4. Secondary Beneficiary Factories

4. Secondary Beneficiary Factories

4.1 S-1 Tovarna volnenih tkanin MERINKA, p.o.(TVT MERINKA)

4.1.1 Factory Profile

1) General

MERINKA is the largest woolen textile factory in Slovenia. The factory imports and processes slivers for yarn dyeing, cloth dyeing, and textiles. About 80% of the products is exported to North America. The factory is also a subcontractor for foreign companies, processing stockings with sewing ; dyeing; finishing, and packaging. Materials and processing facilities are furnished by other companies; MERINKA provides only place and labor. Overall the factory is well managed.

Total factory area	:	333,430m^2	
Products	:	Woolen fabrics	Stockings
Annual production	:	650,000m	20,000,000pairs
Annual sales	:	11,000,000DM	4,000,000DM (Processing charge only)
Number of employees	:	ca. 330	ca. 280
Working conditions	:	3 shifts	1 shift

2) Water consumption by source and use

Table 4.1.1

3) Flow diagram of water supply and waste water discharge

Fig. 4.1.2 Fig. 4.1.3

4) Quality of make up water and waste water

Table 4.1.2 Table 4.1.3

Fig.4.1.1 Factory Layout of Merinka

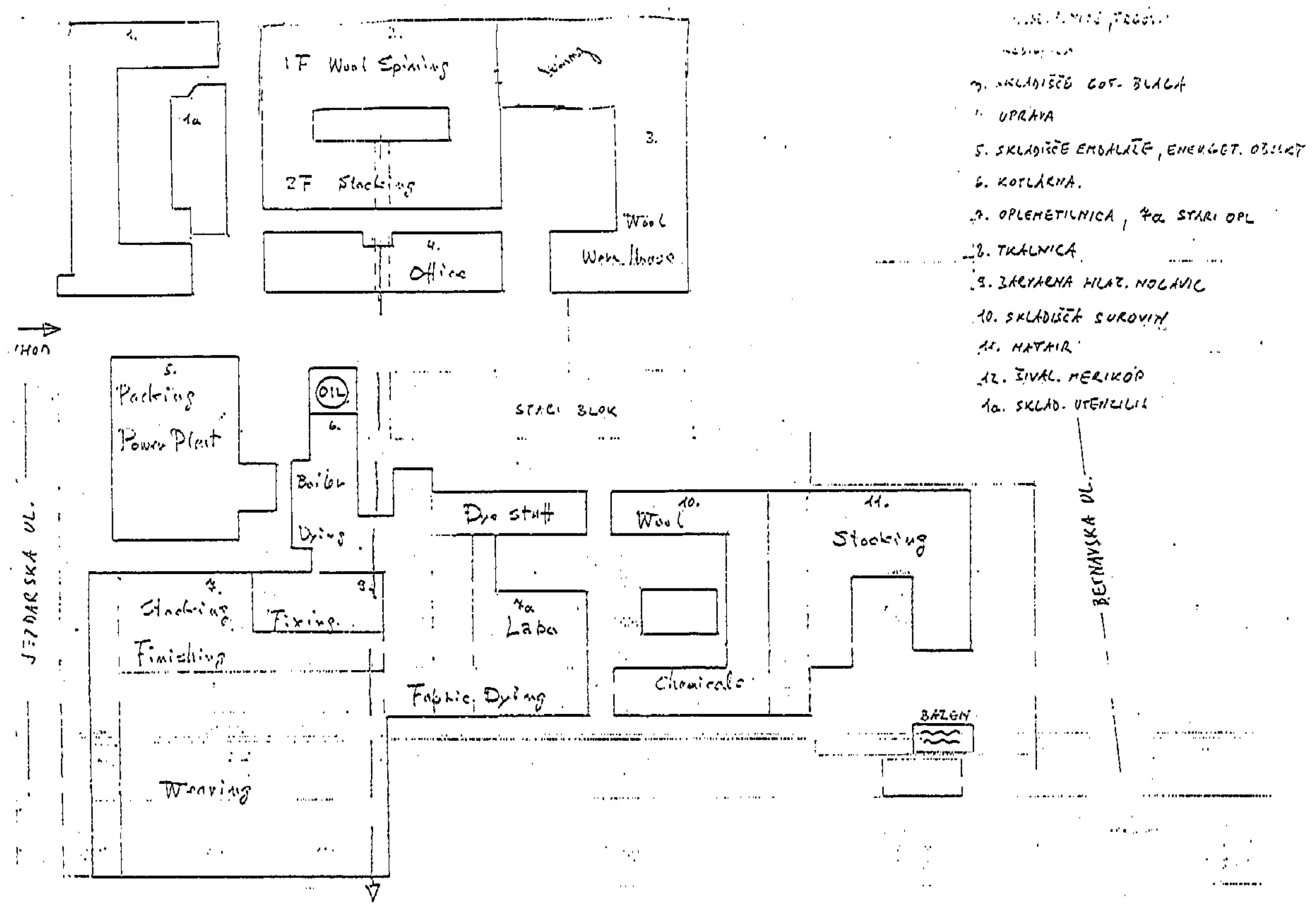


Fig. 4.1.2 Process Diagram of Production Line

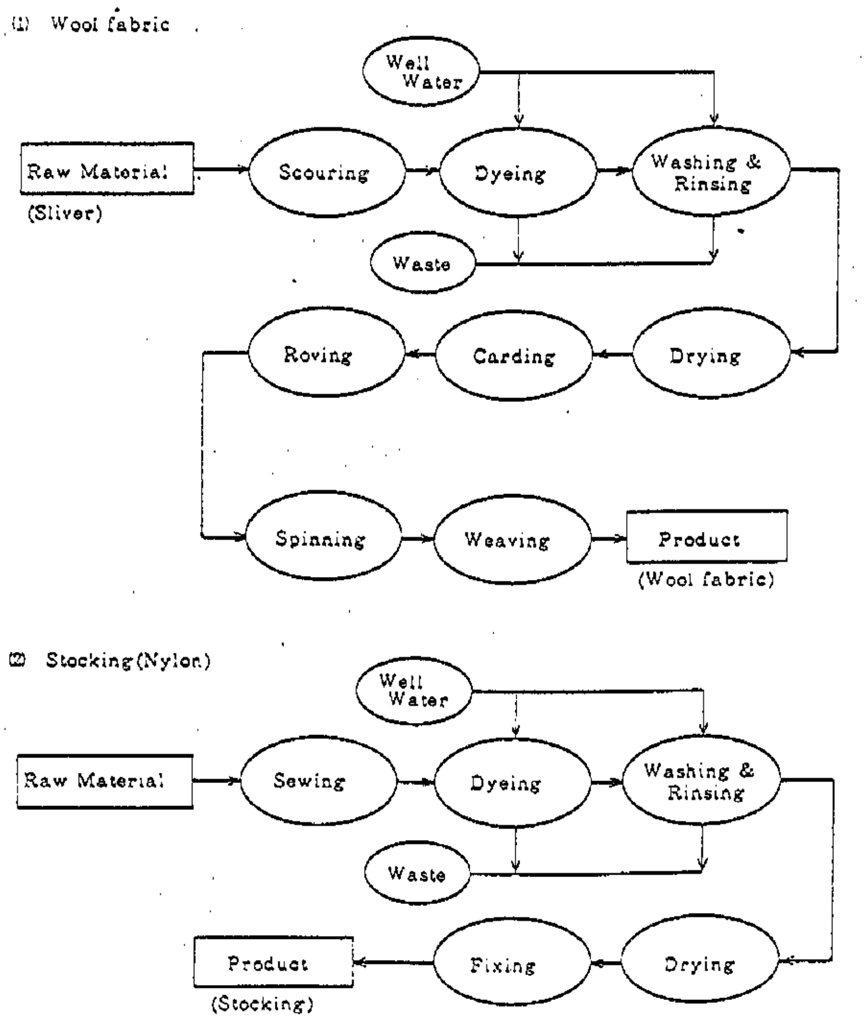
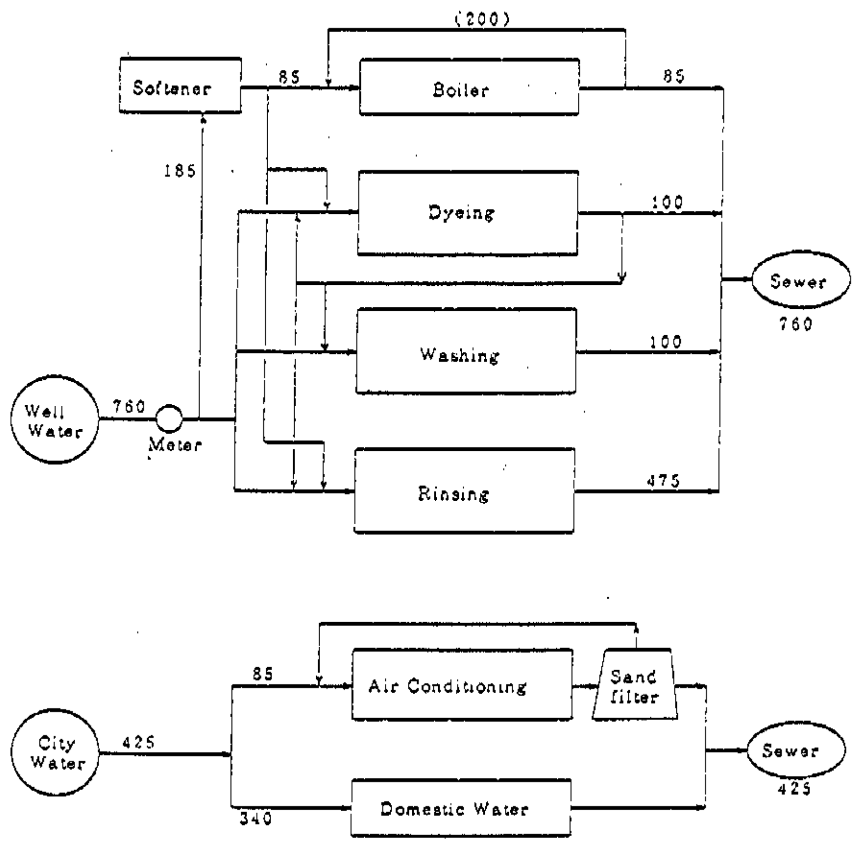


Fig. 4.1.3 Water Balance Diagram (m³/day)



Note : The figure in parenthesis is estimated value.

Table 4.1.1 Quantity of Consumed Water Classified by Source and Use

Industry; Textile(Dyeing)

Unit: m³/day

Source / Use	Well Water	City Water	River Water	Sub-Total	Recoverd Water	Total
Boiler Feed	85			85	(200)	(285)
Raw Material						
Washing	675			675		675
Cooling						
Air Conditioning		85		85		85
Miscellaneous		340		340		340
Total	760	425		1,185	(200)	(1,385)
				Recoverd Water/Total (14.4)%		

Note; A value in ( ) shows estimated one

Table 4.1.2 Quality of Make-up Water

(Analyzed by the Factory)

Parameter	Unit	Well Water	City Water
Temperature	℃	10	
pH		7.48	
COD	mg/l	0.2	
BOD	mg/l		
Iron	mg/l		
Manganese	mg/l		
Total Hardness	dH	21.18	
Alkalinity	mmo/l		
Chloride	mg/l	11	
Tortal Iron	mg/l	0.13	
Evaporated Residue	mg/l		
Electric Conductivity	μS/cm	300	

Table 4.1.3 Quality of Waste Water

pH		7.8
SS	(mg/l)	720
BOD	(mg/l)	200
COD	(mg/l)	500
Fat/Oil(mg/l)		12
N-NH4(mg/)		
P	(mg/)	
Cr	(mg/)	0.26
Zn	(mg/)	0.17
Cu	(mg/)	< 0.05

4.1.2 Water Conservation

1) Present state of water conservation and use

(1) Water use

① Water is supplied by city water and well water. City water is delivered to the factory through three lines with flow meters. Well water from the three wells is measured and temporarily discharged into the storage tank ($500m^3$) before being distributed within the factory by feed pumps.

② City water is used for air conditioning and other purposes. Miscellaneous water accounts for a relatively high 29%. Air conditioning water is used as make up water for the temperature and moisture control of the spinning and textile factory. The amount used is small, since a few equipments are installed, and theire heating load is low.

③ Well water is used for dyeing rinsing, product processing and boiler feed. About 57% is used for dyeing and processing.

(2) Water conservation

① Well water is not unnecessarily pumped, since well water is supplied from the storage tank with pressure control and quantity control (control by number of pumps).

② The water consumption of dyeing rinsing and product processing is about 177m^3/thousand m^2 (textile width 1.5m), equivalent to that of a Japanese dyeing factory.

③ Recovery of cooling water (heat recovery) of the jet type dyeing machines (two sets) and boiler feed is accomplished. The recovery rate of boiler feed is approximately 70%.

④ Air conditioning water is recycled through the sand filter, the float valve of which supplies make up water.

⑤ Miscellaneous water (city water) consumption by is a rather large 340m^3 (560 liters/person/day), but this suggests that water consumption may be reduced by fostering awareness in the factory of the need to save water.

2) Examination and evaluation

(1) Technical comment

① Considering the above, the precise amount of water consumption for each facility must be measured to determine whether or not domestic and air conditioning water consumption is proper.

With a small facility investment bases upon servey results, water consumption can be brought to a proper level and thereby reduced 10-15% (approx. 50m^3/d) in each facility.

② Estimated facility and labor costs for water conservation, and the anticipated results, are as follows :

Engineer	:	1
Period	:	1 year (concurrent with present work, engagement rate 50%)
Facility costs	:	2,000 thousand SIT (plumbing parts, piping parts, instruments, etc.)
Water conservation	:	50m^3/day

③ The number of engineer should be limited to one, and the working period to one year. After his task is finished, water conservation will be continued to be practiced in daily work, according to the operation manual.

(2) Economic comment

Costs estimates based on above premises :

① Annual investment

Labor costs : 3,000,000 SIT x 1 engineer x 50%
= 1,500 (thousand SIT/y)
Facility costs : 2,000
Total : 3,500 (thousand SIT/y)

② Anticipated water saving:

$50m^3/d \times 200SIT/m^3 \times 240d/y = 2,400$ (thousand SIT/y)

According to the above, investment should be recovered in about 1.5 years. It will be therefore economically feasible.

4.1.3 Pretreatment and Waste Water Treatment

1) Present situation

① All waste water is discharged into the sewerage system.
② The most current water quality analysis indicates that a pretreatment system for sewerage system discharge is unnecessary.
③ Direct river discharge is uneconomical due to the factory's distance from the river.

2) Waste water treatment system

There is no proposition regarding the waste water treatment system.

4.1.4 Pretreatment for Reduction of the Pollution Load

1) Background

The June survey consisted of just confirmation of the questionnaire and a brief tour of the plant, however, in December, samples of waste water were taken and analyzed and examination of a pretreatment system for sewerage system discharge was carried out.

2) Quality of waste water

All the waste water is discharged from one outlet into the sewerage system. Waste water from each of the factory processes does not pass through any pits but is simply discharged as it is generated. Sampling for water analysis was carried out at the following three points:

1. Final discharge outlet: flow ratio sampling (flow measurement was also carried out)
2. Cloth dyeing plant: highest concentration waste water from three machines was mixed in batch capacity proportions.
3. Yarn dyeing plant: spot sampling of the highest concentration waste water

The analysis and test results are shown in Tables 4.1.4 and 4.1.5.
The waste water quality satisfies the standards for discharge into the sewerage system.

3) Preliminary study

As was mentioned in the general summary, one of the river discharge standards relates to water color. In order for the WWTP to satisfy standards for river discharge in the future, there is a possibility that calls may be raised for it to install an appropriate pretreatment system for dealing with textile factories, which discharge colored waste water. If a pretreatment system were not to be installed, it is likely that premium charges would be imposed.

Generally speaking, the most economic method of pretreatment in the case of a dyeing factory is coagulating sedimentation. Moreover, if the highly concentrated waste water following dyeing can be separated and treated apart, the treatment can become even more economical. In consideration of this, concentrated waste water from dyeing underwent separation by coagulation sedimentation, and oxidation dissolution testing by the Phenton Method was also conducted on part of the sample.

The results of the tests are good and showed that coagulation treatment can be performed on the total waste water. However, the results from testing on the concentrated waste water from the dyeing process were not favorable. In particular, regarding the yarn dyeing waste water, even though testing was carried out using widely defined conditions, absolutely no floc was formed in response to the use of inorganic coagulant. In other words, separation by coagulation is not suited to this waste water. Moreover, no effect in terms of color and COD reduction could be observed through application of the Phenton Method to the yarn dyeing waste water.

Table 4.1.4 Quality of Waste Water

Parameter		Final outlet	Coagulation test	Emission standard
Note		09 - 10.12.1996 flow proportional	PAC 100 mg/L Anion P 200 Cation P 20 Floc size middle Settling 30sec	discharge to river for Textile
pH		8.2	6.7	6.5 - 9.0
SS	mg/l	37	< 30	80
Color		violet	no color	
α (436nm)	1/m	37	0.9	7
α (525nm)		30	0.5	5
α (620nm)		25	0.3	3
t - N	mg/l	24		
t - P	mg/l	3.1		2
COD_{Cr}	mg/l	650	350	120
COD_{Mn}	mg/l	300		
BOD_5	mg/l	150		25
t - Fat	mg/l	30		20

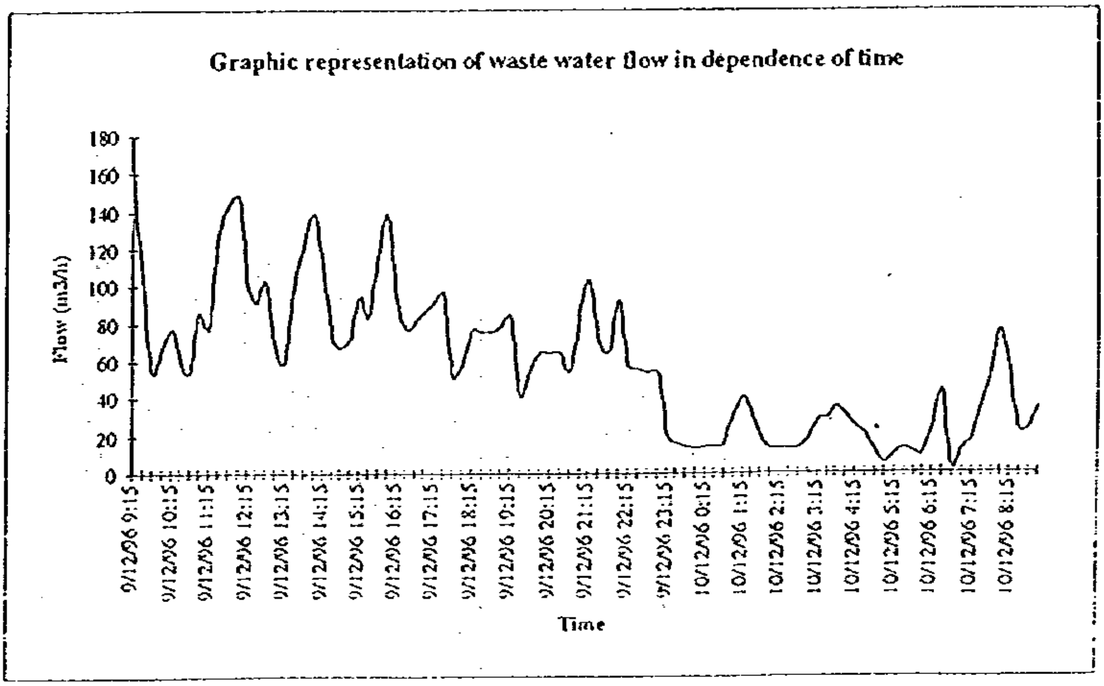


Table 4.1.5 Result of Coagulation Test

	textile dyeing machines (mixed)		yarn dyeing machine in spinning factory	
	Sampling	Coagulation Test	Sampling	Coagulation Test
Note	02.12.1996 12:00 Spot Sampling	PAC 100 ppm Anion P 200 Cation P 20	02.12.1996 12:20 Spot Sampling	PAC 200 ppm Anion P 200 Cation P 0
Parameter		Floc-size middle Settling 60sec		Floc-size no floc Settling none
pH	4.0	6.1	5.5	5.6
SS mg/l	46	< 30	< 30	< 30
Color	black-violet	black-violet	black	black
α (436nm) 1/m	78	25	82	82
α (525nm)	79	21	79	79
α (620nm)	83	15	82	82
t - N mg/l				
t - P mg/l				
COD_{Cr} mg/l	3,700	3,500	3,200	2,900
COD_{Mn} mg/l				
BOD_5 mg/l				

4) Outline of pretreatment facilities

Judging from the test results, it is difficult to separate and treat the concentrated waste water from dyeing. Coagulation sedimentation treatment shall be carried out on the total waste water.

Table 4.1.6 Quality and Pollution Loads of Waste Water and Treated Water

Kind of wastewater	Quantity m³/d	CODcr mg/L (kg/d)	BOD mg/L (kg/d)	SS mg/L ( )	color (1/m)	t-Fat mg/L (kg/d)	t-P mg/L (kg/d)
*1 Raw total wastewater	1,200	650 (780)	150 (180)	40 (48)	37	30 (36)	3
*2 Case-1 Coagulation & sedimentation	1,200	350 (420)	80 (96)	< 30	< 3	< 20	< 1

(Note) * 1: quality of total waste water
* 2: when total waste water undergoes pretreatment (coagulating sedimentation)

Fig. 4.1.4 Equipment Flow of the Pretreatment System

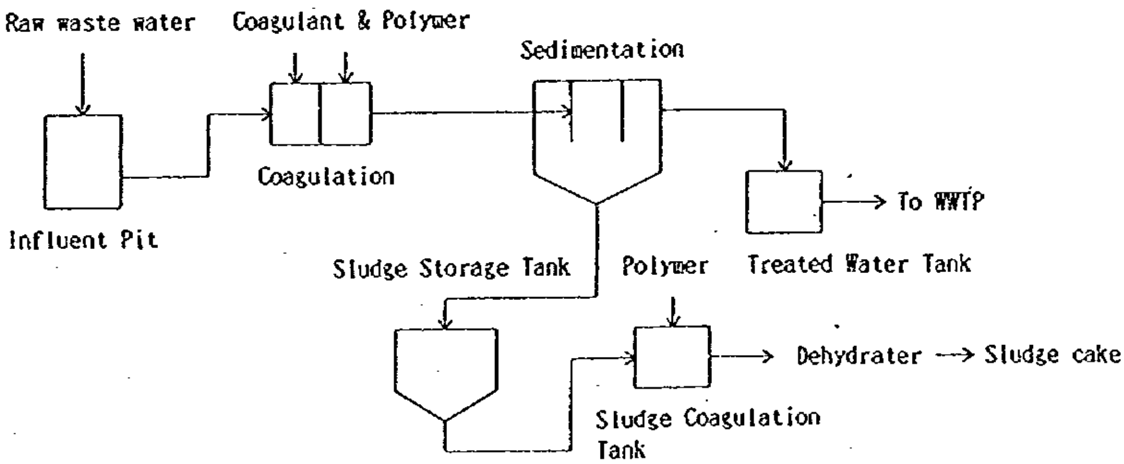


Table 4.1.7 Equipment and Running Costs of the Pretreatment System

	Equipment cost SIT	Depreciation & Interest SIT/m³	Running Cost SIT/m³	Total treatment cost SIT/m³
CASE-1	143,800,000	47	105	152

3) Conclusion

The present waste water would satisfy discharge standards in the case of discharge into the sewerage system. In the event where reduction of water coloration becomes necessary due to additional requirements, it would be difficult to separate and treat by coagulation waste water from the dyeing processes only. Thus, it would be advisable to carry out treatment by coagulation sedimentation on the total waste water.

4.2 S-2 Tekstilna tovarna TABOR, d.o.o.

4.2.1 Factory Profile

1) Outline of factory

Capital	: 1,005,895 thousand SIT
Total factory area	:
Number of employees	: 400
Products	: Polyester-based mixed fabrics
Annual production (1995)	: 3,140,216m^2
Annual sales	: 940,725 SIT (processing charge only)
Working conditions	: 3 shifts, 249 days/year

2) Water consumption by source and use

Table 4.2.1

3) Flow diagram of water supply and waste water discharge

Fig. 4.2.1 Fig. 4.2.2

4) Quality of make up water and waste water

Table 4.2.2 Table 4.2.3

4.2.2 Water Conservation

1) Present state of water conservation and use

(1) Uses of water

① Water is supplied from city water and well water. City water is used for domestic water and well water for production processes, after being measured its quantity.

Well water is pumped up from two wells, each having pressure control, and is directed to the main pipe for distribution to production processes. No storage tank is used.

② Most (about 85%) of the water is used for dyeing process rinsing and product processing.

Fig. 4.2.1 Process Diagram of Production Line

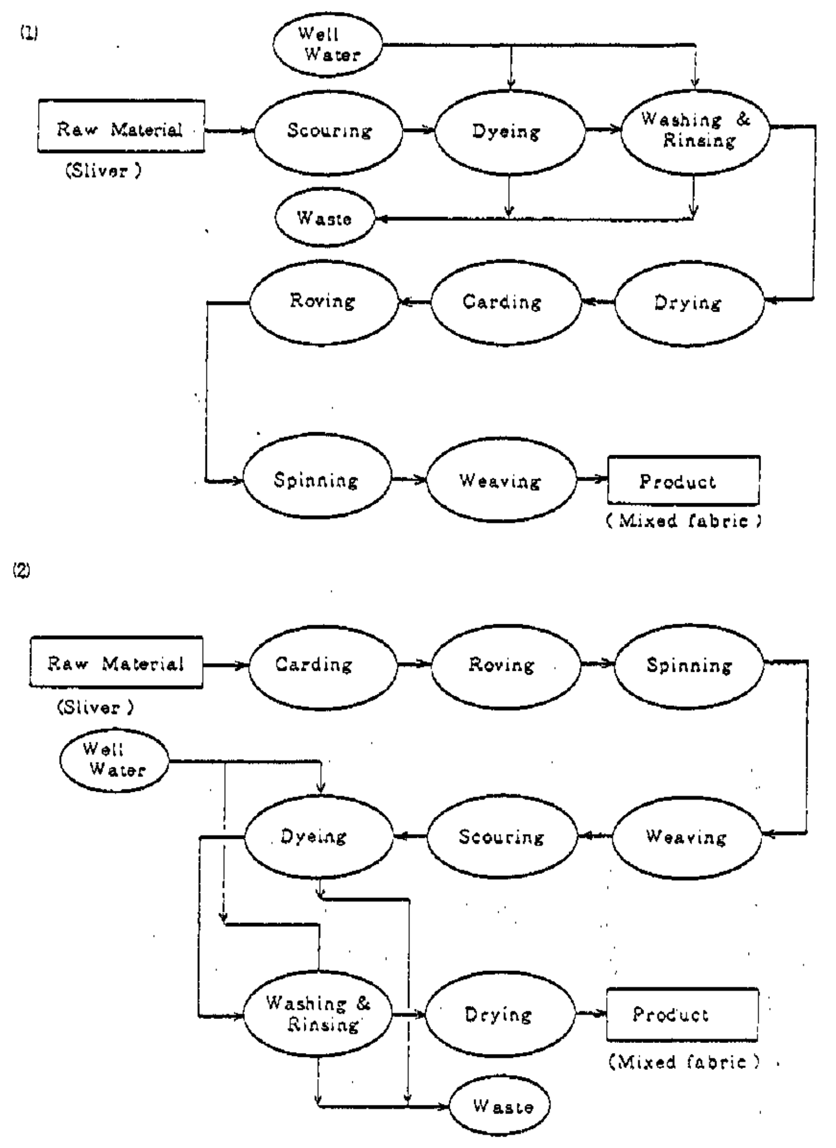
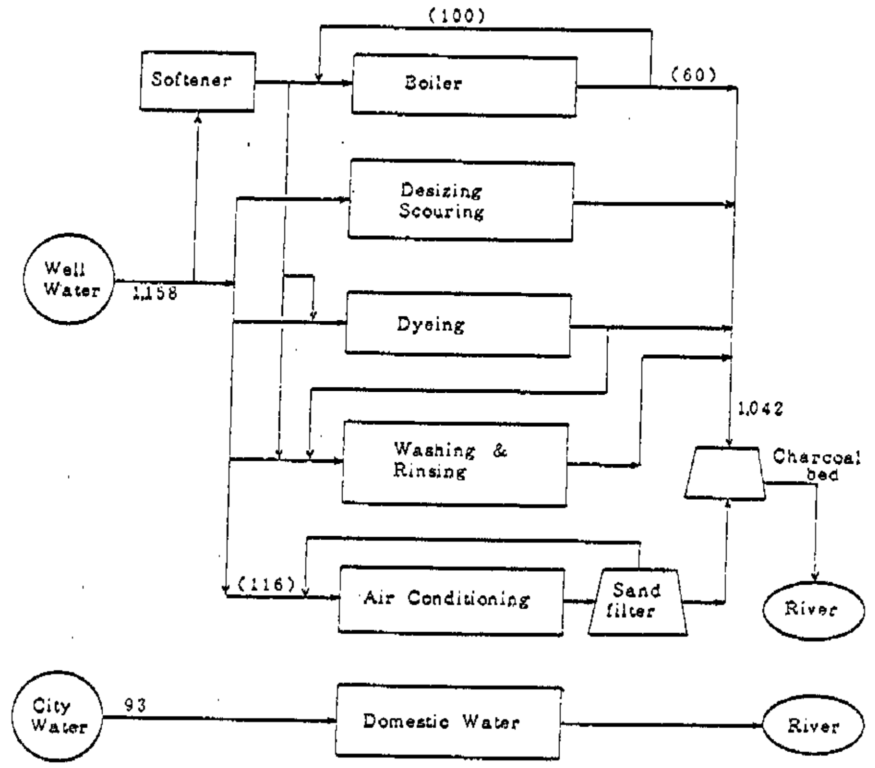


Fig. 4.2.2 Water Balance Diagram (m³/day)



Note: a) The figure in parenthesis is estimated value.

Table 4.2.1 Quantity of Consumed Water Classified by Source and Use

Industry: Textile(Dyeing)

Unit: ㎥/day

Source / Use	Well Water	City Water	River Water	Sub-Total	Recoverd Water	Total
Boiler Feed	60			60	(100)	(100)
Raw Material						
Washing	982			982		982
Cooling						
Air Conditioning	116			116		116
Miscellaneous		93		93		93
Total	1,158	93		1,251		(1,351)
				Recoverd Water/Total (7.4)%		

Note: A value in ( ) shows estimated one

Table 4.2.2 Quality of Waste Water

S-2 TABOR

Datum analize: 5.5.1995

Analiza:

temperatura vode	17	°C
pH	7.4	
električna prevodnost	568	mS/cm
vsebnost anorganskih soli	266	mg/l*
vsebnost neraztopljenih snovi	12	mg/l
vsebnost vseh raztopljenih snovi	353	mg/l
vsedljive snovi	0.3	ml/l
kemijska poraba kisika	53	mg O/l
biokemijska poraba kisika	22	mg O/l
celokupen krom	<0.01	mg Cr/l
fenol	<0.01	mg /l
površinsko aktivne snovi	250	ug MBAS/l

* Izračunana vrednost iz električne prevodnosti preračunano na KCl. (f 20 st.C).

③ Air conditioning water is make up water for the temperature control in the spinning and textile factory. The quantity is small, because there are few installed facilities (spinning machines, weaving machines, etc.); therefore the heating load is low.

(2) Present state of water conservation

① Well water is supplied from two wells. The water is distributed after pressure control, thereby avoiding unnecessary water pumping.

② The main equipment of the dyeing process is as follows :

(a) Cloth dyeing :

Winch type	8 sets (5 are for pre-washing)
High pressure	2 sets, Small tester of the same system 1set liquid flow type
Jet type	2 sets (with heat recovery system for its waste water)
Pad type	1 set (Not in present use)

(b) Yarn dyeing : Dyeing tank (2) and drying tank (1) 2 sets

(c) Cotton dyeing : Atmospheric tank 2 sets

③ The water consumption of the dyeing rinsing and product processing is about $78m^3$/thousand m^2, equivalent to that of a Japanese dyeing factory. Water consumption varies with kind and quality of products, however, and simple conclusions cannot be drawn from this comparison alone.

④ Boiler feed is recovered at the rate of approximately 60%.

⑤ Air conditioning water is recycled through the sand filter. Its make up water is supplied to the sand filter tank without water flow control.

2) Examinations and evaluations

(1) Technical comment

① Since the operation rate of the factory is low, it is difficult to draw conclusions on the present state of water conservation based on this survey.

② However, since water consumption varies with kind and quality of products, simple conclusions cannot be drawn from this comparison alone.

③ The University of Maribor has proposed various system improvement policies for electricity, water , steam, dye, waste water, etc. Improvements will be made when financing concerns are cleared.

(2) Economic comment

The situation is as mentioned above, with no additional remarks of note.

4.2.3 Waste Water Treatment

1) Present conditions

① The charcoal filter is working effectively.

② The charcoal filter, as a pretreatment system, has sufficient capacity for sewerage system discharge.

③ As a treatment system, it has in sufficient capacity for direct river discharge.

2) Design basis of waste water treatment system

Quantity of water		1,000^{3}m/day	24hr/day	
Quality of water		Inlet	Outlet	Emission Standard
pH		7-10	7-8	6.5-9
COD	mg/l	500	90	200
BOD	mg/l	300	10	30
SS	mg/l	40	10	80
NH4-N	mg/l	30	4	5
Total N	mg/l	50	20	-
Total P	mg/l	10	1	1
Color (436)	l/m	30	7	7
(525)		30	5	5
(620)		30	3	3

3) Waste water treatment flow outline

(Waste water)→Collecting pit (present)→Stabilization tank→Neutralization tank →Anaerobic tank→Aeration tank→1st. Sedimentation tank→Coagulation tank →2nd. Sedimentation tank→Sand filter→Ozonizing tube→Activated carbon absorber→Treated water tank→Discharge to the river

(Coagulated suludge)→Sludge storage tank→Sludge dehydrator→Cake hopper →Truck

4.2.4 Pretreatment for Reduction of the Pollution Load

1) Background

The June survey consisted of just confirmation of the questionnaire and a brief tour of the plant, however, in December, upon carrying out analysis of sampled waste water, confirmation of the effects of a unique form of charcoal filtration and examination of waste water treatment and pretreatment facilities was carried out.

2) Quality of waste water

The total waste water is discharged from two outlets into the Drava River. Waste water from one of the outlets mainly consists of cooling water and domestic waste water and is discharged without undergoing any treatment. Waste water from the other outlet comes from the plant processes and is passed through a pretreatment system that uses charcoal as a filter medium before being discharged. The sampling for water analysis was carried out at the three points indicated below. Incidentally, the number three sample is to undergo waste water treatment and pretreatment testing.

1 Before charcoal filtration
2. After charcoal filtration (final discharged water)
3. Dyeing plant (spot sample of the most highly concentrated waste water in the factory)

The sampling results are shown in Table 4.2.3.

The effects of the charcoal filtration are recognized actually, though the pollution load of the inlet waste water is rather low. Color and COD are reduced by half. However, because the BOD and oil and fat content are reversed, it cannot be said that this alone is confirmation of the effect. Having said that, the quality of the waste water on the day of the survey would have satisfied even the discharge standards for direct river discharge, needless to say the standards for discharge into the sewerage system. This treatment method is a most interesting one and is worthy of careful observation in the future.

3) Reduction of water consumption and cost through waste water treatment and pretreatment

It is possible that, if concentrated waste water from dyeing is separated and decolored separately, washing water that is currently used in large quantities for dilution can be reduced and the resulting cost lessened. With this in mind, testing of separation by coagulating sedimentation was carried out.

Table 4.2.3 Quality of Waste Water

Parameter	Inlet of Charcoal	Outlet of Charcoal	Emission standard
Note	03.12.1996 12:20	03.12.1996 12:30	discharge to river for Textile
pH	7.7	7.9	6.5 - 9.0
SS mg/l	< 30	< 30	80
Color	light gray	light gray	
α(436nm) 1/m	5.5	2.6	7
α(525nm)	6.7	1.9	5
α(620nm)	2.8	1.5	3
t - N mg/l		23	
t - P mg/l	11	1.3	2
COD_{Cr} mg/l	68	34	120
COD_{Mn} mg/l	38	15	
BOD_5 mg/l	5	25	25
t - Fat mg/l	11	30	20

Samples of waste water from the cloth dyeing machines (most highly concentrated waste water) and from the final discharge outlet (for comparison purposes) were taken. The results of jar testing are shown in Table 4.2.4.

From the results, it can be seen that the effects of coagulation treatment are large. Moreover, good discoloring can be achieved by using an inorganic coagulant and not cation polymer. The test conditions are equivalent to the case of ideal batch treatment. Because the factory batch operates three dyeing machines, it would be possible to design a waste water treatment system for batch mode operation, however, in terms of ease of operation, it is more practical to perform automatic operation by monitoring the water level in a storage tank.

4) Outline of treatment system

Based on the test and analysis results shown in Tables 4.2.5 and 4.2.6, alternative treatment systems shall be compared.

Case 0 : direct discharge into the river of total waste water in its present state

Case 1 : adding treatment by coagulating sedimentation to reduce the water usage to 1/3 before directly discharging into the river

Case 2 : treating colored water only by coagulating sedimentation, and thus reducing water usage to 1/3

Table 4.2.4 Result of Coagulation Test

	Textile Dyeing Machine		Outlet from Charcoal Treatment	
	Sampling	Coagulation Test	Sampling	Coagulation Test
Note	03.12.1996 12:10 Spot Sampling	PAC 100 ppm Anion P 200 Cation P 20	03.12.1996 12:30 Spot Sampling	PAC 100 ppm Anion P 200 Cation P 0
		Floc-size Large Settling 30sec		Floc-size Large Settling 30sec
Parameter				
pH	4.3	6.0	7.9	8.0
SS mg/l	< 30	< 30	< 30	< 30
Color	yellow brown	light yellow	light gray	no color
α (436nm) 1/m	53	6	2.6	0.5
α (525nm)	23	3	1.9	0.3
α (620nm)	11	2	1.5	0.2
t - N mg/l	579	532	22.6	17.1
t - P mg/l	2.6	< 0.5	1.3	< 0.5
COD_{Cr} mg/l	2,700	2,000	34	< 15
COD_{Mn} mg/l	860	160	15	< 15
BOD_5 mg/l	2,000		30	< 15

Table 4.2.5 Quality and Pollution Loads of Waste Water and Treated Water

Kind of wastewater	Quan-tity m3/d	CODcr mg/L (kg/d)	BOD mg/L (kg/d)	SS mg/L ( )	color (1/m)	T-N mg/L (kg/d)	T-P mg/L (kg/d)
*1 Case-0 total water	1,200	100 (120)	25 (30)	< 30	3	23 (28)	< 2
*2 three times concentrated	400	300 (120)	75 (30)	80	9	70 (28)	2
*3 Case-1 coagul-sedim'n	400	100 (40)	25 (10)	< 30	< 3		< 1
*4 thick color wastewater	40	3,000 (100)	750 (30)	100 (2)	60	600 (24)	10
*5 Case-2 coagul-sedim'n	40	1,000 (40)	250 (10)	< 30	7		2
*6 CASE-2' mixed total	400	100 (40)	25 (10)	< 30	< 3		< 1

(Note) *1: quality of total waste water
*2: total waste water when water usage is reduced to 1/3
*3: Case 1: case of coagulating sedimentation treatment of waste water that reduces water usage to 1/3
*4: water quality when colored waste water from the dyeing process is separated
*5: Case 2: pretreatment (coagulating sedimentation) of colored waste water only
*6: Case 2: total waste water when treated colored waste water is mixed with other waste water

Table 4.2.6 Equipment and Running Costs of the Pretreatment System

	Equipment cost SIT	Depreciation & Interest SIT/m³	Running Cost SIT/m³	Total treatment cost SIT/m³
CASE-1	50,000,000	55	80	135
CASE-2	18,000,000	20	35	55

The running cost have been calculated for the case of a treatment volume of 400 m^3/d.
Case 1 : case of coagulating sedimentation treatment of waste water that reduces water usage to 1/3
Case 2 : pretreating (by coagulating sedimentation) only colored waste water before mixing with other waste water

In Case 1, coagulating sedimentation treatment would be added upstream of the existing charcoal filtration facilities.

In Case 2, piping and a storage tank for collecting concentrated waste water from the dyeing machines only would be newly installed, and waste water would be supplied automatically to the coagulating sedimentation system based on monitoring of the water level in the tank.

In Case 1, the daily treatment cost will be as follows: 400 x 135 = 54,000 SIT. However, because this method will allow a water saving of 800 m^3 to be achieved, the system will balance out if the total cost of well water is 65 SIT/m^3.

In Case 2, the daily treatment cost will be as follows: 400 x 55 = 22,000 SIT. The system will achieve a balance if a daily water saving of 800 m^3 can be achieved.

3) Conclusion

The existing waste water quality practically satisfies the standards for river discharge.

As the factory has free use of the well under its possession, it adopts a policy of conducting ample dilution before discharging. If a waste water treatment system is to be introduced, in place of the current system of water dilution, to reduce water consumption and cost, it would be best to separate only the colored waste water from the dyeing process and treat it by coagulating sedimentation. The resulting treated water could then be passed through the existing charcoal filtration process together with the other waste water, and then be discharged into the river.

4.3 S-3 Mariborska tekstilna tovarna Melje, d.d,(MTT MELJE), d.d., Tovarna tkanin MELJE, d.o.o.

4.3.1 Factory Profile

1) Outline

Capital	:	1,369,568 thousand SIT
Factory area	:	
Number of employees	:	750
Working conditions	:	8 hrs./day
Products	:	Cotton fabric Polyester blends
Annual production (1995)	:	7,140,000m 3,600,000m

2) Water consumption by source and use

Table 4.3.1

3) Flow diagram of water supply and waste water discharge

Fig. 4.3.1 Fig. 4.3.2

4) Quality of make up water and waste water

Table 4.3.2 Table 4.3.3

4.3.2 Water Conservation

1) Current conditions of water usage and water conservation

(1) Features of water usage

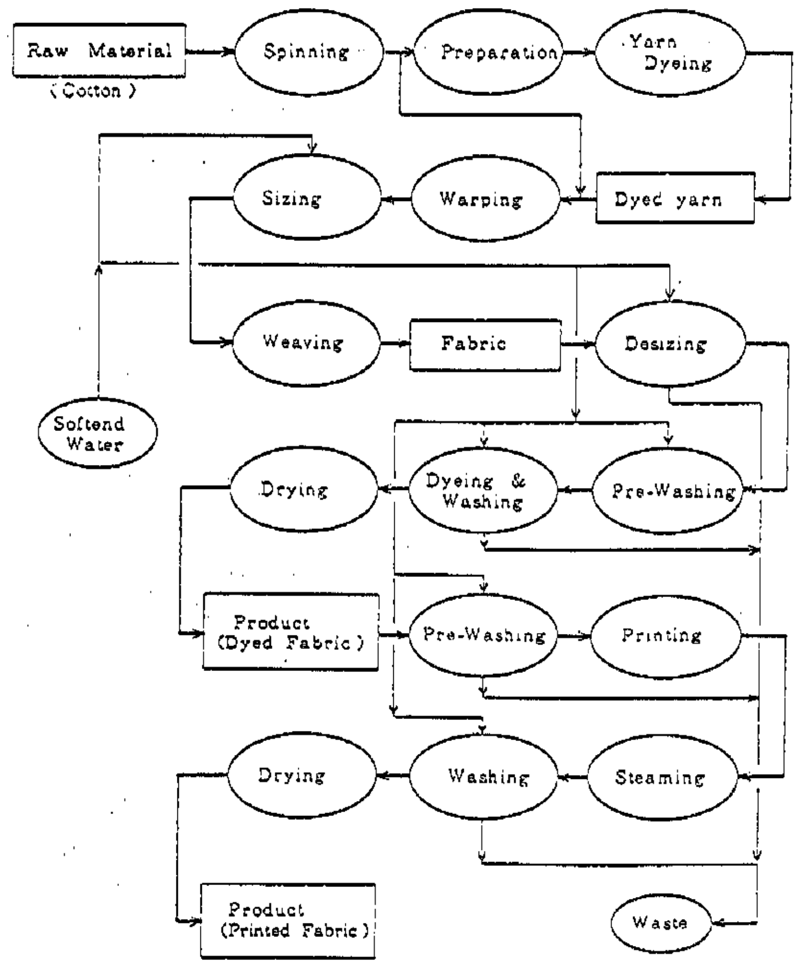
① Water is supplied from three sources : city water, well water and river water (Drava River).

Three of the five wells mix with river water for use in the dyeing process. Another well is used only for the spinning and weaving processes. The fifth well is not in present use.

The most commonly used source is river water (about 57% of all water consumption). This is mixed with well water for use in the dyeing process.

No. S-3-1

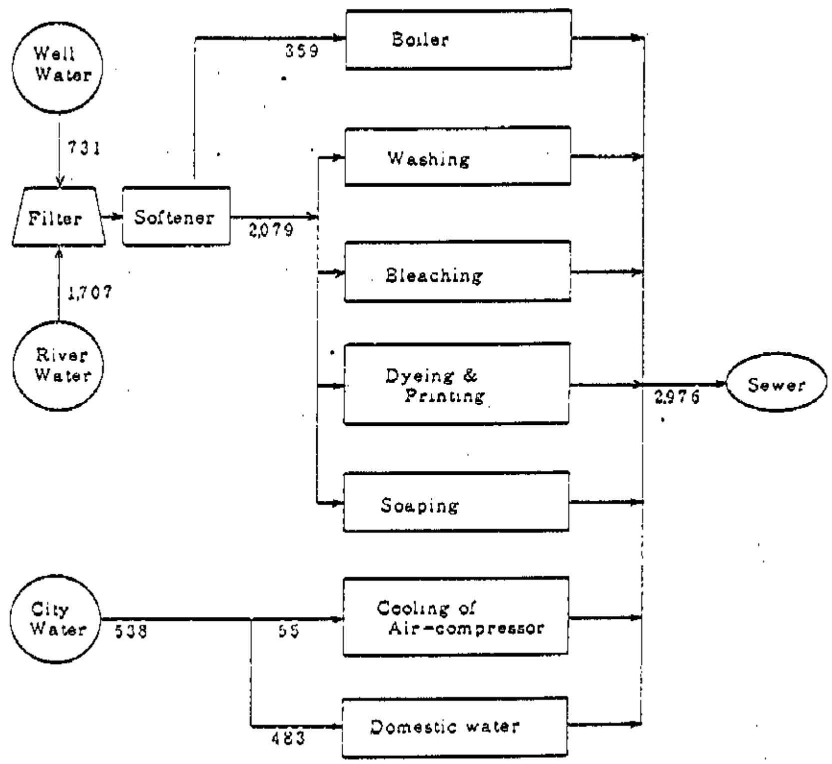
Fig. 4.3.1 Process Diagram of Production Line



Note : a) Air conditioning of the weaving shop is only ventilation method without using water.

No. S-3-2

Fig. 4.3.2 Water Balance Diagram (m³/day)



Note : a) No flow meter for the well and river water are applied. These flow rate are estimated value.

Table 4.3.1 Quantity of Consumed Water Classified by Source and Use

Industry; Textile(Dyeing)

Unit; m³/day

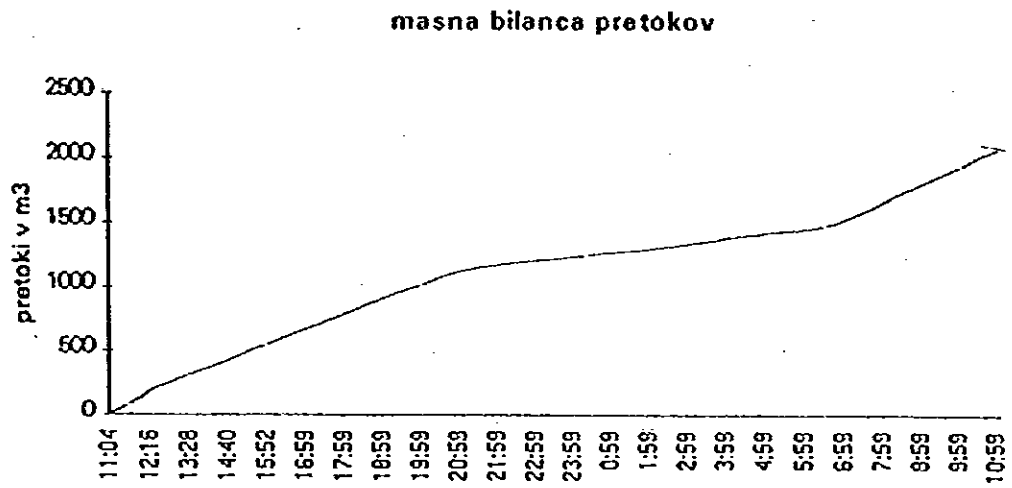
Source / Use	Well Water	City Water	River Water	Sub-Total	Recoverd Water	Total
Boiler Feed			359	359		359
Raw Material						
Washing	731		1,348	2,079		2,079
Cooling		55		55		55
Air Conditioning						
Miscellaneous		483		483		488
Total	731	583	1,707	2,976		2,976
				Recoverd Water/Total		%

Table 4.3.2 Quality of Make-up Water

(Analyzed by the Factory)

Water Source / Parameter	Unit	Well Water	City Water
Temperature	℃		
pH		7.8-8.2	
COD	mg/l		
BOD	mg/l		
Iron	mg/l		
Manganese	mg/l		
Total Hardness	dH		
Alkalinity	mmo/l		
Chloride	mg/l		
Tortal Iron	mg/l		
Evaporated Residue	mg/l		
Electric Conductivity	μS/cm		

Fig. 4.3.3 Quantity of Waste Water



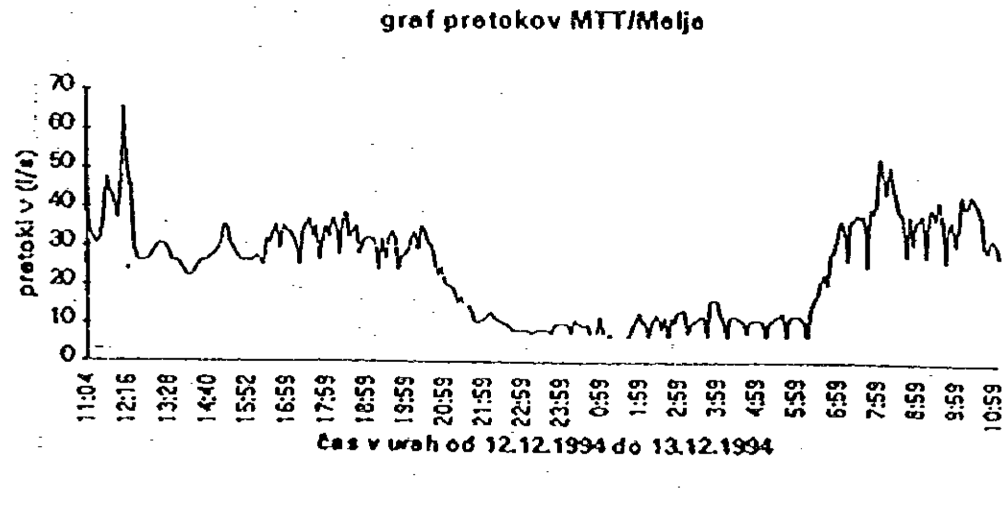


Table 4.3.3 Quality of Waste Water

Parameter	Podano kot	Enota	Metoda	1 Lab. št. 11306
Splošni parametri				
Opis				motna, modre barve
pH-vrednost			DIN 38404-C5	10,8
Elektroprevodnost		µS/cm	DIN 38404-C8	1050
Raztopljene snovi		mg/l	DIN 38409-H1-2	720
Raztopljene anorganske snovi		mg/l	DIN 38409-H1-3	450
Neraztopljene snovi		mg/l	DIN 38409-H2-2	320
Usedljive snovi		ml/l	DIN 38409-H9	4,0
Anorganski parametri				
Baker	Cu	mg/l	DIN 38406-E7	0,10
Cink	Zn	mg/l	DIN 38406-E8	0,19
Krom-skupni	Cr	mg/l	DIN 38406-E10	<0,05
Prosti klor	Cl_2	mg/l	DIN 38408-G4-2	<0,05
Aktivni klor	Cl_2	mg/l	DIN 38408-G4-2	<0,05
Amonijum	N	mg/l	DIN 38406-E5	0,9
Sulfid	S	mg/l	DIN 38405-D26	<0,05
Sulfit	SO_3	mg/l	DEV D 6	4
Organski parametri				
KPK	O_2	mg/l	DIN 38409-H43	270
BPK$_5$	O_2	mg/l	DIN 38409-H51	100
AOX	Cl	mg/l	DIN 38409-H14	<0,02
Skupni ogljikovodiki		mg/l	DIN 38409-H18 mod	0,10
Biološki parametri				
Test strupenosti - ribe		fr	DIN 38412-L31	3

② Water consumption is not measured except for city water. The water quantity in questionnaire indicates only assumed values. Water fees, taxes, etc., paid to the nation and city are also assumptions, except in the case of city water.

③ Recovered water is not used ; all water is used in one pass flow.

④ Most water (about 70% of the total) is used for washing in the dyeing process.

⑤ City water is used for cooling the air compressor in one pass flow.

⑥ Water of the temperature and humidity conditioning is not used for the spinning and weaving processes, which use only ventilation.

⑦ The total cost of water and waste water accounts for about 2.2% of sales. The unit cost required for water and waste water is about 100 SIT /m^3, assuming sales of 3,200 million SIT/y, and total water consumption of 70,000 thousand m^3/y.

This value is slightly less than the calculation based on water fees and taxes. The actual cost required may therefore be much higher.

(2) Current conditions of water conservation

① a water flow meter is not installed, except for citywater. Water consumption control is negligible.

② The unit consumption of water for the dyeing process alone is about 50m^3/thousand m^2, a little more than that of a Japanese dyeing factory. But unit consumption varies with kind and quality of products. It cannot be concluded from this aspect alone that water conservation is inefficient.

③ Two continuous dyeing systems are used. The washing method is not a complete counter-flow multistage system, however.

2) Planning of water conservation system

(1) Implementation of water usage control

The quantity of pumped well water is not measured, which implies a lack of water consumption control. A flow meter, the basis of water conservation, should first be installed for the purpose of water consumption control in the factory.

Since water quantity indicated in the questionnaire is not precise, it is irrelevant to discuss ways to save water.

(2) Recycling of indirect cooling water for air compressor

(a) Outline of plan

Indirect cooling water is at present used only temporarily for the air compressor. Water temperature at the outlet is about 22℃. The waste water is to be recycled by the cooling tower.

(b) Basic conditions

		Present	Plan
Water quantity (m^3/d)		55	55
Operation time (h/d)		8	8
Water quantity (m^3/h)		6.9	7.0
Water temperature ℃	inlet	12	25
	outlet	22	35
Recovery rate %			95
Reduced water (m^3/d)			52
Cooling load (Kcal/h)		69,000	70,000
Annual operating days : 235			

(c) Equipment outline specification

Item	Number of Unit	Specifications
Cooling tower	1	70,000Kcal/h Fan power 0.6kw
Circulation pump	2 (one spare)	Aperture 40 ϕ, Power 1.5kw
Meters, Controller	Overall	Electrical conductivity
Piping	Overall	Circulation pipe 65 ϕ
		Discharge pipe 25 ϕ
		Water supply pipe 15 ϕ

(d) Cost estimate

• Facility cost approx. 1,900 thousand SIT

• Operation cost

Item	Required amount	Unit price	Required cost (SIT/d)	(Thousand SIT/y)	Cost per recovery (SIT/m³)
Electricity	2.1kw x 8h/d x 0.8	15SIT/kw·h	202	47.4	3.9
Labor	Concurrent with other work				
Chemicals		4SIT/m³	200	47.0	4.0
Total		402	94.4	7.9	

• Required cost

Item	Annual cost (Thousand SIT)	Cost per recovery (SIT/m³)	Remarks
Fixed cost			
Facility depreciation,etc.	317	25.9	15 year equal depreciation
Interest			10%
Facility maintenance cost/year	87.5		5% of annual facility
Operation cost	94	7.9	
Total	411	33.8	

(e) Technical comment

① At present, the temperature of cooling water used is about 15°C. The temperature of water obtained from the cooling tower is about 25°C during the hottest period of summer. During the short summer period there is probably inadequate cooling of the machine. Then it is necessary to increase the supply of make up water from the well, or use only well water. This period is presumably only two months at most, so in general there is sufficient water conservation.

② The well water source contains much dissolved salt and is considered high in hardness. If the circulation degree (usually expressed as degree of concentration) by the cooling tower is raised, scales are deposited or corrosion occurs. The quality of well water in the area shows that a concentration degree of 2 or less avoids this operating problem.

(f) Economic comment

The anticipated cost of water recycling in this system is 34 SIT/m^3. But when city water is used, the cost exceeds 200 SIT/m^2, and recycling of water is economically feasible.

(3) Reclamation of waste water

(a) Basic considerations

Reclamation of waste water is possible if cost is not considered. Water for dyeing must be of high quality, however. Reclamation then is not economically feasible, except in special cases. For this reason, only basic guidelines will be presented.

The basic guidelines of waste water reclamation are as follows :

① Waste water of the good quality (least polluted) should be separated and collected for reclamation.

② Reclaimed water should only be used in processes having little effect on product quality.

③ Reclaimed water should be of the minimum required quality.

(b) Reclamation plan

i. Selection of source water

According to Basic Guideline ① above, colored waste water which is not easily decolorized should be avoided. Waste water may be selected from the following:

① Effluent of cooling water
② Colorless waste water of pre- rinsing and bleaching processes.

Since it is more economical to circulate ① within the same process than to reclaim it, ② should be selected. Its quantity is unknown, however.

ii. Quality of reclaimed water

The minimum required quality of reclaimed water is determined by function (e.g., dyeing rinsing water). Actually, the quality of usable water is often unknown by function In that case, it must be checked by experiment.

The following water quality determined by experiment in Japan may be used as a reference :

Quality item	Source	Reclaimed
SS mg/l	<30	<1
BOD mg/l	<100	<1
COD mg/l	<100	<10

iii. Reclamation process

According to water reclamation experiments in Japan, the basic process is as follows :

Water source→pH control→Two stage biological treatment (Trickling filter, submerged bio-filter)→Coagulation and sand filtration→Activated carbon absorption→Recovered water

(d) Technical comment

① A chief problem in water reclamation is determining the minimum required quality for the appropriate usage. Otherwise water must be treated to the same degree as river water or well water currently used. This is extremely cost-consuming.

② Often the engineers who use processing water do not themselves know the minimum required water quality, which can only be determined by considerable experimentation.

③ In Japan, the quality of reclaimed water has been determined as a result of many experiments. The values vary considerably with waste water features and processes for which recovered water is used. Therefore, this water quality should be considered as an example only.

(e) Economic comment

① The cost for reclamation of water is quite high, probably exceeding 200 SIT/m^3.

② The necessary costs included in water reclamation, are the costs of facilities to collect recovered waster water, storage tanks to temporarily hold waste water and recovered water, facilities to supply recovered water (piping, pump, etc.), and others.

In light of the above, the anticipated cost of water reclamation is high.

③ A charge of about 160 SIT/m^3 is expected in the future when the WWTP is built. But if there is a tax for water use (about 41 SIT/m^3) water reclamation may be economically feasible under certain conditions.

(4) Other possibilities of water conservation

The large quantity of domestic water may be reduced in the following ways :

① Using water saving toilets
② Install automatic washing equipment for men's urinals
③ Equip faucets and showers with water saving disk or orifices, etc.

These are easily implemented, and should be used for existing facilities as well as for new equipment to be installed in the future.

The quantity of domestic water (483m^3/day) is too large for the number of employees (750) which is probably unrealistic. The entire excess water amount seems to have been categorized under domestic water in the water balance calculation. The actual amount is thought to be one half of this.

4.3.3 Pretreatment and Waste Water Treatment

1) Present conditions

① Of the 8 sewage outlets, 6 are currently used. All outlets merge at the final downstream outlet. According to the most recent data, the pH sometimes exceeds emission standards, and pretreatment is necessary. A neutralization tank is less expensive than a large stabilization tank.

② The overall capacity of water related systems is excessively large. These facilities should also be examined in regard to the current consolidation and reduction of the production system.

4.3.4 Pretreatment for Reduction of the Pollution Load

1) Background

The June survey consisted of just confirmation of the questionnaire and a brief tour of the plant, however, in December, samples of waste water were taken and analyzed and examination of a pretreatment system for sewerage system discharge was carried out.

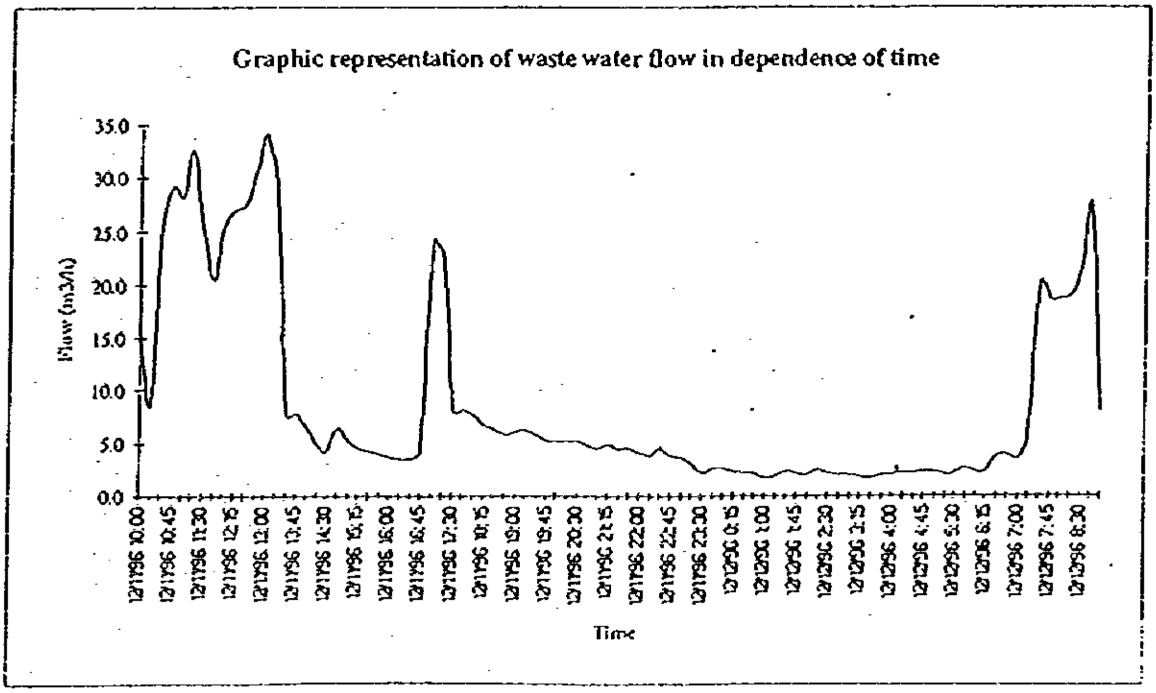
2) Quality of waste water

The total waste water is discharged from eight outlets, of which six lead into the sewerage system. Waste water from each of the factory processes does not pass through any pits but is simply discharged as it is generated. Sampling for water analysis was carried out at the following three points:

1. Final discharge outlet: time-dependent sampling (flow measurement was impossible)
2. Cloth dyeing plant: flow ratio sampling (flow measurement was also carried out)
3. Yarn dyeing plant: spot sample from the waste water pit

The sampling results are shown in Table 4.3.4. Except for the pH, the waste water satisfies standards for sewerage system discharge.

Fig. 4.3.5 Flow Rate of Wastewater from Textile Dyeing Factory



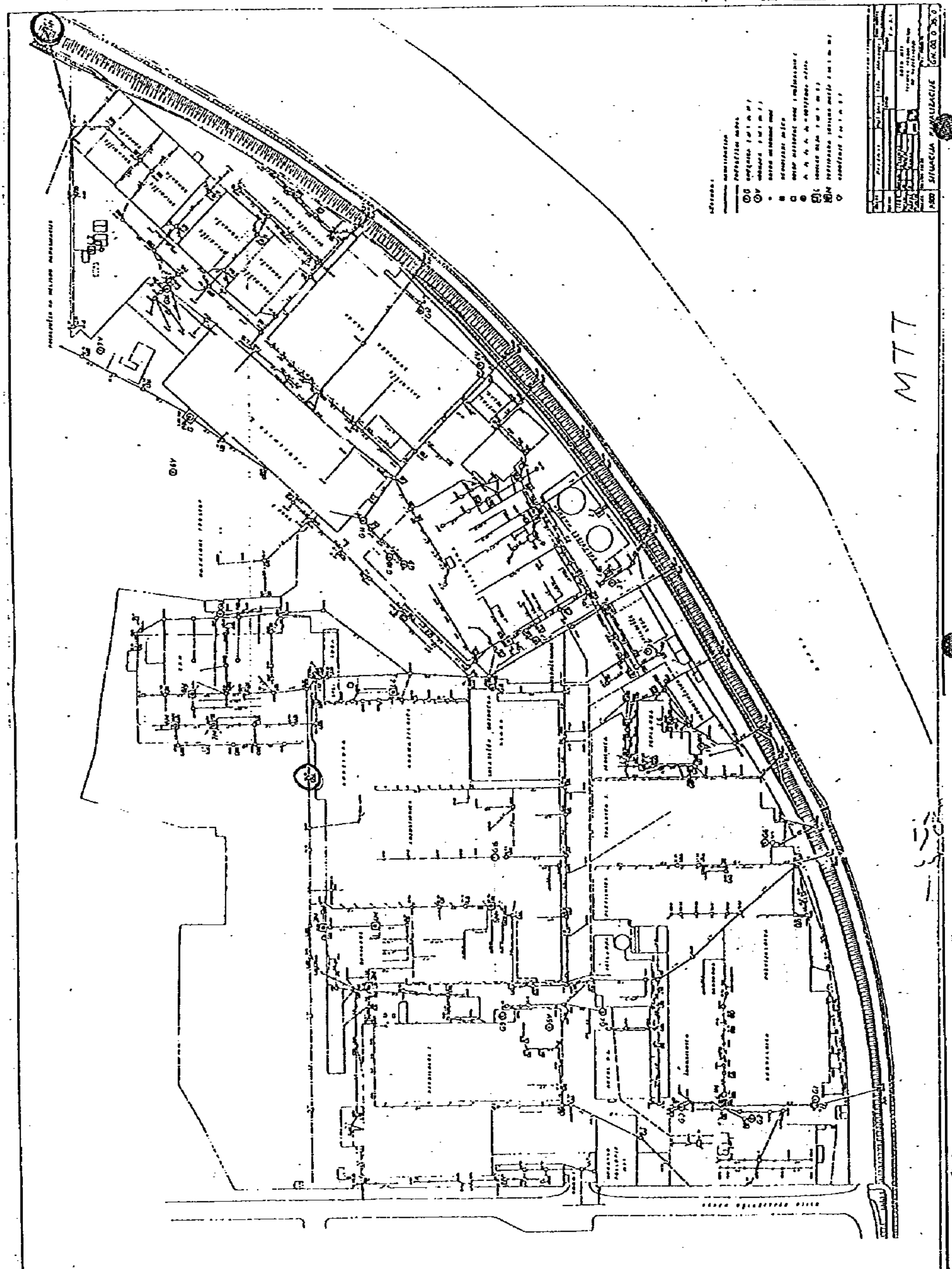

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Table 4.3.4 Quality of Waste Water

Characterization of the sample			Final outlet port	Outlet port of the printing factory	Pit of the yarn dyeing factory
Type of the sample			time - prop.	flow - prop.	spot
Date of sampling			16. - 17.12.1996	11. - 12.12.1996	04.12.1996
Time of sampling			12:00 (06.12.) - 12:00 (17.12.)	9:45 (06.12.) - 9:00 (12.12.)	9:15
Lab. No.			12853	12729	12364
Parameter	expr.as	Unit			
pH			11.3	8.3	9.8
Suspended solids		mg/l	340	58	< 30
Colour:			blue - violet	brown - grey	light blue - violet
α (436 nm)		m^{-1}	17	42	3.7
α (525 nm)		m^{-1}	14	36	3.3
α (620 nm)		m^{-1}	13	32	2.8
Total nitrogen:	N	mg/l	21.7	15.3	7.0
- ammonium nitrogen	N	mg/l	0.72	0.50	0.03
- Kjeldahl nitrogen	N	mg/l	15	7.2	0.80
- nitrite nitrogen	N	mg/l	0.09	0.09	0.05
- nitrate nitrogen	N	mg/l	6.6	8.0	6.1
Total phosphorus	P	mg/l	0.5	< 0.5	2.3
COD_{Cr}	O_2	mg/l	340	230	100
COD_{Mn}	O_2	mg/l	120	100	48
BOD_5	O_2	mg/l	140	-	-
Total fat		mg/l	12	-	-

3) Preliminary study

As was mentioned in the general summary, one of the river discharge standards relates to water color. In order for the WWTP to satisfy standards for river discharge in the future, there is a possibility that calls may be raised for it to install an appropriate pretreatment system for dealing with textile factories, which discharge colored waste water. If a pretreatment system were not to be installed, it is likely that premium charges would be imposed.

Generally speaking, the most economical method of pretreatment in the case of a dyeing factory is coagulating sedimentation. Moreover, if the highly concentrated waste water following dyeing can be separated, the treatment can become even more economical. However, in the current circumstances, it would be extremely difficult to separate only the concentrated waste water. Tests on separation by coagulation sedimentation were carried out on waste water samples by plant unit from the cloth dyeing plant and the yarn dyeing plant.

As can be seen from the test results shown in Table 4.3.5, the coagulation of waste water from the cloth dyeing plant was effective, however, the results of coagulation of waste water from the yarn dyeing plant were not good.

Table 4.3.5 Result of Coagulation Test

	Outlet of Textile Dyeing Factory		Pit of Yarn Dyeing Factory	
	Sampling	Coagulation Test	Sampling	Coagulation Test
Note	11 - 12. 12.1996 9:45 - 9:00 Flow-proportional	PAC 100 ppm Anion P 200 Cation P 0	04.12.1996 9:15 Spot Sampling	PAC 100 ppm Anion P 200 Cation P 0
Parameter		Floc-size large Settling 30 sec		Floc-size small Settling 300 sec
pH	8.3	7.9	9.8	4.7
SS mg/L	58	< 30	< 30	< 30
Color	brown gray	very light gray	light blue-violet	very light violet
α (436nm) m^{-1}	42	0.6	3.7	1.3
α (525nm)	36	0.4	3.3	1.0
α (620nm)	32	0.3	2.8	0.7
t - N mg/L	15.3	10.9	7.0	5.5
t - P mg/L	< 0.5	< 0.5	2.3	< 0.5
COD_{Cr} mg/L	230	120	100	74
COD_{Mn} mg/L	100		48	
BOD_5 mg/L				

4) Outline of pretreatment facilities

Because each plant in MTT is not installed with a water supply flow meter, the volume of water consumption at each plant is unclear. It is even difficult to measure the quality and volume of waste water from each plant because there are no discharge pits and the discharge system consists largely of conduits. Under these circumstances, it is impossible to plan a pretreatment system over all MTT.

For reference purposes, a pretreatment system shall be introduced as follows for the case of the cloth dyeing plant only, from which good coagulation results were obtained.

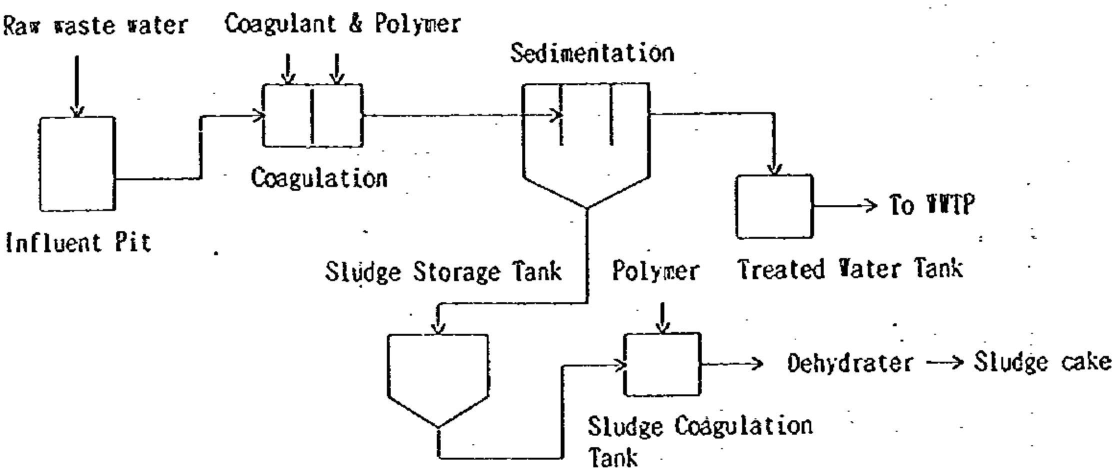


Table 4.3.6 Quality and Pollution Loads of Waste Water and Treated Water

Kind of wastewater	Quantity m^3/d	CODcr mg/L (kg/d)	BOD mg/L (kg/d)	SS mg/L ( )	color (1/m)	t-N mg/L (kg/d)	t-P mg/L (kg/d)
*1 Wastewater from Printing	400	230 (90)	150 (60)	60 (12)	40	16 (36)	1
*2 Case-1 Coagulation & sedimentation	400	120 (50)	80 (30)	< 30	< 5		< 1

(Note) * 1: quality of waste water from the printing plant
* 2: when waste water is pretreated (by coagulating sedimentation)

Table 4.3.7 Equipment and Running Costs of the Pretreatment System

	Equipment cost SIT	Depreciation & Interest SIT/m³	Running Cost SIT/m³	Total treatment cost SIT/m³
CASE-1	50,000,000	55	80	135

The running cost have been calculated for the case of a treatment volume of 400 m^3/d.

5) Conclusion

In total, all the plants of MIT consume thousands of cubic meters of water every day. If a waste water treatment system for direct river discharge is to be built, the treatment unit cost would be cheaper if all the waste water was handled together, however, if a pretreatment system for discharge into the sewerage system is adopted, it is often more economical to treat waste water that has a high pollution load separately.

First of all, it is necessary to gain an understanding of the actual water consumption at each plant within the group.

4.4 S-4 Tovarna sukancev in trakov TSP.p.o.

4.4.1 Factory Profile

1) Outline

Capital	: 637,588 Thousand SIT		
Total factory area	: 9,038m²		
Number of employees	: 198		
Products	: Sewing thread	Ribbons	Belt fabric
	Polyester 95%	Mixed cotton 5%	
Annual production	: 182,300kg		
Annual sales	: 470,950 SIT		
Working conditions	: 8 hours/day		

2) Water consumption by source and use

Table 4.4.1

3) Flow diagram of water supply and water discharge

Fig. 4.4.1 Fig, 4.4.2

4) Quality of make up water and waste water

Table 4.4.2 Table 4.4.3

4.4.2 Water Conservation

1) Current conditions of water usage and water conservation

(1) Features of water usage

① Water is supplied from three water sources city water, well water, and river water (Drava River).

The well is located outside the factory site. Well water, mixed with river water, is used mostly for the dyeing process. A small amount of well water is used for temperature and humidity conditioning of the spinning process.

River water is the largest source, providing 72% of all water used. It is supplied by the adjoining MTT, and mixed with well water for use in the dyeing process.
All city water is for domestic use.

Table 4.4.1 Quantity of Consumed Water Classified by Source and Use

Industry; Textile(Dyeing)

Unit: m³/day

Source / Use	Well Water	City Water	River Water	Sub-Total	Recoverd Water	Total
Boiler Feed			16	16		16
Raw Material						
Washing	29		262	291	43	334
Cooling						
Air Conditioning						
Miscellaneous		36		36		36
Total	29	36	278	343	43	386
				Recoverd Water/Total 11.1 %		

Table 4.4.2 Quality of Make-up Water

(Analyzed by the Factory)

Parameter	Unit	Well Water	After Ion Exchange
Temperature	℃	14	14
pH		6.5	6.5
COD	mg/l		
BOD	mg/l		
Iron	mg/l		
Manganese	mg/l		
Total Hardness	dH	8	<0.8
Alkalinity	mmo/l		
Chloride	mg/l	21	<21
Tortal Iron	mg/l	0.14	-
Evaporated Residue	mg/l		
Electric Conductivity	μS/cm	0.51	-

Fig. 4.4.1 Factory Layout

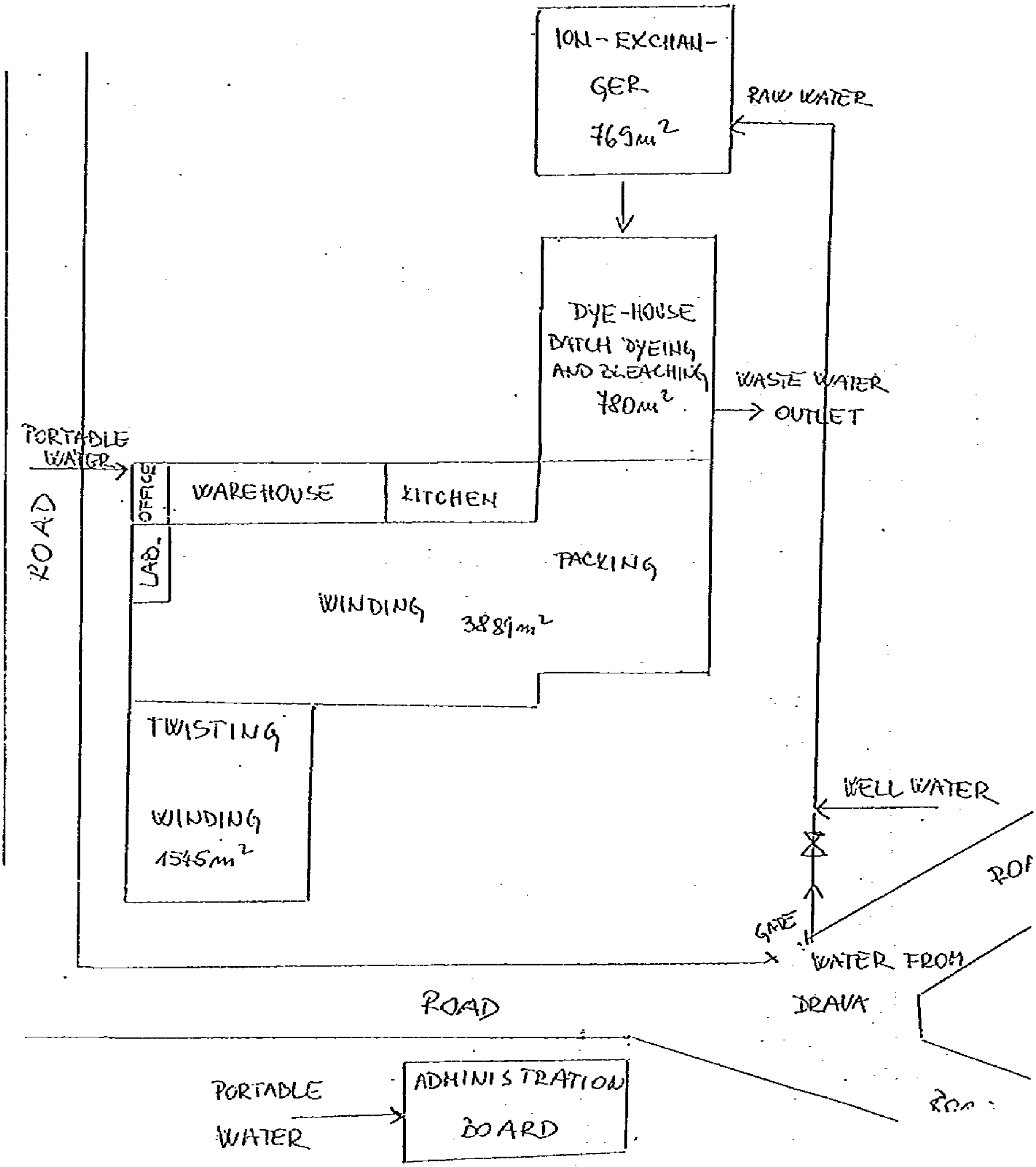


Fig. 4.4.2 PROCESS DIAGRAM of PRODUCTION LINE

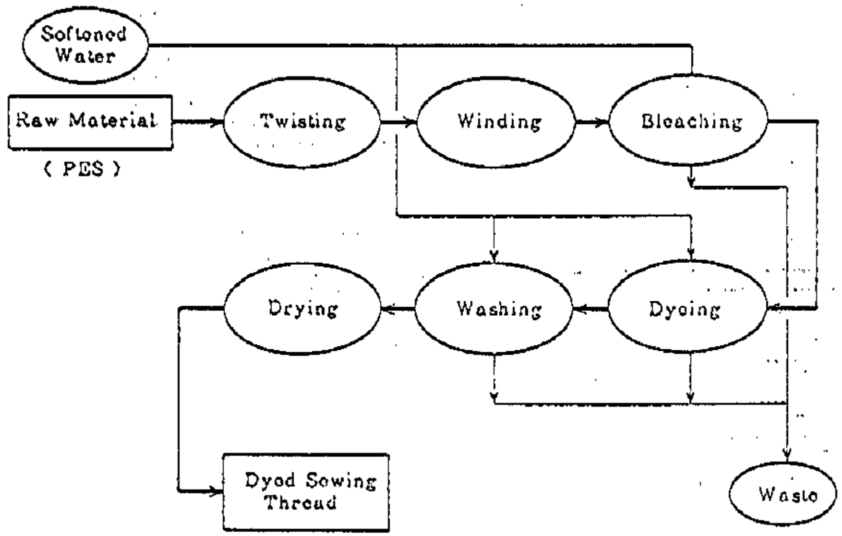
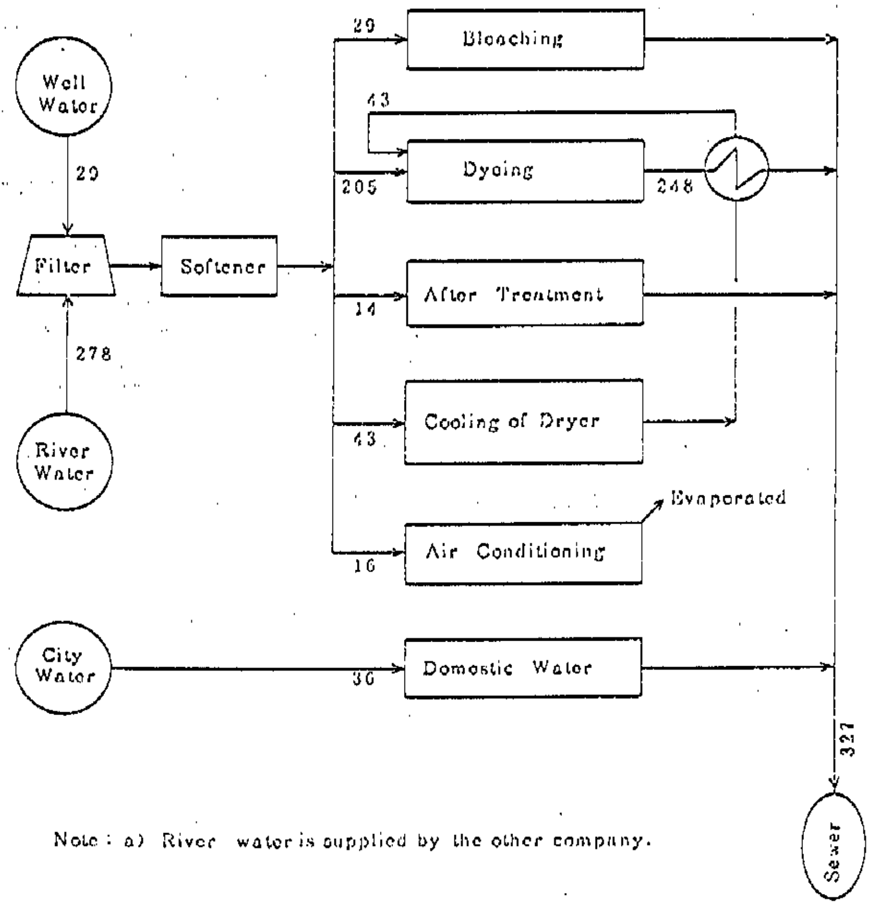
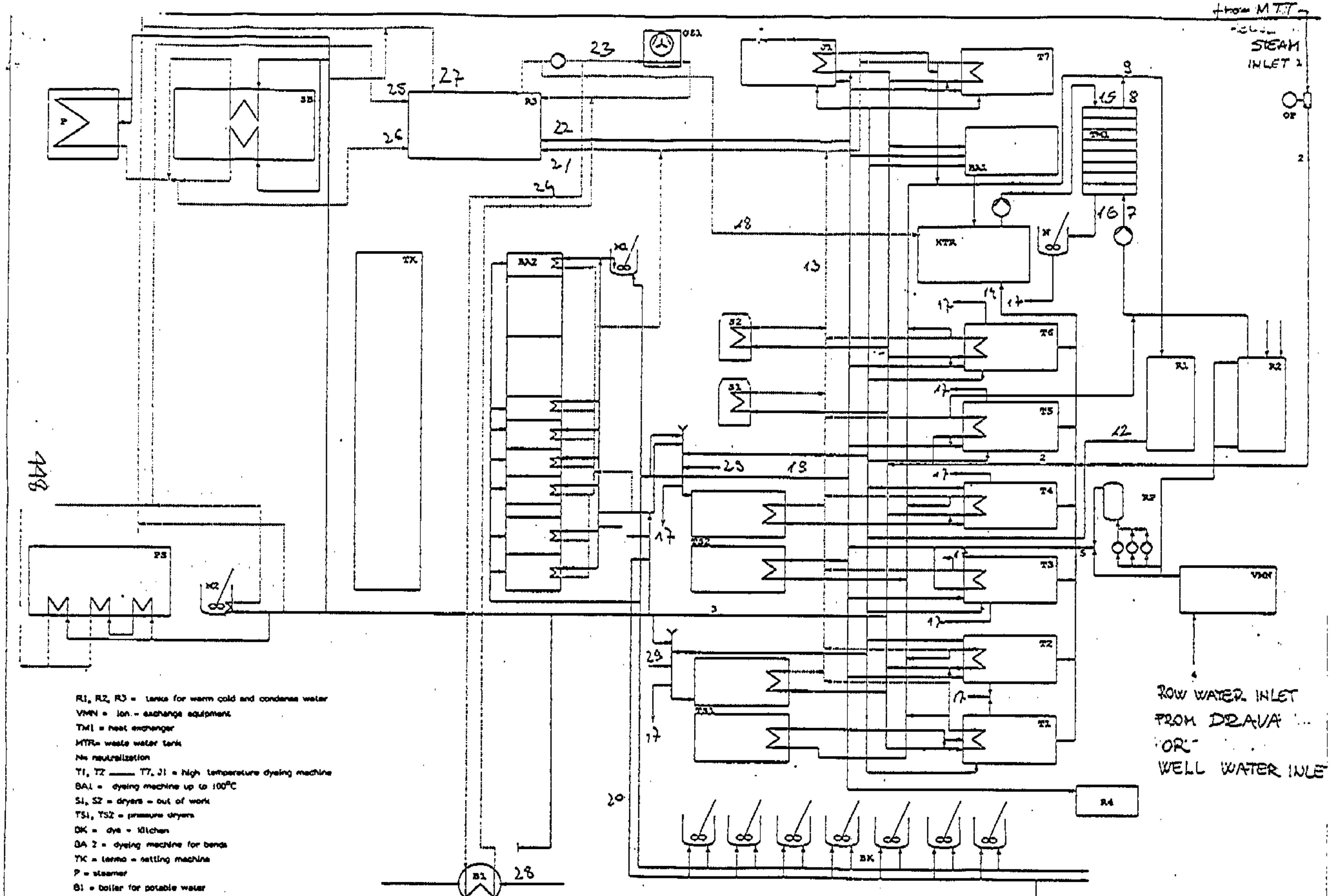


Fig. 4.4.3 WATER BALANCE DIAGRAM (m³/day)



Note : a) River water is supplied by the other company.



R1, R2, R3 = tanks for warm cold and condense water
VMN = ion - exchange equipment
TMI = heat exchanger
MTR= waste water tank
N= neutralization
T1, T2 ——— T7, J1 = high temperature dyeing machine
BA1 = dyeing machine up to 100°C
S1, S2 = dryers - out of work
TS1, TS2 = pressure dryers
DK = dye - kitchen
BA 2 = dyeing machine for bends
TK = termo - setting machine
P = steamer
B1 = boiler for potable water

Fig. 4.4.4 Water Usage Flowsheet

② Most of the water (approx. 87%) is used as washing water of the dyeing process.

③ The main dyeing is of yarns, for which sevsn high temperature dyeing units have been installed. It is entirely operated by the batch system. A small amount of tapes and ribbons are also dyed.

④ Cooling water is used for dryers. The waste water, after heat exchange with hot washing water, is used for washing water of the dyeing process with the cascade method.

⑤ During the spinning process, very little water is sprayed for temperature and humidity control.

⑥ The paid expense for water and waste water are as follows:

- City water charge (sewerage charge included) : about 209 SIT/m^3
- Well water : Free (except for internal costs)
- River water : about 169 SIT/m^3 (paid to MTT)

(2) Current conditions of water conservation

① The water quantity of each water source is measured. Water conservation is thus managed to a certain extent.

② As mentioned before, cascade method is applied with cooling water, which shows an effort to conserve water.

③ The unit water consumption of the dyeing process is 440m^3/ton. This is large in comparison with that of Japanese dyeing factories (100-200m^3/ton). Unit water consumption varies with kind and quality of products, however. It cannot be concluded that the factory is failing to conserve water.

2) Planning of water conservation system

(1) Implementation of water usage control

As said previously, water conservation is currently practiced to a certain extent. But since well water is free, water conservation control is not enough.

However, there are plans to reduce expensive river water and to increase well water usage. If well water is used and discharged into sewage, more than 100 SIT/m^3 (for tax and sewage fees) will be required. When the WWTP is built in the future, the cost is expected to exceed 100SIT/m^3. Well water use should not be increased without considering these factors.

(2) Reclamation of waste water

(a) Basic considerations

The cascade use of cooling water is in operation. Further water conservation depends on reducing the amount of water used for the dyeing process, which accounts for most of the water. But reducing the water quantity in yarn dyeing is technically difficult, with the exception of waste water reclamation.

Waste water reclamation is possible if costs are not considered. Since dyeing requires high quality water, reclamation is not economically feasible, except in special cases. For this reason, only basic guidelines will be presented here.

The basic guidelines of waste water reclamation are as follows :

① Waste water of the good quality (least polluted) must be separated and collected for reclamation.
② Use of reclaimed water should be restricted to those processes which have little effect on product quality.
③ Reclaimed water should be of the minimum required quality.

(b) Reclamation plan

i. Selection of source water

According to Basic Guideline ①, colored waste water which is not easily decolorized should be avoided. The following may be selected :

① Colorless waste water of the pre-washing and dyeing processes
② Relatively less colored rinsing waste water of dyeing process.

The water of ① is presumably of small quantity. The water of ② is needed to ensure a large amount of recovered water.

ii. Quality of reclaimed water

The minimum required quality of reclaimed water is determined by purpose (eg. rinsing water of dyeing process). But the quality of usable water by function is often unknown. Then it must be checked by experiment.

The following quality, determined by experiment in Japan is a reference :

Quality item	Source	Reclaimed
SS mg/l	<30	<1
BOD mg/l	<100	<1
COD mg/l	<100	<10

iii. Reclamation process

Based on water reclamation experiments in Japan, the basic process is as follows :

Water source→pH control→Two stage biological treatment (Trickling filter, submerged bio-filter)→Coagulation and sand filtration→Activated carbon absorption→Recovered water

(d) Technical comment

① A chief problem of water reclamation is determining the minimum required quality for the appropriate usage. Otherwise water must be treated to the same degree as river water or well water currently used. This is extremely cost consuming.

② Often the engineers who use processing water do not themselves know the minimum required water quality, which can only be determined by considerable experimentation.

③ In Japan, the quality of reclaimed water has been determined as a result of many experiments. The quality varies considerably with waste water features and processes for which the recovered water is used. Therefore, this water quality should be considered as an examples only.

(e) Economic comment

① The anticipated cost for water reclamation is quite high, probably in excess of 200 SIT/m^3.

② Costs included in water reclamation are facilities to collect waste water and recovered water; storage tanks to temporarily hold waste water and recovered water, facilities to supply recovered water (piping, pump, etc.), and others.

In light of this, the anticipated cost of water reclamation is high.

③ A charge of about 160 SIT/m^3 is expected in the future when the WWTP is built. But if a tax for water use (about 41 SIT/m^3) is charged, water reclamation may be economically feasible under certain conditions.

(3) Other means of water conservation

The large quantity of domestic water can be reduced in the following ways:

① Using water saving toilets
② Installing automatic washing equipment for men's urinals
③ Equip faucets and showers with water saving disk or orifices, etc.

Easily implemented, they should be used for existing facilities as well as for new equipment to be installed in the future.

4.4.3 Pretreatment and Waste Water Treatment

1) Present conditions

① A heat exchanger for cooling waste water (preheating of make up water) and neutralization system are both installed.

② According to analyzed data of the last three years, emission standards for sewerage discharge are cleared even without these facilities.

③ Direct river discharge is clearly uneconomical.

4.4.4 Pretreatment for Reduction of the Pollution Load

1) Background

The June survey consisted of just confirmation of the questionnaire and a brief tour of the plant, however, in December, samples of waste water were taken and analyzed and examination of a pretreatment system for sewerage system discharge was carried out. The factory is steadily advancing water conservation through adjusting the operation of dyeing machines and remodeling equipment to handle small lots and, as a result, the volume of water consumption has dropped.

2) Quality of waste water

All the waste water is discharged from one outlet into the sewerage system. Waste water from each of the factory processes does not pass through any pits but is simply discharged as it is generated. Sampling for water analysis was carried out at the following three points:

1. Final discharge outlet: flow ratio sampling (flow measurements were also conducted)
2. Yarn dyeing plant: spot sample of the highest concentration waste water
3. Yarn dyeing plant: spot sample of light colored waste water (for comparison)

The sampling results are shown in Table 4.4.3.

The waste water quality satisfies the standards for discharge into the sewerage system.

3) Preliminary study

As was mentioned in the general summary, one of the river discharge standards relates to water color. In order for the WWTP to satisfy standards for river discharge in the future, there is a possibility that calls may be raised for it to install an appropriate pretreatment system for dealing with textile factories, which discharge colored waste water. If a pretreatment system were not to be installed, it is likely that premium charges would be imposed.

Generally speaking, the most economical method of pretreatment in the case of a dyeing factory is coagulation sedimentation. If the highly concentrated waste water following dyeing can be separated and treated apart, the treatment can become even more economical. In consideration of this, testing was carried out on the concentrated, colored waste water. For comparison purposes, testing was also carried out on the total waste water.

Based on the test results, comparison shall be carried out on the following two alternative pretreatment systems.

Case 1: pretreatment (coagulating sedimentation) of total waste water
Case 2: pretreatment (coagulation but no floc separation) of colored waste water only

Table 4.4.3 Quality of Waste Water

Parameter	Final outlet	Coagulation test	Emission standard
Note	04 - 05.12.1996 flow proportional	PAC 100 mg/L Anion P 200 Cation P 20 Floc size Large Settling 30sec	discharge to river for Textile
pH	8.8	7.1	6.5 - 9.0
SS mg/l	32	< 30	80
Color	brown	no color	
α (436nm) 1/m	31	1.0	7
α (525nm)	30	0.5	5
α (620nm)	27	0.2	3
t - N mg/l	14	9.5	
t - P mg/l	0.7	< 0.5	2
COD_{Cr} mg/l	360	210	120
COD_{Mn} mg/l	190	115	
BOD_5 mg/l	100		25
t - Fat mg/l	19		20

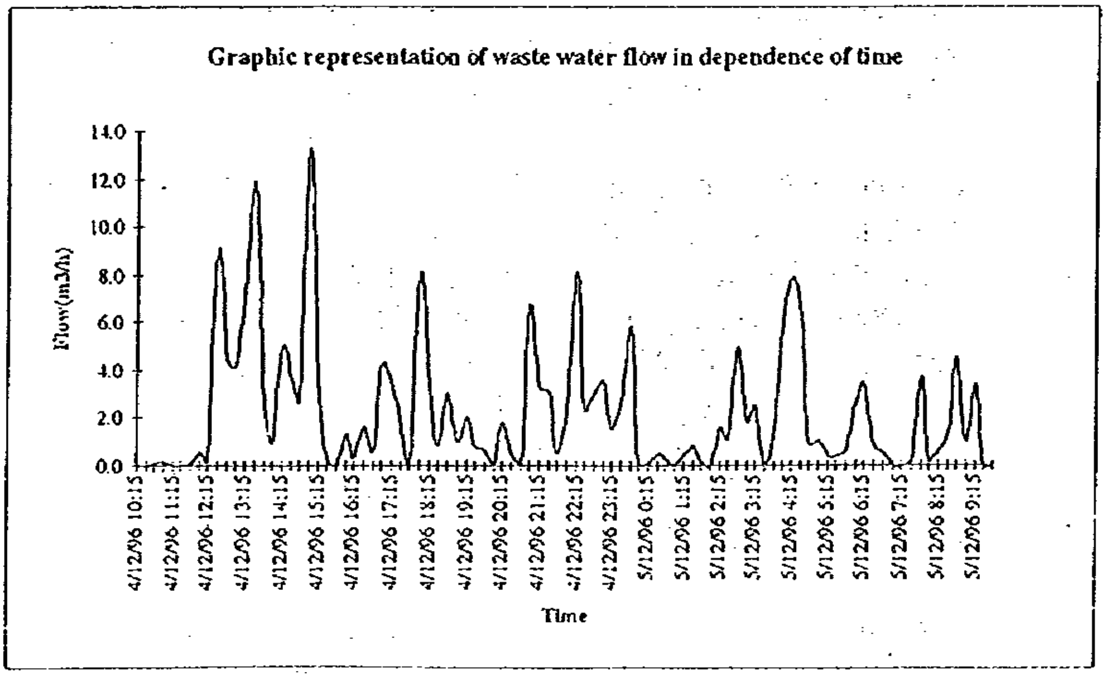


Table 4.4.4 Result of Coagulation Test

	Yarn Dyeing Machine (2% brown)		Yarn Dyeing Machine (0.1% brown)	
	Sampling	Coagulation Test	Sampling	Coagulation Test
Note	02.12.1996 12:00 Spot Sampling	PAC 100 ppm Anion P 200 Cation P 20	02.12.1996 12:20 Spot Sampling	PAC 100 ppm Anion P 200 Cation P 20
Parameter		Floc-size Large Settling 30sec		Floc-size Large Settling 30sec
pH	12.1	6.1	8.8	7.5
SS mg/l	< 30	< 30	< 30	< 30
Color	yellow brown	light yellow	light brown	very light brown
α (436nm) 1/m	82	5	14	7
α (525nm)	72	1	7	4
α (620nm)	46	0.4	5	3
t - N mg/l	45	35	30	
t - P mg/l	0.7	2.4	2.8	
COD_{Cr} mg/l	2,100	1,300	3,100	2,300
COD_{Mn} mg/l	730	620	710	
BOD_5 mg/l	1,000		850	

Table 4.4.5 Quality and Pollution Loads of Waste Water and Treated Water

Kind of wastewater	Quan-tity m3/d	CODcr mg/L (kg/d)	BOD mg/L (kg/d)	SS mg/L ( )	color (1/m)	T-N mg/L (kg/d)	T-P mg/L (kg/d)
*1 Raw total wastewater	200	400 (80)	200 (40)	40 (8)	30	15 (3)	1
*2 Case-1 Coagulation & sedimentation	200	250 (50)	80 (16)	< 30 (<6)	< 3		
*3 Thick wastewater (Raw water)	40	2,000 (80)	900 (36)	50 (2)	80	45 (2)	5
*4 CASE-2 Coagulation only	40	1,300 (52)	500 (20)	500	7		2
*5 CASE-2' Mixed total discharge	200	300 (60)	120 (24)	100	< 3		< 1

(Note) * 1: quality of total waste water
* 2: Case 1: case of pretreatment (coagulating sedimentation) of total waste water
* 3: quality of only colored waste water separated from the dyeing processes
* 4: Case 2: pretreatment (just coagulating sedimentation) of colored waste water only
* 5: Case 2: total waste water when treated colored waste water is mixed with other waste water

Case 1: pretreatment (coagulating sedimentation) of total waste water

COD and BOD fall and the reduction in SS and color is great.

If 200 m^3 of waste water is collected and treated by coagulation every day, floc separation will be necessary.

Case 2: pretreatment (coagulation only with no floc formation) of colored waste water only

SS will increase but coloration will almost completely disappear.

In the case where only 40 m^3/d is treated by coagulation, even if the waste water is discharged without forming floc that adsorbs the colored matter, because the final effluent will be diluted five times by the other waste water, the increase in the SS value will not be too extreme.

Because the unit treatment cost will become very high due to the small scale of the facilities, the cost of treating the total waste water will be higher than the sewage charge. However, if the colored waste water only is treated and then discharged with other waste water, the treatment cost will be reduced and the system will become more economical.

Table 4.4.6 TSP Equipment and Running Costs of the Pretreatment System

	Equipment cost SIT	Depreciation & Interest SIT/m^3	Running Cost SIT/m^3	Total treatment cost SIT/m^3
CASE-1	40,000,000	120	105	225
CASE-2	10,000,000	30	25	55

3) Conclusion

The present waste water would satisfy discharge standards in the case of discharge into the sewerage system. In the event where reduction of water coloration becomes necessary due to additional requirements, it would be best to separate only the colored waste water from the dyeing processes and carry out treatment by coagulation. Fortunately in the case of TSP, because the dyeing machines are on the second floor and the waste water piping is on the first, it is relatively easy to switch over to piping for colored waste water only and install a water storage tank.

4.5 S-5 METALNA, STROJE-GRADNJA, KONSTRUKCI-JE MONTAZA IN STORITIVE, d.d.

4.5.1 Factory Outline

1) Outline

Metalna, Strojegradnasa, Konstrukcije, Montaza In Storitive, d.d. is a major heavy industrial company within Slovenia. It used to be a state factory possessing a work force of 4,200, however, divided between the 12 companies of the Metalna group. 10 of those companies, possessing a combined work force of 2,000, are located in Maribor, and the other two companies, with a combined work force of 500, are in Kriska.

The factory's main products are all forms of hydraulic generator (not including turbines), construction and transportation equipment such as cranes and rings., etc., and various industrial machinery for the chemicals, paper, food and dye sectors, etc.

With the cooperative operating setup of the group behind it, the company is currently being active on the international stage. Participation of the iron working division is anticipated in future WWTP construction.

2) Volume of water usage by water source and purpose of use (m^3/day)

The volume of water usage by water source and purpose of use is indicated in Table 4.5.1.

Table 4.5.1 Volume of Water Usage by Water Source and Purpose of Use

Use \ Source	Well Water	City Water	River Water	Sub-Total	Recovered Water	Total
Boiler Feed						
Raw Material						
Washing		(10)		(10)		(10)
Cooling		(100)		(100)		(100)
Air Conditioning						
Miscellaneous		(100)		(100)		(100)
Total		212		212		212
				Recovered Water/Total		%

Note : Figures in parentheses are estimates.

3) Water supply and waste water discharge flow diagrams

The balance of water at the factory is indicated in Fig. 4.5.1.

(1) Water supply facilities

The factory group prossesses a well on its grounds and it uses water from this and also city water. Metalna provides the water supply to each company in the group.

Of the industrial water, that supplied to the plasma cut division, compressors and boilers is treated in a softening plant. Regeneration from the softening plant is performed using NaCl in amounts that is in the order of 15kg, 40kg and 130kg.

(2) Manufacturing processes and sources of waste water

The major manufacturing processes are as illustrated in Fig. 4.5.2.

Rather than mass producing standard items, this heavy industrial factory processes raw iron to make products on order. Thus, there is no regular pattern of water usage and waste water discharge, although almost all the waste water is stored, treated and discharged at regular intervals. The basic flow of the manufacturing processes is as follows.

Steel plate → (Cutting) → (Forming) → (Machining) → (Welding) → (Pre-treatment for painting) → (Painting) → (Hydraulic pressure test) → (Assembly) → Product

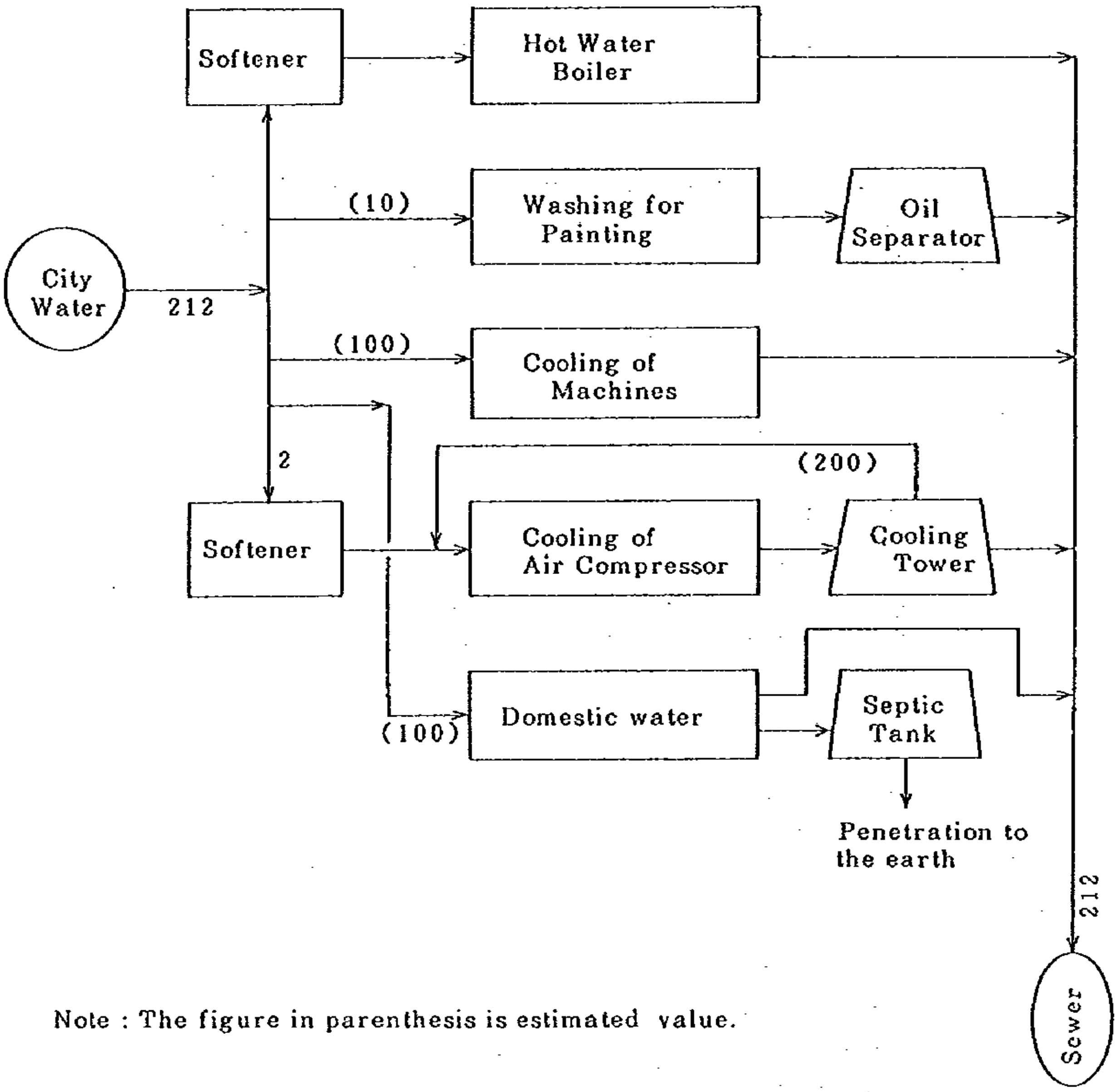
① Cutting

In this process, the raw material steel plate undergoes cutting. Because plasma cutting takes place under water, the waste water generated in these cases contains iron dust, but as the iron dust is separated by sedimentation, it is not discharged with the waste water.

② Forming

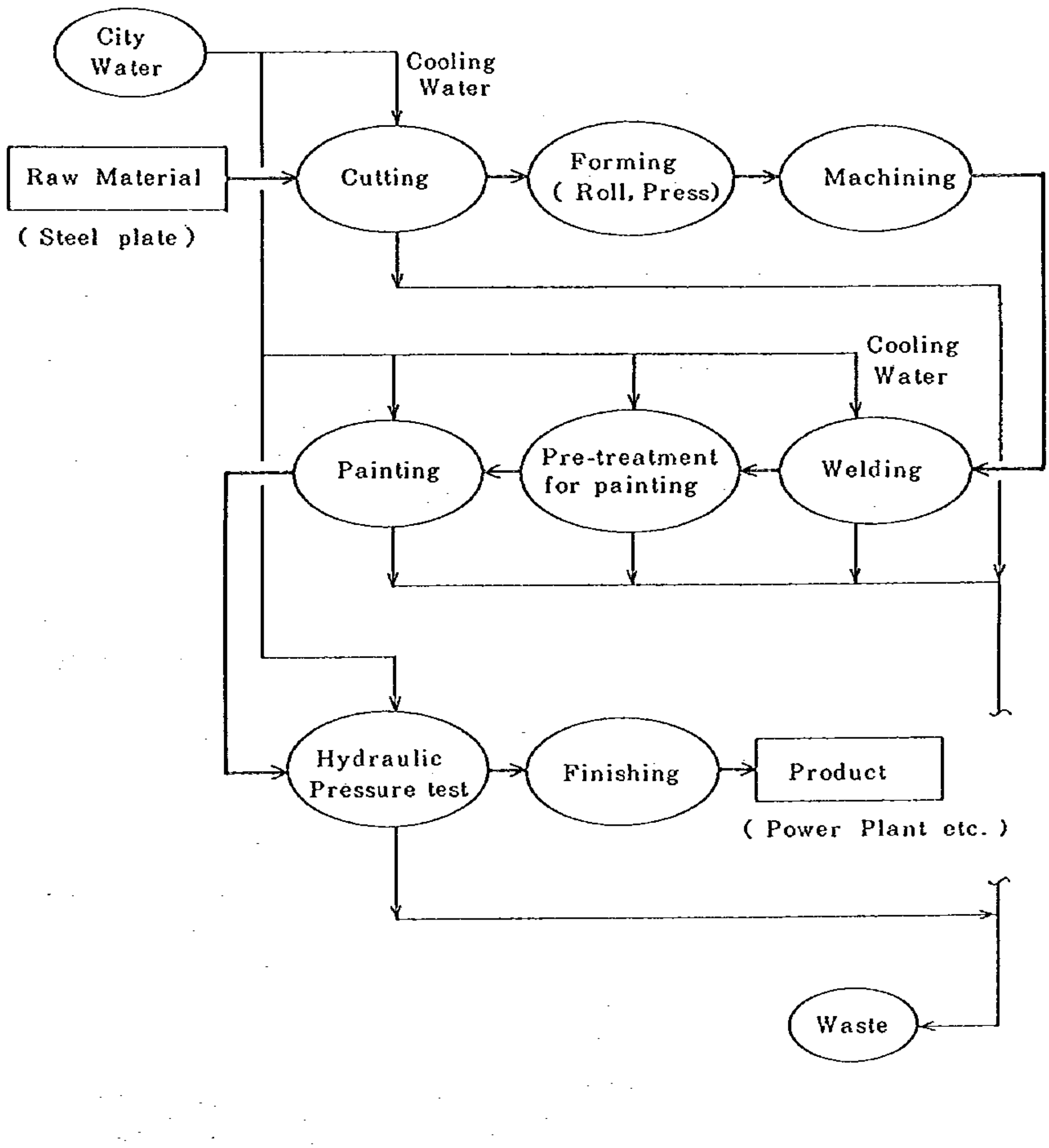
In this process, pressure is applied to the cut steel plate in order to bend it or mold it in the shape desired. Because water is not used in this process, no waste water is generated.

Fig. 4.5.1 Water Balance at the Factory (m³/day)



Note : The figure in parenthesis is estimated value.

Fig. 4.5.2 Flow of Manufacturing Processes



Note : Waste water from the pre-treatment and the painting process is polluted.

③ Machining

In this process, burrs are removed from the molded parts, screw holes, etc. are opened and the surface polishing required to finish the shaping of the parts is carried out. Waste cutting oil is generated in this process.

Because the waste cutting oil is collected and consigned to a specialist handler of industrial waste products, no waste water is generated here.

④ Welding

In this process, the formed parts are welded and assembled into the product shape. Cooling water is generated here.

⑤ Pre-treatment for painting

In this process, a jet washer is used to blast water containing surface active agent onto the assembled product, so as to wash the surface of the said product. Washing waste water is generated here.

⑥ Painting

The painting of washed products is carried out by brushing and spraying. The spray painting takes place in a booth, from which waste water is generated. This waste water is generated when tanks are washed, and this washing is carried out two times per year. Before this waste water is discharged, solid waste paint is removed and the pH level is stabilized.

⑦ Hydraulic pressure testing

The finished tanks are sealed and hydraulic pressure is applied to check for leaks and test the ability to withstand pressure. Waste water is generated in this process, however, it is not polluted waste water.

(3) Waste water treatment plant

Waste water is treated at each area of generation prior to being discharged. In other words, waste water from the cutting process undergoes sedimentation treatment, oil-bearing waste water from the machining process is filter treated, waste water from the pre-treatment and painting processes undergoes coagulation and sedimentation treatment, and other waste water receives neutralization treatment.

(4) Waste water treatment and water usage control setup

The control of water usage and waste water is carried out by managers of the utility division, etc. under the guidance of researchers in charge of environmental control within the 10 companies making up the Metalna group.

4) Quality of make-up water and waste water

(1) Quality of make-up water

The forecast quality of make-up water is shown in Table 4.5.2.

Table 4.5.2 Quality of Make-up Water

Items \ Name of Sample \ No.	① City Water	② Outlet of Softener
Temp. (℃)	15	15
pH (−)	7.5	7.5
COD_{cr} (mg/ℓ)	1.5	−
T-Hardness* (°dH)	12.4	0.02
Cℓ (mg/ℓ)	8	−
T-Fe (mg/ℓ)	< 0.05	0

(NOTE) * : mmol/ℓ as CaO

(2) Quality of waste water

Waste water is broadly divided into waste water from the painting booths, domestic waste water, machine cooling water and compressor cooling water, and it is discharged from four discharge mouths.

a. Characteristics of waste water discharge

The forecast characteristics of waste water discharge are as follows.

① Waste water from pre-treatment washing for painting ($10m^3$/day)

The daily amount of waste water generated in the painting booths works out to $10m^3$/day.

② Domestic waste water (100 m^3/day)

There are 2,000 employees in the factory.

③ Machine cooling water (100 m^3/day)

This waste water comes from cooling water used in the welding process. It contains hardly any pollution at all.

④ Compressor cooling water (2 m^3/day)

This waste water contains hardly any pollution at all.

b. Quality of waste water

The quality of waste water overall according to the materials received is shown in Table 4.5.3.

Table 4.5.3 Quality of Waste Water Overall

Items \ Name of Sample		Effluent
Temp.	(℃)	10
pH	(−)	7.4
COD_{Cr}	(mg/ℓ)	213
BOD	(mg/ℓ)	99
Oil/Fat	(mg/ℓ)	8
Organic Solvet	(mg/ℓ)	< 0.1

4.5.2 Water Conservation

(1) Features of water usage

① The city water is the only water source used, and the volume of water used is measured. However, the volumes of water used in each area are totally unclear, and the figures indicated in Table 4.5.1 and Fig. 4.5.2 were estimated by the study team.

② It is estimated that approximately half of the water is used for machine cooling and that the rest is used mainly as domestic water.

③ Washing water is used in the painting process, however, it is estimated that the amount used is extremely small.

④ Compressor cooling water is recycled by a cooling tower.

⑤ As the hot water boiler is used for heating purposes, it is estimated that the amount of water used in it is very small.

(2) Current conditons of water conservation

① As was mentioned above, although the overall water usage is measured, the volumes of water used in each area are totally unclear, and the control of water usage cannot be described as thorough.

② Although some of the cooling water is recycled, it is guessed that most of the cooling water is used only one-through system.

③ Because the production mode is one of multiple models in small quantities, it is impossible to calculate the unit consumption of water.

(3) Technical comment

① Because the current control of water usage cannot be described as sufficient, it is necessary to put into effect a much stricter control system by first attempting to grasp the volumes of water used in each area.

② It is possible for the cooling water currently being used in one-through to be recycled by the cooling tower. However, consideration does need to be given to the following points.

- Maximum allowed water temperature required for cooling and the minimum water temperature that can be obtained in the summer from the cooling tower.

- As the machinery that requires cooling is thought to be dispersed throughout the factory, the ability to group it and carry out the recycled use of water.

(4) Economic comment

① In order to carry out the sufficient control of water usage, in addition to the installation of flow meters, etc., more control staff are needed. The volume of water saving required to balance the extra personnel expenses created by this is calculated in Table 4.5.4 based on set preconditions.

Table 4.5.4 Volume of Water Saving Needed to Recover Personnel Expenses

Case	Preconditions				Water saving where expenses can be recovered	
	Operating days (days/year)	Personnel expenses unit rate (1000 SIT/year)	Required staff	Costs relating to water usage and waste water (SIT/m^3)	Volume of water saving (m^3/day)	Rate of water saving (%)
Now	250	3,000.0	2 x 0.5	213	56.3	26.6
*Future	250	3,000.0	2 x 0.5	310	38.7	18.2

*Note : In the case where a WWTP is completed.

It would be difficult to recover the additional costs in the current situation. However, the economic feasibility of the future case is high.

② In the case of recycle using cooling water by the cooling tower, the cost per unit of recycled water would not exceed 100 SIT/m^3 (roughly 30-40 SIT/m^3), and indeed this proposition would be economically feasible even now.

4.5.3 Pretreatment that Satisfy WWTP Discharge Standards, and Waste Water Treatment

1) Current conditons of waste water

Judging from the manufacturing processes, the discharge characteristics of waste water are assumed to be as follows.

a. Waste water that requires treatment

① Plasma cut cooling water

The waste water contains iron dust and is discharged at irregular intervals.

② Washing waste water from pre-treatment for painting

The waste water contains oil and surface active agent and is discharged at irregular intervals.

③ Painting booth waste water

The waste water contains paint and solvents and is discharged at irregular intervals.

④ Domestic waste water

This is discharged all the time.

⑤ Other waste water

Regenerated waste water from, etc.

b. Waste water that requires no treatment

① Hydraulic pressure test water

② Machine cooling water

③ Compressor cooling water

2) Quality of treated water

The water quality standards for river discharge and the case of WWTP discharge are shown in Table 4.5.5.

Table 4.5.5 Discharged Water Quality Standards

	Item	unit	River	Sewage
1	Temperature	℃	30	40
2	pH	—	6.5--9.0	6.5--9.5
3	SS	mg/l	80	(a)
4	SV^{30}	ml	0.5	10
5	SAK(Color unit)			
	436nm	m^{-1}	7.0	
	525nm	m^{-1}	5.0	(b)
	620nm	m^{-1}	3.0	
6	Toxicity test (SD)	mg/l	3	—
7	Biodegradation	%	—	(c)
8	B	mg/l	1.0	10.0
9	A	mg/l	3.0	(d)
10	As	mg/l	0.1	0.1
11	Cu	mg/l	0.5	0.5
12	Ba	mg/l	5.0	5.0
13	Zn	mg/l	2.0	2.0
14	Cd	mg/l	0.1	0.1
15	Co	mg/l	1.0	1.0
16	Sn	mg/l	2.0	2.0
17	T-Cr	mg/l	0.5	0.5
18	Cr^{6+}	mg/l	0.1	0.1
19	Ni	mg/l	0.5	0.5
20	Ag	mg/l	0.1	0.1
21	Pb	mg/l	0.5	0.5
22	Fe	mg/l	2.0	(d)
23	Hg	mg/l	0.01	0.01
24	Cl_2(Free chlorine)	mg/l	0.2	0.5
25	Cl_2(Total effective chlorine)	mg/l	0.5	1.0
26	N-NH3	mg/l	10	(e)
27	$N\text{-}NO_2$	mg/l	1.0	1.0
28	$N\text{-}NO_3$	mg/l	(i)	—
29	T-CN	mg/l	0.5	10
30	Free CN	mg/l	0.1	0.1
31	F	mg/l	10	20
32	Cl^-	mg/l	(g)	—
33	T-P	mg/l	2.0(1.0(h))	—
34	SO_4	mg/l	(f)	300
35	S	mg/l	0.1	1.0
36	SO_3	mg/l	1.0	10
37	TOC	mg/l	30	—
38	COD_{Cr}	mg/l	120	—
39	BOD_5	mg/l	25	—
40	Total oil and fat	mg/l	20	100
41	THC	mg/l	10	20
42	Aromatic organic chlorine	mg/l	0.1	1.0
43	Absorbent organic chlorine	mg/l	0.5	0.5
44	Evaporative organic chlorine	mg/l	0.1	0.1
45	Aqueous organic chlorine	mg/l	(k)	(l)
46	Phenol	mg/l	0.1	10
47	Surfactant	mg/l	1.0	—

3) Pretreatment system

(1) Basis for system selection

As the quality of waste water overall satisfies the WWTP discharge standards, there is no need to install a pre-treatment system. However, when waste water that is discharged irregularly is discharged all together within a short time, there are cases where the overall waste water quality exceeds the allowable standards. From the types of waste water that require treatment, those considered to be in danger of exceeding quality standards shall be selected, and a model case shall be indicated for a system that can treat these waste water types.

① Plasma cut cooling water

The waste water contains iron dust, but this can be easily removed through sedimentation. The separated iron dust is heavy and may stick together, but as there will only be small quantities, it is appropriate that it be removed by manual labor.

② Washing waste water from pre-treatment for painting

The waste water contains oil and surface active agent, but as those concentrations are extremely low, there is no need to perform treatment.

③ Painting booth waste water

The waste water contains paint and solvents, and treatment does need to be carried out. Because coagulation and floatation involves cheap running costs and allows the simple removal of oil, this shall generally be adopted as the pre-treatment method.

④ Domestic waste water

Because the organic matter contained in the waste water is extremely biodegradable, there is no need to perform treatment.

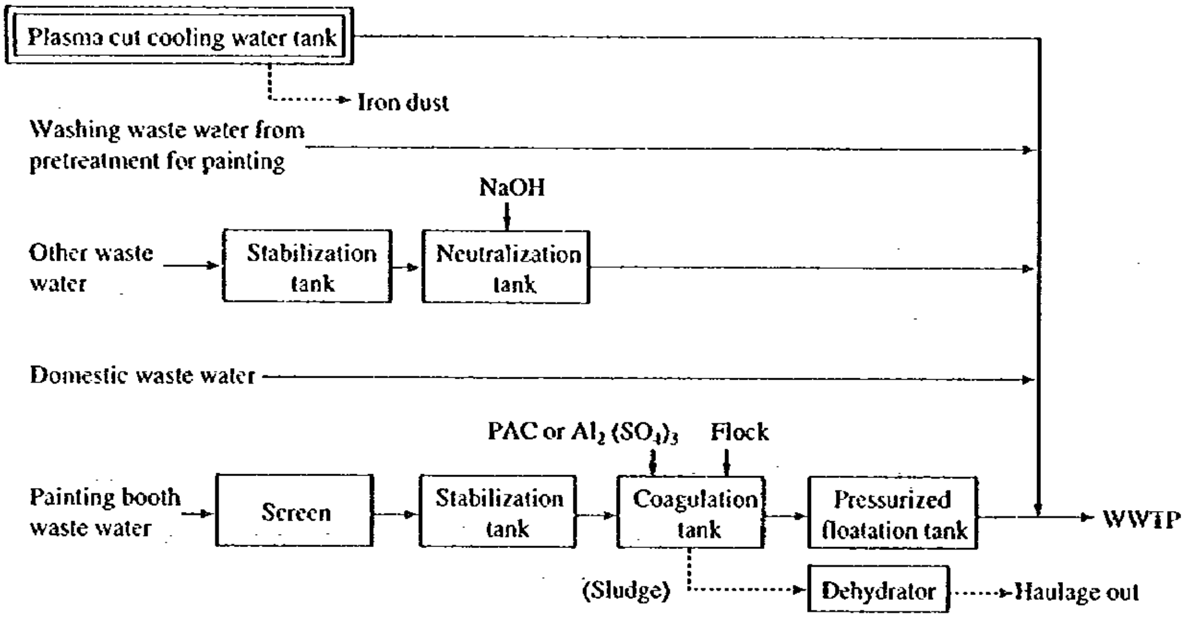
⑤ Other waste water

Because acid is used in the regeneration of softener, the resulting waste water is acidic. It is thus necessary to neutralize the waste water.

(2) Outline of the pre-treatment system

The pre-treatment system is shown in Fig. 4.5.3.

Fig. 4.5.3 Pretreatment System Flow Sheet



① Plasma cut cooling water

Only the supernatant liquid in the cooling water tank is discharged into the WWTP. Following discharge, the iron dust collected at the bottom of the tank is removed.

② Washing waste water from pre-treatment for painting

The waste water is directly discharged into the WWTP.

③ Other waste water

Waste water is discharged into a stabilization tank. After being guided into a neutralization tank from the stabilization tank by storage pump, NaOH is added under control by a pH meter installed in the neutralization tank to make the pH neutral. Following this, the waste water is discharged into the WWTP.

④ Domestic waste water

The waste water is directly discharged into the WWTP.

⑤ Painting booth waste water

After the waste water is led through a screen, where impurities are removed, it is stored in a stabilization tank. A set amount of waste water is fed into a coagulation tank by storage pump, PAC or $Al_2(SO_4)_3$ are added to coagulate it, and high-polymer coagulant is then added to form flock. Next, the waste water is fed into a pressurized air floatation tank where the flock is floatation separated and is then discharged into the WWTP.

4) Waste water treatment system

(1) Basis for system selection

In the waste water requiring treatment that has received pre-treatment, organic matter still remains. Organic matter is also contained in the waste water that has been directly discharged. Thus, in order to obtain a satisfactory standard of discharge water quality, it is necessary both pre-treat this waste water and also carry out treatment of the contained organic matter.

Biological treatment is generally adopted in order to treat organic matter. Because domestic waste water contains ample quantities of nitrogen and phosphorous necessary for biological treatment and such waste water is continuously discharged, pre-treated waste water shall be mixed with domestic waste water and treated simultaneously. Taking a digestion of remaining ammonia, a contact aeration tank shall be used after the activated sludge treatment.

(2) Outline of the waste water treatment system

The waste water treatment system is shown in Fig. 4.5.4.

① Plasma cut cooling water

After the supernatant liquid in the cooling water tank has been stored in the stabilization tank, it is fed into the domestic waste water stabilization tank.

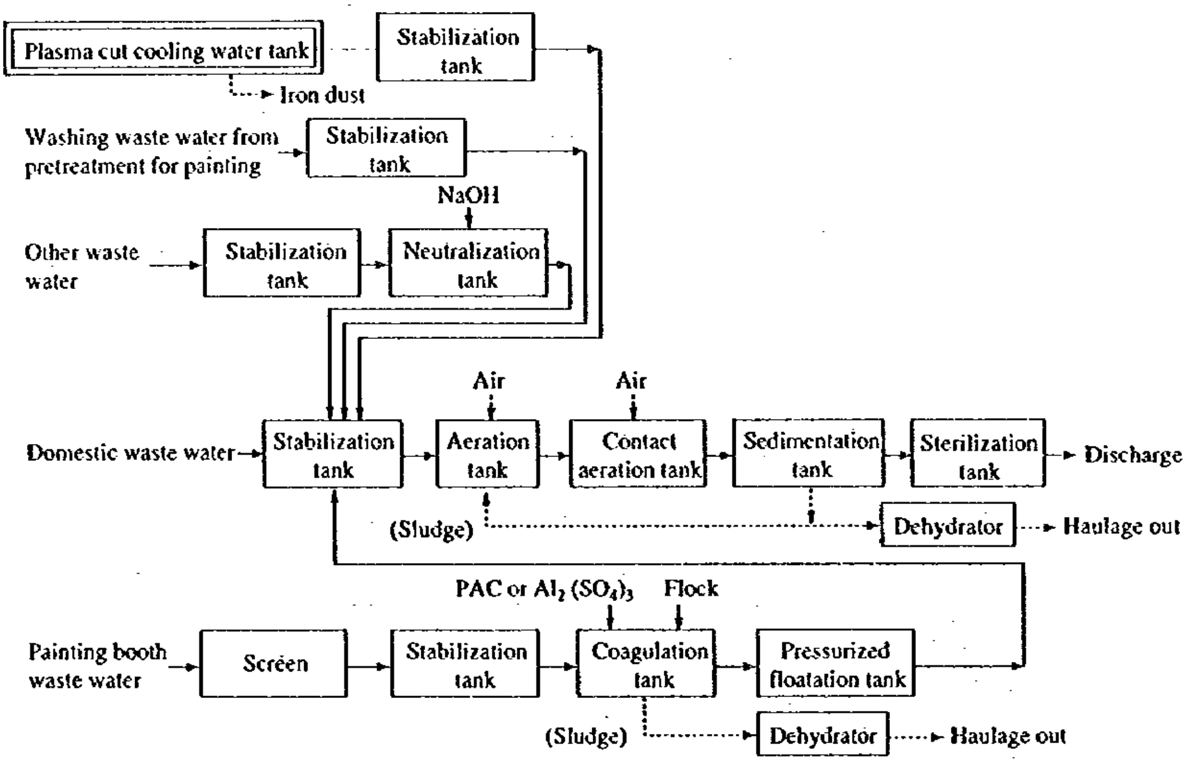
② Washing waste water from pretreatment for painting

After the waste water has been stored in the stabilization tank, it is fed into the domestic waste water stabilization tank.

③ Other waste water

The waste water is discharged into the stabilization tank. From there it is fed into a neutralization tank by storage pump, where NaOH is added under control by a pH meter to make the pH level neutral. After that, the waste water is guided into the domestic waste water stabilization tank.

Fig. 4.5.4 Waste Water Treatment System Flow Sheet



④ Domestic waste water

After being discharged into the stabilization tank, the waste water is fed into a contact aeration tank, where organic material and remaining N-NH_3 are oxidized and NH_3 is changed to NO_3.

Moreover, in cases where the domestic waste water contains much SS or oil, it is necessary to provide a screen and oil-water separator respectively before the stabilization tank.

⑤ Painting booth waste water

After the waste water is passed through a screen, where impurities are removed, it is stored in a stabilization tank. A set amount of waste water is fed into a coagulation tank by storage pump, PAC or $Al_2(SO_4)_3$ are added to coagulate it, and high-polymer coagulant is then added to form flock. Next, the waste water is led into a pressurized air floatation tank where the flock is floatation separated and is then fed into the domestic waste water stabilization tank.

4.5.4 Pretreatment for Reduction of the Pollution Load

Measurements of the volume and quality of waste water were made during the follow-up survey. Based on the data that was obtained, a pretreatment system for reducing the pollution load for the case of WWTP discharge was examined.

1) Results of follow-up survey

A follow-up survey was carried out on the volume and quality of waste water.

Of the four outlets (1099, 1079, 372, 769) used for discharging total waste water, the flow of waste water was measured at two (372, 769) and the measurement results are shown in Fig. 4.5.5.

The quality levels of the sampled individual types of waste water and total waste water are shown in Table 4.5.6. High concentrations were measured in the waste water discharged from outlet 1099. Judging from the waste water discharge characteristics and the measured quality data, it is thought that these high concentrations were caused by the discharge of waste water from the painting booths just at the time of sampling, in addition to the waste water that is discharged from all the outlets at normal times.

Fig. 4.5.5 Results of Waste Water Flow Measurement (372)

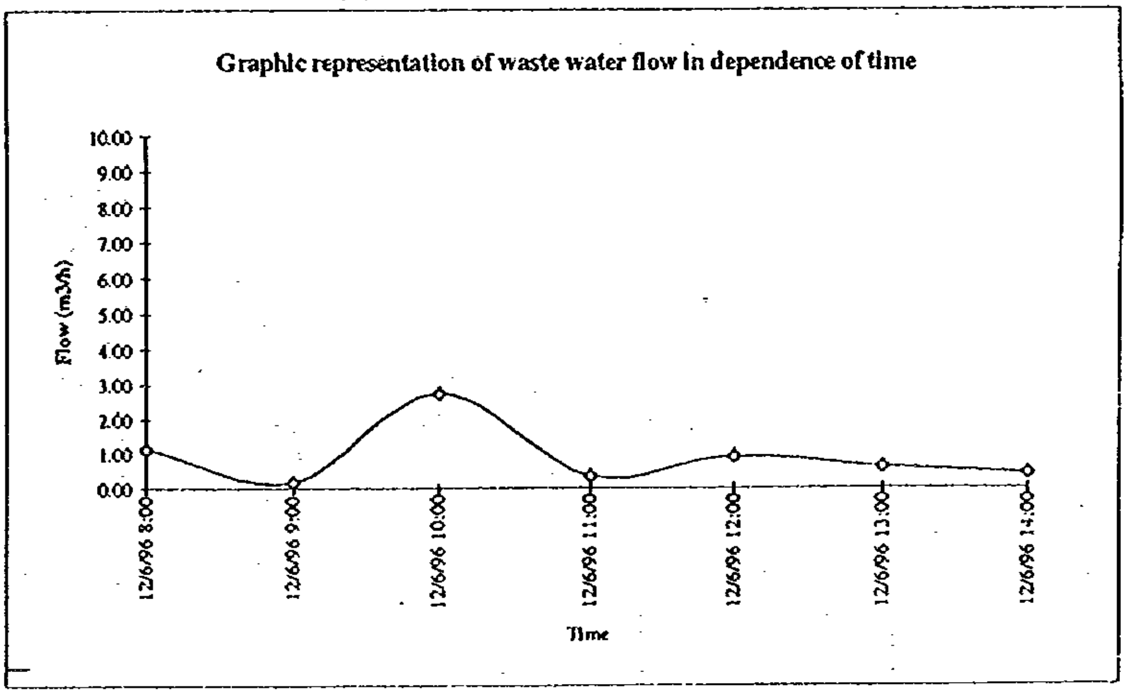


Fig. 4.5.5 Results of Waste Water Flow Measurement (769)

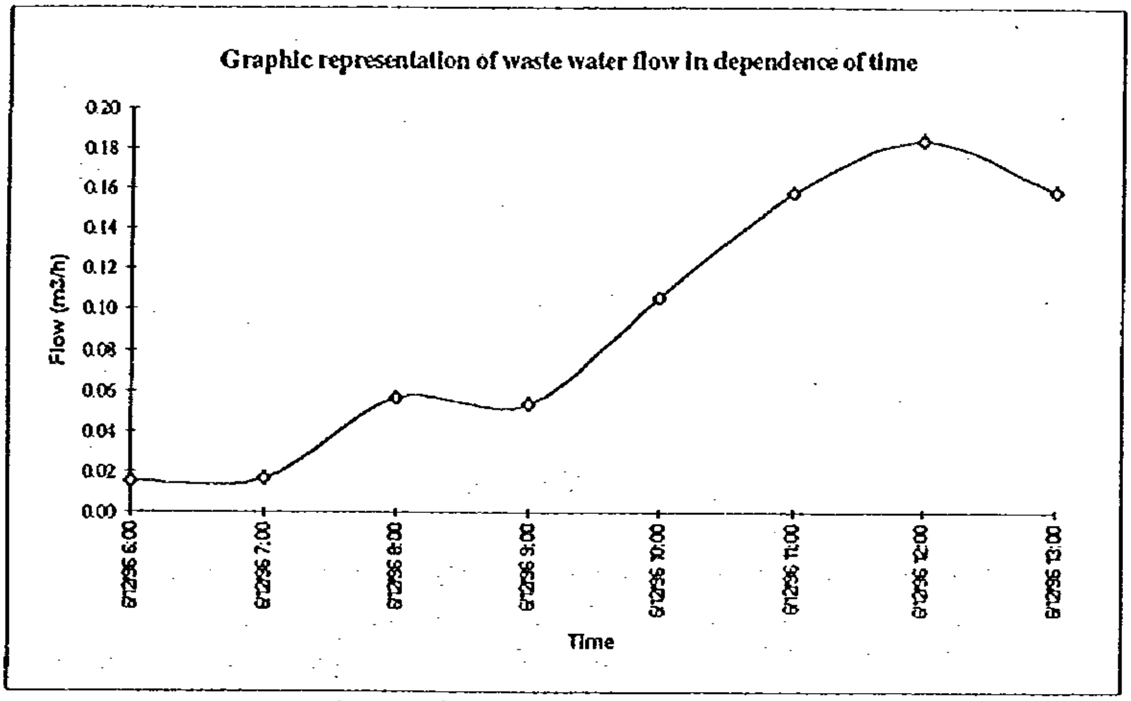


Table 4.5.6 Quality of Individual Waste Water Types and Total Waste Water

Items \ Name of Sample \ No.	1	2	3	4	5	6	7
	Effluent (1099)	Effluent (1079)	Effluent (372)	Effluent (769)	Plasmacut ECCE	Plasmacut Palfiger	Varnishing
pH (−)	7.9	8.2	8.6	8.0	8.7	8.5	8.7
COD_{Cr} (mg/ℓ)	1,600	84	300	85	19	77	1,800
COD_{Mn} (mg/ℓ)	550	30	54	30	15	32	750
BOD (mg/ℓ)	1,200	<5	50	<5	<5	<5	300
SS (mg/ℓ)	940	35	170	<30	80	<30	85
Oil / Fat (mg/ℓ)	26	<5	150	<5	8	11	5
T-P (mg/ℓ)	1.5	2.8	3.3	1.8	0.9	<0.5	4.7
T-N (mg/ℓ)	54	26.4	82	39.6	29.3	50.5	19.9
Surfactants (mg/ℓ)	3.1	1.1	4.6	5.3	−	−	1.4
LKCH* (mg/ℓ)	−	−	−	−	−	−	<0.01
BTX* (mg/ℓ)	−	−	−	−	−	−	0.65
AOX* (mg/ℓ)	−	−	−	−	−	−	0.44

(Note) * : Expression as Cℓ

2) Pretreatment system

(1) Selection of pretreatment system

As was indicated in 4.5.3, the main sources of waste water in this factory are plasma cut cooling water, painting pre-washing waste water, and painting booth washing waste water. Because the frequency of generation of these waste water types is extremely low, it is necessary to carry out treatment only at the discharge times. As a result of the waste water quality measurements carried out in the follow-up survey, it was found that the only waste water requiring pretreatment was that from the painting booths washing. Therefore, examination of the pretreatment system shall be limited to one that targets the waste water generated in the painting booths washing.

(2) Outline of the pretreatment system

Waste water from the painting booths washing is carried out in batches. After being discharged into a waste water receiving tank, the waste water is then fed into a reaction tank by storage pump. Here, a set amount of $Al_2(SO_4)^3$ is added and, moreover, NaOH is added under control by a pH meter installed in the tank in order to neutralize the water. Next, anionic high polymer coagulant is added to form floc, and this completes the coagulation process. Following that, the floc is left to separate by sedimentation. After more anionic high polymer coagulant has been added to the sludge sediment, the sludge is dehydrated in a dehydrator, and the resulting dehydrated cake is then carried out to the landfill for final disposal.

(3) Design conditions

a. Quality of waste water

The quality of waste water from the painting booths washing is laid down in Table 4.5.7.

Table 4.5.7 Quality of Waste Water from Painting and Rinsing Booths

pH	(−)	8.7
COD_{Cr}	(mg/ℓ)	1,800
COD_{Mn}	(mg/ℓ)	750
BOD	(mg/ℓ)	300
SS	(mg/ℓ)	85
Oil / Fat	(mg/ℓ)	5
T-P	(mg/ℓ)	5
T-N	(mg/ℓ)	20

b. Volume of treated water

10 m^3 of water is treated each time the treatment is carried out.

c. Waste water inflow time

8 hours/day

d. Operating time

8 hours/day

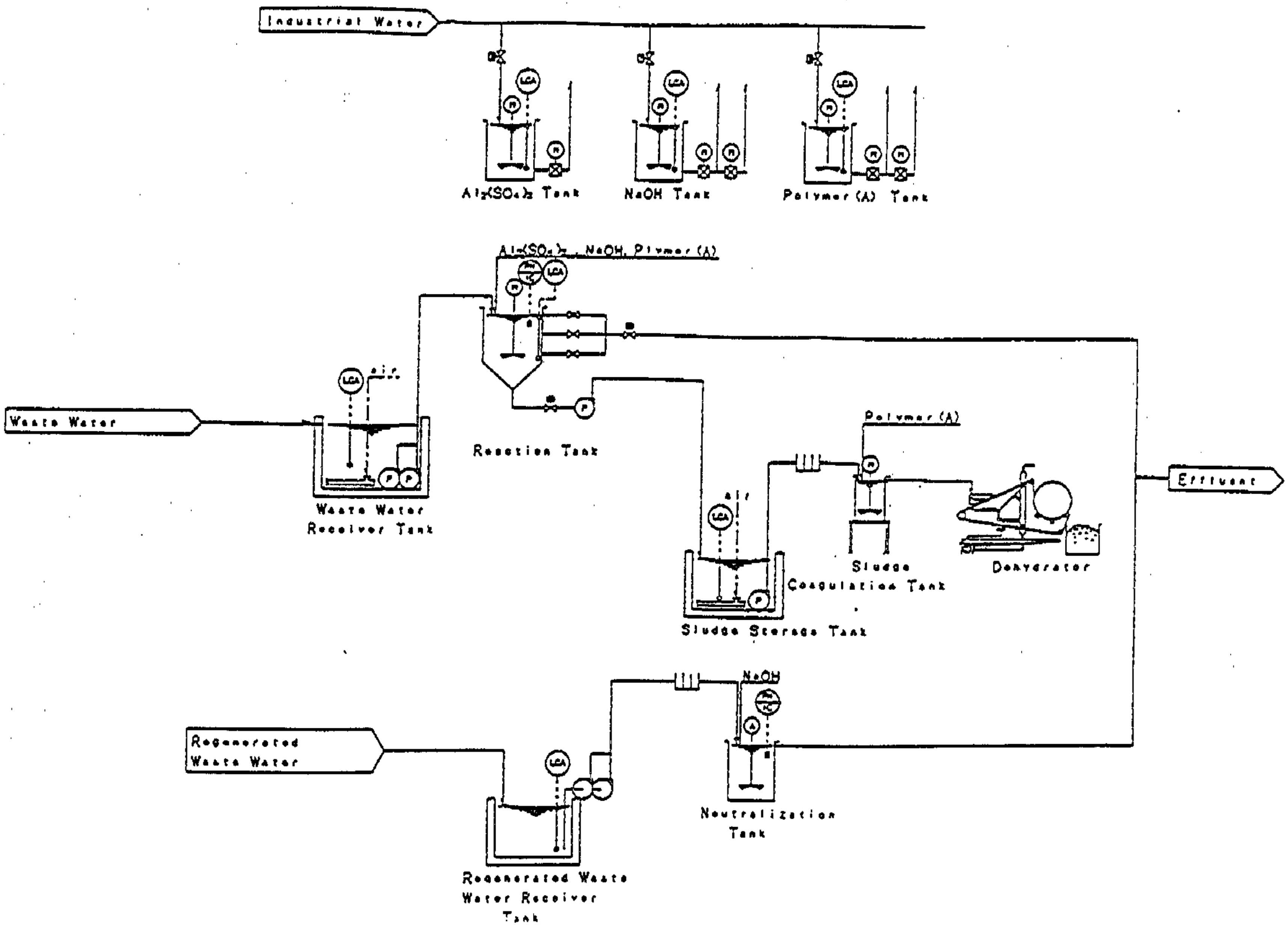
e. Quality of treated water

WWTP discharge standards

(4) Flow sheet

The flow sheet of the pretreatment system is shown in Fig. 4.5.6.

Fig. 4.5.6 Pretreatment System Flow Sheet



3) Results of examination

(1) Technical comment

The volumes, quality and pollution loads of the total waste water, painting booth washing waste water and treated water are shown in Table 4.5.8.
It is considered that, by carrying out pretreatment, it would be possible to achieve an organic substance removal rate of 20% in the painting booth washing waste water, thus enabling almost all organic solvents to be removed and biodegradability to be attained.

Table 4.5.8 Volumes, Quality and Pollution Loads of Waste Water

Kind of Waste Water	Case	Quantity m³/d	pH	COD_{cr} mg/ℓ (kg/d)	BOD mg/ℓ (kg/d)	SS mg/ℓ (kg/d)	T-N mg/ℓ (kg/d)	T-P mg/ℓ (kg/d)
Varnishing	Raw Waste Water (1)	10	8.7	1,440 (14.4)	300 (3)	85 (0.85)	20 (0.2)	5 (0.05)
	Pre-Treatment (2)	10	7	1,152 (10.5)	240 (2.4)	30 (0.3)	20 (0.2)	5 (0.05)
Total Waste Water	Raw Waste Water (3)	212	8.2	85 (18.0)	50 (10.6)	30 (6.36)	30 (6.36)	2 (0.42)
	Raw Waste Water(1+3)	222	7	146 (32.4)	62 (13.6)	32 (7.21)	30 (6.56)	2 (0.47)
	Pre-Treatment(2+3)	222	7	128 (28.5)	59 (13.0)	30 (6.66)	30 (6.56)	2 (0.47)

(2) Economic comment

The equipment and running costs that would be incurred by the treatment system are shown in Table 4.5.9.

Table 4.5.9 Equipment and Running Costs of the Treatment System

		Equipment Cost SIT	Depreciation & Interest SIT/m³ ①	Running Cost SIT/m³ ②	Total Treatment Cost SIT/m³ ①+②
Pretreatment	Case-1	24,000,000	52	43	95

4) Conclusion

Judging from the water quality measurements, there is no need to install a pretreatment system for general waste water. However, in the case of waste water generated in the painting booths washing, it would be desirable to perform pretreatment before discharging to the WWTP.

4.6 S-6 MERKATOR-SLOSAD, d.d.

4.6.1 Factory Outline

1) Outline

Merkator-Slosad d.d. is a manufacturer of natural fruit juices, fruit soft drinks, sarcocarp drinks, fruit syrups, cherries soaked in alcohol and frozen fruits, etc. Its raw materials include strawberries, apples, cherries, and so on. The factory possesses freezer equipment that enables it to operate throughout the year, however, production of cherry juice reaches a peak in the first three weeks of June and production of apple juice reaches a peak between September and November.

2) Volume of water usage by water source and purpose of use

The volumes of water usage by water source and purpose of use are indicated in Table 4.6.1.

Table 4.6.1 Volume of Water Usage by Water Source and Purpose of Use

(m^3/day)

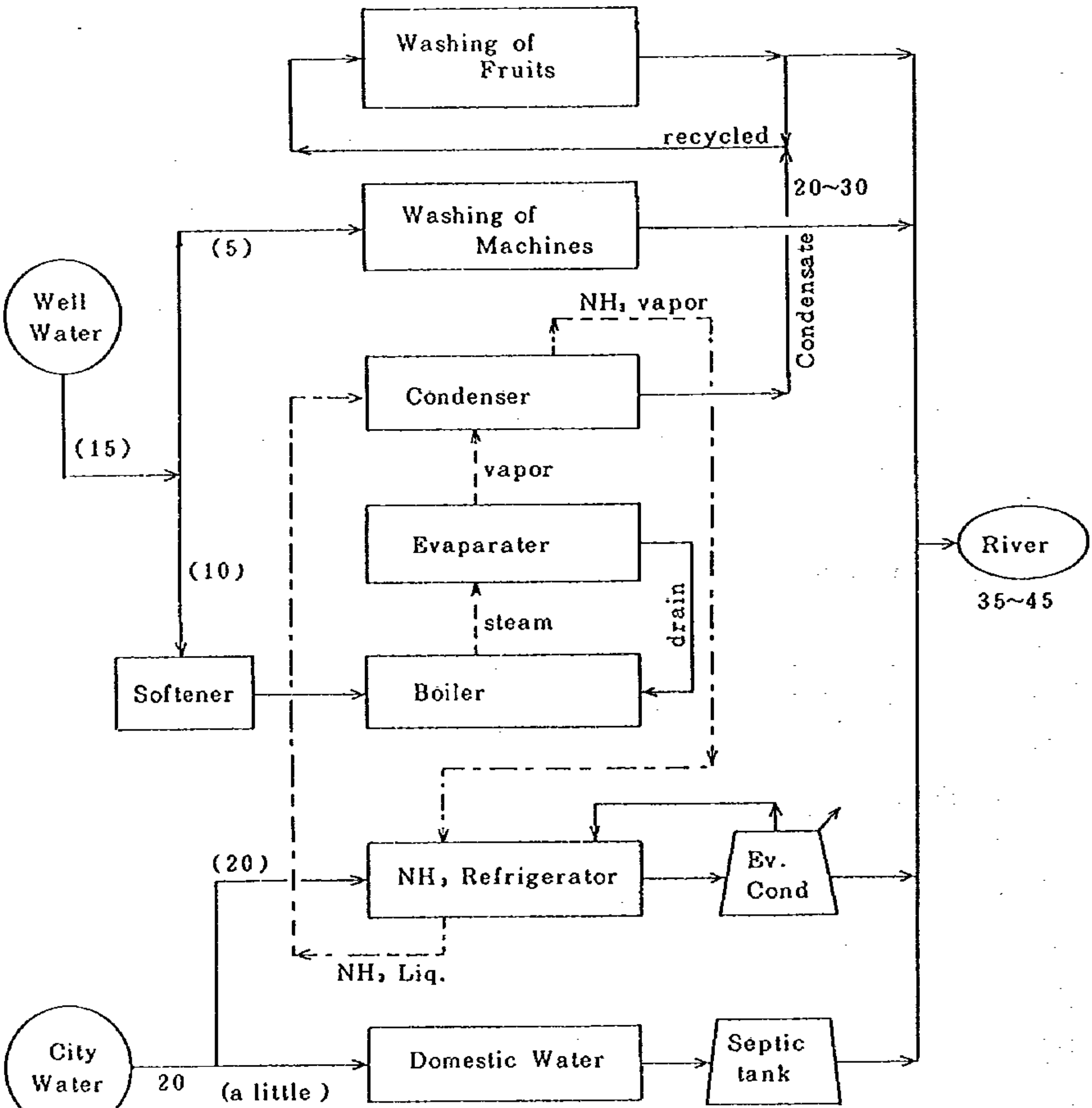
Use \ Source	Well Water	City Water	River Water	Sub-Total	Recovered Water	Total
Boiler Feed	(10)			(10)		(10)
Raw Material	-					
Washing	(5)			(5)		(5)
Cooling		(20)		(20)		(20)
Air Conditioning						
Miscellaneous						
Total	15	20		35		35
				Recovered Water/Total		%

Note: Figures in parentheses are estimates.

3) Water supply and waste water discharge flow diagrams

The balance of water at the factory is indicated in Fig. 4.6.1.

Fig. 4.6.1 Water Balance at the Factory (m³／day)



Note : a) The figure in parenthesis is estimated value.

b) Ev. Cond. is Evaporated Condenser.

(1) Water supply facilities

The factory grounds contain wells, and well water accounts for 60% of the overall water usage and is used for cooling in the manufacturing processes. The remaining 40% is city water and is used as potable water. Steam condensate generated in the juice thickening process is reused as water for washing raw fruit.

(2) Manufacturing processes and sources of waste water

The major manufacturing processes are indicated in Fig. 4.6.2.

In subsequent processes where fruit syrup is made, pectin and concentrated juices are also manufactured.

① Washing

In this process, raw fruit that has been delivered to the factory is washed. The water used here is recycled for repeated use, and steam condensate obtained in the fruit thickening process is also utilized. Waste water from washing is generated here.

② Crushing

As well as obtaining some of the juice from crushing the raw fruit, this process also serves as pre-treatment for the next process of obtaining all the juice. The crushers are washed after the completion of work here, however, because the water is cascade used in the following pressing process, no waste water is generated here.

③ Pressing

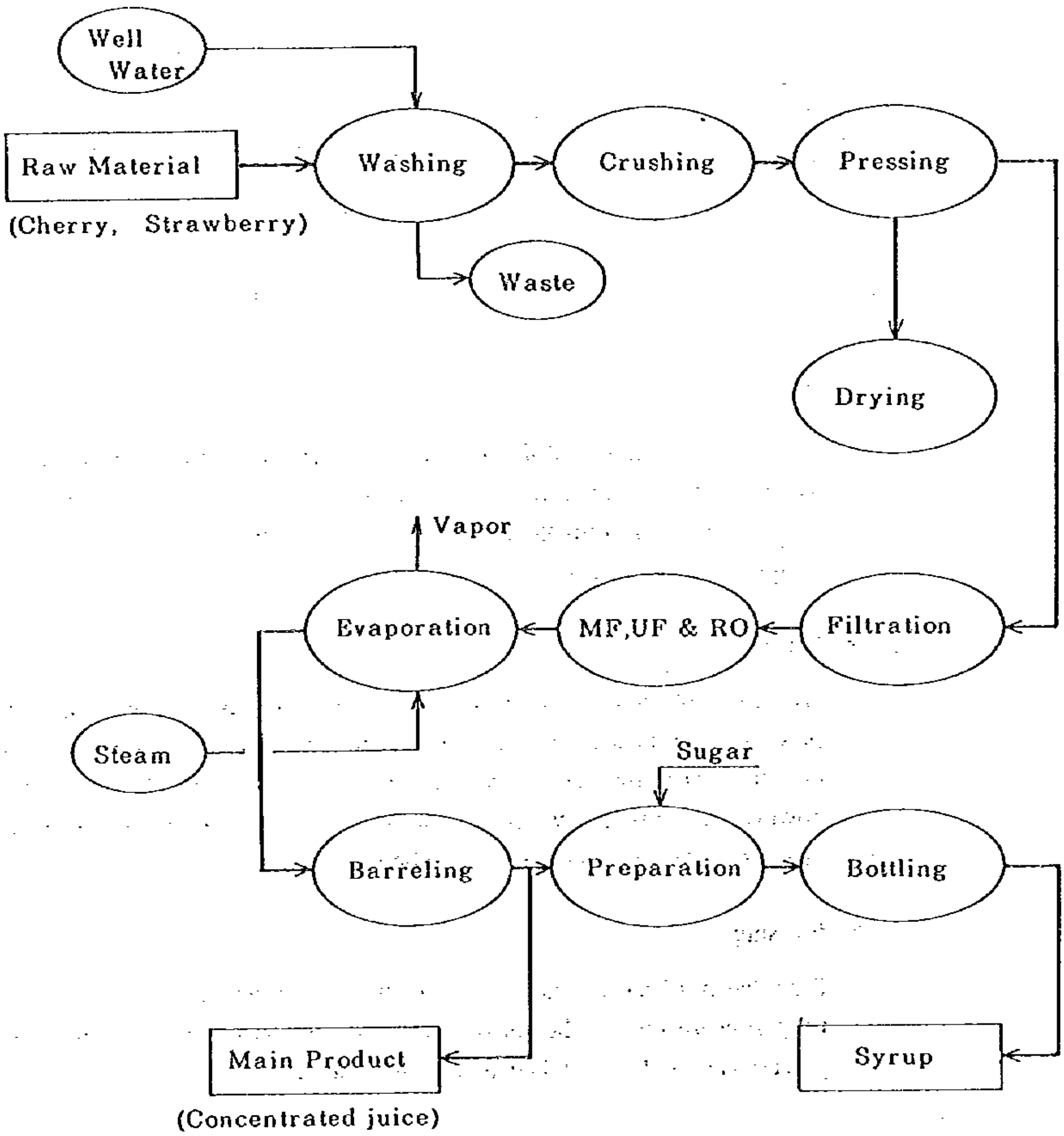
Fruit that has been crushed in the crushers is further pressurized here to fully squeeze out all the juice. The washing water from the previous process is reused here and becomes waste water.

Citrus fruit skins and pectin contained in apple juice are separated here, dried and shipped as products.

④ Filtration

Juice that has been obtained from the pressing process is stored and then undergoes filtration in order to remove solids. Here, waste water is generated from washing of the storage tank and filtration equipment.

Fig. 4.6.2 Manufacturing Processes



Note : a) MF ········ Micro-Filter
b) UF ········ Ultra-Filter
c) RO ········ Reverse Osmosis Membrane

⑤ Sterilization

In this process, the fruit juice is sterilized in a plate sterilizer. After sterilization, it is stored in a holding tank. Here, waste water is generated from washing of the sterilizer and holding tank.

⑥ Membrane filtration and thickening

In this process, concentrated fruit juice is manufactured. The juice stored in the holding tank is concentrated through a process of membrane filtration that consists of the following.

Fruit juice→(MF)→(UF)→(RO)→Concentrated fruit juice

Here, waste water is generated in the form of water extracted from each filter and from washing.

⑦ Evaporation

The concentrated fruit juice from the membrane filtration process is further concentrated by means of multiple-effect evaporator. Here, waste water is generated in the form of steam condensate from the multiple-effect evaporator of washing water of the evaporator. The steam condensate is reused to wash raw fruit.

⑧ Storage

The concentrated fruit juice is stored in storage tanks. Some of the juice is put into containers, packaged and shipped in the form of products.

⑨ Fruit syrup preparation

In this process, liquid sugar is added to the concentrated fruit juice to make fruit syrup. The syrup is put into containers and shipped in the form of products.

Cherries that have been soaked in alcohol are processed in the next process. Here, waste water is generated from washing once per week.

Cherries→(Soaking in alcohol)→(Sorting)→(Seed removal)→Products

(3) Waste water treatment plant

A waste water treatment plant is not in place.

4) Quality of make-up water and waste water

(1) Quality of make-up water

The forecast quality of make-up water is shown in Table 4.6.2.

Table 4.6.2 Quality of Make-up Water

Items \ Name of Sample		City Water	Well Water
Temp.	(℃)	15	—
pH	(−)	7.5	—
COD_{cr}	(mg/ℓ)	1.5	—
T-Hardness*	(°dH)	12.4	15.0
Cℓ	(mg/ℓ)	8	—
T-Fe	(mg/ℓ)	< 0.05	—

(NOTE) * : mmol/ℓ as CaO

(2) Quality of waste water

As the detailed volume and quality of waste water are unclear, the case of a soft drinks maker in Japan is given as an example below.

a. Characteristics of waste water discharge

The waste water discharged can be divided into equipment washing waste water, bottle washing waste water, bottle washing warm waste water, product cooling waste water, floor washing waste water and miscellaneous waste water, etc. (The factory in question does not have a bottle washing process). Domestic waste water is also generated by the work force of 90.

The volume of waste water overall shows no major fluctuations except for a fall during the one-hour lunch break. The BOD level remains low at around 200mg/l at the start of operations in the morning and during the lunch break, it gradually increases as the day's operations go on, and then jumps dramatically to between 900 and 1, 400mg/l roughly one hour before the end of operations. Washing of the manufacturing equipment takes place at this time.

b. Quality of waste water

Table 4.6.3 shows an example of the quality of waste water from manufacturing equipment washing. In this case, the washing is divided into two stages: preliminary rough washing and finish washing. In the first stage, highly concentrated waste water containing pieces of raw materials is discharged.

Table 4.6.3 Example of the Quality of Waste Water from Manufacturing Equipment Washing

Item	Name of sample	Waste water volume		BOD	
	m^3/day	%	kg/day	%	
1	Stabilization tank pre-washing	0.8	6.7	5.60	26.3
2	Stabilization tank finish washing	5.4	45.0	3.24	15.2
3	Centrifuge pre-washing	0.06	0.5	9.00	42.3
4	Stabilization tank finish washing	0.33	2.8	0.45	2.1
5	Holding tank pre-washing	0.09	0.8	1.17	5.5
6	Filling and capping machine pre-washing	0.03	0.3	1.47	6.9
7	Consecutive finish washing of 5 and 6	0.71	5.9	0.37	1.7
	Total	12.0	100.0	21.30	100.0

Source) Small Enterprise Waste Water Treatment Countermeasures, Pollution Countermeasure Technology Association (1989 (edited by the Environment Agency, Water Quality Preservation Departments))

4.6.2 Water Conservation

(1) Features of water usage

① The factory relies on city water and well water as its water sources. The amount of city water used is measured, but the well water is not, and the figures given on the questionnaire were estimated based on production volumes. The volumes used of each source are extremely small.

② Well water is used in boilers and for the washing of equipment. Because the quality of the well water is low, it cannot be used as potable water. Furthermore, the amount of well water that can be lifted is limited and it would be difficult to increase the current volume.

③ Water from the city water is mainly used as cooling water in refrigerator, and some is used for domestic purposes.

(2) Current condition of water conservation

① Condensate water which is generated in the concentration process of fruit juice is used to wash the raw materials. Moreover, much of this washing water is recycled.

② Cooling water for the refrigerator is recycled by the evaporative condenser.

(3) Comment

Because water conservation is already being practiced to a satisfactory degree and only very small volumes of water are being used, there is no room to carry out further water saving.

4.6.3 Pretreatment that Satisfy WWTP Discharge Standards, and Waste Water Treatment

1) Current condition of waste water

Waste water can broadly be divided into washing waste water from the manufacturing processes, domestic waste water and other miscellaneous waste water.

a. Waste water that requires treatment

① Washing waste water

The waste water is discharged from various items of manufacturing equipment, but only in small quantities. Also, because of the fruits used and the production lines adopted, the waste water is generated at irregular intervals.

② Domestic waste water

Domestic waste water is continuously generated, however, septic tanks are in place.

③ Other waste water

Other waste water includes regenerated waste water from softening equipment and that from the washing of membrane filtration.

b. Waste water that requires no treatment

① Freezer cooling water

2) Quality of treated water

The water quality standards for the case of river discharge and the case of WWTP discharge are shown in Table 4.6.4

3) Pre-treatment system

(1) Basis for system selection

If regenerated waste water from softening equipment and waste water from filtration membrane washing is discharged without any treatment, there is a danger that the pH level of waste water overall will exceed the discharge standard. It is, therefore, necessary to neutralize the waste water.

(2) Outline of the pre-treatment system

The pretreatment system is shown in Fig. 4.6.3.
Regenerated waste water from softening equipment and waste water from membrane washing is discharged into a stabilization tank. From there, it is guided into a neutralization tank by storage pump, the pH level is neutralized by adding NaOH under control from a pH meter placed in the tank, and the treated water is then discharged into the WWTP.

Fig. 4.6.3 Pretreatment System Flow Sheet

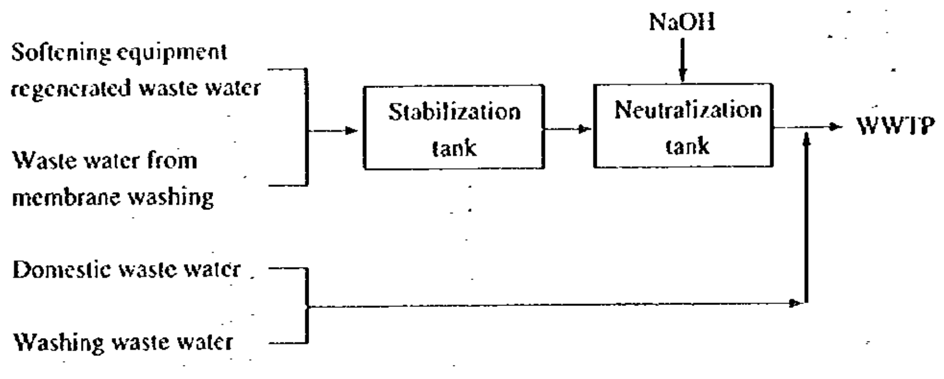


Table 4.6.4 Discharged Water Quality Standards

	Item	unit	River	Sewage
1	Temperature	℃	30	40
2	pH	—	6.5--9.0	6.5--9.5
3	SS	mg/l	80	(a)
4	SV^{30}	m/	0.5	10
5	SAK(Color unit)			
	436nm	m^{-1}	7.0	
	525nm	m^{-1}	5.0	(b)
	620nm	m^{-1}	3.0	
6	Toxicity test (SD)	mg/l	3	—
7	Biodegradation	%	—	(c)
8	B	mg/l	1.0	10.0
9	A	mg/l	3.0	(d)
10	As	mg/l	0.1	0.1
11	Cu	mg/l	0.5	0.5
12	Ba	mg/l	5.0	5.0
13	Zn	mg/l	2.0	2.0
14	Cd	mg/l	0.1	0.1
15	Co	mg/l	1.0	1.0
16	Sn	mg/l	2.0	2.0
17	T-Cr	mg/l	0.5	0.5
18	Cr^{6+}	mg/l	0.1	0.1
19	Ni	mg/l	0.5	0.5
20	Ag	mg/l	0.1	0.1
21	Pb	mg/l	0.5	0.5
22	Fe	mg/l	2.0	(d)
23	Hg	mg/l	0.01	0.01
24	Cl_2(Free chlorine)	mg/l	0.2	0.5
25	Cl_2(Total effective chlorine)	mg/l	0.5	1.0
26	$N\text{-}NH_3$	mg/l	10	(e)
27	$N\text{-}NO_2$	mg/l	1.0	10
28	$N\text{-}NO_3$	mg/l	(f)	—
29	T-CN	mg/l	0.5	10
30	Free CN	mg/l	0.1	0.1
31	F	mg/l	10	20
32	Cl^-	mg/l	(g)	—
33	T-P	mg/l	2.0(1.0(h))	—
34	SO_4	mg/l	(f)	300
35	S	mg/l	0.1	1.0
36	SO_3	mg/l	1.0	10
37	TOC	mg/l	30	—
38	COD_{Cr}	mg/l	120	—
39	BOD_5	mg/l	25	—
40	Total oil	mg/l	20	100
41	THC	mg/l	10	20
42	Aromatic organic chlorine	mg/l	0.1	1.0
43	Absorbent organic chlorine	mg/l	0.5	0.5
44	Volatile organic chlorine	mg/l	0.1	0.1
45	Water soluble organic chlorine	mg/l	(k)	(l)
46	Phenol	mg/l	0.1	10
47	Surfactant active agent	mg/l	1.0	—

4) Waste water treatment system

(1) Basis for system selection

In the waste water that has received pretreatment, organic matter still remains. Organic matter is also contained in the domestic waste water that receives no pretreatment. Thus, in order to obtain a satisfactory standard of discharge water quality, it is necessary both pre-treat this waste water and also carry out treatment of the contained organic matter.

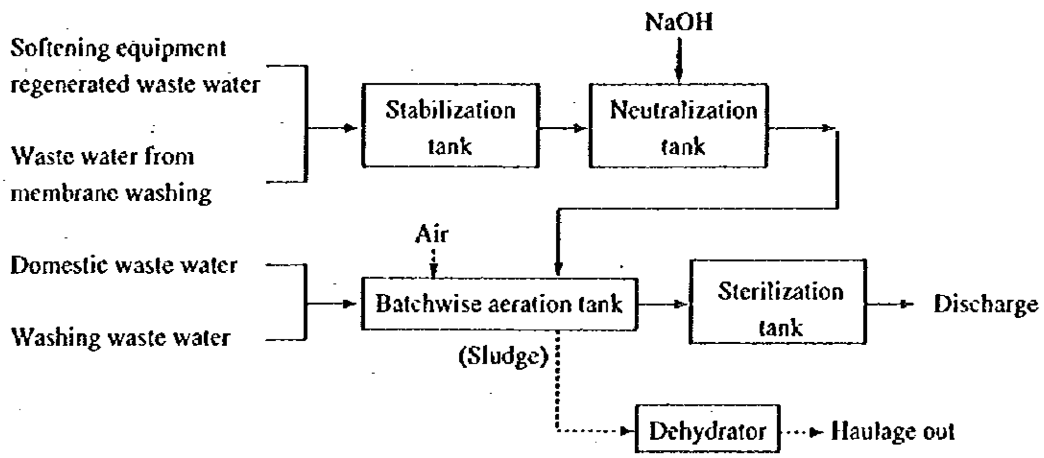
Biological treatment is generally adopted in order to treat organic matter. Because domestic waste water contains ample quantities of nitrogen and phosphorous necessary for biological treatment and such waste water is continuously discharged during factory operation, pre-treated waste water shall be mixed with domestic waste water and treated simultaneously.

Because washing waste water is discharged irregularly in small amounts, a sequencing batch activated sludge method is adopted. Because this method does not require a stabilization tank or sedimentation tank and is effective in removing nitrogen and phosphorous, it is widely adopted for waste water treatment by small and medium enterprises. In this method, waste water is discharged into an aeration tank during factory operating time, and then undergoes aeration, sedimentation and final discharge during the night when no more waste water is generated.

(2) Outline of the waste water treatment system

The waste water treatment system is shown in Fig. 4.6.4.

Fig. 4.6.4 Waste Water Treatment System



① Domestic waste water

The waste water is directly discharged into an aeration tank. The processes of waste water inflow, aeration, sedimentation and discharge are then repeated in that order over a 24 hour cycle, in order to complete the waste water treatment.

② Other waste water

Regenerated waste water from softening equipment and waste water from membrane filtration washing is discharged into a stabilization tank. From there, it is guided into a neutralization tank by storage pump, the pH level is neutralized by adding NaOH under control from a pH meter placed in the tank, and the treated water is then discharged into the aeration tank.

4.6.4 Pretreatment for Reduction of the Pollution Load

The total volume of waste water generated by this factory is extremely small at 35-45 m^3/d, and 20 m3/d of that is accounted for by domestic waste water. Furthermore, because waste water generated in the manufacture of soft drink contains no harmful substances that may detrimentally affect the WWTP, there is no need to introduce a pretreatment system.

In the follow-up survey, waste water discharged and stored during the peak production season was sampled and the water quality was measured. Based on the obtained data, a pretreatment system suited to a small-scale, seasonal industry shall be introduced.

1) Results of waste water quality measurement

Currently, the waste water is stored in two waste water storage tanks, where it is mixed with the domestic waste water, etc. and equarized before being discharged. The quality of the waste water in the two storage tanks on which sampling was performed is shown in Table 4.6.5.

Table 4.6.5 Quality of Waste Water

Items \ Name of Sample		No. 1 Tank-1 (Juice)	No. 2 Tank-2 (Cherry)
pH	(−)	4.4	6.7
COD_{Cr}	(mg/ℓ)	7,000	1,600
COD_{Mn}	(mg/ℓ)	3,200	630
BOD	(mg/ℓ)	2,500	250
SS	(mg/ℓ)	850	80
Oil / Fat	(mg/ℓ)	13	< 5
T-P	(mg/ℓ)	10	0.3
T-N	(mg/ℓ)	141	11.6
Suefactants	(mg/ℓ)	1.6	< 0.05

2) Pretreatment system

(1) Selection of the pretreatment system

This factory uses fruit as raw materials in the production of soft drinks. The factory possesses freezer facilities, however, the contents and condition of operation differ according to the season, and the generation of waste water is concentrated around the peak production time. Because the factory is a foodstuffs manufacturer, the waste water contains no harmful substances (except for pH) that may have a detrimental impact on the WWTP, and the basic nature of the waste water is biodegradable. Consequently, the main purpose of a pretreatment system would be to reduce the pollution load of organic substances.

A pretreatment system of neutralization that satisfies the WWTP discharge standards shall be assumed as Case 1.

The waste water discharge characteristics are unique to a seasonal industry; that is to say that large volumes are discharged during the peak production season and small volumes are discharged during the off-peak season. It is thus necessary for the pretreatment system to have operating and non-operating periods, yet nevertheless to be easily operable. For this reason, the

UASB method of anaerobic biological treatment shall be selected for consideration as Case 2.

(2) Outline of pretreatment system

a. Case 1

In this case, all the waste water stored in the two storage tanks is mixed together for joint treatment. The waste water, which is fed into the pretreatment system from the storage tanks by transfer pump, is screened to remove impurities and then stored in a pump pit. From the pump pit, the waste water is fed into a neutralization tank where it undergoes neutralization before being discharged.

b. Case 2

Following the neutralization described in Case 1, the waste water is stored in an equarization tank where it undergoes acid fermentation. Next, the waste water is fed into the UASB reactor where it undergoes methane fermentation before finally being discharged to the WWTP.

(3) Design conditions

a. Quality of waste water

Waste water from the manufacturing process is mixed and stored together with domestic waste water before being discharged. For this reason, the average quality of the target waste water is as prescribed in Table 4.6.6.

b. Volume of treated water

40 m^3/d

c. Waste water inflow time

The inflow time during the peak production season is 24 hours/d.

d. Operating time

24 hours/d (however, the neutralization system is 8 hours/d)

e. Quality of treated water

The organic substance removal rate shall be assumed to be 50%.

Table 4.6.6 Quality of Waste Water

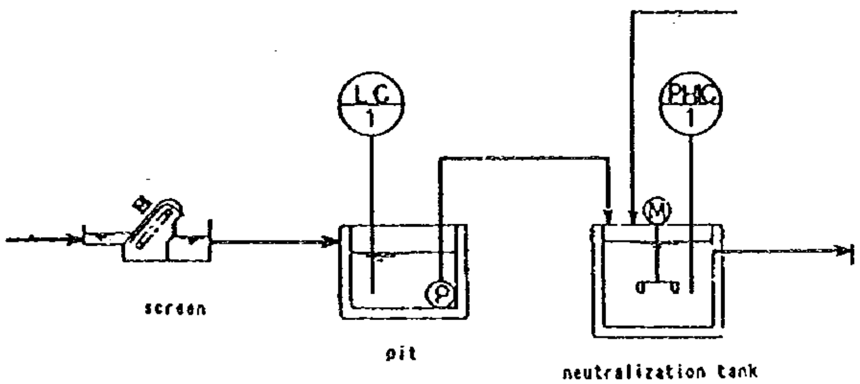
pH	(--)	5
COD_{cr}	(mg/ℓ)	4,300
COD_{Mn}	(mg/ℓ)	2,000
BOD	(mg/ℓ)	1,400
SS	(mg/ℓ)	500
Oil / Fat	(mg/ℓ)	10
T-P	(mg/ℓ)	5
T-N	(mg/ℓ)	50
Suefactants	(mg/ℓ)	1

(4) Flow sheet

a. Case 1

The flow sheet of the Case 1 pretreatment system is shown in Fig. 4.6.5.

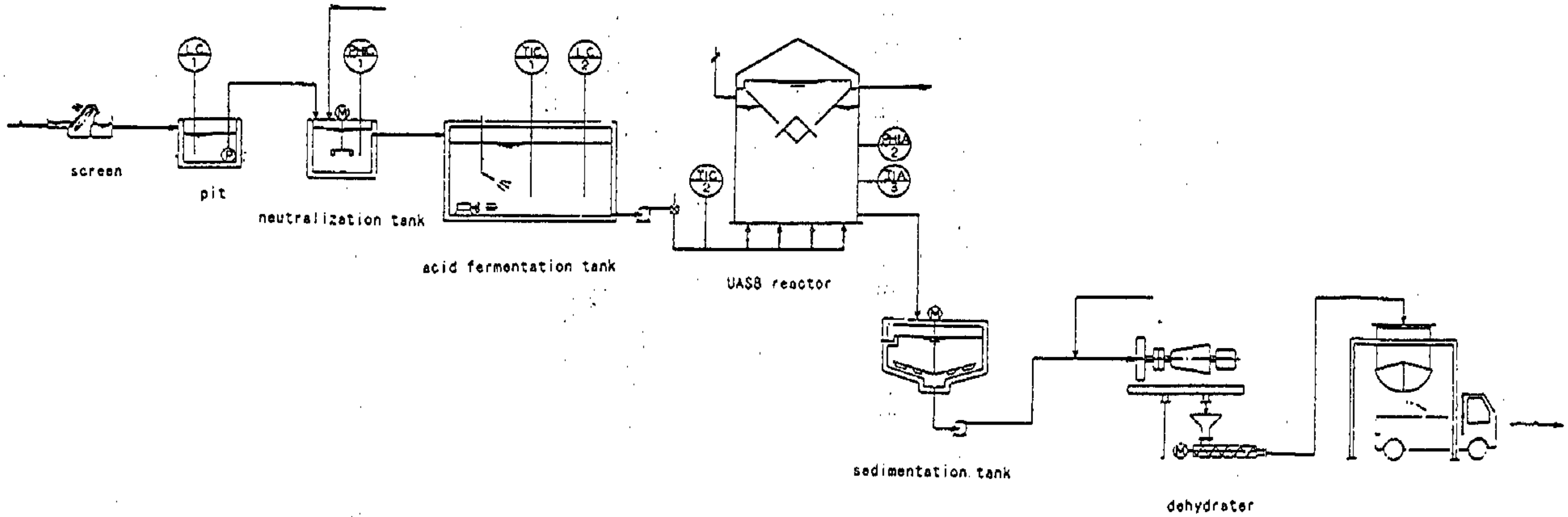
Fig. 4.6.5 Case 1 Pretreatment System Flow Sheet



b. Case 2

The flow sheet of the Case 2 pretreatment system is shown in Fig. 4.6.6.

Fig. 4.6.6 Case 1 Pretreatment System Flow Sheet



3) Results of examination

(1) Technical comment

The quality, volumes and pollution loads of the waste water and treated water are shown in Table 4.6.7.

The anaerobic pretreatment system, which does not involve the heating of waste water, has been proposed. This is because, as a pretreatment process, the organic substance removal rate can amply be achieved at around 50% operation.

Table 4.6.7 Volumes, Quality and Pollution Loads of Waste Water and Treated Water

Kind of Waste Water	Case	Quantity m³/d	pH	CODcr mg/ℓ (kg/d)	BOD mg/ℓ (kg/d)	SS mg/ℓ (kg/d)	T-N mg/ℓ (kg/d)	T-P mg/ℓ (kg/d)
	Raw Waste Water	40	5	4,300 (172)	1,400 (56)	500 (20)	50 (2)	5 (0.2)
Pre-treatment	Case-1	40	7	4,300 (172)	1,400 (56)	500 (20)	50 (2)	5 (0.2)
	Case-2	40	7	2,150 (86)	700 (28)	250 (10)	15 (0.6)	2 (0.08)

(2) Economic comment

The equipment and running costs of the treatment system are shown in Table 4.6.8.

Table 4.6.8 Equipment and Running Costs of the Treatment System

		Equipment Cost SIT	Depreciation & Interest SIT/m³ ①	Running Cost SIT/m³ ②	Total Treatment Cost SIT/m³ ①+②
Pretreatment	Case-1	1,500,000	13	10	23
	Case-2	12,000,000	125	15	140

4) Conclusion

There is no need to install a pretreatment system.

Because the waste water does not contain any harmful substances, there is room to examine a pretreatment system that reduces the pollution load of organic substances. In the future, if the WWTP discharge standards are reviewed or a system of charges according to the pollution load is adopted, it would be possible to improve the pollution load removal rate by adding facilities step by step to the Case 2 system.

4.7 S-7 INTES MLIN TESTENINE

4.7.1 Factory Outline

1) Outline

Intes Mlin Testenine was established in Slovenia 130 years ago and is currently the second largest milling factory in the country. In the past, it made all conceivable products from flour milled from wheat and it had a work force of 1,000, however, the bread factory was made into a separate company five years ago and the work force fell to 400. The work force has since fallen to 180.

The factory's 54,000 ton silo contains 2,200 tons of domestically produced wheat and it mills 150 tons of wheat flour, 24 tons of corn starch and also rye, etc. every day.

The factory started pasta manufacturing 110 years ago and it possesses a production capacity of 4,500 tons. The current production is 3,000 tons and all sorts of pasta products are made.

2) Volume of water usage by water source and purpose of use (m^3/day)

The volume of water usage by water source and purpose of use is indicated in Table 4.7.1.

Table 4.7.1 Volume of Water Usage by Water Source and Purpose of Use

(m^3/day)

Use \ Source	Well Water	City Water	River Water	Sub-Total	Recovered Water	Total
Boiler Feed		36		36		36
Raw Material		39		39		39
Washing		11		11		11
Cooling		21		21		21
Air Conditioning						
Miscellaneous		55		55		55
Total		162		162		162
				Recovered Water/Total		%

Note : Figures in parentheses are estimates.

3) Water supply and waste water discharge flow diagrams

The balance of water at the factory is indicated in Fig. 4.7.1.

(1) Water supply facilities

The factory relies totally on city water as its water source.

(2) Manufacturing processes and sources of waste water

The major manufacturing processes are indicated in Fig. 4.7.2.

Water is not used in the milling process. Moreover, because dried pasta products are produced, only small amounts of waste water are generated.

a. Milling (Wheat flour)

① Drying

In this process, wheat is dried until its water content falls to 12%. No waste water is generated here.

② Classification and storage

In this process, dried wheat is classified according to quality and stored in the silo. No waste water is generated here.

③ Humidification

In this process, the wheat in the silo is humidified until its water content rises to 16%. No waste water is generated here.

④ Milling

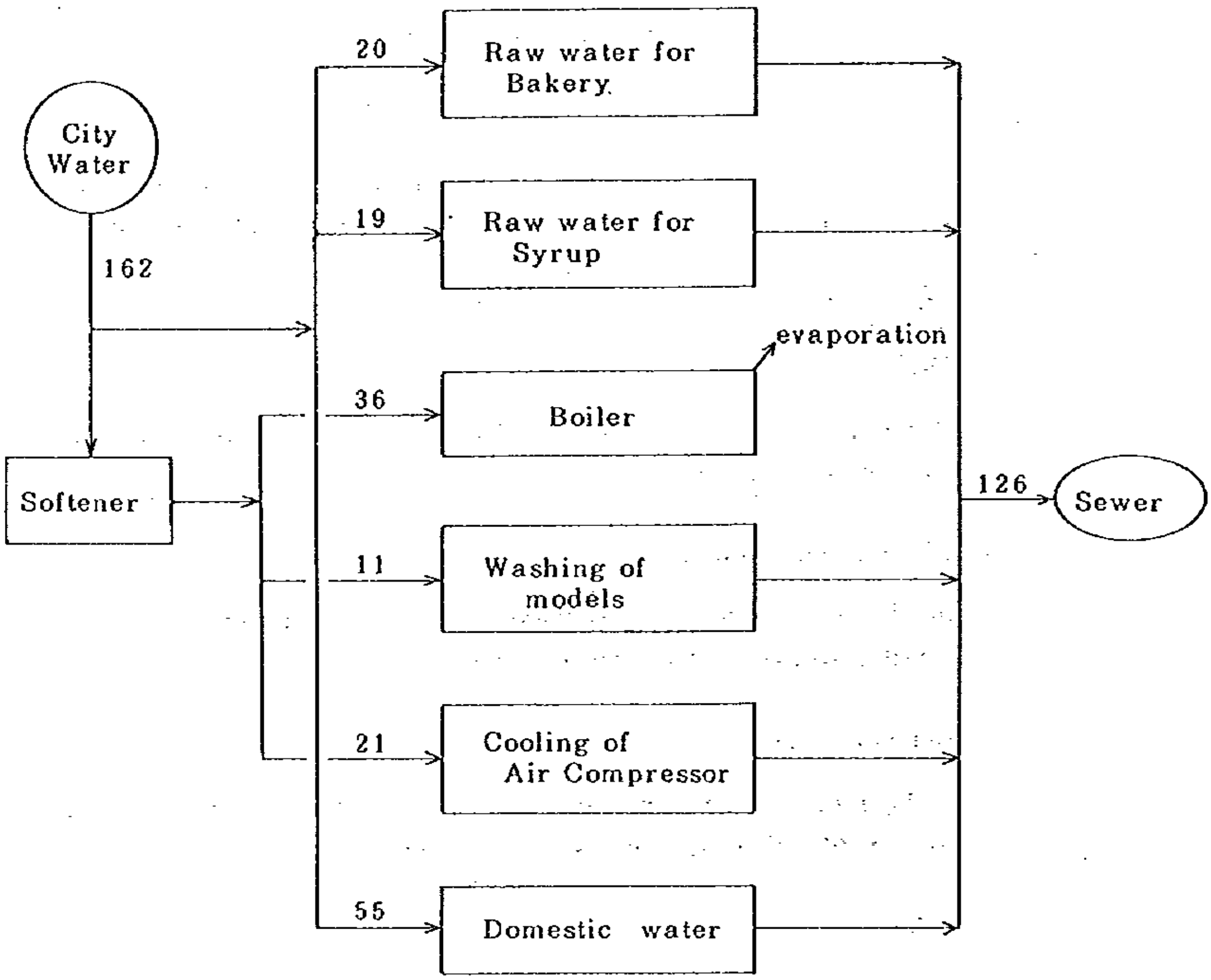
In this process, the humidified wheat is put into a flour mill and made into flour. The flour is then bagged and shipped.

b. Pasta

① Mixing

In this process, salt and water are added to the raw wheat, and the mix is kneaded in a mixer to give it elasticity and cohesion. Here, a small amount of waste water is generated from the washing of the mixer.

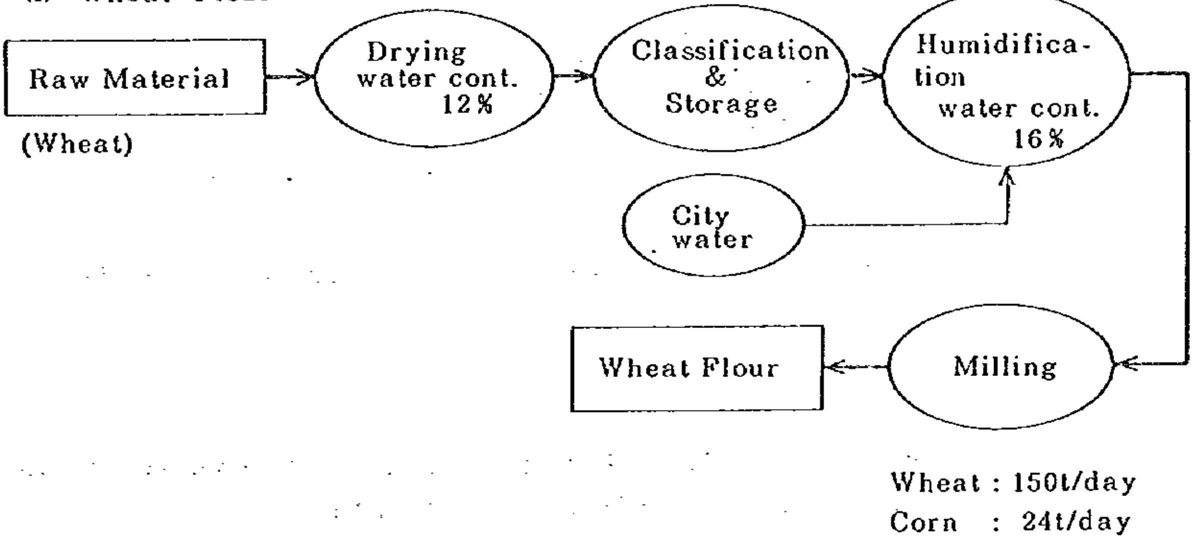
Fig. 4.7.1 Water Balance at the Factory (m³／day)



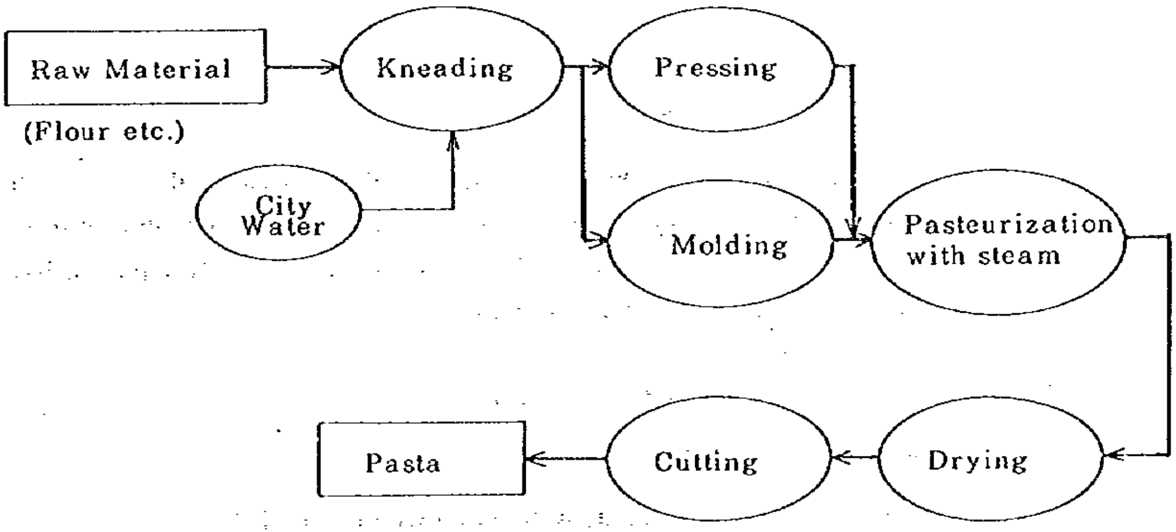
Note : Bakery section belongs to the other company.

Fig. 4.7.2 Manufacturing Processes

(1) Wheat Flour



(2) Pasta



② Pressing and molding

In this process, the kneaded pasta is rolled into gluttonous noodle formation. The rolled pasta is then molded according to the type of product. Here, a small amount of waste water is generated from the washing of the press roller and mold forms.

③ Pasteurization

In this process, the various types of pasta are pasteurized with steam. A small amount of steam condensate is generated in this process.

④ Drying

In this process, the pasteurized pasta is dried in a hot air oven. No waste water is generated here.

⑤ Cutting

In this process, the noodle pasta is cut. Here, a small amount of waste water is generated from the washing of the cutter.

⑥ Other

Croutons are produced, however, waste oil is retrieved. No waste water is generated here.

(3) Waste water treatment plant

There is no waste water treatment plant in place. Because there is great movement of trucks carrying raw materials in and products out, and oil from these vehicles mixed with storm water in the past, an oil-water separator has been established to counter this problem.

4) Quality of make-up water and waste water

(1) Quality of make-up water

The forecast quality of make-up water is shown in Table 4.7.2.

Table 4.7.2 Quality of Make-up Water

Items \ Name of Sample		City Water
Temp.	(℃)	15
pH	(−)	7.5
COD_{Cr}	(mg/ℓ)	1.5
T-Hardness *	(°dH)	12.4
Cℓ	(mg/ℓ)	8
T-Fe	(mg/ℓ)	< 0.05

(NOTE) * : mmol/ℓ as CaO

(2) Quality of waste water

a. Characteristics of waste water discharge

The only manufacturing waste water is that generated from the washing of equipment. Waste water is discharged at the end of operations, when all the equipment is washed. The only other waste water is the domestic sort.

b. Quality of waste water

Table 4.7.3 shows the quality of waste water overall, together with an example of equipment washing waste water in Japan.

Table 4.7.3 Quality of Waste Water Overall and Example of Washing Waste Water

Items \ Name of Sample		Effluent	Example of Washing W.W.
pH	(−)	7.2	7.5
BOD	(mg/ℓ)	44	470
COD_{Mn}	(mg/ℓ)	48	1,000*
SS	(mg/ℓ)	−	340

4.7.2 Water Conservation

(1) Features of water usage

① The city water is the only water source, and the volume of water use is measured. The volume of water use by area is also indicated to some extent.

② Looking at the volume of water by purpose of use, 80% is used on raw materials (24%), for the boiler (22%) and for domestic use (34%), and the remainder is used to wash mold forms and cool the compressor.

(2) Current condition of water conservation

① As was mentioned above, the volume of water use is measured and control of water usage is implemented to a certain degree.

② Compressor cooling water is discharged after being used only once.

③ Because a high percentage of water is used for domestic purposes, there is little point in calculating the unit consumption of water.

(3) Technical comment

① It is possible to recycle compressor cooling water by means of a cooling tower. Consideration should, however, be given to the maximum water temperature required for cooling and the minimum water temperature that can be obtained in a cooling tower during the summer.

② Because the water used for raw materials and the boiler is essential, it is near impossible to make any savings in this area.

③ It is extremely difficult to save on water used for other purposes (washing water, domestic water) too.

(4) Economic comment

In the event where the recycled use of cooling water is carried out by means of a cooling tower, the cost per unit of recycled water would not exceed 100 SIT/m^3 (roughly 30-40 SIT/m^3) and is cheaper than the existing cost relating to water and waste water of approximately 213 SIT/m^3. Thus, it is considered that this proposition would be economically feasible.

4.7.3 Pretreatment that Satisfy WWTP Discharge Standards, and Waste Water Treatment

1) Current condition of wastewater

Waste water can broadly be divided into that from washing in the manufacturing processes and domestic waste water.

a. Waste water that requires treatment

① Washing waste water

Waste water from the washing of manufacturing equipment is generated at irregular intervals and in small quantities.

② Domestic waste water

This is discharged all the time.

③ Other waste water

There is also generated waste water from softening equipment.

b. Waste water that requires no treatment

① Boiler blow water

② Compressor cooling water

2) Quality of treated water

The water quality standards for the case of river discharge and the case of WWTP discharge are shown in Table 4.7.4

Table 4.7.4 Discharged Water Quality Standards

	Item	unit	River	Sewage
1	Temperature	℃	30	40
2	pH	—	6.5--9.0	6.5--9.5
3	SS	mg/l	80	(a)
4	SV^{30}	m/	0.5	10
5	SAK(Color unit)			
	436nm	m^{-1}	7.0	
	525nm	m^{-1}	5.0	(b)
	620nm	m^{-1}	3.0	
6	Toxicity test (SD)	mg/l	3	—
7	Biodegradation	%	—	(c)
8	B	mg/l	1.0	10.0
9	A	mg/l	3.0	(d)
10	As	mg/l	0.1	0.1
11	Cu	mg/l	0.5	0.5
12	Ba	mg/l	5.0	5.0
13	Zn	mg/l	2.0	2.0
14	Cd	mg/l	0.1	0.1
15	Co	mg/l	1.0	1.0
16	Sn	mg/l	2.0	2.0
17	T-Cr	mg/l	0.5	0.5
18	Cr^{6+}	mg/l	0.1	0.1
19	Ni	mg/l	0.5	0.5
20	Ag	mg/l	0.1	0.1
21	Pb	mg/l	0.5	0.5
22	Fe	mg/l	2.0	(d)
23	Hg	mg/l	0.01	0.01
24	Cl_2(Free chlorine)	mg/l	0.2	0.5
25	Cl_2(Total effective chlorine)	mg/l	0.5	1.0
26	$N\text{-}NH_3$	mg/l	10	(e)
27	$N\text{-}NO_2$	mg/l	1.0	1.0
28	$N\text{-}NO_3$	mg/l	(f)	—
29	T-CN	mg/l	0.5	10
30	Free CN	mg/l	0.1	0.1
31	F	mg/l	10	20
32	Cl^-	mg/l	(g)	—
33	T-P	mg/l	2.0(1.0(h))	—
34	SO_4	mg/l	(f)	300
35	S	mg/l	0.1	1.0
36	SO_3	mg/l	1.0	10
37	TOC	mg/l	30	—
38	COD_{Cr}	mg/l	120	—
39	BOD_5	mg/l	25	—
40	Total oil	mg/l	20	100
41	THC	mg/l	10	20
42	Aromatic organic chlorine	mg/l	0.1	1.0
43	Absorbent organic chlorine	mg/l	0.5	0.5
44	Volatile organic chlorine	mg/l	0.1	0.1
45	Water soluble organic chlorine	mg/l	(k)	(l)
46	Phenol	mg/l	0.1	10
47	Surfactant active agent	mg/l	1.0	—

3) Pre-treatment system

(1) Basis for system selection

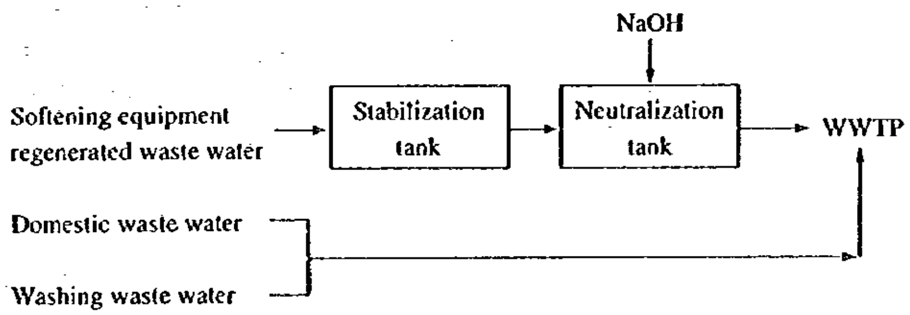
If regenerated waste water from softening equipment is discharged without any treatment, there is a danger that the pH level of waste water overall will exceed the discharge standard. It is, therefore, necessary to neutralize the waste water.

(2) Outline of the pre-treatment system

The pre-treatment system is shown in Fig. 4.7.4.

Regenerated waste water from softening equipment is discharged into a stabilization tank. From there, it is guided into a neutralization tank by storage pump, the pH level is neutralized by adding NaOH under control from a pH meter placed in the tank, and the treated water is then discharged into the WWTP.

Fig. 4.7.4 Pretreatment System Flow Sheet



4) Waste water treatment system

(1) Basis for system selection

Washing waste water and domestic waste water contains organic material. Thus, in order to obtain a satisfactory standard of discharge water quality, it is necessary to carry out treatment of this organic matter.

Biological treatment is generally adopted in order to treat organic matter. Because domestic waste water contains ample quantities of nitrogen and phosphorous necessary for biological treatment and such waste water is continuously discharged during factory operation, pre-treated waste water shall be mixed with domestic waste water and treated simultaneously.

Because washing waste water is discharged irregularly in small amounts, a sequencing batch activated sludge method is adopted. Because this method does not require a stabilization tank or sedimentation tank and is effective in removing nitrogen and phosphorous, it is widely adopted for waste water treatment by small and medium enterprises. In this method, waste water is discharged into an aeration tank during factory operating time, and then undergoes aeration, sedimentation and final discharge during the night when no more waste water is generated.

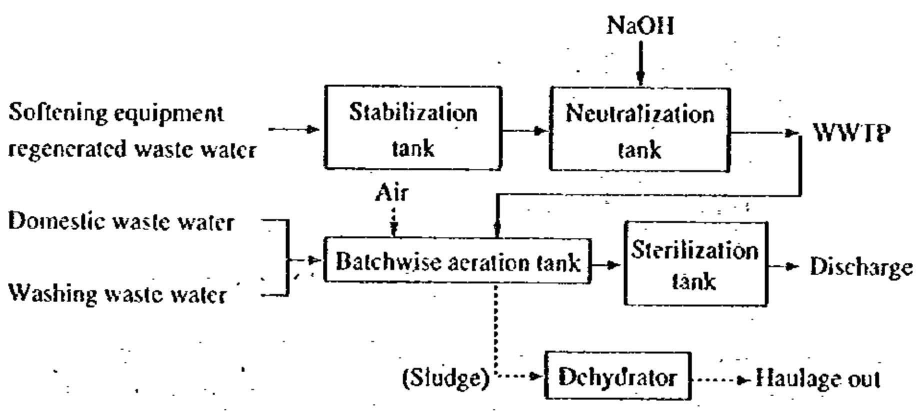
(2) Outline of the waste water treatment system

The waste water treatment system is shown in Fig. 4.7.5.

① Washing waste water and domestic waste water is directly discharged into an aeration tank. The processes of waste water inflow, aeration, sedimentation and discharge are then repeated in that order over a 24 hour cycle, in order to complete the waste water treatment.

② Regenerated waste water from softening equipment
Regenerated waste water from softening equipment is discharged into a stabilization tank. From there, it is guided into a neutralization tank by storage pump, the pH level is neutralized by adding NaOH under control from a pH meter placed in the tank, and the treated water is then discharged into the aeration tank.

Fig. 4.7.5 Waste Water Treatment System



4.7.4 Pretreatment for Reduction of the Pollution Load

The factory is mainly a milling establishment. The volume of waste water generation is 126 m^3/d, of which 50 m^3/d comes from the manufacturing processes, 55 m^3/d comes from domestic waste water and 21 m^3/d comes from compressor cooling water. The factory is divided into a bread making plant and a pasta making plant, and the volume of waste water generation over each factory is extremely small. Moreover, as this is a foodstuffs manufacturing factory, the waste water contains no substances that may have a detrimental effect on the WWTP and biodegradability is good. As a result, the pretreatment system shall be limited to one for reducing the pollution load of organic substances (COD, BOD). However, because the scale of an individually installed pretreatment system would be so small in this case, the economic efficiency would be poor and this would not be advantageous for either the factory itself or the WWTP.

In consideration of the above, a pretreatment system is considered to be unnecessary at this factory and the idea shall be abandoned.

As it was not possible to carry out a follow-up survey of water quality and water volume, pollution loads obtained from water quality data provided by NIGRAD are shown in Table 4.7.5.

Table 4.7.5 Volumes, Quality and Pollution Loads of Waste Water and Treated Water

Kind of Waste Water	Quantity m^3/d	pH	COD_{cr} mg/ℓ (kg/d)	BOD mg/ℓ (kg/d)	SS mg/ℓ (kg/d)	T-N mg/ℓ (kg/d)	T-P mg/ℓ (kg/d)
Total Waste Water	126	8.2	212 (26.7)	82 (10.3)	67 (8.4)	– (–)	– (–)