7	8	9
Parameter	Unit				
Time		13:22	13:28	13:35	13:14
Temp.	℃	30	29	28	27.5
pH		4.8	6.7	6.2	7.4
Conductivity	MmS/cm	15.87	5.58	1.27	0.03
Turbidity	NTU	1,680	1,780	830	10
Oil content	mg/l	0.56	0.40	0.28	0.12
BOD5	mg/l	1,770	1,972	560	18
COD	mg/l	3,040	3,320	1,120	32
DO	mg/l	5.0	5.3	6.0	6.1
SS	mg/l	1,225	1,348	1,000	15
T-nitrogen	mg/l	2,329	2,219	833	7.8
CN	mg/l	0.159	0.044	0.092	<0.001
Phenol	mg/l	0.012	0.010	0.021	0.005
Residual Cl	mg/l	5.96	0.74	1.32	0.21
SO_4	mg/l	146	32	45	8

4.2 Regulation Standards for Industrial Wastewater

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 8.

According to the comparison between the data in Table 7 and Table 8, discharged water from the company, Sample No.8, shows that BOD_5, COD, SS, total nitrogen and cyanide exceed the regulated standard values. This is because the wastewater treatment facilities were not operating at the time samples took place.

Table 8 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
pH		5.5-9	Ni	mg/l	1
BOD5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Start operation of the wastewater treatment facilities as soon as possible to satisfy the regulation standards. At the same time, the condition of was water and its fluctuation for the optimum operation of the wastewater treatment facilities.

(2) Study measures to reduce water consumption by recycling through continuous analysis of quality and quantity of water, and also separation of water lines due to kind of water.

(3) Improve the turbidity of wastewater by utilizing coagulation and sedimentation ponds.

(4) Increase efficiency of water used, for example, cooling by heat exchanger and its operation should be done in a counter flow system.

(5) Clean up the factory and floor, especially in order to remove the foul odor through specifying the sources of odor.

(6) Apply for ISO9000 as soon as possible. In order to apply, the factory and facilities should be maintained cleanly and orderly, and the documentation system for production and quality control should be completed orderly.

5.2 Mid- Term and Long Term Countermeasures

(1) If BOD or COD is extremely high, a special wastewater treatment is necessary to improve the quality of the discharge water. One example of this kind of system would be an improved activated sludge treatment system.

CASE STUDY C-19

Tico Detergent Powder Company

Survey Date : December 15, 1999

1. General

1.1 Profile

TICO Detergent Powder Company is one of the Ho Chi Minh city government-owned companies producing detergent chemicals and powder detergent itself. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	TICO Detergent Powder Company / BINH DUONG Factory, TAN BINH Factory
Ownership:	Local Government owned
Address:	Road 14- Tan Binh- HCM City
Vice Director:	Mr. Nguyen Van Kieng
Established:	1972 for Tan Binh Factory 1995 for Binh Duong Factory
Corporate Capital:	
Number of Employees:	387 for Tan Binh Factory, 70 for Binh Duong Factory including 12 engineers
Main Products:	Detergent Powder at Tan Binh Factory LAS & Liquid Detergent at Binh Duong Factory

The company was established in 1972 in an 8,000 m^2 area in Tan Binh district in HCMC. In 1995, a new factory was established in Binh Duong province with advanced facilities for producing LAS with advanced technology from Italy.

The products of the Tan Binh factory are powder detergent based on LAS and liquid detergent. The products of the Binh Duong factory are linear alkylbenzene sulfate derived from linear alkylbenzene imported from Japan(NPCC, Nippon Petrochemical Co., Ltd), Korea, India and sulfur imported from Singapore which originated in Australia. The Binh Duong factory is 40 km far from the head office in Tan Binh.

A new petrochemical complex is planned for construction from 2000 in the Da Nang region and will start production in 2003. Raw materials for LAS are expected to be produced domestically in spite of the severe cost competitiveness due to their huge investment in construction of the complex.

The main problem in the head factory is leakage of products because sieve shaker doesn't have any cover for it. High frequency tone from weighing machine for packaging , and low frequency tone from blower also cause noise problem in this factory. Most of water is used for washing water and wastewater is discharged to city sewage.

A petrochemical complex will be starting built in 2000 in Da Nang, and plan to be started operation around the year 2003.

1.2 Status of Business

Total capacity of LAS in Viet Nam is 100,000t/y and is produced by 2 companies in the North and 3 companies in the South. However, the demand for LAS is not active even now with its supply at 1/3 of capacity. Because of the market situation they are planning to increase the ratio of sales of LAS to other powder detergent producers. In 2000 they will sell 90% of their LAS to powder detergent makers and only 10% of LAS will be utilized for their own powder detergent production. This means they will shift their business from consumer products to raw material chemical products.

(1) Production

A new production facility from Italy was introduced in 1995. The production capacity of LAB is 12,000 t/y and production in 1998 was nearly equal to full capacity.

20% of LAS is utilized for powder detergent production and 80% is sold to the other powder detergent producers in Viet Nam. In spite of the weak demand for LAS, they have plans to double their production capacity in the year 2000.

There are 5 enterprises that produce powder detergent, 3 in the North and 2 in the South, and their combined total production capacity is estimated at 100,000 t/y which is 3 times the total demand in Viet Nam. Quality and price of their products are similar each other and profits are rather small.

The company plans to produce liquid detergents using lauryl alcohol imported from Japan and Singapore.

Actual annual Production and Revenues are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Amount (t)	Revenue (million VND)
LASA	11,595	100,107
Detergent Powder	7,915	64,232
Detergent Paste	376	2,009
Total		166,351

(2) Debt

According to the data submitted by the company, the total amount of debt as of December, 1999 is as follows;

Commerce Bank : 560 million VND

State Bank : 300 million VND

Investment Bank : 0.885 million VND

Industrial and Commerce Bank : 83,000 US$

Total investment in the construction of LAS production facilities is 3.6 million US$, including 2.4 million US$ for equipment. The debt has to be paid back in 7 years and the interest rate is 9.6 %/y (0.2% / month).

2. Production Technology

2.1 Process

In the Binh Duong factory, LAS is produced under the conditions of a reaction temperature of 50 ℃ and a pressure of 200 mbar(reactor inlet) and 300 mbar(reactor outlet). Raw material used in production for LAB is imported from Japan, Korea and India, and another raw material, SO_3 is derived from sulfur which is imported from Australia. This production technology for LAS was introduced from Italy in 1995 and also, the main equipment was made in Italy.

Figure 1 shows LAS production Process, and Figure 2 shows powder and paste detergent production process.

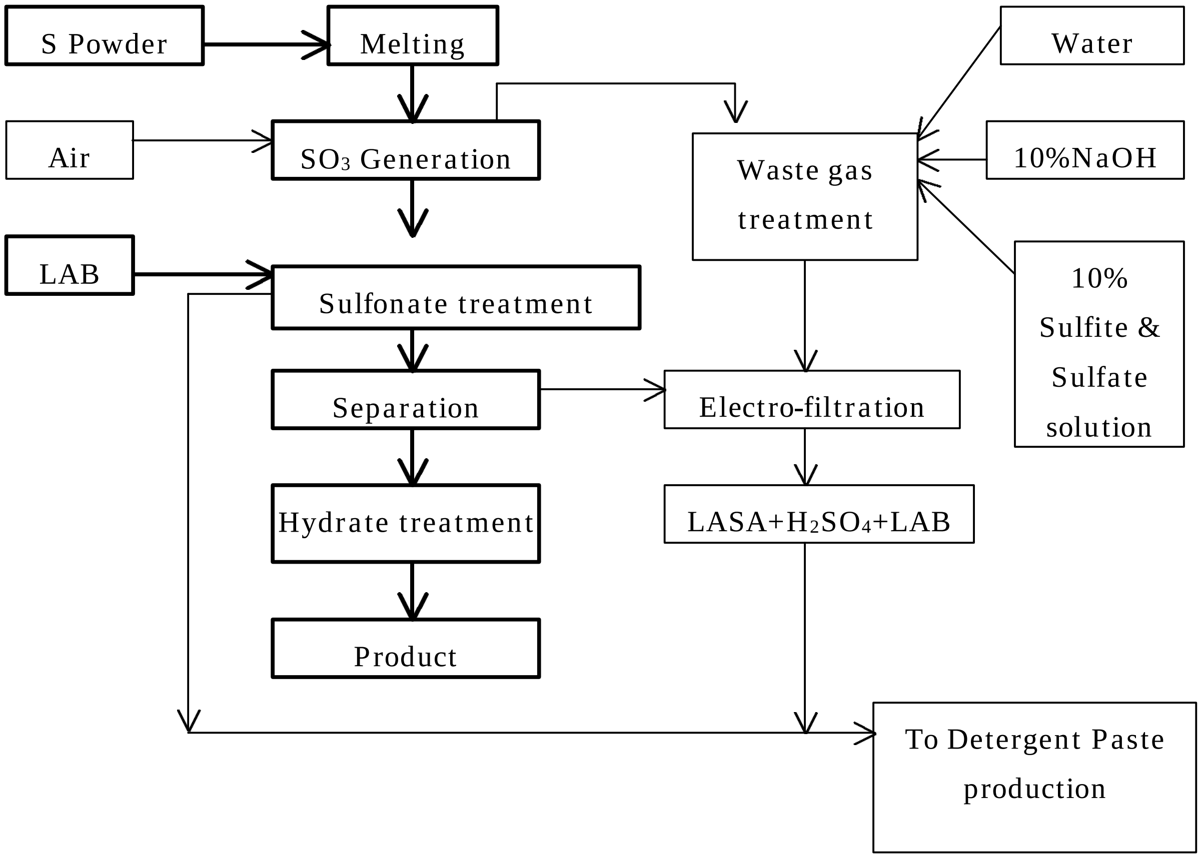


Figure 1 LAS Production Process（Binh Duong Factory）

2.2 Wastewater resource

Basically, the Binh Duong factory discharges no industrial wastewater outside of the factory and has had no problems so far. Supply water is drawn from a deep well in the factory and is used at a rate of 80 m^3/d, including for domestic use. The volume of cooling water is 200m^3/h and is circulated completely. Supplemental water flowing to the circulation system is only 5 m^3/h. Water is used for floor cleaning once a week, and for equipment cleaning only once every 2 months. Treated supply water is also used for circulating cooling water to a SO_3 reactor. This cleaning work requires 5 m^3/1t every time. Domestic wastewater and industrial wastewater are gathered in each pond for evaporation and permeation into the soil, and no wastewater is discharged by the company.

Water system and sampling points are shown in Figure 3.

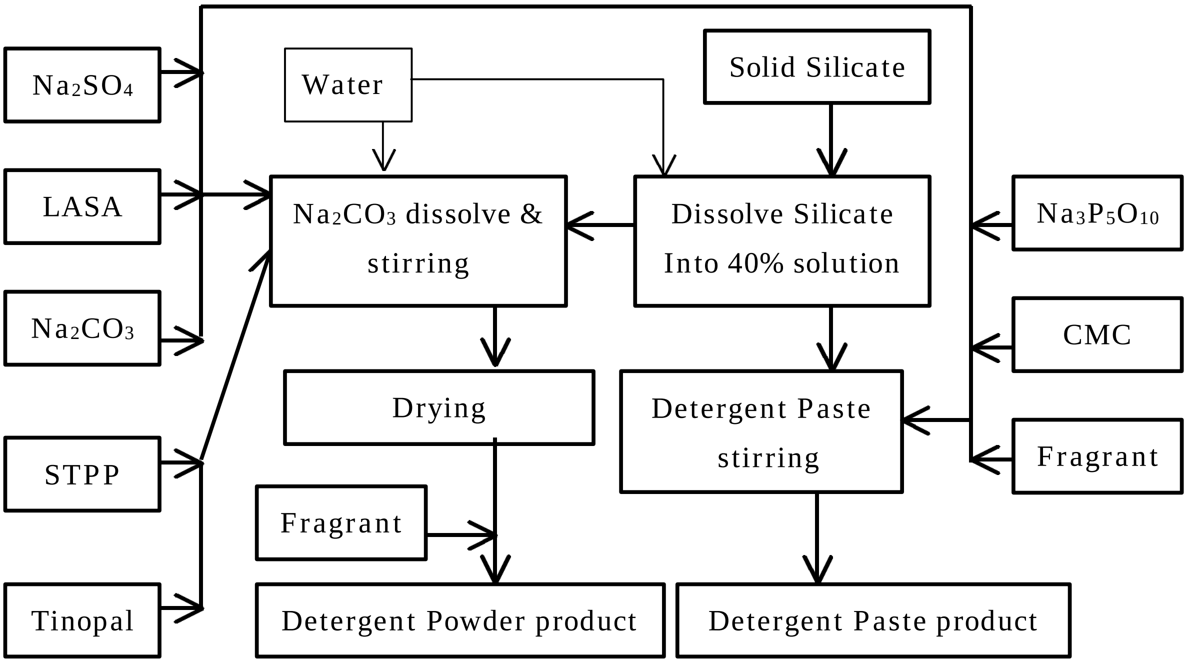


Figure 2　Powder and Paste Detergent Production Process（Tan Binh Factory）

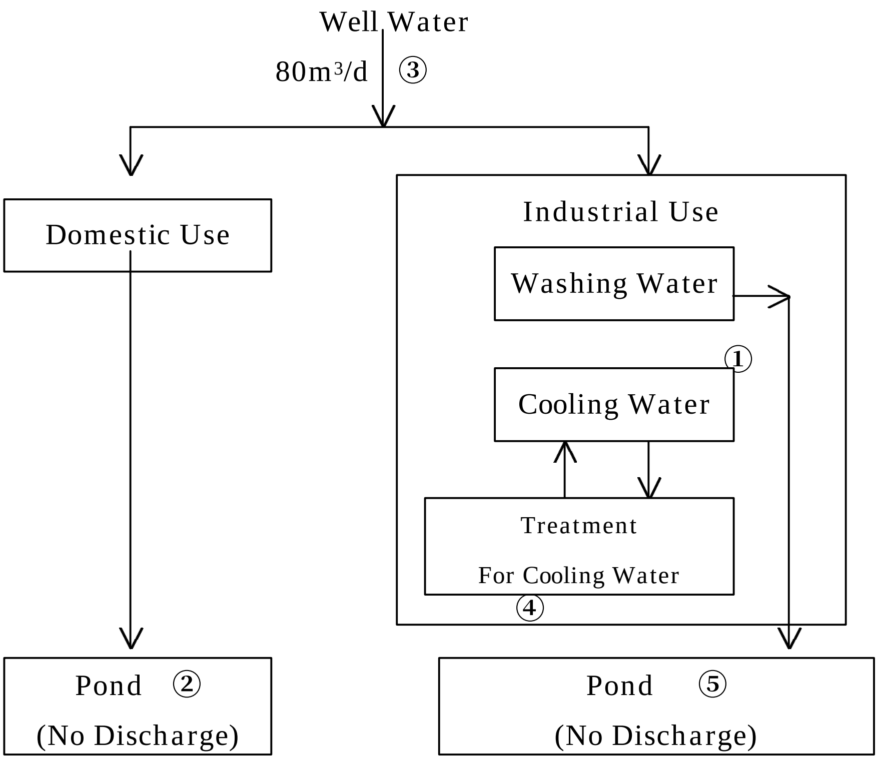


Figure3　Water System Chart and Sampling point（Binh Duong Factory）

3. Management

3.1 General

From the general observation the management of the factory seems rather good because of the well maintained factory site, facilities and equipment.

Environmental problems in Tan Binh factory are leakage of products from the vibrating sieves, and noise from the blowers disrupting the community.

Regarding wastewater, there are no environmental problems.

3.2 Raw material and utility consumption

Table 3 shows consumption amount of raw material and utilities in 1998.

Table 3 Consumption Amount of Raw Material and Utility (1998)

Material Used	Unit	Amount	Cost/Unit	Cost
Detergent Powder				
LABSA	kg/t	1,425.00	10,576.91	15,072,096.00
Na_2CO_3		633.00	1,622.42	1,026,991.80
Sodium Sulfate		3,989.00	1,124.23	4,484,553.00
STPP		673.00	6,090.14	4,098,664.20
TINOPOL,CBS-X	l/t	1,583.00	355,542.52	5,628,238.40
Fuel Oil & Diesel Oil		831,075.00	FO:1,583.69	394,849,550.00
			DO:3,153.05	1,834,294,720.00
Silicate (40%)		3,348.00	764.75	2,560,383.00
Process Water		7,836.00	3,100.00	24,291,600.00
Electricity	kw/t	792.00	740.00	586,080.00
Fragrant	l/t	20.00	278,374.79	5,567,495.80
CMC		39.60	11,674.00	462,290.40
LAS				
LAB	kg	8,812.00	12,509.34	110,234,805.90
Sulfur		1,230.00	1,267.46	1,558,975.80
NaOH		104.40	4,000.00	132,322.82
Electricity	kw/t	2,551,000.00	810.00	2,066,310.00
Fuel Oil	l/t	173,925.00	1,583.69	275,443,283.30
Diesel Oil	l/t	28,987.00	3,135.05	91,397,460.35
Detergent Paste				
LABSA	kg/t	57.20	10,576.91	604,999.25
Na_2CO_3		30.10	1,622.42	48,834.84
Sodium Sulfate		37.60	1,124.23	42,271.01
STPP		15.00	6,090.14	91,352.10
Silicate (40%)		64.00	764.75	48,994.00
Electricity		18,800.00	740.00	13,912,000.00
Process Water		169.20	3,100.00	524,520.00
Fragrant	l/t	0.94	278,374.97	261,672.00
CMC		3.00	11,674.00	35,022.00

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater Quality

The water system and sampling points are described in Table 4 and the results of the analysis for wastewater by the JICA team are shown in Table 5.

Table 4 Sampling Points (Binh Duong Factory)

Sampling Point	
1	Washing Water
2	Domestic Wastewater in the Pond
3	Well Water
4	Cooling Water after Treatment
5	Industrial Wastewater in the Drainage
6	River Water (the Sai Gon River at Bing Duong Province)

Basically, the Binh Duong factory discharges no industrial wastewater outside of the factory and has had no problems so far.

Table 5 Wastewater Quality in Binh Duong Factory (CECO)

Sampling Point		1	2	3	4	5	6
Parameter	Unit						
Time		11:15	11:32	11:40	11:45	11:52	13:54
Temp.	℃	31	26	29	32	28	27
pH		6.7	6.9	5.0	6.4	5.4	7.8
Conductivity	mmS/cm	0.05	0.07	0.2	0.2	0.04	0.03
Turbidity	NTU	1	15	10	1	31	40
Oil content	mg/l	0.03	0.1	<0.01	<0.01	0.12	0.15
BOD5	mg/l	4.7	27	4	2	10	6
COD	mg/l	12.8	48	14	3.2	14.4	9.2
DO	mg/l	6.7	4.9	4.0	6.4	5.6	5.0
SS	mg/l	6	12	6	1	26	35
T-nitrogen	mg/l	1.8	9.2	1.7	1.6	6.35	3.2
CN	mg/l	<0.001	0.024	<0.001	<0.001	0.012	0.003
Phenol	mg/l	<0.001	0.002	<0.001	<0.001	0.020	0.001
Residual Cl	mg/l	0.02	0.04	0.04	0.05	0.06	0.02
SO4	mg/l	1.6	27	2	0.32	18	2.6
LAS	mg/l	10.3	4.8	<0.01	<0.01	38.4	1.02
T-P	mg/l	0.01	0.17	0.02	0.01	1.33	0.02

Remarks:

Sampling Point No.1: Washing Water

Sampling Point No.2: Domestic Wastewater in the Pond

Sampling Point No.3: Well Water

Sampling Point No.4: Cooling Water Downstream of the Treatment Process

Sampling Point No.5: Industrial Wastewater in the Drainage

Sampling Point No.6: River Water (the Sai Gon River at the Binh Duong Province)

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Apply for ISO 9000 as soon as possible. In order to apply, the factory and facilities should be maintained cleanly and orderly, and the documentation system for production and quality control should be completed orderly.

(2) Reduce product loss by installing sliding lids on vibrating sieves in the Tan Binh Factory. This results cost reduction and environmental improvement.

5.2 Mid- Term and Long Term Countermeasures

(1) Conduct a study on countermeasures for noise generated by the rotating machines in the Tan Binh Factory. In order to improve the present condition, the detail analysis on noise sources such as rotating machines is required, for example, measurement of frequency of noise and noise level and check of maintenance condition of machines. According to above analysis, the appropriate countermeasures can be selected and implemented effectively.

CASE STUDY C-20

Da Nang Chemical Industry Company

Survey Date: December 16, 1999

1. General

1.1 Profile

The Da Nang Chemical Industry Company is one of the State-owned companies producing powder detergents and NPK fertilizers. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Da Nang Chemical Industrial Company
Ownership:	State-owned
Address:	53- Le Hong Phong- Da Nang City
Vice Director:	Mr. Huynh Ngoc Thuyen
Established	1975
Corporate Capital	
Number of Employees:	300 including 60 engineers,150 technicians
Main Products:	Detergent & Additives, NPK fertilizer

The company was established in 1975 as part of the Viet Nam Chemical Corporation and is located in the Hoa Khanh Industrial Zone 15 km west of Da Nang City. The company's 3 main activities are ① production of chemical products, ②research, development and design of chemical products and ③ construction of chemical plants.

1.2 Status of Business

As for powder detergents, the business had grown every year prior to 1998, but since 1998 the business has decreased steeply because of increased competition with JV companies supported by P&G and Unilever. Though the market is very tight the company has an estimated sales plan and hopes to keep developing at 20-25% a year. On the other hand, the fertilizer business is in good condition and production is expected to double in 1999 compared to 1998' production levels. However, NPK fertilizer is the only the product whose raw materials are all purchased from other enterprises and the company has future plans (as pre-F/S) to install a new fertilizer production plant for superphosphate using fused magnesium.

(1) Production

The capacity of the facility and their total production in 1998 are shown in the attachment, but the actual capacity for fertilizer is now 10,000t/y after renovation of the process. Excessive amounts of the product have been exported to IRAQ recently. LAS for detergent powder is supplied by domestic producers like TICO, a company in Hai Phong, a company in HCMC and a JV company with an Indonesian company in Long Thang province. Silicate compound is also produced in the company utilizing soil mined from the area near the factory as a natural resource, and the liquid by-product of Na_2SiO_2 is stored in two storage tanks at 50ºC for selling to detergent producers and for consumption for their powder products. Actual annual production and revenues are shown in Table 2.

Table 2 Annual Production and Revenues in 1998

Product	Capacity (t/y)	Production (t)	Revenue (million VND)
Detergent Powder	5,000	6,506	
Detergent Paste	3,000	1,704	
Fertilizer	5,000	2,086	
Sodium Silicate	5,000	3,003	
Total			32,728

(2) Debt

According to the data submitted by the company, they have 3,500 million VND of debt with the Da Nang Industrial and Commerce Bank.

2. Production Technology

2.1 Process

The production technology for both powder detergent and NPK fertilizer were developed autonomously as their own technology, but they do not give this process a good evaluation and the facility itself is rather old. The NPK fertilizer production process in the JV company with a Japanese company, stands out as one of reference for the design of their processes, especially the design for the steam granular production unit.

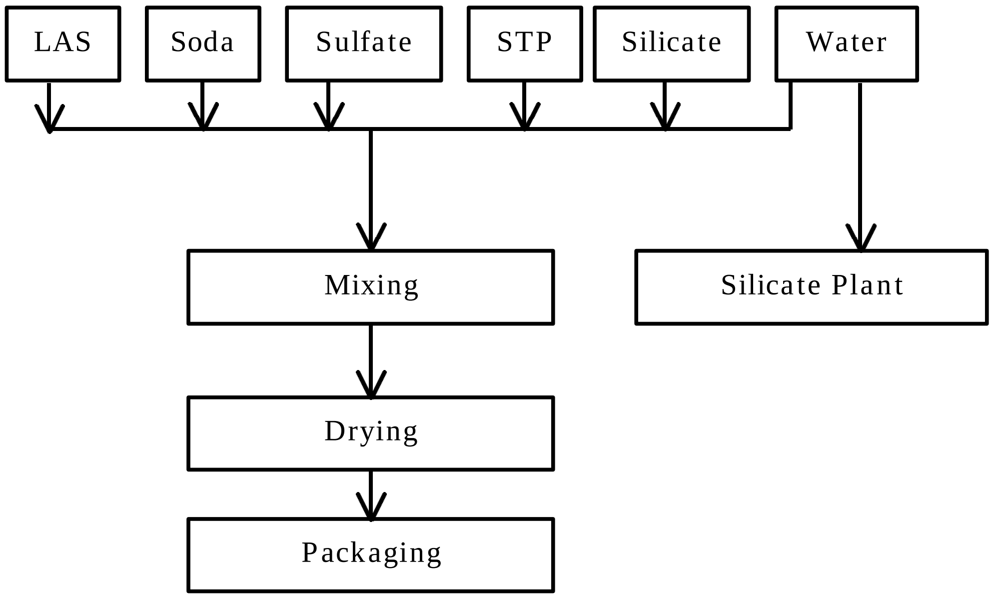


Figure 1　Detergent Production Process

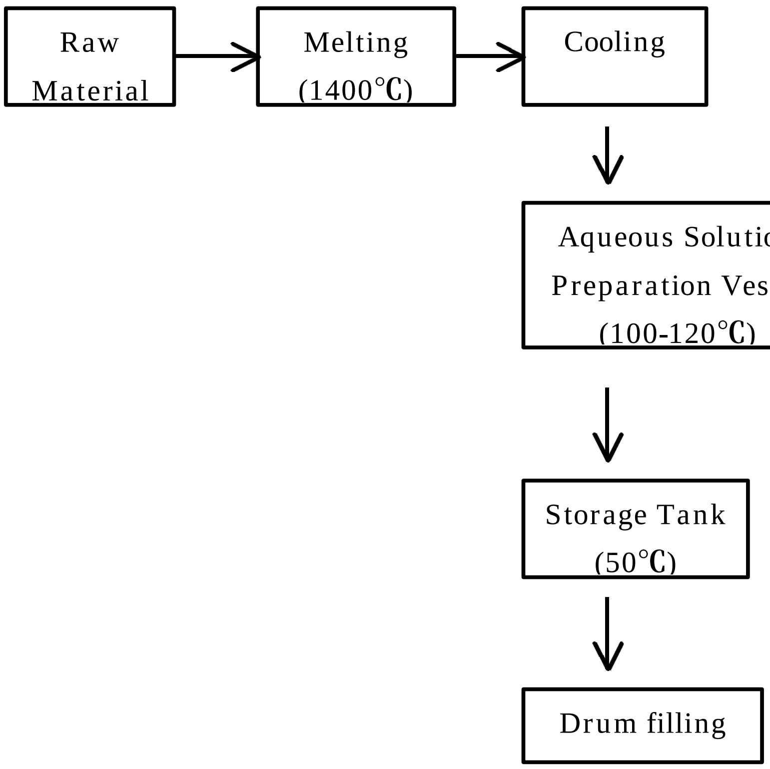


Figure 2　Sodiam Solicate Production Process

2.2 Wastewater Source

Supply water is drawn from a deep well in the factory at 40-150m^3/d and it goes through a filtering treatment and is supplied to the powder detergent production process as cooling water, cleaning water, process water, boiler feed water at 1t/hr and for domestic use. In addition process water is lost through evaporation in the drying unit at 20m^3/d. The actual volume of supply water is 80m^3/d at present operating conditions. At the NPK fertilizer plant, only a little water is consumed to add moisture to the product. A periodical analysis for circulating water is said to be done.

The factory discharges no industrial wastewater outside the factory. In the Hao Khanh Industrial Zone, it is already prohibited to discharge industrial wastewater to the big, nearby lake and the company installed a wastewater treatment system based on a sedimentation pond. The wastewater issue has been the only subject related to the environment considered by the government and the company. However, technology for the wastewater treatment is not yet complete and they hope to complete it soon in the near future.

The water system and sampling points are described in Figure 3.

3. Management

3.1 General

The management of the factory is concentrating on increasing production. In order to improve environmental conditions, they think about, study and implement ways to improve the production system itself. On the other hand, they are not considering applying for ISO yet because of their busy work on quality management. There are no environmental problems in the factory.

3.2 Annual Consumption of Raw Material and Utilities

Table 3 shows annual consumption of raw material for each product, additives, and utilities with their cost in 1998.

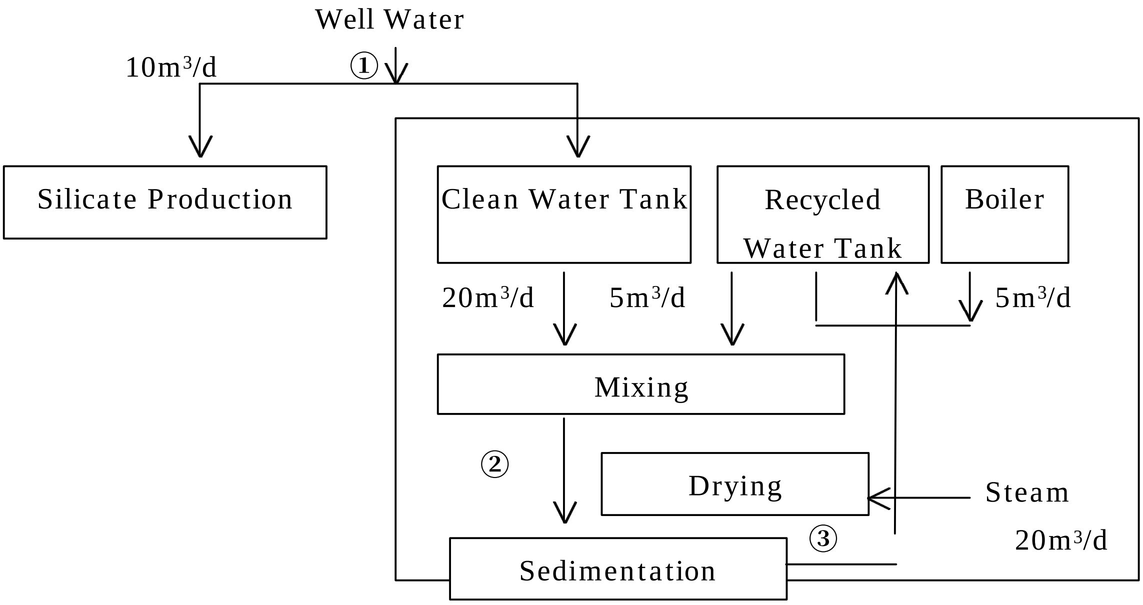


Figure 3 Water System and Sampling Points

Table 3 Annual Consumption and Cost in 1998

Material Used	Unit	Amount	Cost (million VND)
Detergent			25,135.85
LAS	Tons	1,120	12,320
Soda		1,500	3,300
Sodium Sulfate		2,395	2,874
STP		255	1,785
Sodium Silicate		2,500	2,375
Water	m^3	11,650	34.95
Fuel Oil	Tons	950	1,520
Diesel Oil		104	374.4
Electricity	kwh	690,645	552.5
Fertilizer			
Urea	Tons	250	
FA		550	
DAP		140	
Superphosphate		600	
Potassium Sulfate		260	
Coal Powder		300	
Electricity	kwh	73,000	

4. Industrial Wastewater Treatment and Discharge

4.1 Wastewater quality

Table 4 shows sampling points, and table 5 shows results of analysis by CECO for wastewater samples taken at the same time as the JICA Team.

Table 4 Sampling Points

Sampling Points	Samples
1	Well Water
2	Recycled Water before Sedimentation
3	Recycled Water after Sedimentation

Table 5 Wastewater Quality (CECO)

Sampling Point		1	2	3
Parameter	Unit			
Time		9:55	10:05	9:50
Temp.	℃	25	24	25
pH		6.6	10.6	6.6
Conductivity	mmS/㎝	0.3	10	0.3
Turbidity	NTU	4	331	4
Oil content	㎎/l	<0.01	0.25	<0.01
BOD5	㎎/l	7	68	7
COD	㎎/l	16	128	16
DO	㎎/l	4.6	4.3	4.6
SS	㎎/l	7	389	7
T-nitrogen	㎎/l	2.3	13	2.3
Phenol	㎎/l	<0.001	0.05	<0.001
Residual Cl	㎎/l	0.07	0.58	0.07
SO4	㎎/l	62	275	62
CN	㎎/l	0.009	0.063	0.009
T-P	㎎/liter	0.02	0.21	0.02
LAS		0.0	1,564.1	0.0

There is no wastewater pollution to environment because the factory discharges no industrial wastewater outside the factory.

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Apply for ISO 9000 as soon as possible. In order to apply, the factory and facilities should be maintained cleanly and orderly, and the documentation system for production and quality control should be completed orderly.

(2) Prevent the leakage of oil from the storage tank through reinforcement of maintenance and operation. Clean up the oil leakage in the oil storage tank of the furnace.

5.2 Mid- Term and Long Term Countermeasures

(1) There are no special recommendations.

CASE STUDY C-21

Da Nang Rubber Company

Survey Date : December 17, 1999

1. General

1.1 Profile

The Da Nang Rubber Company is one of the state-owned companies producing tires and tubes for cars and motorbikes. The company profile is summarized in Table 1.

Table 1 Company Profile

Company Name:	Da Nang Rubber Company
Ownership:	State-owned
Address:	01 Le Van Hien- Da Nang City
Vice Director:	Mr. Phan Thanh Hoang
Established	1975
Corporate Capital	
Number of Employees:	1,000 including 120 university graduates
Main Products:	Auto, and Motorcycle Tires

1.2 Status of Business

The business is in good position at present because of the high growth rate of demand for cars and motorbikes in the country. Revenues in 1998 were 175,000,000,000VND(15,000,000US$) for tire and tube sales. The main clients for their tires and tubes are domestic.

(1) Production

The production amount for car tires in 1998 was 100,000 sets and for motorbike tires 1,500,000 sets. This included a renewal of car tires of 20,000 sets and for motorbike tires, 60,000 sets. Development of the tire business has risen very steep during the years from 1994 to 1997, with a growth rate of almost double that of the previous year. Rapid development continued even after 1998. Sales by production for each year are shown in Table 2.

Table 2 Sales Trends

Year	Sales (million VND)
1994	16,000
1995	32,000
1996	64,000
1997	114,000
1998	175,000
1999 (Estimated)	250,000

(2) Debt

There is no description.

2. Production Technology

2.1 Process

The production technology used for tires and tubes is a mixture of various technologies, and equipment from many countries have been introduced into the process.

Figure 1 shows car or motorcycle tires and tubes production process, and Figure 2 shows bicycle tires and tubes production process.

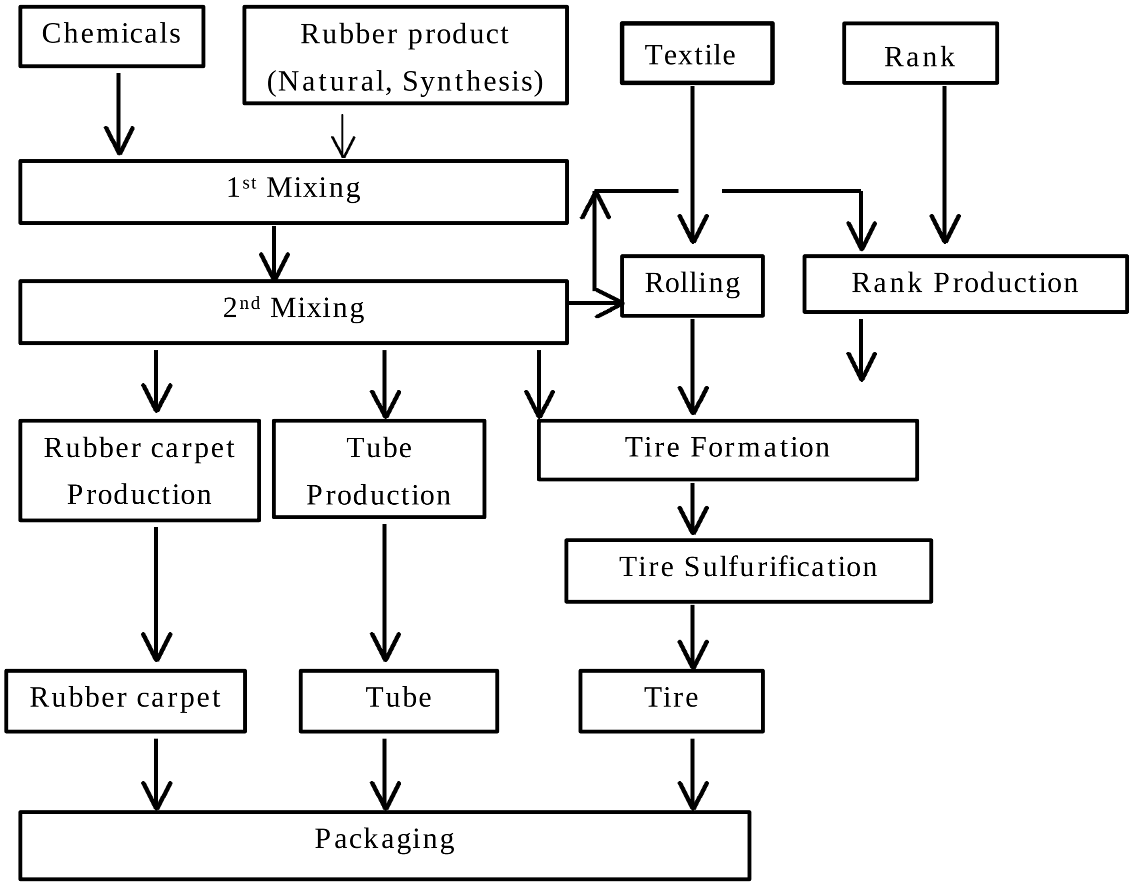


Figure 1 Car and Motorcycle Tires and Tubes Production Process

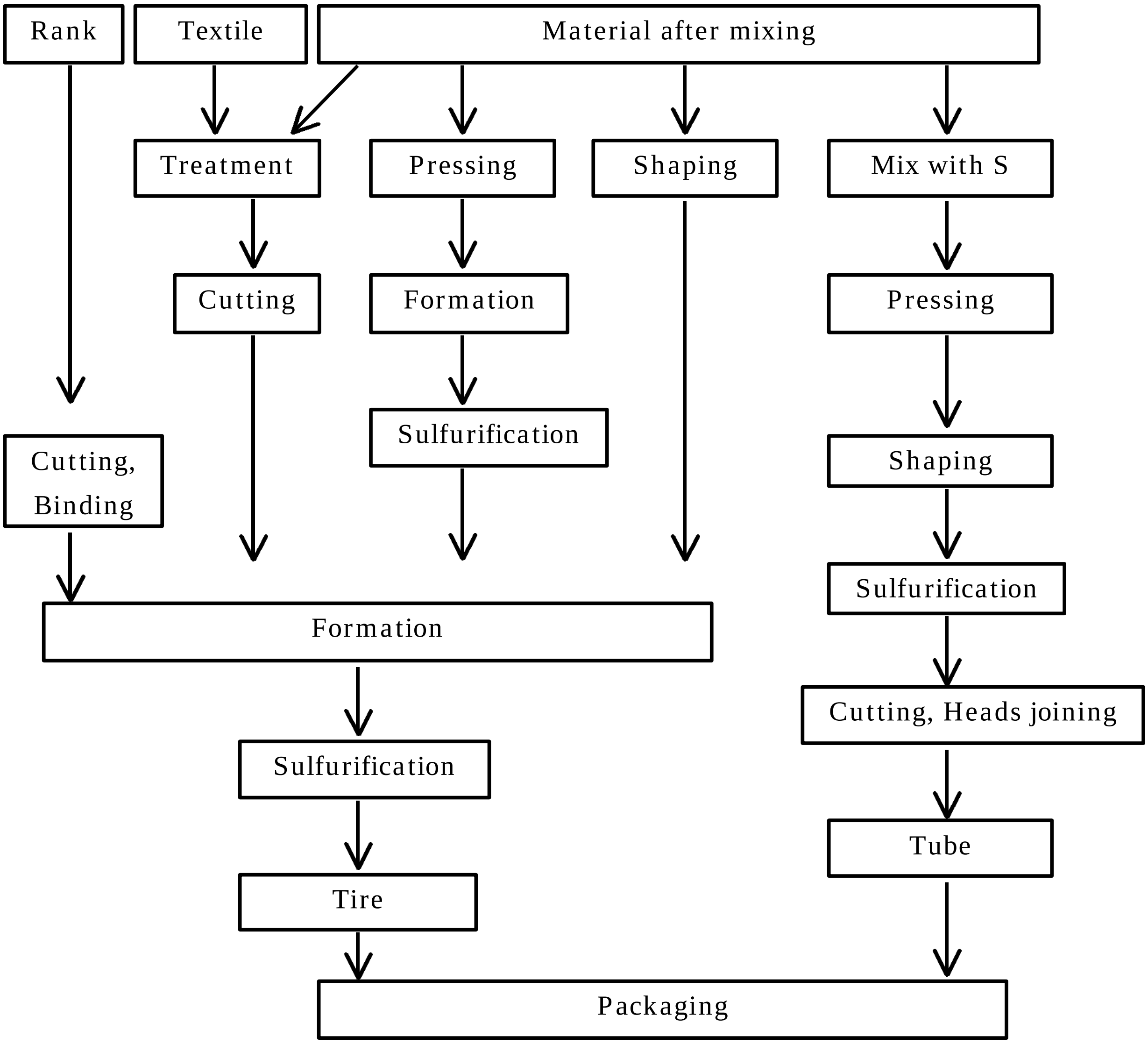


Figure 2 Bicycle Tire and Tube Production Process

2.2 Wastewater Source

The factory utilizes deep well water for its industrial and domestic water at 1000 m^3/d without any treatment except for boiler feed water. According to our estimation, their consumption amount is supposed to be about 500 m^3/d consisting of 200-300m^3/d for industrial use and 200 m^3/d for domestic use. Cooling water and steam condensate is recycled fully.

There are 3 wastewater lines that come from the ; ①tire production unit, ② mixing unit for raw materials and ③domestic wastewater.

Industrial wastewater is discharged from the cooling and product washing process, and part of the water is circulated in the factory. So the wastewater is said to have no contamination from the production process. The amount of industrial wastewater discharged to common city drainage is estimated to be around 200-300 m^3/d and common drainage is connected to the sea. Because the local government is very strict on environmental issues, a periodical analysis of environmental items is performed by DOSTE as EIA every 3 months.

The treatment facilities for industrial water include an ion exchange for boiler feed water and a sedimentation pond for circulation water. The treatment of 2 industrial wastewater discharge is only a small sedimentation pond. Actually, almost all drainage, including that for domestic use water, contains oil on the surface and all roads in the factory are smeared by oil which was explained to be leakage oil, and to come especially, from lubricant oil of equipment in all production facilities. The floors of several buildings were observed to be very dusty and dirty.

Water system and sampling points are shown in Figure 3.

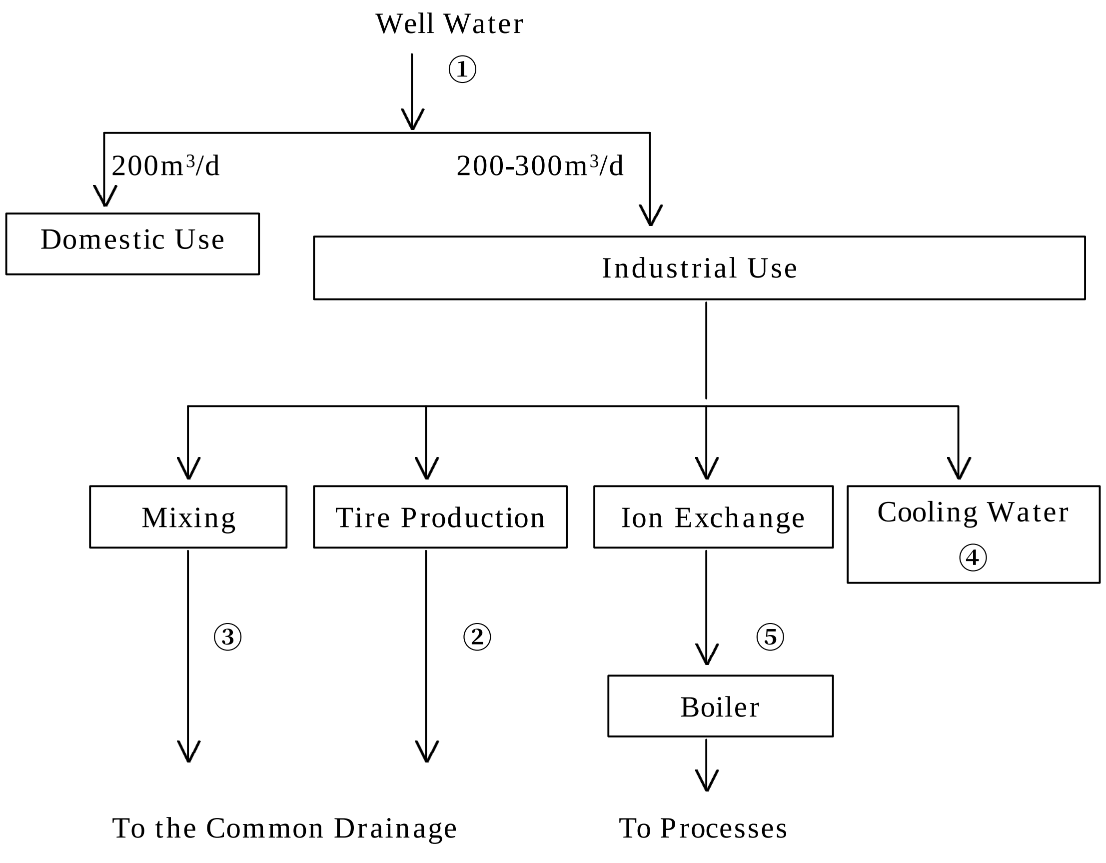


Figure 3 Water system and sample points

3. Management

The management at the factory is concentrating on further production expansion and 2 future projects are being proceeded with at present for car tires and car tubes. The first project is an expansion of capacity from the existing 120,000 sets to 200,000 sets in the year 2000. This project requires an investment of 75,000,000,000 VND which has already been approved by MOI. The second project is a plan for expansion of production capacity from 200,000 sets to 500,000 in the year of 2003 and the required investment is estimated to be about 430,000,000,000 VND. As the area for expansion is limited in the existing factory, the main mixing unit will be installed in another industrial zone, the Lien Chieu Industrial Zone, for the second project.

Main concerns for the environmental protection are waste gas emission , solid waste and industrial wastewater. The gas from the boiler facility contains sulfur compounds and the rubber sulfurnizing unit emits toxic exhaust gas. Dust of carbon black is another air pollution problem. Solid waste from rubber production is rather huge, and includes polyamide products and all kinds of waste rubber.

The application for ISO 9000 is now under way and is expected to be complete in the middle of next year. An application for ISO 14000 will be discussed at the second project stage.

3.2 Unit Consumption Ratio

Unit consumption ratios for raw materials at 100 kg of rubber, the main raw material, are shown in Table 3.

Table 3 Unit Consumption Ratio for Raw Materials

Commercial Name	Unit Cosumption
Sulfur	2.5
Zinc Oxide	4.0
Stearic Acid	2.0
Accelerator DM	1.0
Accelerator D	0.5
Accelerator DMTD	0.1
Accelerator Cz	0.6
Accelerator Ez	0.05
Paraffin	1.0
Calcium Carbonate	10.0
Kaolin	20.0

Commercial Name	Unit Cosumption
Anti Aging Agent RD	1.5
Silicate Oxide	5.0
Tale Powder	2.0
Asbestos	20% x 4.2
Iron Oxide	2.0
Titanium Oxide	8% x 4.2
Phthalic Anhydride	0.5
Zinc Stearate	—
Pine Resin	0.5
Pine Oil	1.0
DB_3 Oil	Insignificant amount
Bitumen	0.5
Cumaion	

4. Industrial Wastewater Treatment and Discharge

The results of the quality analysis implemented by the Da Nang City authorities in October, 1999 are shown in Table 4.

Table 4 Results of the Quality Analysis (Da Nang City)

Parameter	Unit	Result		Standard	
		Sample 1	Sample 2	For Ground Water	For Wastewater
pH		7.38	6.95	6.5-8.5	5.5-9.0
COD	mg/l	119	56	—	100
T-Fe	mg/l	1.94	0.07	1-5	5
Zn	mg/l	0.004	ND	5.0	2.0
S	mg/l	0.266	ND	—	0.5
T-N	mg/l	7.11	0.42	—	60

Remarks:

Sample 1: At the drainage in the company flowing to the Ngu Hanh Son Street Drainage System

Sample 2: At the Ngu Hanh Son Street Drainage System (just outside the company)

Standard for the Ground Water: Vietnam Standards (TCVN) 5944-1995

Standard for the Wastewater: Vietnam Standards (TCVN) 5944-1995 (Column B)

Sampling points are described in Table 5.

Table 5　Sampling Points and Detail of the samples

Sample Points	Sampling Points
1	Well Water
2	Wastewater from the Tire Production Process
3	Wastewater from the Mixing Unit
4	Cooking Water in the Recycle Line
5	Boiler Feed Water downstream of the Treatment Process

The results of the analysis by CECO for wastewater samples taken at the same time as the JICA Team are shown in Table 6.

Table 6　Wastewater Quality (CECO）

Sampling Point		1	2	3	4	5
Parameter	Unit					
Time		10:25	10:40	10:50	10:20	10:35
Temp.	℃	27.5	38	29	23	28
pH		7.3	8.2	8.0	8.4	7.6
Conductivity	mmS/㎝	0.45	0.43	0.35	0.43	0.65
Turbidity	NTU	3	4	1	1	0
Oil content	mg／l	<0.01	0.15	0.1	0.12	<0.01
BOD5	mg／l	3	16	18	9	3
COD	mg／l	12	24	32	20	8
DO	mg／l	5.7	3.9	3.3	4.3	5.1
SS	mg／l	7	4	3	4	2
T-nitrogen	mg／l	1.9	6.8	7.8	5.7	1.2
Phenol	mg／l	<0.001	0.002	0.002	0.001	0.001
Residual Cl	mg／l	0.03	0.02	0.02	0.03	0.04
SO4	mg／l	3.5	8.59	5.25	5.67	2.73
CN	mg／l	0.003	0.001	0.001	0.002	0.007
Fe	mg／l	0.04	0.07	0.06	0.04	0.03
Zn	mg／l	0.22	0.28	0.3	0.32	0.4
S	mg／l	5.67	34	28.70	34	3.86

4.2 Regulation standard for Industrial Wastewater

Regulation Standards for Industrial Wastewater (Rank B) in Viet Nam are shown in Table 7.

Table 7 TCVN 5945-1995（Rank B）

Parameter	Unit	Wastewater Discharge Standard (B)	Parameter	Unit	Wastewater Discharge Standard (B)
Temp.	℃	40	Mn	mg/l	1
PH		5.5-9	Ni	mg/l	1
BOD5	mg/l	50	Organic P	mg/l	0.5
COD	mg/l	100	Fe	mg/l	5
SS	mg/l	100	Sn	mg/l	1
Mineral Oil	mg/l	1	Hg	mg/l	0.005
Organic Oil	mg/l	10	T-Nitrogen	mg/l	60
As	mg/l	0.1	T-P	mg/l	6
Cd	mg/l	0.02	F Compounds	mg/l	2
Residual Cl	mg/l	2	Phenol	mg/l	0.05
Cr(VI)	mg/l	0.1	S Compounds	mg/l	0.5
Cr(III)	mg/l	1	CN	mg/l	0.1
Zn	mg/l	2			
Pb	mg/l	0.5			
Cu	mg/l	1			

5. Recommended Countermeasures for Improvement

5.1 Short Term Countermeasures

(1) Take countermeasures to decrease the sulfur content exceeding regulations at sampling points No.2 and No.3 wastewater is discharged to the common drainage.

(2) Take countermeasures to stop the oil leakage from the equipment and oil leakage spilling on to the floor and road.

(3) Clean up the oil on the floor and all smeared roads as soon as possible.

(4) Implement clean up activities in the factory , and with strong leadership from top management encourage company-wide participation.

5.2 Mid- Term and Long Term Countermeasures

(1) Apply for ISO 14000 after receiving the certificate of ISO 9000. In order to apply for ISO 14000, it is necessary that the periodical EIA, the activity on the environmental management, committee system, manager system should be implemented in the near future.