1.2 Liquidity of Assets and Funds Flow

1.2.1 Liquidity of assets

Table V-1.5 shows a balance sheet and financial ratios of PT. ISI from 1975 to 1983, and more details can be known in Appendix V-1 for 1981 to 1983. Liquidity of assets is not sound as well due to the deterioration of profitability in recent years as mentioned before.

Current ratio had been less than 1.0 since 1977 until 1980 when the ratio was recovered to 1.66. After the year, the ratio was lowered again to be less than 1.0 in 1982 and 1983. Quick ratio or acid test ratio has naturally been lower than the current ratio. For sound operation, it is said that the ratios are to be more than 2.0 for the current ratio and 1.0 for the quick ratio.

It shall be said that the financial position of PT. ISI is critical. For an example, cash on hand as of the end of 1983 was only Rp120 which was an 11 days equivalent to direct manufacturing cost as known in Table AV-1.8 of Appendix V-1.

1.2.2 Funds flow

Naturally, funds flow is also in a critical position. Debt service coverage ratio which indicates ability of amortization of debt recorded 1.09 in 1981 and eventually less than 1.0 in 1983, which meant that the debt can be repaid no more.

To relieve PT. ISI from a bankrupt, the lender, BAPINDO, rescheduled the repayment for 1983 and 1984. Most of the borrowings was made for expansion project of 20 t/d NaOH in 1979. Interest rate at present is a mixture of 13.5% and 18%.

Besides, account payable was suddenly increased as Rp614 million in 1983 from Rp169 million of the previous year, that is 3.6 times. It is deemed that payment for the purchased raw salt which was supplied by state owned company, Perum Garam, was put off.

Main reason of the deteriorated funds flow is considered as lower sales prices of products during the year as well as the investment to the expansion project with the high interest loan.

Existence of excessive account receivable is another reason to have made cash position worse. At the end of 1983, account receivable amounted to Rp1,486 million, which is 1.63 times of the previous year, or 44.6% of sales revenue of the year.

Even though there would be the fact that PT. ISI could not compete with imported products without allowances to her customers for payment, the receivable shall be liquidated as much and soon as possible.

Finally, inventories of raw materials and spare parts shall be well controlled at adequate level, although the finish goods inventory is kept at reasonable amount as much as 10 days production.

Table V-1.5 HISTORICAL BALANCE SHEET, 1975-1983

(Unit: Million Rp)

	1975	1976	1977	1978	1979	1980	1981	1982	1983
Assets									
Current Assets	733	645	673	495	1,112	1,916	1,881	1,903	2,550
Stock of PT. Ajinomoto	122	122	122	122	187	234	281	281	444
Fixed Assets	363	332	2,037	2,777	5,215	4,746	4,295	3,912	3582
Other Assets	162	906	117	56	481	446	864	1,825	364
Total	1,379	2,005	2,949	3,450	6,995	7,342	7,322	7,921	6940
Liabilities									
Current Liabilities	305	514	700	758	1,152	1,155	1,355	1,971	1,910
Long Term Debt	562	1,039	1,974	2,411	2,416	2,361	2,295	2,474	3.058
Total	867	1,553	2,674	3,169	3,568	3,516	3,650	4,445	4,968
Share Holder's Equity									
Share and Equity	184	264	168	275	3,449	3,512	3,656	3,685	2,300
Profit and Loss	328	188	7	6	(22)	302	16	(209)	(328)
Total	512	452	275	281	3,427	2,826	3,662	3,476	1972
Financial Ratio									
Aft. Tax Profit to Sales (%)	16.3	12.2	0.7	0.8	1.2	9.4	0.6	-	-
Aft. Tax Profit to Equity (%)	35.0	24.6	1.8	1.8	0.6	11.5	0.5	-	-
Current Ratio	2.40	1.25	0.96	0.65	0.96	1.66	1.39	0.97	1.34
Acid Test Ratio	1.62	0.47	0.53	0.39	0.46	1.15	0.94	0.64	0.83
Debt Coverage Ratio	-	-	-	-	1.39	2.30	1.09	1.06	1.43 1/

(Note) 1/ Repayment was re-scheduled.
(Source) PT. ISI Financial Report

Table V-1.6 PRICE & COST INCREASE FOR PT.ISI DURING 1979-1983

	1979	1983	Escalation Rate
Production	6,193 t/y	6,595 t/y	-
Sales Revenue (MRp/ton of NaOH)	329	505	11.3%
Variable Cost (MRp/ton of NaOH)	164	353	21.1
Salaries & Wages (MMRp/y)	171	325	17.4
Social Welfare (MMRp/y)	153	195	6.3
Maintenance Cost (MMRp/y)	151	215	9.2
Other Fixed Cost Excluding Depreciation & Interest (MMRp/y)	100	237	24.0
Total Production Cost Excl. Depreciation & Interest			
(MMRp/y)	1,589	3,298	20.0
(MRp/t of NaOH)	257	500	18.1

Chapter 2 Prerequisites for Financial Analysis

Effects of investment to renovation program is to be measured taking note of incremental parts which is calculated by deduction of 'without' renovation from 'with' renovation for both cost and return.

In 'without' case, the present situation of technical, marketing and financial aspects will be carried over for comming years, in which case repairing and maintenance cost is deemed to increase year by year to maintain the present production level.

In 'with' case, benefits from efficient use of materials and utilities, expansion of production capacity as well as reduction of maintenance cost can be expected, while fixed costs derived from capital cost requirements will rise.

Escalation rate, prerequisites and assumptions used for financial evaluation are studies here in this chapter.

2.1 Escalation Rate

2.1.1 Escalation rate for imported goods in foreign currency

Price increase of imported goods such as machinery and equipment, materials, chemicals and parts is examined taking into account consumer index as well as average export price in and from advanced industrialized countries.

CHANGE IN PRICES (%) 1/

	Consumer Price			Average Export Prices 3/
	U.S.A.	Japan	7 Countries 2/	
1978	7.7	3.8	6.9	5.7
1979	11.3	3.6	9.2	11.9
1980	13.5	8.0	12.1	11.9
1981	10.4	4.9	9.8	6.3
1982	6.2	2.6	6.9	3.3
1983	3.0	2.0	5.0	3.0

(Notes) 1/ In US$ terms
2/ U.S.A., Japan, West Germany, U.K., France, Italy and Canada
3/ Export price from advanced industrialized countries

(Source) IMF

As is evident from the above data, inflation rate of advanced countries has been lowered since 1981. Further, OECD forecast inflation rates in OECD countries in June, 1984 as follows:

PROJECTED ANNUAL INFLATION RATE (%)

	1984	1985
U.S.A.	4.0	5.25
Japan	2.25	3.0
W. Germany	3.0	3.25
U. K.	5.0	5.25
France	7.5	5.75
OECD Total (24 Countries)	5.25	5.25

(Source) OECD

On the other hand, average increase rate of export prices for past 10 years was around 6% which was estimated by IBRD (World Bank) on industrial goods experted from advanced countries.

These data indicate that low prices increase will continue for a coming few years, while, in view of long term fore-cast, it will be higher than that of recent years.

Regarding above, the following escalation rate is assumed for the financial analysis.

ESCALATION RATE (%)

1983	3.0
1984	3.5
1985	3.5
1986	4.0
1987	5.0
1983 onward	6.0

2.1.2 Escalation rate of local currency and exchange rate

Financial projection will be made in US dollar terms in this report. In such case, relation among inflation rate in Indonesia, exchange rate to US$ and escalation of US$ or international inflation shall be carefully examined to measure real financial value of the project.

Table V-2.1 shows past trend of inflation in Indonesia and the exchange rate of Indonesian Rupiah to U.S. dollars. The domestic inflation recorded 13.5% per annum from 1975 to 1983 as average rate in Rp terms, while its was only 2.6% in US$ terms because of twice devaluation, by 50% in 1978 and by 38% in 1983. Eliminating the effect of the latest deva-luation, however, the rate can be computed as 5.7% which is more or less the same rate of international escalation of 6.0%.

The inflation rate in U.S. dollar terms, during a few years immediately after the devaluation remains lower. From the first devaluation in 1978 to the year before the second devaluation in 1983, for an example, the average inflation in U.S. dollar terms recorded 3.6% per annum.

In most of developing countries, domestic inflation used to increase after the devaluation more than before, so that inflation rate in terms of U.S. dollar which is computed by the devaluated exchange rate also rises sometime as far as the exchange rate would be fixed.

In Indonesian case, the floating exchange rate showed Rp1,003/US$ as of March, 1984, while the devaluated rate in 1983 was Rp980/US$.

Taking all the above into consideration, it is observed that the U.S. dollar terms inflation of Indonesia will continue at 3% to 4% during a few years due to the effect of the 1983 devaluation, then at the level of 6% in long term.

Eventually, escalation of Indonesian Rupiah portion involved in the project is assumed to follow the same rate of international escalation as far as it is expressed in U.S. dollar terms.

Table V-2.1 PRICE INDEX IN INDONESIA

Year	Consumer Price Index in 17 Cities				
	RP Term	Change (%)	Exchange Rate	US$ Term	Change (%)
1975	100.0	19.7	420	100.0	13.7
1976	114.2	14.2	420	114.2	14.2
1977	127.7	11.8	420	127.7	11.8
1978	136.2	6.7	446 1/	128.5	0.6
1979	177.4	21.8	630	118.3	7.9
1980	207.8	17.1	632	138.5	17.0
1981	223.0	7.3	655	142.9	3.2
1982	245.4	10.0	697	147.8	3.4
1983	274.7	12.2	938 2/	123.2	16.6
Average (1975-1983)		13.5			2.6
Average (1975-1982) 3/					5.7

(Notes) 1/ Average in the year taking into account the devaluation in November, 1978 from Rp 420/US$ to Rp 630/US$.

2/ Same as above. The devaluation was in March, 1983 from Rp 710/US$ to Rp 980/US$.

3/ Computed to eliminate the effect of the latest devaluation in 1983.

(Source) INDICATOR ECONOMI, BPS

2.2 Production and Sales Plan

2.2.1 Production plan

Rated production capacity for the renovation cases as well as for the case that the existing factory continues operation without any renovation (it is referred to as W/O hereinafter) are shown below.

Standard operational days are deemed as 330 days per year in this study.

The maximum rate, however, of capacity utilization for W/O is assumed as 90%, while 100% is to be adopted for the renovation cases.

Rated capacity of independent factories in advanced countries is based on 365 days operation per year undertaking scheduled maintenance. Therefore, 100% or 330 days operation can be easily attained after renovation if there would be no constrain in market size.

In case of W/O, however, 90% of that or 300 days operation will be the most because of superannuation of the factory and the receiving voltage of 20 kV which has rather frequent power failure than that of 70 kV for the renovation cases.

(Unit: t/d)

	W/O	Case 1	Case 2	Case 3
NaOH (as 100%)	36	46	47	63
L-CL (99% Cl)	6	15	15	15
HCL (33% Cl)	83	125	130	200
BLN (12% Cl)	4	5	5	5
BLC (8% Cl)	25	30	30	30

Production shall be planned so as to meet the projected market size. Though Case 1 and Case 2 have enough market to produce products at the full capacity operation since 1988 when the renovation program will be completed, 90% operation is assumed for the first year as trial operation period for the new technology. Case 3 is projected to reach 100% operation in 1995.

Table II-1.11 in Chapter 1 of Part II shows a detailed production and sales plan by product.

2.2.2 Self use and finish goods inventory

A part of caustic soda production is used as chemicals for brine purification and as a raw material of BLN in the own factory. In addition, hydrochloric acid is partly used as chemicals for brine purification. the production plan shown in Table II-1.11 has been made taking account such self use.

Besides, salable amount is computed by deduction of increase in inventory during the year from total production volume.

Amount of finished goods inventory is presumed as 10 days' production in the year.

2.2.3 Decrease in production volume during construction works

Shutdown of the entire factory and decrease in production will come during the construction period in 1987 for the renovation as scheduled in Chapter 5 in Part III.

For all cases, the factory will be entirely shut down as long as one month, after which commissioning works will follow for another month.

During the commissioning, it is assumed that production would decrease at a half of the capacity.

Thus, the following decrease in production is calculated for 1987 as NaOH 100% basis:

Case 1 : 1,735.0 t/y
Case 2 : 1,712.5 t/y
Case 3 : 1,712.5 t/y

2.2.4 Unit sales price of products

Projected sales prices has been studied in details in Part II Chapter 2, paragraph. 2.1.

In the study, high price of liquefied chlorine (L-Cl) is forecast to be lowered to a reasonable level until 2,000 and reversely low valued bleaching liquor (BLC) will recover the real value by 1995.

Prices of other products are projected to increase in proportion to the escalation rate assumed in the paragraph 2.1 in this Chapter.

CURRENT SALES PRICES IN THE YEAR

(Unit: $/t)

	1984	1988	1990	1995	2000
NaOH (100%)	288.0	345.0	387.7	518.8	694.3
L-CL (99%)	576.0	675.0	724.0	848.0	971.0
HCL (33%)	109.4	131.1	147.3	197.1	263.8
BLN (12%)	109.4	131.1	147.3	197.1	263.8
BLC (8%)	17.3	42.2	66.2	88.6	118.6

2.3 Production Cost Items

2.3.1 Variable cost

Tables V-2.2 and V-2.3 show unit consumption and cost of variable cost items i.e. raw materials, utilities, chemicals and lub oil for each case including W/O.

The cost is deemed to increase at the rate of the escalation every year.

Description is made on major items hereinafter.

(1) Raw salt

Present unit consumption of raw salt is 2.0 tons/ton of NaOH which is used for W/O case as it is.

That for all renovation cases will be improved to 1.7 t/t owing to a recovery of waste brine.

Unit cost is estimated as US$32.4/t in 1984 prices (1984 prices are used for all items in this paragraph).

(2) Electricity

Unit consumption of electricity per ton of NaOH is estimated as follows:

W/O (M process)	3,230 kWh
Case 1 (M 30t/d & IM 16 t/d)	2,940 kWh
Case 2 & Case 3 (1 M)	2,394 kWh

The consumption for W/O is assumed as the same level experienced in the existing factory.

Unit cost for W/O case is calculated as US$0.067/kWh from the tariff of PLN. As for all the renovation cases, tariff to be adopted will change due to alternation of receiving voltage (20 kV to 70 kV) and power factor (0.84 to 0.94). As the result, unit cost is reduced to US$0.060/kWh or by around 10%.

(3) Fuel oil

Electricity for power is assumed to be supplied from the existing diesel generators in all cases as presently undertaken.

In addition to the such requirements of fuel oil, all renovation caes requires additional fuel oil for concentration of caustic soda.

Unit cost is estimated as US$0.143/l referring to prevailing prices.

(4) Other variable cost items

Unit consumption and cost for other consumable materials are deemed as more or less the same as purchasing price at present.

2.3.2 Fixed cost items
(Refer to Table V-2.4)

(1) Salaries and wages and relevant expenses

The costs are estimated on the basis of actual record and system in recent years especially in 1983.

Salaries and wages in 1983 was US$1,265 per year per man in average for 256 employees. No increase in number of employees is planned for any renovation program because the present numbers are rather in excess.

The salaries and wages consist of basic salaries, physical allowance, pension, overtime, call-out at night and production bonus. The escalated salaries and wages to 1984 will be US$336,044 per year in total.

Social welfare comprising medical, food allowance, pensions imposed to the company, sports, recreation and clothing, etc. is counted as 85% equivalence of the salaries and wages.

Office cost is estimated as 7% on the salaries and wages. General expenses which consist of business trip, education, social expenses, housing warehouse and allowances for board members, etc. are deemed as 53% of the salaries and wages basing upon experienced costs.

All the overhead expenses are summarized as 145 against 100 of the salaries and wages, which can be considered resonable in this country.

(2) Maintenance cost

Maintenance and repairing cost gradually increase according to superannuation of the factory. In general, medium scale overhaul every five years and large one every ten years shall be made to maintain steady operation.

The figures shown in Table V-2.4 as percentage to acquisition plant cost are made from data field in the consultant office for similar industries.

In W/O Case, since most of the existing machinery and equipment was purchased in 1976, maintenance cost in 1983 can be deemed as 4.0% level already. It last in the rate of 4.4% for next 5 years starting in 1986, and so on.

As for renovated plant, all facilities is to be regarded as an entirely new ones because most critical section, electrolizer, is replaced, existing facilities is overhaul or rehabilitated. So, 3.1% for the first five years is adopted stating in 1988, 4.0% for the next five years and so on.

In addition, escalation rate has to be multiplied by the maintenance cost which had been obtained by the above mentioned calculation method.

(3) Insurance and sales expenses

Insurance for fire is counted as 0.5% of the book value of fixed assets.

Sales expenses has experienced around 0.6% of total sales in recent years. One percent of total sales, however, is assumed in the study since sales promotion is one of the most important items for PT. ISI in the future.

(4) Depreciation

The existing fixed assets are deemed to be depreciated as scheduled in Table V-2.5 for all cases.

Tangible fixed assets which will be newly invested for renovation are to be depreciated during 10 years because civil works such as buildings and roads are little involved in the renovation.

Intangible fixed assets, i.e. interest during construction and pre-operation expenses are depreciable in 5 years.

Depreciation is made on straight line method with no salvage value.

(5) Interest

Installments and interest on the existing debt of PT. ISI shall be paid as per the schedule shown in Table V-2.6 in any case.

All capital requirements for renovation are assumed to be met by borrowings in the following hypothetical terms and conditions:

Foreign loan

Interest rate	:	10% per annum
Repayment	:	8 year-repayment in equal installments after 2 year-grace period.

Local loan

Interest rate	:	18% per annum
Repayment	:	3 year-repayment in equal installments after 2 year-grace period.

(6) Corporate income tax

Tax rate is as follows;

Profit (Million Rp)	Rate (%)
0 to 10	15%
More than 10 to 50	25%
More than 50	35%

For the study purpose, 35% is used to all profit amount for simplified computation.

As shown in Table V-1.4, PT. ISI recorded deficit amounting to Rp209 million in 1982 and RP328 million in 1983 which can be carried over to the succeeding years until the deficit will be set off by coming profit. Regarding the above, it is assumed that no income tax payment will be imposed for the years of 1985 and 1986.

Table V-2.2 PROJECTED MATERIAL CONSUMPTION

	No Renovation (36 t/d)	Case 1 (46 t/d)	Case 2 (47 t/d)	Case 3 (63 t/d)
NaOH (as 100% NaoH)				
Salt (t/t)1/	2.0	1.7 4/	1.7 4/	1.7 4/
Electricty (kWH/t)	3,230	2,940 5/	2,394	2,394
Fuel for Power (l/t)2/	23.8	32.2	28.6	23.0
Fuel for Boiler (l/t)	-	30.1	77.6	77.6
Chemicals ($/t)3/	8.85	11.03	13.31	13.31
Lub-oil ($/t)3/	2.63	2.63	2.63	2.63
HCL (as 33% HCl)				
Fuel for Power (l/t)2/	10.4	12.5	13.3	11.3
L-CL (as 99% Cl_2)				
Sulfuric acid (kg/t)	90	90	90	90
Freon-22 ($/t)3/	3.0	3.0	3.0	3.0
Fuel for Power (l/t)	63.7	63.7	63.7	63.7
BLC (as 8% Cl_2)				
Slaked lime (kg/t)	200	200	200	200
Fuel for Power (l/t)2/	10.5	10.5	10.5	10.5
BLN (as 12% Cl_2)				
Fuel for Power (l/t)2/	12.5	26.1 6/	26.1 6/	26.1 6/

(Notes) 1/ For electrolizer
2/ For driving power generated by the diesel engines
3/ in 1984 prices
4/ Unit consumption is to be improved by recycling filtrated brine.
5/ M-process for No. 2 unit and 1M-process for No. 1 Unit are mixed.
6/ Power consumption will increase by adopting cooling system.

Table V-2.3 PROJECTED UNIT MATERIAL COST

(in 1984 prices)

1.	Salt	US$32.4/t
2.	Electricty	US$0.067/kWh for without renovation
		US$0.060/kWh for Case-1, 2 and 3 1/
3.	Fuel	US$0.143/l
4.	Sulfuric acid	US$217.8/t
5.	Slaked lime	US$43.6/t

(Note) 1/ Receiving voltage and power factor are improved.

Table V-2.4 PROJECTED DIRECT FIXED COST (WITH/WITHOUT RENOVATION)

A. Salaries and Wages

256 employees at an average salaries and wages US$1,313.-/year/man makes US$336,044.- per annum in 1984 price. Costs in 1984 and 1988 are increased by the assumed inflation rate.

1984	1988
US$336,044.-/year	US$416,694.-/year

B. Social Welfare

85% of the salaries and wages.

C. Maintenance Cost and Miscellaneous Investment

The following percentages will be applied on the total erected plant cost after being adjusted by the assumed escation.

Operation years of the plant	Percentage
1st year - 5th year	3.1%
6th year - 10th year	4.0%
11th year - 15th year	4.4%
16th year - 20th year	5.6%
21th year - 25th year	5.8%
26th year - 30th year	7.1%

- Anode shall be recoated every five years and membrane shall be replaced every two years. Those coats, however, are allocated as every year's cost in the financial projection.

	Case 1	Case 2	Case 3
Anode	71.8	208.7	279.4
Membrane	31.3	92.2	123.5
	103.1	300.9	402.9

D. Office and Insurance

- Office cost -- 7% of the salaries and wages.
- Insurance -- 0.5% of the book value of fixed assets exclusive of land.

E. Sales Expenses -- 1.0% of total sales.

F. General Expenses -- 53% of the salaries and wages

Table V-2.5 PROJECTED DEPRECIATION COST (WITH/WITHOUT RENOVATION)

A. For New Installation

The following service lives are to be used for depreciation in straight line method without any salvage value.

Road & Field : 20 years
Building : 30 years
Machinery & Equipment : 10 years
Cars, Transportations,
Furniture & Fixtures : 3 years

B. For Existing Assets

It is assumed that the book value shall be fully depreciable according to the following service life remained in 1983.

Road & Field : 10 years
Building : 12 years
Machinery & Equipment : 4.5 years
Car, Transportations,
Furniture & Fixtures : 1.5 years

	Road & Field	Building	Mach.& Equip.	Cars	Trans-port	Furn. & Fixture	Total
1984	1	45	503	7	25	23	605
1985	2	45	503	6	13	11	580
1986	2	44	503	-	-	-	549
1987	2	44	503	-	-	-	549
1988	2	44	250	-	-	-	296
1989	2	44	-	-	-	-	46
1990	2	44	-	-	-	-	46
1991	2	44	-	-	-	-	46
1992	2	44	-	-	-	-	46
1993	2	44	-	-	-	-	46
1994	1	44	-	-	-	-	45
1995	-	44	-	-	-	-	44
Total 1/	20	530	2,626	3	38	34	2,899

(Note) 1/ Book value at the end of 1983

Table V-2.6 INTEREST AND REPAYMENT SCHEDULE OF EXISTING LOAN

(Unit: 1,000 Rp)

Year	Principal (Beg. of the of the year)	Additional Loan During the Year	Repayment	Interest	Outstandings (End of the year)
1983	2,814,979	223,377	-	103,951	3,058,091
	3,038,356	-	-	105,358	3,058,091
	3,038,356	-	-	106,933	3,058,091
	3,038,356	19,735	-	109,174	3,058,091
1984	3,058,091	160,994	-	116,182	3,219,085
	3,219,085	-	-	117,757	3,219,085
	3,219,085	-	-	119,332	3,219,085
	3,219,085	-	-	120,907	3,219,085
1985	3,219,085	-	152,500	120,907	3,066,585
	3,066,585	-	152,500	120,907	2,914,085
	2,914,085	-	152,500	110,613	2,761,585
	2,761,585	-	152,500	105,467	2,609,085
1986	2,609,085	-	152,500	100,320	2,456,585
	2,456,585	-	152,500	95,173	2,304,085
	2,304,085	-	152,500	90,026	2,151,585
	2,151,585	-	152,500	84,879	1,999,085
1987	1,999,085	-	154,500	79,732	1,844,585
	1,844,585	-	154,500	74,518	1,690,085
	1,690,085	-	138,500	69,303	1,551,585
	1,551,585	-	138,585	64,629	1,413,000
1988	1,413,000	-	161,500	59,952	1,251,500
	1,251,500	-	161,500	54,501	1,090,000
	1,090,000	-	130,000	12,263	960,000
	960,000	-	130,000	43,200	830,000
1989	830,000	-	140,000	37,351	690,000
	690,000	-	140,000	31,051	550,000
	550,000	-	140,000	24,751	410,000
	410,000	-	140,000	18,563	270,000
1990	270,000	-	135,000	12,151	135,000
	135,000	-	135,000	6,075	-
	-	-	-	-	-
	-	-	-	-	-

(Note) The interest ratef 13.5% and 18.0% are mixed.

(Source) PT. ISI

2.4 Current Assets and Liabilities

In a study of renovation project, the present status of assets and liabilities shall be reflected or continued to the projection. It is almost impossible and useless for projection, however, to carry forwards all accounts of assets and liabilities as they are because companies being presently operated have specific manners in accounting system and the financial reports are usually very complicated.

Table V-2.7 shows the method of projection on current assets and current liabilities after precise assessment of the existing financial reports and relevant data taking into consideration;

- Continuation of past, present and projection,

- Simplification of computation,

- No conflict among relevant items and

- Appropriateness of assumption.

Supplementary explanation on major items is made in the followings. (Refer to Table V-2.7)

(a) Other receivables

Most of the other receivables is an advance to employees.

(b) Prepaid income tax

This is a tax which was prepaid as a part of corporte income tax when dealings took place.

Though surplus or shortage should be liquidated every year, the amount has been counted as a current assets without any liquidation more than five years.

It is assumed that the assets would be liquidated during three yeas from 1983 to 1985 for simplified calculation.

(c) Stock of PT.Ajinomoto

PT. ISI is one of stock holders of PT.Ajinomoto. PT. ISI has received dividend or stocks at free of charge during these years. To avoid complication of projected cash flow statement, it is assumed that the existing stock PT.Ajinomoto worth Rp444 million would increase at an annual growth rate of 5% instead of cash dividends.

(d) Other account payable

Account payable for employees such as transportation allowance and insurance, etc. is major part of the account.

(e) Guarantee fees for L-Cl cylinder

When customers lends PT. ISI owned cylinder for liquified chlorine, guarantee fees shall be bonded to PT. ISI until return of the cylinders.

(f) Tax payable

In contrast of (b), corporate income tax has been accumulated as an account payable because the tax has not been fixed during these years.

In the same view of (b), the liabilities is assumed to be liquidated during three years since 1985.

Table V-2.7 ASSUMPTION FOR CALCULATION OF CURRENT ASSETS AND LIABILITIES

A. Current Assets

(1) Operating Cash

One (1) month value of cash operating cost which is exclusive of interest and depreciation.

(2) Account Receivable

Three (3) months value of total sales revenue.

(3) Other Receivable
Three (3) months value of salaries and wages.

(4) Inventories

- Consumable materials

Two (2) months consumption of total variable cost less electricity.

- Spare parts

Equivalent to maintenance cost of the year.

- Finished goods and work-in process

Ten (10) days of the cash production cost.

(5) Prepaid Income Tax

It is assumed that the value of Rp 532 million at the end of 1983 shall be liquidated equally over three years, 1985, 1986 and 1987.

(6) Stock of PT, Ajinomoto

Assumed that the existing stock of PT, Ajinomoto worth Rp 444 million would increase at an annual growth rate of 5% instead of cash dividends.

B. Current Liabilities

(1) Account Payable

- Salt

Purchasing cost equivalent to four (4) months operation.

- Other variable cost

Equivalent to two (2) month expenses.

(2) Other Account Payable

Same value as annual cost of salaries and wages.

(3) Guarantee Fees for L-CL Cylinder

Equivalent to 9% of L-CL sales.

(4) Tax Payable

It is assumed that the value of Rp 480 million at the end of 1983 shall be liquidated eually over three years, 1985, 1986 and 1987.

Chapter 3 Financial Analysis and Case Study

3.1 Method for Financial Analysis

3.1.1 Financial projection for each case

In accordance with the precondition of financial analysis mentioned in the previous chapter, the projected financial reports will be provided up to the year of 2,000 in the following four cases.

(a) Case without renovation (W/O = 36 t/d)
(b) Case 1 of renovation (Case 1 = 46 t/d)
(c) Case 2 of renovation (Case 2 = 47 t/d)
(d) Case 3 of renovation (Case 3 = 63 t/d)

In case of (b), (c) and (d), the existing facilities have been incorporated into these cases in the form after the required modification is completed.

Hence, the financial reports are ones reflecting the actual financial circumstances after the renovation being implemented.

The financial reports are attached in Appendix V-2 at the end of the report in the form of the computer outputs as follows.

(a) Production and Sales Plan
(b) Production Cost Statement
(c) Working Capital Statement
(d) Income Statement (P&L)
(e) Funds Flow
(f) Balance Sheet
(g) Financial Indicators (Financial Ratio)
(h) Cash Flow (Current Price Basis)
(i) Cash Flow (Constant Price Basis)

3.1.2 Comparison of increments and method for measuring investment

The return on investment can be measured by the incremental comparison for cost and return. For example, the internal rate of return (IRR) to be computed by the incremental comparison for cost and return of Case 1 and W/O will indicate the investment effect of Case 1 renovation project.

The investment effect of Case 2 and Case 3 will also be computed in the same manner by the incremental comparison method of cost and return for W/O.

For measuring the return of the investment, IRR (hereinafter referred to as FRR in the financial analysis to distinguish ERR in the economical analysis) is used together with NPV (Net Present Value) which is for supplemental purpose.

Since, the financial reports are computed in the current price basis by means of the escalated costs and prices, IRR and NPV have to be re-computed and discounted to 1984 constant price basis by using the deflator which is equivalent to the escalation rate. The computed outcome based on the incremental comaprison for each case is shown in Appendix V-2 attached at the end of the report.

3.2 Financial Analysis for Each Case of Renovation Project and Selection of Optimum Case

3.2.1 FRR and NPV

Table V-3.1 shows the computed outcome of FRR and NPV. FRR after tax in constant price basis is generally used as the basis for judgement of the financial feasibility comparison. The results of them is as follows.

	FRR after Tax (in 1984 Constant Price)
Case 1	7.7%
Case 2	7.4%
Case 3	9.0%

Though either case of them tentatively remains marginal but feasible, IRR of Case 3 shows the highest while that of Case 2 shows the lowest.

The comprehensive comparison summalizing the advantages and disadvantages for each case is shown below.

COMPARSION OF ADVANTAGES AND DISADVANTAGES FOR EACH CASE

	Case 1 (46 t/d)	Case 2 (47 t/d)	Case 3 (63 t/d)
Increase in Production (t/y)	X (4,488)	Δ (4,818)	O (10,098)
Construction Cost per Ton of Increased Production (US$1,000/t)	Δ (3.81)	X (4.03)	O (2.41)
Year of Capacity Utilization Reaching 100%	O (1988)	O (1988)	X (1995)
Year of Sales Quantity Reaching Full Capacity	X (1988)	X (1988)	O (1995)
Electricity Consumption (kWh/t)	X (2,940)	O (2,394)	O (2,394)
Salareis/Wages per Ton	X	Δ	O
Expense of Membrane and Arnode per Ton	O	X	X
Investment for Environmental Control	Δ	O	O

(Notes) O: most advantageous for the Case.
Δ: neutral in advantages comparing with other two Cases
X: disadvantages for the Case.

When compared Case 2 with Case 1, the followings can be said.

(a) Since the elecholytic cells of 16 t/d are to be newly installed in Case 1 while the electrolytic cells of 46 t/d are to be done in Case 2 for nearly the same production quantity, the project cost of Case 2 becomes relatively higher. The same situation is observed in the facility for concentration of caustic soda.

(b) For replacing ion exchange membranes in every two years and recoating metal arnodes in every five years, the expense of Case 2 for 46 t/d cells becomes relatively higher than that of Case 1 for 16 t/d cells.

(c) The above disadvantages are larger than the advantages arised from improvement of unit consumption of electricity and unnecessity of investment to environmental control facilities.

As a conclusion, in case that the renovation project increases the production capacity only by 10 t/d from 36 t/d to 46 or 47 t/d, Case 1 project which is less in investment cost shows the higher return of investment.

When compared Case 3 with Case 1, the followings can be said,

a) Although the capacity utilization of Case 3 is 73% in the start-up year of 1988 and is slow to reach a full operation at last in 1995, the production amount is able to increase complying to increase in the market size. On the other hand, the full operation can be expected from the start-up year onward in Case 2, but the opportunity loss will arise in salable volume since the sales amount will be limited by the production capacity.

b) The project cost for the incremental production capacity is relatively lower in Case 3 than that of Case 1, so that the scale merit can be enjoyed in Case 3.

c) The improvement of electricity unit consumption in Case 3 contributes to the profitability in proportion to the larger amount of production.

d) The above advantages are larger than the disadvantages arised from the expenses for replacing membranes and arnodes.

As observed from the above, the investment effect of Case 3 is the highest among the three cases of renovation project.

3.2.2 Production cost and profit and loss

(1) Profit and loss

The income statements of W/O, Case 1, Case 2 and Case 3 are attached in Table AV-2.4, AV-2.13, AV-2.22 and AV-2.31 of Appendix V-2 at the end of the report. Even in the case of W/O which does not implement any renovation project, the profit can be expected if No. 2 Unit which will replace arnodes with metal ones and expand the production capacity in 1984 can enter into the full operation and the sales of the products can be expected as scheduled. The profit of W/O is larger than those of the renovation project in 1980s. The year when the profit of the renovation project exceeds the profit of W/O is in 1992 both in Case 1 and Case 2, and in 1991 in Case 3, thereafter the gap becomes expanded.

The loss will arise in any renovation cases in 1988. The reason is due to a large amount of interest to be paid for the loans of the renovation project (interest rate for foreign loan is assumed to be 10%, for local loan 18%), large amount of depreciation, increase in inventory of finished goods, the low capacity utilization, and expense for the operation advisor to be invited from abroad.

In 1989 onwards, the profit can be favorably expected and profitability will be in a good condition. The accumulated profit in Case 3 is the largest among the three cases of the renovation project principally due to its largest production capacity. The profitability of W/O will not increase reflecting the high production cost.

(2) Production cost

Table V-3.2 shows each year's production cost and the sales price per ton of caustic soda for all cases, which were computed by dividing the total production cost and the total sales revenues by production tonnages and sales tonnages of caustic soda respectively.

For all renovation cases, the production cost becomes lower in big amount than that of the previous year both in

1993 when the interest payment is decreased due to the completion of repayment for the local loans, and in 1998 which is the next following year when the depreciation is completed.

As for the year when the production cost becomes lower than that of W/O case, it is projected to be in 1995 in Case 1 and Case 2, and in 1994 in Case 3 by one year earlier than the year in Case 1 and Case 2. Thereafter, the production cost of W/O case becomes relatively higher with years proceeding.

(Note) There are slight differences in the unit sales prices by each case as shown in Table V-3.2 due to the slight different composition of the products to be produced (especially of chlorine products). The unit prices of W/O case are lower than those of other cases since the production capacity of high priced liquefied chlorine can not be expanded due to the limited production capacity of the existing facilities.

Table V-3.3 shows the composition of the production cost taking Case 3 as a typical example. The year of 1995 is selected when the plant reaches the full operation. In view of the ex-factory cost, the variable cost occupies 69.2% of the total cost, in which electricity cost shares 60% that is equivalent to 41.4% of the total cost. Raw salt cost occupies 15.9%. Hence, since the sum of the raw salt and electricity cost becomes 57.3%, it will be no exaggeration to say that the trend of above two expenses will determine the profitability of an electrolysis plant.

The cost composition of W/O (existing plant) as of 1984 is roughly shown as follows.

COMPOSITION OF PRODUCTION COST IN 1984
(Existing: W/O Renovation)

Salt	14.4%
Electricity	48.0%
Other Materials	5.6%
Variable Cost	68.0%
Labor Cost	14.0%
Maintenance Cost	5.4%
Fixed Cost	12.6%
Ex-Factory Cost	100.0%

The major differences in the cost composition when compared the cases of renovation project with the existing plant (W/O) are as follows.

(a) The composition ratio of electricity cost will decrese due to the improvement of unit consumption, receiving voltage and power factor.

(b) The ratio of salaries and wages will largely decrease since the present number of the employees will not be increased.

(c) The expenses for replacing ion exchange membranes and arnodes will be added.

(d) In general, the ratio to account for the fixed cost will decrease except payment for the interest.

3.2.3 Financial ratio and cash flow

The financial ratios of W/O, Case 1, Case 2 and Case 3 are shown in Table AV-2.7, AV-2.16, AV-2.25 and AV-2.34 at the end of the report, the outline of which is shown in Table V-3.4

For all cases in the period from 1984 to 1987 when the renovation project will be completed, it is projected that the financial situation will be gradually recovered from the deprerssed conditions up to 1983 to the better ones due to contribution both of the capacity expansion of No. 2 unit and the recovery of the sales prices. In the case of W/O, all of current ratio, quick ratio, debt service ratio (hereinafter referred to as DSR) and break even point satisfy the levels of the stable operation. In other words, if the cheap sales prices in 1982 and 1983 can be recovered to the appropriate price levels and the existing plant can be operated at the full capacity utilization, the financial management of PT. ISI will be restored to the normal situation even without any renovation project.

As observed in Table V-3.4, Case 1 and Case 2 show almost the same situation of cash flow. In the four year period from 1988 to 1991 after the renovation, the assets situation will be deteriorated. It is projected that the deteriorated financial situation will continue by two more years in Case 3, the reason is supposed to be the severe terms and conditions of the loans assumed to be financed for the project.

It is needed for all cases of renovation project to make an additional financing after the resumption of operation due to the cash flow being deteriorated. The interest rate of the short term loan is assumed to be 18% and this payment for interest will also make the cash in shortage. The additionally required amount to be financed for each case are as follows. For details, see Table AV-2.14, AV-2.23 and AV-2.32 attached at the end of the report.

(Unit: US$1,000)

	1989	1990	1991	1992	1993	1994	1995
Case 1	1,325	2,761	3,204	1,164	0	0	0
Case 2	1,909	3,646	4,250	2,300	334	0	0
Case 3	3,477	6,760	8,716	7,446	5,997	3,491	39

Unless the terms and conditions of loans can be moderated, the renovation project will face the difficulty for realization. The appropriate terms and conditions of the loans will be discussed in section 3.3.

3.2.4 Selection of optimum case of renovation project

As the advantages and disadvantages for each case of the renovation project have been discussed heretofore, Case 3 deems to have the highest investment effect, so that the study team wishes to recommend the selection of Case 3 unless the other restrictive conditions are found.

In the event that the investment amount is so limited as to make it unable to select Case 3, Case 1 is to be selected as the second best selection.

Regarding Case 3, the sensitivity analysis will be made in section 3.4 assuming that the major factors such as capacity utilization, sales price, electricity cost, raw salt price and project cost have fluctuated.

Table V-3.1 FRR AND NPV FOR INCREMENTAL

	Case 1	Case 2	Case 3
(1) FRR-In 1984 Constant Prices			
After Tax (%)	7.7	7.4	9.0
Before Tax (%)	8.3	8.0	11.0
(2) FRR-In Current Prices			
After Tax (%)	13.6	13.4	15.0
Before Tax (%)	14.3	14.1	17.3
(3) NPV-In 1984 Constant Prices, 10% Discount Rate			
After Tax (US$1,000)	-1,203	-1,487	-1,846
Before Tax (US$1,000)	-1,027	-1,316	1,045

Table V-3.2 PRODUCTION COST AND SALES PRICE

	Production Cost (US$/t 1/)					Sales Price (US$/t 2/)			
	W/O	Case 1	Case 2	Case 3		W/O	Case 1	Case 2	Case 3
1988	576.5	841.6	860.6	835.3	1988	730.8	741.6	740.3	735.7
1989	578.0	750.6	763.1	769.6	1989	774.9	782.1	780.9	779.7
1990	599.8	748.4	763.6	757.4	1990	818.5	832.6	831.2	826.8
1991	642.1	756.3	770.8	754.5	1991	861.2	883.3	881.8	874.0
1992	678.6	772.0	784.4	760.3	1992	907.2	937.1	934.5	923.2
1993 3/	717.9	753.1	763.7	728.3	1993	956.2	993.2	990.3	974.9
1994	760.4	768.4	768.0	726.9	1994	1,009.5	1,051.5	1,049.7	1,030.4
1995	805.4	801.2	794.5	722.9	1995	1,065.9	1,114.0	1,112.2	1,089.8
1996	851.4	833.3	824.3	719.8	1996	1,125.1	1,178.5	1,176.6	1,153.5
1997	902.2	872.4	862.8	756.7	1997	1,187.8	1,242.8	1,242.6	1,221.6
1998 4/	956.2	830.3	809.2	758.4	1998	1,254.0	1,308.0	1,308.1	1,293.5
1999	1,013.3	878.3	855.2	805.2	1999	1,323.8	1,377.4	1,376.1	1,369.2
2000	1,073.9	926.8	903.1	853.8	2000	1,397.6	1,446.5	1,446.5	1,447.2

(Notes) 1/ Total production cost is divided by production volume of NaOH (100%).
2/ Total sales revenue is divided by sales volume of NaOH (100%).
3/ Local loan is to be paid out.
4/ Depreciation is completed. Differences among the cases are caused by different products mix to be sold.

Table V-3.3 COMPOSITION OF PRODUCTION COST FOR CASE 3

(in 1995 Prices)

		US$1,000/y	US$/t 1/	Composition	%
(a)	Salt	2,063	103.7	15.9	14.4
(b)	Electricity	5,380	270.3	41.4	37.4
(c)	Other Materials	1,544	77.6	11.9	10.7
(d)	Variable Cost	8,987	451.6	69.7	62.5
(e)	Labor Cost 2/	1,232	61.9	9.5	8.6
(f)	Maintenance Cost	1,037	52.1	8.0	7.2
(g)	Membrane & Anode	726	36.5	5.6	5.0
(h)	Depreciation	1,003	50.4	7.7	7.0
(i)	Fixed Cost	3,997	200.9	30.8	27.8
(j)	Ex-factory Cost (d + i)	12,984	652.5	100.0	90.3
(k)	Sales and Admin. Exp.	538	27.0		3.7
(l)	Interest 3/	865	43.4		6.0
(m)	Operating Expenses (k + l)	1,403	70.4		9.7
	Total Production Cost	14,387	722.9		100.0

(Notes) 1/ Cost items are divided by NaOH production of 19,900 t/y as 100% NaOH.

2/ Salaries and wages, social welfare and office expenses

3/ Interest on long term and short loan

Table V-3.4 SUMMARY OF FINANCIAL RATIO

	1986	1987	1988 3/	1989	1990	1991	1992
Without Renovation							
Current Ratio	2.69	2.99	3.12	4.18	5.86	6.03	6.03
D.S.R. 1/	1.54	1.76	1.97	2.17	5.26	-	-
B.E.P. (%) 2/	64.0	60.3	49.4	41.1	38.6	40.8	41.1
Case 1							
Current Ratio	2.69	1.64	0.90	0.83	0.81	1.12	1.89
D.S.R. 1/	1.54	1.51	0.84	0.67	0.79	0.96	2.46
B.E.P (%) 2/	64.0	58.5	114.0	93.2	81.7	73.9	67.9
Case 2							
Current Ratio	2.69	1.54	0.86	0.74	0.70	0.93	1.39
D.S.R. 1/	1.54	1.44	0.81	0.65	0.76	0.93	2.19
B.E.P. (%) 2/	64.0	58.0	116.9	96.6	86.3	78.7	72.8
Case 3							
Current Ratio	2.69	1.39	0.77	0.56	0.50	0.58	0.71
D.S.R. 1/	1.54	1.44	0.74	0.53	0.63	0.74	1.73
B.E.P. (%) 2/	64.0	58.0	91.6	74.5	68.9	64.7	61.8

(Notes) 1/ Debt Service Coverage Ratio
2/ Break Even Point in percentage of capacity utilization
3/ Starting year of the commercial operation after renovation for Case 1, Case 2 and Case 3

3.3 Discussion on Terms and Conditions of Loan and Recommendation

Through the local survey in Indonesia, the financing plan and terms and conditions of the loans are assumed as a base case as follows.

Financing plan	:	Both of foreign and local portions to be entirely borrowed.
Foreign loan	:	Interest 10% p.a., 8 year repayment in equal installment after 2 year grace period.
Local loan	:	Interest 18% p.a., 3 year repayment in equal installment after 2 year grace period.

The investment for this project deems to be feasible in view of financial and economic rate of return concerned.

However, as mentioned in the previous section 3.2, the above terms and conditions of the loans are so severe that PT. ISI will face difficulty in funds flow operation. That is, implementation of the project will be almost impossible as far as the terms and conditions of the above base case shall be adopted to the project.

It is indispensable for the project implementation to soften the terms and conditions of financing through the following countermeasures.

(a) A less interest rate

(b) A longer payment period

(c) A longer grace period

(d) A less loan due to an increase of equity

(e) A less loan due to a total or partial tax exemption from the project cost

Since some of the above countermeasures will be unable for the practical application, it is thought to be realistic if some of them are used combined together.

Hence, the terms and conditions of financing plan will be discussed here as examples.

All study is made for Case 3.

(Example-1) All capital required is to be met by borrowing.

Regarding Case 3, DSR (Debt Service Coverage Ratio) is computed in the following terms and conditions, provided, however, that these terms and conditions are assumed to be applicable for both of the foreign and local loans to make a calculation simple.

Loan	:	Total project cost of US$24,314,000
Interest	:	10% p.a.
Grace period	:	Construction period and additional two years after commencement of operation, in total 4 years
Payment period	:	Ten years after grace period
Payment	:	Equal installment of principal

DSR indicates the payment capability of loans and is expressed in the following formula.

$$D.S.R. = \frac{\text{After Tax Profit (A)} + \text{Depreciation (D)} + \text{Interest (I)}}{\text{Principal Repayment (R)} + \text{Interest (I)}}$$

The outcome is shown in Tables V-3.5 and V-3.6. If DSR is less than 1.0, the repayment of loans becomes unable and the bankruptcy will take place unless an additional financing or a repayment rescheduling of loans is made. It is generally said that DSR more than 1.5 seems to be sound and to be desirable if it becomes more than 2.0.

As observed in Table V-3.5, DSR becomes 1.12 of almost the lowest possible cash flow in 1991, and can get away from the critical situation in 1994. In the event that all capital requirements are to be financed by the loans, the terms and conditions shall not be worse than those of the above.

(Example-2) Paid-up share capital can be increased.

Cash flow is computed on the assumption that 30% of total capital requirements can be additionally paid-up to appropriate for a part of local currency requirements as well as softer terms and condition of loans can be applied as follows.

Debt/equity ratio: 70/30
(Equity is to be used for the local currency requirements)

Foreign currency requirements is to be met by borrowing with the following conditions:

Interest rate	:	7.5% per annum
Repayment	:	10 year-equal-installment of principal after 2 year-grace-period

Deficit amount of the local currency requirements is to be met by borrowing with the following terms and conditions.

Interest rate	:	13.5% per annum
Repayment	:	5 year-equal-installment of principal after 2 year-grace-period

Total capital requirements for Case 3 decreases because of the lower interest during construction. Other costs are the same as estimated in Table IV-1.3.

REVISED CAPITAL REQUIREMENTS

(US$1000)

	Foreign	Local	Total
Erected plant cost	12,482	4,757	17,239
Tax and duties	-	1,799	1,799
Pre-operating expenses	-	630	630
Additional working capital	-	2,200	2,200
Interest during construction	772	317	1,087
Total capital required	13,254	9,703	22,957

FINANCING PLAN

(US$1000)

	Foreign	Local	Total
Equity 1/	-	6,887	6,887
Debt	13,254	2,816	16,070
	13,254	9,703	22,957

(Note) 1/ 22,957 x 30% = 6,887

Tables V-3.7 and V-3.8 show the cash flow and the financial ratios calculated on the basis of the above assumptions.

The D.S.R. stated in the Table V-3.7 will be 1.04 at the lowest in 1989, which is still critical but no cash shortage is expected. The ratio is improved as 1.33 and 1.68 for the succeeding years.

Therefore, the above assumption of the financing plan is also considered as one of marginal but feasible conditions for the Project.

(Example 1, 10% interest, 4 year-grace)

Table V-3.5 *** CAUSTIC SODA RENOVATION PLANT PROJECT IN INDONESIA ***
FUNDS FLOW STATEMENTS (FOR ENDING DECEMBER 31)
- CASE (3) - 63 T/D (USD 1000)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
SOURCE OF FUNDS	1902.	1766.	8801.	18281.	3817.	4675.	4953.	5297.	5695.	5839.
CASH GENERATED	1741.	1766.	1507.	1261.	3817.	4675.	4953.	5297.	5695.	5839.
PROFIT AFT. TAX, BFR INT.	1136.	1186.	958.	712.	1947.	3054.	3332.	3677.	4075.	4834.
DEPRECIATION AND AMORTIZATION	605.	580.	549.	549.	1870.	1620.	1620.	1620.	1620.	1005.
FINANCIAL RESOURCES	161.	0.	7294.	17020.	0.	0.	0.	0.	0.	0.
SHARE CAPITAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LONG TERM DEBT	161.	0.	7294.	17020.	0.	0.	0.	0.	0.	0.
SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OTHER CASH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NON-CASH FUNDS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
USES OF FUNDS	1644.	1150.	7743.	16197.	4862.	3454.	3703.	5195.	4991.	5056.
FIXED CAPITAL EXPENDITURE	0.	0.	6634.	15480.	0.	0.	0.	0.	0.	0.
NON-DEPRECIABLE ASSETS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DEPRECIABLE FIXED ASSETS	0.	0.	5900.	13768.	0.	0.	0.	0.	0.	0.
INTEREST DURING CONSTRUCTION	0.	0.	734.	1712.	0.	0.	0.	0.	0.	0.
CHANGE IN WORKING CAPITAL	1170.	82.	128.	-157.	1678.	351.	450.	478.	517.	825.
DEBT SERVICES	474.	1068.	980.	874.	3184.	3103.	3253.	4717.	4474.	4231.
REPAYMENT OF LONG TERM DEBT	0.	610.	610.	586.	583.	560.	817.	2431.	2431.	2431.
REPAYMENT OF SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INTEREST ON LONG TERM DEBT	474.	458.	370.	288.	2601.	2543.	2436.	2286.	2042.	1799.
INTEREST ON SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CASH INCREASE OR (DECREASE)	258.	616.	1059.	2084.	-1045.	1221.	1249.	102.	704.	783.
BEGINNING CASH BALANCE	0.	258.	874.	1932.	4016.	2971.	4192.	5441.	5543.	6247.
ENDING CASH BALANCE	258.	874.	1932.	4016.	2971.	4192.	5441.	5543.	6247.	7030.

Table V-3.5 (Continued)

(Example 1, 10% interest, 4 year-grace)

*** CAUSTIC SODA RENOVATION PLANT PROJECT IN INDONESIA ***
FUNDS FLOW STATEMENTS (FOR ENDING DECEMBER 31)
- CASE (3) - 63 T/D (USD 1000)

YEAR	1994	1995	1996	1997	1998	1999	2000
SOURCE OF FUNDS	6327.	6776.	7012.	7273.	7117.	7417.	7721.
CASH GENERATED	6327.	6776.	7012.	7273.	7117.	7417.	7721.
PROFIT AFT. TAX, BFR INT.	5323.	5773.	6053.	6314.	7117.	7417.	7721.
DEPRECIATION AND AMORTIZATION	1004.	1003.	959.	959.	0.	0.	0.
FINANCIAL RESOURCES	0.	0.	0.	0.	0.	0.	0.
SHARE CAPITAL	0.	0.	0.	0.	0.	0.	0.
LONG TERM DEBT	0.	0.	0.	0.	0.	0.	0.
SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.
OTHER CASH	0.	0.	0.	0.	0.	0.	0.
NON-CASH FUNDS	0.	0.	0.	0.	0.	0.	0.
USES OF FUNDS	4609.	4357.	3980.	3760.	3659.	3341.	2597.
FIXED CAPITAL EXPENDITURE	0.	0.	0.	0.	0.	0.	0.
NON-DEPRECIABLE ASSETS	0.	0.	0.	0.	0.	0.	0.
DEPRECIABLE FIXED ASSETS	0.	0.	0.	0.	0.	0.	0.
INTEREST DURING CONSTRUCTION	0.	0.	0.	0.	0.	0.	0.
CHANGE IN WORKING CAPITAL	621.	613.	479.	502.	644.	569.	602.
DEBT SERVICES	3987.	3744.	3501.	3258.	3015.	2772.	1995.
REPAYMENT OF LONG TERM DEBT	2431.	2431.	2431.	2431.	2431.	2431.	1884.
REPAYMENT OF SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.
INTEREST ON LONG TERM DEBT	1556.	1313.	1070.	827.	584.	340.	111.
INTEREST ON SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.
CASH INCREASE OR (DECREASE)	1718.	2419.	3032.	3513.	3457.	4075.	5124.
BEGINNING CASH BALANCE	7030.	8748.	11167.	14199.	17712.	21169.	25244.
ENDING CASH BALANCE	8748.	11167.	14199.	17712.	21169.	25244.	30368.

(Example 1, 10% interest, 4 year-grace)

Table V-3.6 *** CAUSTIC SODA RENOVATION PLANT PROJECT IN INDONESIA ***
PROFITABILITY AND FINANCIAL INDICATORS
- CASE (3) - 63 T/D (USD 1000)

YEAR	(1) AFT TAX PROFIT -TO- SALES REV (PCT)	(2) AFT TAX PROFIT -TO- S/H EQUITY (PCT)	(3) BFR TAX PROFIT -TO- INVESTMENT (PCT)	(4) AFT TAX PROFIT -TO- S/CAPITAL (PCT)	(5) CURRENT RATIO	(6) QUICK RAITO	(7) DEBT SERVICE RATIO	(8) L/T DEBT -TO- S/H EQUITY	(9)* PROFIT B.E.P. CAPACITY UTILIZE (PCT)	(10)* CASH B.E.P. SALES PRICE (PRICE)	(11)* CASH B.E.P. CAPACITY UTILIZE (PCT)
1984	10.0	25.1	11.5	20.7	2.23	1.81	3.67	50 / 50	71.0	484.6	49.4
1985	11.4	21.7	12.6	22.8	2.40	1.92	1.65	37 / 63	68.1	559.3	65.5
1986	8.8	14.9	7.3	18.4	2.69	2.11	1.54	69 / 31	64.0	574.9	63.3
1987	7.1	9.7	2.3	13.3	2.88	2.20	1.44	85 / 15	58.0	628.4	54.3
1988	-6.2	-17.6	-2.3	-20.5	3.89	2.92	1.20	87 / 13	82.0	699.3	64.0
1989	4.3	12.1	1.8	16.0	3.36	2.54	1.51	85 / 15	70.4	679.7	56.4
1990	6.8	17.5	4.7	28.0	1.81	1.38	1.52	81 / 19	66.8	695.7	56.1
1991	9.5	21.3	7.7	43.5	1.93	1.47	1.12	74 / 26	63.4	821.9	72.3
1992	12.6	23.8	11.2	63.5	2.04	1.56	1.27	66 / 34	59.3	817.2	67.9
1993	16.8	26.2	16.7	94.8	2.23	1.67	1.38	55 / 45	52.2	841.9	68.4
1994	19.0	24.5	20.8	117.7	2.35	1.77	1.59	43 / 57	49.0	845.4	64.4
1995	20.6	22.5	24.6	139.4	2.47	1.86	1.81	32 / 68	46.1	856.6	60.7
1996	21.7	20.1	27.5	155.7	2.55	1.92	2.00	21 / 79	43.0	883.2	57.3
1997	22.6	18.1	30.3	171.5	2.63	1.98	2.23	12 / 88	40.6	912.1	54.1
1998	25.4	17.7	36.1	204.2	2.75	2.05	2.36	5 / 95	32.8	976.0	55.2
1999	26.0	16.1	39.1	221.1	3.24	2.42	2.68	-0 / 100	31.1	1010.7	52.4
2000	26.5	14.8	42.0	237.8	6.40	4.77	3.87	-0 / 100	29.8	1005.3	45.1
AVERAGE1	14.3	17.0	17.3	91.0	2.81	2.14	1.93	47 / 53	54.6	781.7	57.4
AVERAGE2	17.7	17.9	18.2	91.0	2.67	2.02	1.77	41 / 59			

(AVERAGE1) : SUM OF ANNUAL FIGURES OF PERCENTAGE AND RATIO IS DIVIDED BY NO. OF YEARS(SIMPLE AVERAGE)
(AVERAGE2) : AVERAGE FIGURES ARE CALCULATED BY ACTUAL VALUES ACCUMULATED OVER THE PROJECT LIFE(WEIGHTED AVERAGE)
* NOTE FOR (9)(10)(11)
WHEN THERE ARE TWO OR MORE PRODUCTS, AND DURING THE YEARS WHEN ALL OF PRODUCTS ARE NOT PRODUCED AT THE SAME RATE OF CAPACITY UTILIZATION, ABOVE BREAK-EVEN-POINTS CANNOT GIVE CORRECT FIGURES.

(Example 2, Equity 30%)

Table V-3.7 *** CAUSTIC SODA RENOVATION PLANT PROJECT IN INDONESIA ***
FUNDS FLOW STATEMENTS (FOR ENDING DECEMBER 31)
- CASE (3) - 63 T/D (USD 1000)

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
SOURCE OF FUNDS	1902.	1766.	8394.	17331.	3572.	3994.	4344.	4723.	5145.	5414.
CASH GENERATED	1741.	1766.	1507.	1261.	3572.	3994.	4344.	4723.	5145.	5414.
PROFIT AFT. TAX, BFR INT.	1136.	1186.	958.	712.	1974.	2645.	2995.	3374.	3796.	4409.
DEPRECIATION AND AMORTIZATION	605.	580.	549.	549.	1599.	1349.	1349.	1349.	1349.	1005.
FINANCIAL RESOURCES	161.	0.	6887.	16070.	0.	0.	0.	0.	0.	0.
SHARE CAPITAL	0.	0.	2066.	4821.	0.	0.	0.	0.	0.	0.
LONG TERM DEBT	161.	0.	4821.	11249.	0.	0.	0.	0.	0.	0.
SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OTHER CASH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NON-CASH FUNDS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
USES OF FUNDS	1644.	1150.	7336.	15247.	4212.	4180.	3721.	3285.	3148.	3167.
FIXED CAPITAL EXPENDITURE	0.	0.	6227.	14530.	0.	0.	0.	0.	0.	0.
NON-DEPRECIABLE ASSETS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DEPRECIABLE FIXED ASSETS	0.	0.	5900.	13768.	0.	0.	0.	0.	0.	0.
INTEREST DURING CONSTRUCTION	0.	0.	327.	762.	0.	0.	0.	0.	0.	0.
CHANGE IN WORKING CAPITAL	1170.	82.	128.	-157.	1670.	351.	450.	478.	517.	833.
DEBT SERVICES	474.	1068.	980.	874.	2542.	3829.	3270.	2807.	2631.	2333.
REPAYMENT OF LONG TERM DEBT	0.	610.	610.	586.	1008.	2449.	2159.	1889.	1889.	1762.
REPAYMENT OF SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
INTEREST ON LONG TERM DEBT	474.	458.	370.	288.	1534.	1381.	1112.	918.	743.	571.
INTEREST ON SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
CASH INCREASE OR (DECREASE)	258.	616.	1059.	2084.	-639.	-186.	623.	1438.	1997.	2248.
BEGINNING CASH BALANCE	0.	258.	874.	1932.	4016.	3377.	3191.	3814.	5252.	7249.
ENDING CASH BALANCE	258.	874.	1932.	4016.	3377.	3191.	3814.	5252.	7249.	9496.

Table V-3.7 (Continued)

(Example 2, Equity 30%)

*** CAUSTIC SODA RENOVATION PLANT PROJECT IN INDONESIA ***
FUNDS FLOW STATEMENTS (FOR ENDING DECEMBER 31)
- CASE (3) - 63 T/D (USD 1000)

YEAR	1994	1995	1996	1997	1998	1999	2000
SOURCE OF FUNDS	5935.	6435.	6721.	7032.	6928.	7298.	7682.
CASH GENERATED	5935.	6435.	6721.	7032.	6928.	7298.	7682.
PROFIT AFT. TAX, BFR INT.	4931.	5432.	5762.	6073.	6928.	7298.	7682.
DEPRECIATION AND AMORTIZATION	1004.	1003.	959.	959.	0.	0.	0.
FINANCIAL RESOURCES	0.	0.	0.	0.	0.	0.	0.
SHARE CAPITAL	0.	0.	0.	0.	0.	0.	0.
LONG TERM DEBT	0.	0.	0.	0.	0.	0.	0.
SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.
OTHER CASH	0.	0.	0.	0.	0.	0.	0.
NON-CASH FUNDS	0.	0.	0.	0.	0.	0.	0.
USES OF FUNDS	2384.	2276.	2043.	1966.	1717.	569.	602.
FIXED CAPITAL EXPENDITURE	0.	0.	0.	0.	0.	0.	0.
NON-DEPRECIABLE ASSETS	0.	0.	0.	0.	0.	0.	0.
DEPRECIABLE FIXED ASSETS	0.	0.	0.	0.	0.	0.	0.
INTEREST DURING CONSTRUCTION	0.	0.	0.	0.	0.	0.	0.
CHANGE IN WORKING CAPITAL	621.	613.	479.	502.	644.	569.	602.
DEBT SERVICES	1763.	1663.	1564.	1464.	1072.	0.	0.
REPAYMENT OF LONG TERM DEBT	1325.	1325.	1325.	1325.	1027.	0.	0.
REPAYMENT OF SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.
INTEREST ON LONG TERM DEBT	437.	338.	239.	139.	45.	0.	0.
INTEREST ON SHORT TERM DEBT	0.	0.	0.	0.	0.	0.	0.
CASH INCREASE OR (DECREASE)	3551.	4159.	4678.	5066.	5212.	6728.	7080.
BEGINNING CASH BALANCE	9496.	13048.	17206.	21885.	26950.	32162.	38890.
ENDING CASH BALANCE	13048.	17206.	21885.	26950.	32162.	38890.	45970.

(Example 2, Equity 30%)

Table V-3.8 *** CAUSTIC SODA RENOVATION PLANT PROJECT IN INDONESIA ***
PROFITABILITY AND FINANCIAL INDICATORS
- CASE (3) - 63 T/D (USD 1000)

YEAR	(1) AFT TAX PROFIT -TO- SALES REV (PCT)	(2) AFT TAX PROFIT -TO- S/H EQUITY (PCT)	(3) BFR TAX PROFIT -TO- INVESTMENT (PCT)	(4) AFT TAX PROFIT -TO- S/CAPITAL (PCT)	(5) CURRENT RATIO	(6) QUICK RAITO	(7) DEBT SERVICE RATIO	(8) L/T DEBT -TO- S/H EQUITY	(9)* PROFIT B.E.P. CAPACITY UTILIZE (PCT)	(10)* CASH B.E.P. SALES PRICE (PRICE)	(11)* CASH B.E.P. CAPACITY UTILIZE (PCT)
1984	10.8	25.1	11.5	20.7	2.23	1.81	3.67	50 / 50	71.0	484.6	49.4
1985	11.4	21.7	12.6	22.8	2.40	1.92	1.65	37 / 63	68.1	559.3	65.5
1986	8.8	9.8	7.5	11.2	2.69	2.11	1.54	51 / 49	64.0	574.9	63.3
1987	7.1	3.8	2.5	4.2	2.08	1.59	1.44	59 / 41	58.0	628.4	56.3
1988	4.2	3.8	2.5	4.4	1.59	1.20	1.41	55 / 45	66.2	654.5	56.8
1989	10.7	9.8	7.3	12.5	1.85	1.40	1.04	48 / 52	54.8	762.9	70.2
1990	14.3	12.7	10.9	18.7	2.16	1.64	1.33	40 / 60	50.4	724.2	60.6
1991	16.8	14.2	14.2	24.4	2.28	1.74	1.60	32 / 68	47.4	698.8	53.2
1992	18.9	15.0	17.7	30.3	2.51	1.93	1.96	24 / 76	44.8	703.6	50.3
1993	21.3	15.9	22.3	38.0	3.19	2.39	2.32	17 / 83	41.4	719.8	49.4
1994	22.6	15.7	26.1	44.5	3.31	2.49	3.37	11 / 89	39.7	699.1	42.0
1995	23.5	15.1	29.6	50.5	3.43	2.59	3.87	7 / 93	38.4	722.0	40.5
1996	24.1	14.1	32.0	54.8	3.51	2.65	4.30	3 / 97	36.8	755.9	39.2
1997	24.4	13.1	34.4	58.8	3.99	3.01	4.80	-0 / 100	35.7	792.0	38.0
1998	26.8	13.2	39.9	68.2	6.44	4.81	6.46	-0 / 100	29.2	840.2	38.0
1999	26.8	12.3	42.3	72.3	6.42	4.79	********	-0 / 100	29.0	805.2	27.7
2000	26.7	11.4	44.6	76.2	6.40	4.77	********	-0 / 100	29.1	853.9	27.8
AVERAGE1	17.6	13.3	21.1	36.0	3.32	2.52	********	25 / 75	47.3	704.7	48.7
AVERAGE2	20.8	12.9	22.5	38.1	3.22	2.43	2.88	17 / 83			

(AVERAGE1) : SUM OF ANNUAL FIGURES OF PERCENTAGE AND RATIO IS DIVIDED BY NO. OF YEARS(SIMPLE AVERAGE)
(AVERAGE2) : AVERAGE FIGURES ARE CALCULATED BY ACTUAL VALUES ACCUMULATED OVER THE PROJECT LIFE(WEIGHTED AVERAGE)
* NOTE FOR (9)(10)(11)
WHEN THERE ARE TWO OR MORE PRODUCTS, AND DURING THE YEARS WHEN ALL OF PRODUCTS ARE NOT PRODUCED AT THE SAME RATE OF CAPACITY UTILIZATION, ABOVE BREAK-EVEN-POINTS CANNOT GIVE CORRECT FIGURES.

3.4 Sensitivity Analysis

Regarding Case 3, fluctuation of FRR to be accompanied by fluctuation of the major financial elements in the comparison with W/O was computed and the outcome is graphically shown in Figure V-3.1. The outline is as follows.

FINANCIAL SENSITIVITY ANALYSIS

(FRR %, 1984 Constant Price)

	10% Up	10% Down
	Bfr.Tax/Aft.Tax	Bfr.Tax/Aft.Tax
Sales Price	13.2/10.7	8.7/ 7.1
Raw Salt Cost	10.9/ 8.9	11.2/ 9.1
Electricity Cost	10.9/ 8.9	11.2/ 9.1
Project Cost	9.6/ 7.9	12.7/10.3
Market Size	12.7/10.3 (maximum)	9.3/ 7.6 (minimum)
Basic Assumptions	11.0/9.0	

The above FRR were strictly computed in the association with the incremenal investment and incremental return in comparison with W/O which is the case without the renovation project. For example, if the unit sales prices of Case 3 are raised by 10%, then those of W/O shall be raised by 10%. Hence, the above figures generally show the lower sensitivities for the same fluctuations of the financial elements when compared with the entirely independent project.

In the case of fluctuation of the electricity cost which occupies more than 40% of the production cost at the plant, FRR is scarcely fluctuated when compared with FRR of the base case. Since the renovation project has been designed within the capacity of the existing rectifier, the electricity consumption of entire factory becomes the same either in Case 3 or in W/O, so that no effect can be observed in FRR computation by incremental analysis because even if the unit electricity cost fluctuates up and down, both cases will fluctuate in the same manner and the balance will become zero. The reason, the slight deviation of FRR is observed, is due to the influence that the unit electricity cost in Case 3 was initially set by 10% lower because of a receiving voltage change and a power factor improvement, and that the electricity consumption is small during the period when the capacity utilization is low.

Further explanation shall be made to avoid the misunderstanding on the fact that fluctuation of the electricity cost does not so much affect to FRR computed in incremental terms. In view of profitability itself, however, the fluctuation of electricity cost exerts the largest influence on profitability for either with- or without- renovation case.

Fluctuation of the sales price has the largest effect on FRR as the price fall of 10% will make FRR after tax down by 1.9% from 9.0% of the base case to 7.1%. Regading fluctuation of the capacity utilization, the sentivity analysis was made on the basis of the Minimum and Maximum Cases in the market size for PT. ISI which is projected in Chapter 1 of Part II. The capacity utilization of W/O has not made fluctuated since its production capacity is small. The former FRR is 7.4% while the latter one is 10.6%. On the other hand, since FRR of Case 1 (46 t/d), the second best project, is 7.7%, this FRR becomes the same as that of Case 3 where the capacity utilization is assumed to be the minimum. Hence, the selection of Case 3 deems to be reasonable.

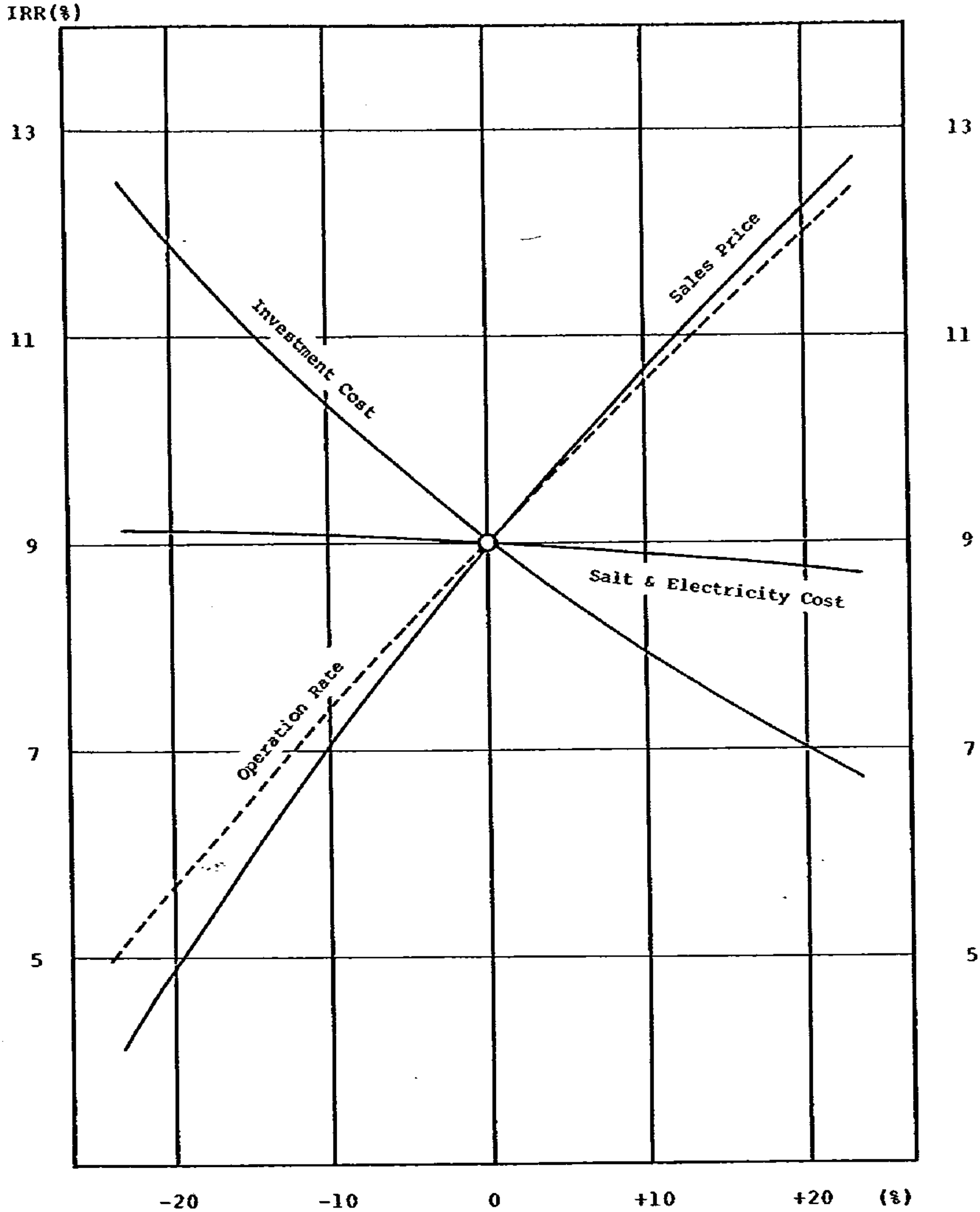


Figure V-3.1 SENSITIVITY ANALYSIS ON THE MAJOR FINANCIAL FACTORS (CASE 3)

PART VI ECONOMIC EVALUATION

PART VI ECONOMIC EVALUATION

Chapter 1 Economic Price

Economic analysis is to be made using economic prices instead of the market prices which are used for the financial analysis to measure economic value of the project.

The economic prices are calculated as follows:

(1) Taxes and duties

Since all taxes and duties imposed on the purchase of equipment and materials as well as on the project contract is deemed as a transferrable cost, the taxes and duties included in the project cost is to be deducted for economic evaluation.

The carparat tax will be excluded from the expense in the same reason.

(2) Sales price of products

The economic prices of goods are defined as the price at the boundaries of a country (CIF or FOB) on the basis of the international price if they are tradable goods. In general, the industrial products are deemed as the tradable goods. Since the products to be produced by this project are all for the domestic consumption, international prices of CIF Indonesia shall be economic prices.

On the other hand, the prices of non-tradable goods such as electric power and water are usually considered that the prevailing market prices have reflected their real economic value.

Thus, the market prices are regarded as equivalent to the economic prices in this study as well.

(a) The price of aqueous caustic soda in 1984 is projected as US$300/t (as 100% basis) as described in Part II, Chapter 2. On the other hand, CIF Indonesia of aqueous caustic soda is around US$150/t. The maximum CIF price in the recent years was US$300/t in the neighboring countries in the years of 1980 - 1981 right after the second oil crisis had happened, although Indonesia has scarcely imparted aqueous caustic soda in those years. At that time, domestic market price in Indonesia was between US$450/t and US$500/t. When the domestic market price became US$400/t in 1982, international market price as CIF was US$220/t.

As illustrated above, CIF price of aqueous caustic soda has been about 50 - 60% of the domestic market price, which shall be economic sales price of caustic soda for the project.

(b) Liquefied chlorine has not been internationally dealt with, but a small amount of it has been imported or exported on spot basis. There is no such a special vessel that has a large capacity container with high presure resistance on board for the bulk transport of liquefied chlorine, so that at the most, a cylinder of 1 ton capacity is used for transportation. According to the hazardous nature of the good as well as the expensive fee for returning cylinders to an export country and the depreciation cost of a cylinder, the transportation cost is inclined to be higher than the content of a cylinder.

Since the international trading quantity is not so much that it is difficult to estimate the common international price of liquefied chlorine, but as far as the import statistics of Indonesia is concerned, it is recorded as US$1,140/t to US$1,240/t in 1981 - 1982. Because of the errors and omissions which are commonly observed in such statistics, it is supposed as precarious to believe those figures as they are, but if taking into account that the price of a cylinder having 1 ton capacity is US$2,000 and a round trip transport cost is expensive as mentioned above, CIF price described above is estimated to be appropraite as noted below.

On the other hand, the projected domestic market price in Indonesia is US$600/t in 1984. Hence, if it is assumed that the economic price is equivalent to the import price, the economic price has to be around two times of the domestic market price.

(Note) A preliminary estimation is made as US$200/t of FOB, US$400/t of 20% depreciation of a cylinder, and US$200/t of a round trip fee for a cylinder, which sum up to US$800/t in total. In addition to the above total price, the unloading fees at the unloading port and the marine insurance for the hazardous material are to be added.

(c) Hydrochloric acid is also not commonly dealt with in overseas business. A content of 33% to 35% hydrochloric acid means that the remained 67 - 65% of water is to be transported simultaneously, resulting in the higher transport cost. For an example, the import was made from Thailand by means of drums. It is said that the import from Thailand is now being reviewed again and CIF Indonesia is estimated as about US$200/t.

On the other hand, the domestic market price in 1984 is projected as US$114/t, so that the economic price becomes about 1.7 times of the domestic market price.

(d) As BLC and BLN have scarcely been traded, it is easily supposed that the ratio of the import price and the market price may be higher than that of hydrochloric acid due to the lower chlorine contents such as 8% and 12% respectively. The economic price will be more than two times of the market price.

(e) According to the outcome of the above discussions, the economic price is projected as 0.5 times of the market price for caustic soda, and 2.0 times of the market price for chlorine products.

(3) Raw salt

Raw salt is a tradable good. The market price of raw salt domestically produced in 1984 is projected as US$32.4/t, whereas CIF price of the imported raw salt from Australia is about US$30/t in Asean countries. The price is varied due to the quality of raw salt such as the content of impurities of Ca, Mg and SO_4. The comparison of the quality is as shown below which indicates inferiority of the raw salt domestically produced.

(Unit: %)

	Indonesia	Australia
Ca (%)	0.30	0.05
Mg (%)	0.30	0.04
SO_4 (%)	0.50	0.15

In view of the price and quality, it is observed that the market price has been determined as comparatively higher than the import price. Hence, in this study, the economic price of raw salt is measured as 90% of the market price.

(4) Chemicals and utilities

Since most of the chemicals are to be imported and the utilities are non-tradable goods, the economic price is measured as equivalent to the market price.

(5) Salaries and wages

As it is supposed that the salaries and wages of the skilled labours among all employees of the works of PT. ISI are reflected by the real values, their salaries and wages can be regarded as the economic values. On the other hand, the unskilled labours in the countries which have many unemployed labours can be easily replaced either by the current unemployed labours or the semi-unemployed labours who are obliged to engage in the work of agriculture. Hence, the real values of the unskilled labours can be estimated as lower than the salaries and wages which they have received.

Out of the operators of 128 persons at the works of PT. ISI (total employees are 256 persons), a half of them are regarded as the unskilled labours, thus a half of the paid salaries and wages for the operators are regarded as shadow wages, which are almost equivalent to 10% of the total salaries and wages. Hence, the economic values of the salaries and wages is projected as 90% of the total paid salaries and wages. Economic cost related to labors such as welfare benefit, overhead expenses and so on are also measured as 90% of the actual expenses paid by PT. ISI.

(6) Exchange rate

In the event that the official exchange rate has not properly reflected the real values of the local and foreign currency, the shadow exchange rate will be used with reference to the real exchange rate available at the black market, etc.

In Indonesia, however, such a circumstance can not be observed and the exchange rate has been so floating as to reflect the real values of the currency. From the such point of view the official rate of exchange can be considered as a real exchange rate.

2.1 Economic Rate of Return (ERR)

The following table shows ERR which is calculated on the basis of the economic price as described in Chapter 1 and NPV with the discount rate of 10%. Either one is calculated by the incremental comparison for W/O as same as in the case of the financial analysis.

	ERR (%)	NPV (US$1,000)
Case 1	17.4	4,680
Case 2	16.7	4,771
Case 3	18.5	8,532

ERR is more than 15% for all cases and can be regarded as economically feasible. In the comparison among the cases, both of ERR and NPV show the higher investment effect in the order of Case 3, Case 1 and Case 2 as the same order as financial analysis.

The reason of the high economic indices is that unless the renovation project has taken place, the domestic supply of the chlorine products will be in shortage and the relevant industries in Indonesia have to import these products at the prices two times higher than those of the domestic products.

In other words, even if it is assumed that caustic soda produced domestically is sold at the price two times higher than the imported one, the contribution of the chlor-alkali industry to the industries of Indonesia is so great that it is supposed as valuable to foster the chlor-alkali industry. At least, it is believed necessary to promote the expansion of the plants to satisfy the domestic demand of chlorine.

2.2 Sensitivity Analysis

The outcome of the sensitivity analysis for Case 3, which was calculated in the same manner as in the case of the financial analysis, is as shown in Figure VI-2.1, and a summary is as shown below.

The column of 'Market Price' in the following table shows ERR which was calculated for reference assuming that economic sales prices would be the same value of the market prices.

ECONOMIC SENSITIVITY ANALYSIS

(ERR%, 1984 Constant Price)

	10% up	10% down
Sales Price	20.9	15.8
Salt	18.3	18.6
Electricity	18.4	18.5
Project Cost	16.6	20.6
Market Size	22.2 (Max)	16.2 (Min)
Basic Assumption	18.5	
Market Price 1/	11.6	

(Note) 1/ Market sales prices are used instead of the economic sales price

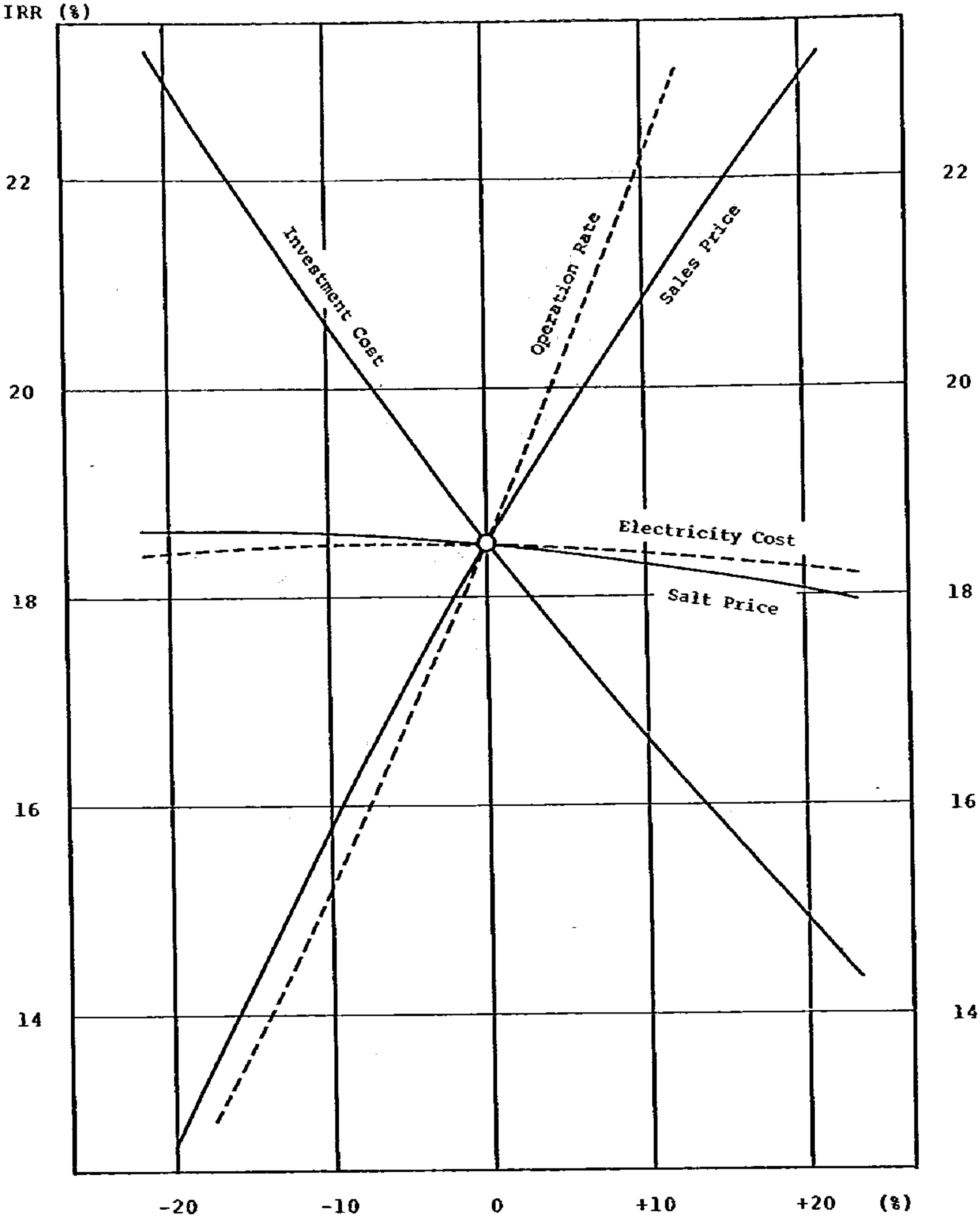


Figure VI-2.1 SENSITIVITY ANALYSIS ON THE MAJOR ECONOMIC FACTORS (CASE 3)

2.3 Foreign Exchange Earnings of the Project

The contribution to improve the foreign exchange balance in Indonesia owing to the implementation of this project is calculated in the following manner.

(a) All prices and costs are based on the market prices.

(b) The incrementals of the renovation project are calcualted by the balance of Case 3 and W/O.

(c) The incremental sales revenues are all regarded as the saving amount of outflow of foreign exchange (import substitution).

(d) The expenses for chemicals and lubricating oil in the production cost are regarded as outflow of foreign exchange except slaked lime being domestically produced.

(e) The fuel oil is regarded as outflow of the foreign exchange since it is an exportable good.

(f) 50% of the maintenance cost and all purchase price of the membranes and anodes are regarded as outflow of foreign exchange.

(g) The expenses for the operation advisors to be invited from abroad are outflow of the foreign exchange.

(h) The foreign loans are inflow of the foreign exchange, which will be set off in the same amount by outflow of the payment for the construction cost. The reimbursement for the loan is outflow of the foreign exchange.

(i) The interest on the foreign loans is outflow of the foreign exchange.

As this renovation project can be considered as the import substitution project in the substance, the outcome of calculation for the foreign exchange earnings is as shown in Table VI-2.1.

Although outflow of the foreign exchange is larger than inflow for the initial two years of 1988 and 1989, it becomes reversed in the third year. The accumulated foreign exchange earnings will turn out to be plus in the fourth year. It is projected that the foreign loans are US$13.51 million and is supposed that the accumulated foreign exchange earnings will reach US$22.03 million in 1995 when the reimbursement for the loan is entirely completed. The implementation of this project will greatly contribute to the foreign exchange balance in Indonesia and prevent the balance from becoming worse.

Table VI-2.1 FOREIGN CURRENCY SAVINGS FOR CASE 3

(Unit: US$ Million)

	1988	1989	1990	1991	1992	1993	1994	1995
In-flow (from sales)	3.17	3.95	4.83	5.80	6.87	8.21	9.51	10.73
Out-flow								
Materials	0.41	0.46	0.53	0.61	0.70	0.80	0.91	1.01
Maintenance & Repairing	0.58	0.61	0.65	0.63	0.67	0.82	0.86	0.92
Operation Advisor	0.26	-	-	-	-	-	-	-
Interest on foreign loan	1.35	1.18	1.01	0.84	0.68	0.51	0.34	0.17
Sub-total	2.60	2.25	2.19	2.08	2.05	2.13	2.11	2.10
Principal Repayment	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.68
Out-flow total	4.29	3.94	3.88	3.77	3.74	3.82	3.80	3.78
Net In-flow	(1.12)	(0.01)	0.95	2.03	3.13	4.39	5.71	6.95
Accumulated Net In-flow	(1.12)	(1.13)	(0.18)	1.85	4.98	9.37	15.08	22.03

2.4 Other Economic Effects

The other economic effects to be expected by the renovation project are as follows.

(a) The increase in employment and income for the inhabitant who are engaging in the production of solar salt due to the increased consumption for raw salt to be domestically produced.

(b) The improvement for the regional environmental circumstance due to installation of the treatment facilities for the exhaust gas and waste water.

(c) The promotion or support for the growth of the associated industries due to the advancement of stable supply to be intensified by the expansion of the production capacity.

APPENDIX

APPENDIX TO PART I

APPENDIX I-1 MEMBERS LIST OF JAPANESE STUDY TEAM

Name	Attached to	Function of the Project
Mr. KATSUO ADACHI	Japan Consulting Institute	Team Leader, Project Manager
Mr. SHOZO INAKAZU	UNICO International Corporation	Sub Leader, Techno-Economist
Mr. TOSHIKAZU YABU	Japan Consulting Institute	Process Engineer
Mr. AKIRA ISHIZAKA	UNICO International Corporation	Marketing Economist
Mr. YOSHIO SATO	UNICO International Corporation	Market Expert
Mr. YASUSUKE OTOKITA	UNICO International Corporation	Mechanical Engineer

APPENDIX I-2 LIST OF COUNTERPARTS IN INDONESIA

Name	Title and Organization	Function of the Project
Messrs;		
Soenaryo	Director for Programming, DGBCI, MOI, Indonesia	Coordination
Tastir	Director for Inorganic Chemical Industry DGBCI, MOI, Indonesia	Coordination
Rustam Djamin	Staff for Directorate of Inorganic Chemical Industry, DGBCI, MOI, Indonesia	Coordination
Soetjipto	Director for PT. ISI	Leader
Sjamsul Arifin	Staff for PT. ISI	Sub Leader
Ngatno	- do -	Marketing
Richard Masdjedi	- do -	Marketing
Soemarsono	- do -	Finance
Soehardi	- do -	Technical
Mahmud Saad	- do -	Process
Achmad Sediono	- do -	Repair & Maintenance
Soedanto	- do -	Secretary
Soerjono	- do -	General Affairs

APPENDIX I-3 LIST OF ORGANIZATIONS VISITED AND PERSONS MET BY THE STUDY TEAM

Organizations	Name	Position
Japanese Embassy	Mr. A. Sugahara	Secretary
Consulate-General of Japan in Surabaya	Mr. T. Yokokawa	Consulate-General
JICA	Mr. K. Yamamura	Resident Representative
	Mr. T. Sugihara	Asst. Resident Representative
OECF	Mr. T. Shinozuka	Chief Representative
JETRO	Mr. S. Sasaki	Director of Industrial Affairs
Directorate of	Mr. G. O. Simanjuntak	
Inorganic Chemical	Ms. Imam Subagyo	
Industry (MOI)	Mr. Karmasuwita	
	Mr. Widiastuti	
BKPM	Mr. R. Soekito	Public Relation Dept.
PLN, Surabaya	Mr. Hartoyo	Distribusi Jawa Timur
PLN, Gresik	Mr. Soetomo	Chief of Operation Dept.
Perum Garam	Mr. Momo Ratmawidjaja	Director of Technical and Production
Jakarta City Water	Ms. Anggraini Dewi	
Pulp and Paper Association	Mr. Marjiyo	Chairman
P.T. Kertas Leces	Mr. R.G. Soetiodibroto	Logistic Dept. Manager
	Mr. Sri Margono	Plant Manager
	Mr. A. Sabur	
P.T. Petrokimia Gresik	Mr. B. Soeprijono	
P.T. Ajinomoto Indonesia	Mr. T. Miyasaka	Director, Factory Manager
	Mr. Made putra	Manager

Organizations	Name	Position
P.T. Unilever Indonesia	Mr. Eddi Harjoto	Surabaya Technical Buyer
	Mr. L. Rubyono	Jakarta Chief Buyer
P.T. Fumira	Mr. F. Sasaki	Production Control Adveiser
P.T. Southern Cross Textile Ind.	Mr. K. Iwase	Director
P.T. G. S. Battery Inc.	Mr. H. Kurata	Director
P.T. Dino Indonesia Industrial Ltd.	Mr. B. Adesoetjohcha	Product Manager
P.T. Rodamas Company Ltd.	Mr. Margono	Director Utama
P.T. Century Textile	Mr. H. Okubo	President
Ind.	Mr. M. Hackike	Director
P.T. Polekao Indonesia Chemicals	Mr. K. Sakamoto	Vice President
P.T. Inprikarin	Mr. K. Hobker	Director
P.T. Union Carbide Indonesia	Mr. Puratman Wongsohardjono	Purchasing Manager

APPENDIX I-4 LOCAL SURVEY SCHEDULE PERFORMED BY THE STUDY TEAM

16 May	All members (JKT)		Left Tokyo and arrived at Jakarayta
17 May	All members (JKT)	1.	Visited Directorate General of Basic Chemical Industry, MOI Mr. M. Tasfir Director for Inorganic Chemical Industry. Mr. R. Djamin Staff for Directorate of Inorganic Chemical Industry. Presentation of the inception report.
		2.	Visited JICA Jakarta Office Presentation of the inception report.
		3.	Visited Embassy of Japan presentation of the inception report.
18 May	All members (JKT) to (SBY)	1.	Visited JETRO and OECF Branch Office. Presentation of the study. Left Jakarta to Surabaya.
19 May	All members		Visited PT. ISI. PT. ISI all counterpart. Presentation and Orientation for the study.

20 May	All members (SBY)	PT. ISI Orientation and discussion in each group.
21 May	All members (SBY)	Holiday
22 May	Technical/Financial (SBY) Market group (SBY)	PT. ISI. Study by each group. Visited PT. Kertas Leces for Demand Survey.
23 May	Technical/Financial (SBY) Market group (SBY)	PT. ISI study for each group. Visited customers for PT. ISI in Gresik.
24 May	Technical/Financial (SBY) Market group (SBY) Mr. Sato (SBY) to (JKT)	PT. ISI. Study by each group. Visited Ajinomoto Surabaya for demand survet. Left Surabaya for market survey to Jakarata.
25 May	Financial/Market (SBY) Technical group (SBY) Mr. Sato (JKT)	PT. ISI study for each group. Visited Perusahaan Umum Garam Mr. Momo Partawidjaja Technical Director Survey for raw material salt. Market survey in Jakarta area (JETRO etc.)

26 May	Financial/Market (SBY)	PT. ISI. Study for each group.
	Technical group (SBY)	Visited salt-farm, Gresik Manyar.
	Mr. Sato (JKT)	Visited P.T. Fumira for a related industry.
27 May	Technical/Financial (SBY)	Holiday
	Mr. Ishizaka (SBY) to (JKT)	Left Surabaya to Jakarta for Market Survey.
	Mr. Sato (JKT)	Holiday
28 May	Technical/Financial (SBY)	PT. ISI. Mr. Soetjipto, Technical Director. Discussion for basic plan of renovation.
	Market group (JKT)	PT. G.S. Battery, PT. Dino, PT. Century Textile, Central Bureau of Statistics.
29 May	Technical/Financial (SBY)	PT. ISI. Discussion for individual equipment to be renovated.
	Market group (JKT)	PT. Polekao, PT. Southern Cross, MOI, Jakarta City Water Service.
30 May	Technical/Financial (SBY)	PT. ISI. Mr. Soetjipto, Technical Director Discussion for basic plan for renovation.
	Market group (JKT)	PT. Union Carbide, PT. Inprikarin, Jakarta port, MOI, PT. Unilever.

31 May	Technical/Financial (SBY)	Preparation of the progress report.
	Market group (JKT)	Preparation of the progress report.
1 June	Technical/Financial (SBY) to (JKT)	PT. ISI Presentation of the progress report. Left Surabaya to Jakarta.
	Market group (JKT)	PT. Centruy Textile (Factory), PT. Southern Cross (Factory). Preparation of the progress report.
2 June	All members	Visited JICA, Jakarta office presentation of progress report. Visited D.G. of Basic Chemical Industry, MOI. Presentation of the progress report.
3 June	All members	Holiday
4 June	All members	Visited D.G. of Basic Chemical Industry, MOI. Submission of a minutes of meeting on the progress report. Left Jakarta.
5 June	All members	Arrived at Tokyo.

APPENDIX I-5 LIST OF DOCUMENTS OBTAINED BY THE TEAM

From PT. ISI

1. General Outline of PT. ISI (Persero) Waru.
2. Table of Organization at PT. ISI Waru
3. General Plot Plant.
4. Single Line Diagram for Power Receiving.
5. Quality of Raw Salt used in PT. ISI (1981-1983)
6. Quality of Purified Brine used in PT. ISI (1981-1983)
7. Production Cost Saving Plant (Electricity).
8. Operation Standards (Brine, Electrolysis, Liquified Chlorine, Hydrochloric Acid)
9. Raw Material Consumption for Products (1981-1983)
10. Number of Worker in Each Section (Shift, Daily)
11. Electricity Consumption in the Factory (1980-1983)
12. Quality of the Products (1983-Present)
13. Mechanical Flow Diagram for Electrolysis, Liquefied Chlorine, Hydrochloric Acid.
14. Equipment List
15. Balance Sheet of Water Treatment
16. Financial reports including P & L, B/S and production cost
17. Detail break down of cost items (labor, material, etc.)
18. List of Subconstructor
19. Data on the Rectifier (MITSUBISHI)
20. Analytical Data on Drain Water
21. PM Schedule Sheet (Power Station, Rectifier)
22. Data on the Operation of Electrolyzer.
23. Makalah Tentang, Kondisi & Rencana Pengembengan, PT. ISI

Publication

1. Statistik Indonesia (1982)
2. Statistik Industri (Volume 1) (1981)
3. Statistik Industri (Volume 2) (1981)
4. Impor (November 1983)
5. Ekspor (November 1983)
6. Penduduk Indonesia
7. Indikator Ekonomi
8. Buletin Ringkas (April 1984)
9. Buku Saku Statistik Indonesia (1982)
10. Indonesian Product Reference (1983-1984)
11. Tarip Bea Masuk
12. Industrial Directory of Indonesia (1982)
13. Daftar Skala Prioritas (Vol I) (1982/84)
14. Priority List for Foreign Investment (Vol. II)
15. Daftar Biding Usaha (Vol III) (1983/84)
16. Daftar Biding Usaha (Vol IV) (1983/84)
17. Daftar Biding Usaha (Vol V) (1983/84)
18. Daftar Biding Usaha (Vol VI) (1983/84)
19. Daftar Petunjuk (Vol VII) (1983/84)
20. Directory 1981
21. Laws and Regulations of Indonesia

APPENDIX TO PART II

APPENDIX II-1 THE DEVELOPMENT PATTERN OF THE SODA INDUSTRY

Chapter 1 The Chlor-alkali Industry

1.1 Introduction

The chemical industry is a basic industry which produces many products without which modern life would not be possible, and the soda and sulphuric acid industries have taken leading roles in the development of the industry by supplying chemicals essential to many other industries. In addition to the many new products introduced as a result of the rapid development of the industry, the industry has had dramatic impacts through promoting the substitution of new raw materials for old, and through progress in reaction technology. The chlor-alkali industry, a basic chemical industry, while receiving the benefits of these developments, has also undergone many changes in regard to its products. As examples of this, vinyl chloride which originally was produced by the coal-industry-based carbide and acetylene route, is now made from esthylene, and rayon staple which used to be made from pulp, has largely been replaced by polyester fiber and acryl fiber due to the development of the petrochemical industry. These changes are one of the reasons that an imbalance has developed of chlorine and caustic soda in the chlor-alkali industry.

Imbalance of chlorine and alkali demand, in Indonesia at present, shows a pattern wherein chlorine demand is less than the supply, but it should also be noted that the industrialized countries have gone through a historical development phase wherein chlorine demand has grown and caustic soda came to be in surplus, in accordance with the development of industry and especially of petrochemical industry. In view of the expectation that the petrochemical industry in Indonesia will undergo further development, this chapter reviews the history of development of Japan's petrochemical industry which also has experienced a shift from prominence of caustic soda to promimence of chlorine, as it is believed that this experience will be of value to Indonesia in planning the development of that country's chlor-alkali industry as well as in determining location of production facilities.

1.2 Outline of the Development of the Chlor-alkali Industry in Japan

Production of chlorine and caustic soda in Japan, by means of electrolysis, began in 1915, 25 years after the Greeceheim Electro company of Germany started the production. Production of soda ash by the ammonia process was begun a year later, in 1916. Production of caustic soda grew rapidly due to the stimulation of demand caused by World War I and the interruption in supply from Europe but after the war for many years the chlor-alkali industry failed to demonstrate significant progress, due to the industry's having a weak business base, failure to develop products which use chlorine, and an export drive by European makers of caustic soda and soda ash. The industry made progress during the 1930's, in accordance with the general growth and development of industry, and whereas there was an increase in caustic soda demand due to development of the rayon industry, chlorine-using industry failed to show comparable development, and starting in 1933 the method of producing caustic soda from soda ash was developed.

A summary of the chlor-alkali industry as it was in 1937 - 1938 is shown in Table AII-1.1. About 80% of the chlorine made was consumed in production of inorganic compounds and only 20% was used to make organic compounds. Total demand for caustic soda was 435,000 tons of which 60% or 270,000 tons was used in the making of rayon. Because chlorine-using industry was undeveloped, and since electrolysis produced 133,000 tons of caustic soda, the shortfall in supply of caustic soda was countered by conversion of soda ash and the small portion of demand which remained after that was satisfied by imports.

At present, vinyl chloride is the largest chlorine-consuming product. Production of vinyl chloride in Japan was begun in 1941; at that time it was made by the synthesis of acetylene, ordinary salt, and sulphuric acid.

Great damage to the chlor-alkali industry -- and all industry -- was at the consequence of World War II but thereafter a process of recovery began and in 1952 production of vinyl chloride was resumed, by use of acetylene, in a chlor-alkali plant using electrolysis.

Subsequently in 1958 production of ethylene on the scale of 20,000 t/y, by cracking naphtha, was begun and although initially almost all the ethylene was consumed to make polyethylene and related products, gradually new uses for ethylene were developed such as chlorinated solvents and EO. In 1967 production of vinyl chloride by the EDC process was begun and it gradually supplanted the acetylene process.

The emergence of the petrochemical industry increased demand for chlorine. Production of chlorine and caustic soda increased, but because demand for caustic soda did not grow in a corresponding way, the production of caustic soda made by the conversion of soda ash was halted.

Together with the development of vinyl chloride resins, production of caustic soda increased steadily, but use of a mercury process to produce it led to pollution of the environment. At the direction of the government, in 1973, it became necessary to replace mercury-process electrolysis facilities with diaphragm production facilities but the first oil shock created great disorder in the chlor-alkali industry. Thereafter, from about 1980, technological progress was made in the area of ion exchange membrane electrolysis facilities, and because this technology made it possible to reduce electric power and steam consumption, it began to be adopted in place of the older methods.

Japan's chlor-alkali industry which thus made swift progress in becoming comparable in scale to that of West germany (both countries, however, producing less than the United States) in terms of having 3,000,000 t/y of capacity nevertheless had to use expensive, imported salt as raw material (costing more than US$20/ton) as well as expensive electric power (USc7/kWh), the cost of caustic soda and chlorine is high and the industry is losing competitiveness compared to other countries.

Table AII-1.1 SUPPLY/DEMAND FOR NaOH AND CHLORINE IN JAPAN

(1) NaOH (1937, 1938)

	1937	1938
Production		
Electrolysis	133,752	145,487
From Soda Ash	234,928	301,671
Total	368,680	447,158
Demand		
Export	5,514	-
Import	27,429	
Domestic consumption	390,595	435,800

(2) Breakdown of NaOH Consumption (1938)

Industry	Consumption (ton)	Composition (%)
Light metal	7,800	1.8
Pulp & paper	30,800	7.1
Soap	22,450	5.1
Rayon	271,600	62.3
Chemical industry	24,800	5.7
Others	78,400	18.0
Total	435,800	100.0

(3) Chlorine (1937)

	Production (ton)	CL Consumption (ton)	Composition (%)
Hydrochloric acid	122,925	46,712	38.8
Bleaching powder	84,834	33,933	28.2
HTH	2,338	3,273	2.7
Liq. Chlorine	12,293	12,908	10.7
Others*	-	23,551	19.6
Total	-	120,377	100.0

* Chlorbenzen, dinitro chloro benzene, ethylen-dibromide, tetra ethyle lead, carbon tetra chloride, metal magnesium, ethylen glycol, sodium hypochlorite, etc.

1.3 Relation of the Chlor-alkali Industry to the GNP

Caustic soda and chlorine are chemicals of basic importance to many industries and the extent to which the chlor-alkali industry has developed can be used as one measure of a country's industry and economy. It is known that there is a close relationship between the scale of production by the industry and the country's GNP. this relationship, in major industrialized countries, is shown in Figure AII-1.1 from which it may be seen that higher levels of caustic soda production are related to the scale of the GNP. Further, the relation between caustic soda prodcution and GNP in Japan from 1948 to 1975 has been consistent, as shown in Figure AII-1.2.

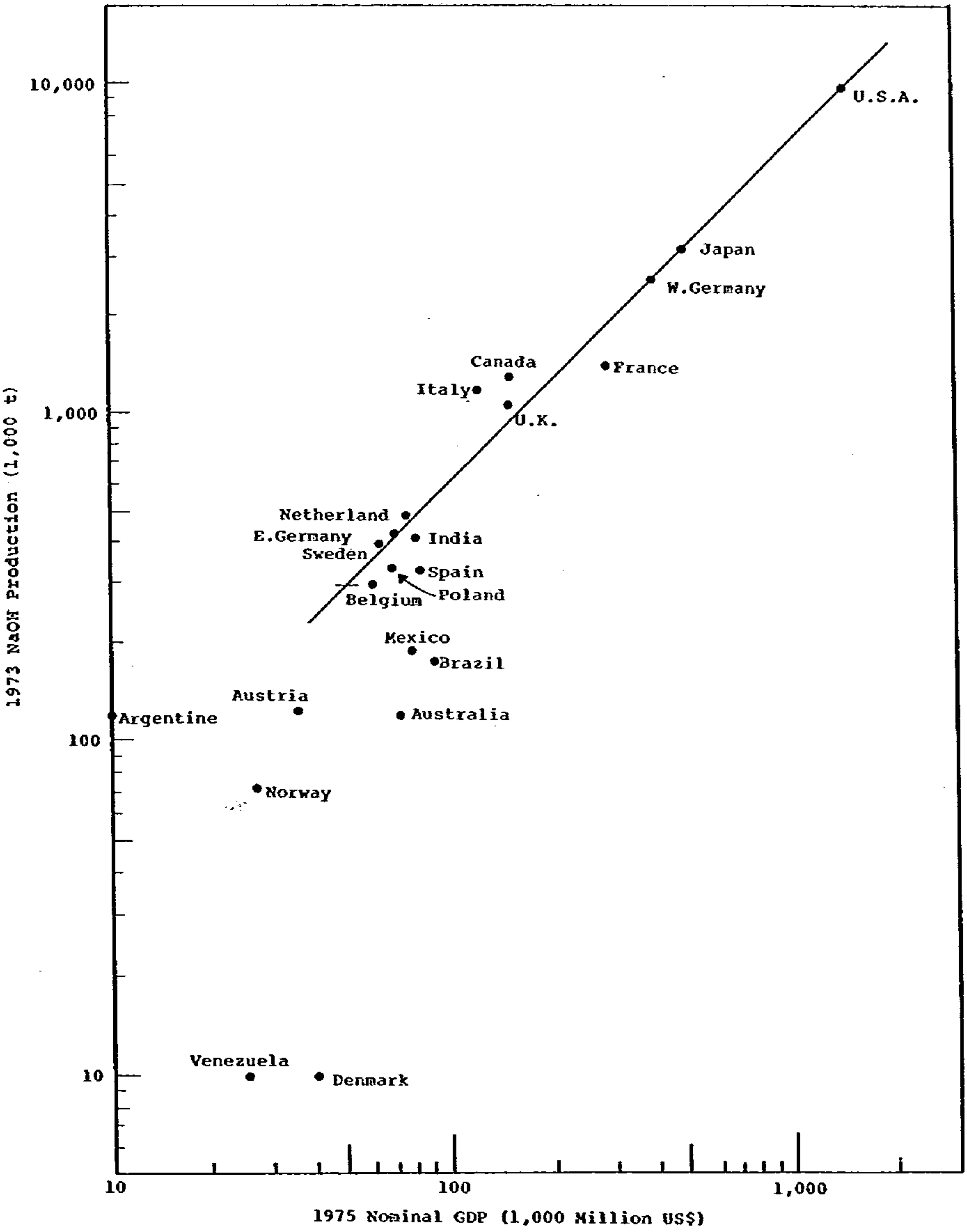


Figure AII-1.1 RELATION OF GNP VS. PRODUCTION OF CAUSTIC SODA IN ADVANCED COUNTRIES

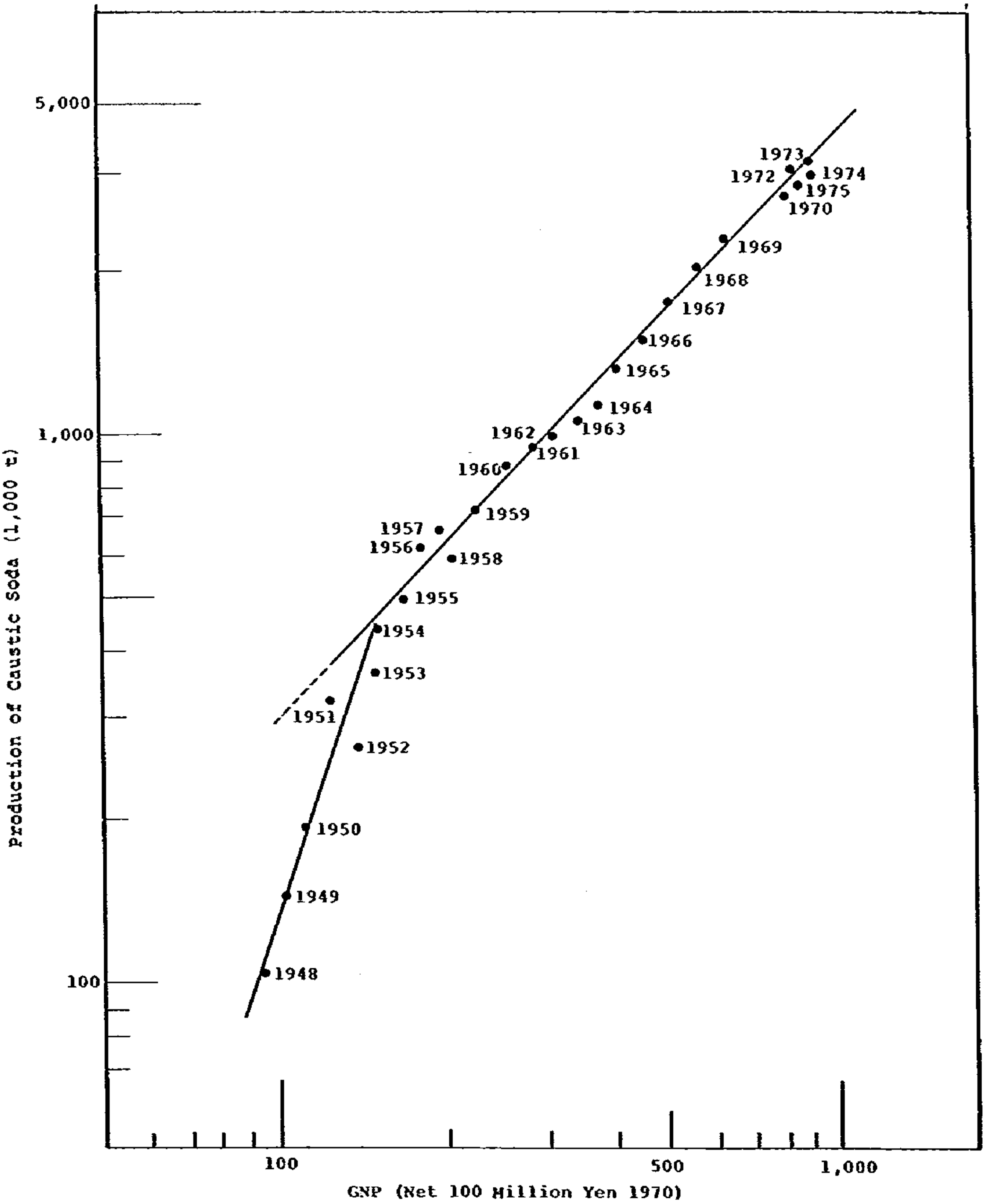


Figure AII-1.2 RELATION OF GNP VS. PRODUCTION OF CAUSTIC SODA IN JAPAN

Chapter 2 Caustic Soda

2.1 Structure of Caustic Soda Supply and Demand in Japan

Caustic soda is widely used for the production of many goods. Industrial goods made by use of caustic soda are shown in Figure AII-1.3. The structure of supply and demand for caustic soda since 1950 is shown in Table AII-1.2, and composition of total demand is shown in Figure AII-1.4. The situation in major caustic soda based industries is described below.

(a) Rayon industry

Japan's rayon industry was created in 1918, and has made rapid growth since 1930, leading to a swift increase in demand for its raw materials namely caustic soda, sulphuric acid, and carbon bisulphide. The influence on growth of demand for caustic soda in particular was strong, in accompaniment with development of the industry. Supply of chlorine could not be increased, however, and it became necessary to rely on conversion of soda ash (see Table AII-1.3).

Production of synthetic textile materials increased after the start of ethylene production in 1958, and as shown by Table AII-1.4 this led to change in the demand for rayon and a decline in the rayon industry's demand for caustic soda. This, combined with improvements in rayon production technology, resulted in demand in 1980 of 230,000 tons, well below the peak level of 310,000 tons and this combined with increases in demand for caustic soda for other uses led to the rayon industry having a share of total caustic soda demand below 10%.

(b) Paper and pulp industry

The paper and pulp industry consumes about 10% of total caustic soda demand. In terms of the quantity consumed, there has been an increase from 33,000 tons in 1950 to 348,000 tons in 1980 -- which roughly paralles the overall growth of caustic soda demand. This industry thus is a rough measure of the trend of caustic soda demand.

(c) Aluminum industry

There has been a rapid increase in demand for caustic soda in the aluminium industry, in keeping with increases in the quantity of alumina processed.

(d) Chemical industry

Within the chemical industry the sources of the greatest influence on caustic soda demand have been production of inorganic chemicals and production of sodium hypochlorite. The influence on demand for chlorine is described separately in another section of this report but it is to be noted that in keeping with the development of the petrochemical industry, demand for chlorine, for use in making vinyl chloride, and chlorinated solvents, has grown, and because increased production of caustic soda has accompanied the increased production of chlorine, the production of caustic soda by conversion of soda ash has ceased. At the same time, efforts were made to have inorganic chemical producers use caustic soda instead of soda ash, as a means of increasing demand.

A comparsion of the quantities of production of major inorganic chemicals, and consumption of caustic soda and soda ash, is shown in Table AII-1.5. In addition to the chemicals shown here, efforts were made to have producers of sodium nitrate, sodium nitrite, sodium sulfite and other chemicals to change from using soda ash as a raw material to using caustic soda.

The need to reduce and control environmental pollution came to be an issue of great concern starting in about 1965 and use of caustic soda to process waste gas and effluent increased rapidly. Industry sources state that consumption of caustic soda for this purpose increased from 60,000 tons in 1970 to 130,000 tons in 1975.

(e) Summary

Consumption of caustic soda, which was 240,000 tons in 1950, has increased to 2,900,000 tons in 30 years. Although there are demand areas such as the rayon industry which now consume less caustic soda than before, in order to satisfy the growth in demand, caustic soda producers, while promoting the development of the chlorine-using industries, have made strong efforts to stop the production of caustic soda from soda ash, and to encourage inorganic chemical makers using soda ash to replace it with caustic soda. In the future, however, demand for caustic soda is not expected to grow by a great margin because of the maturation of user industries such as the soap, detergent, and paper and pulp industries, as well as the lesser need in the structurally depressed industries which have lost competitiveness relative to foreign producers, such as the aluminum industry. On the other hand, if there is an increase in importation of low-cost products made by use of chlorine (such as E.D.C., and chlorine-based organic solvents) there will be a sharp cut in caustic soda production, matching the cutback in chlorine production, and it is expected that there will continue to be an imbalance of supply and demand.

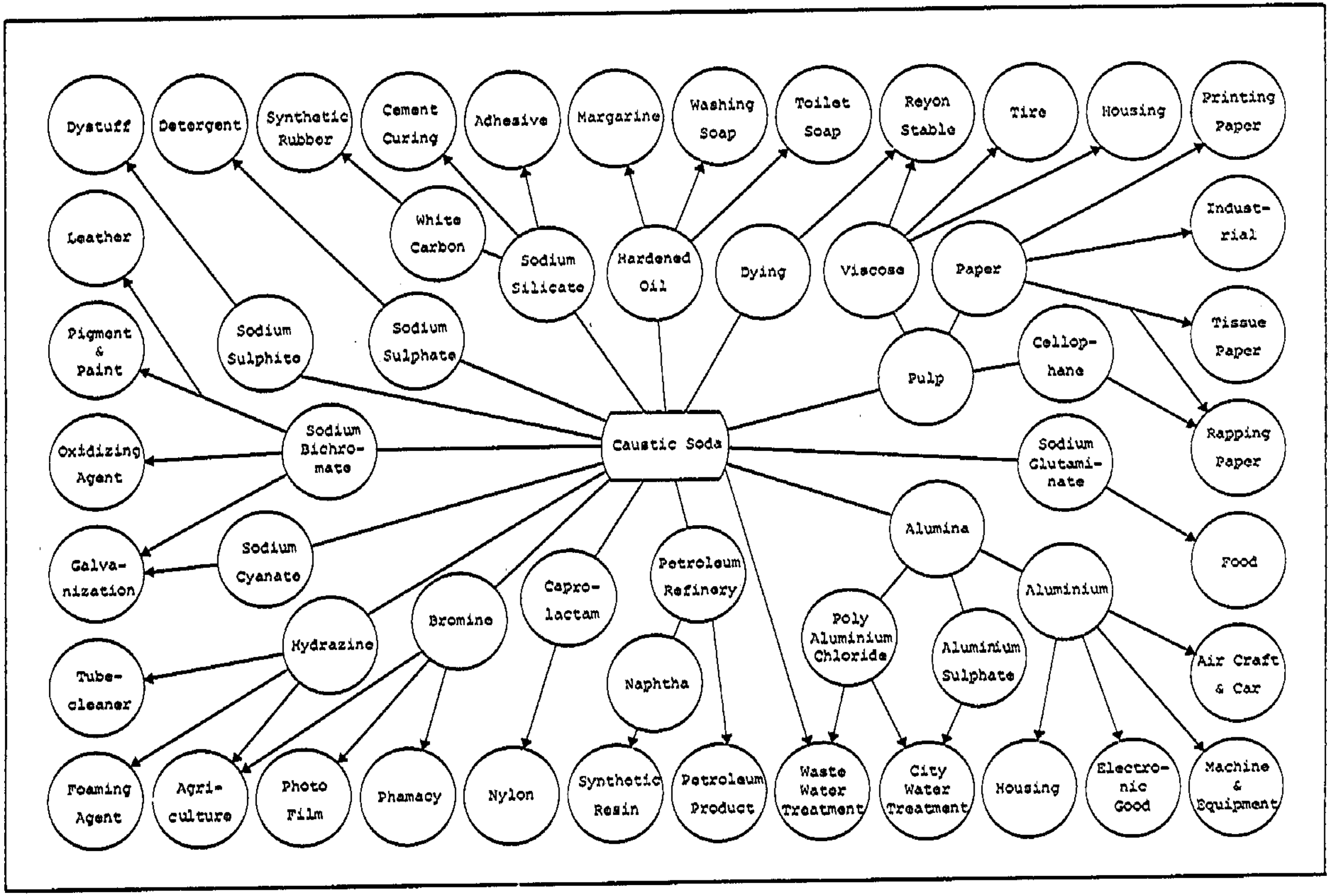


Figure AII-1.3 RELATED PRODUCT OF CAUSTIC SODA

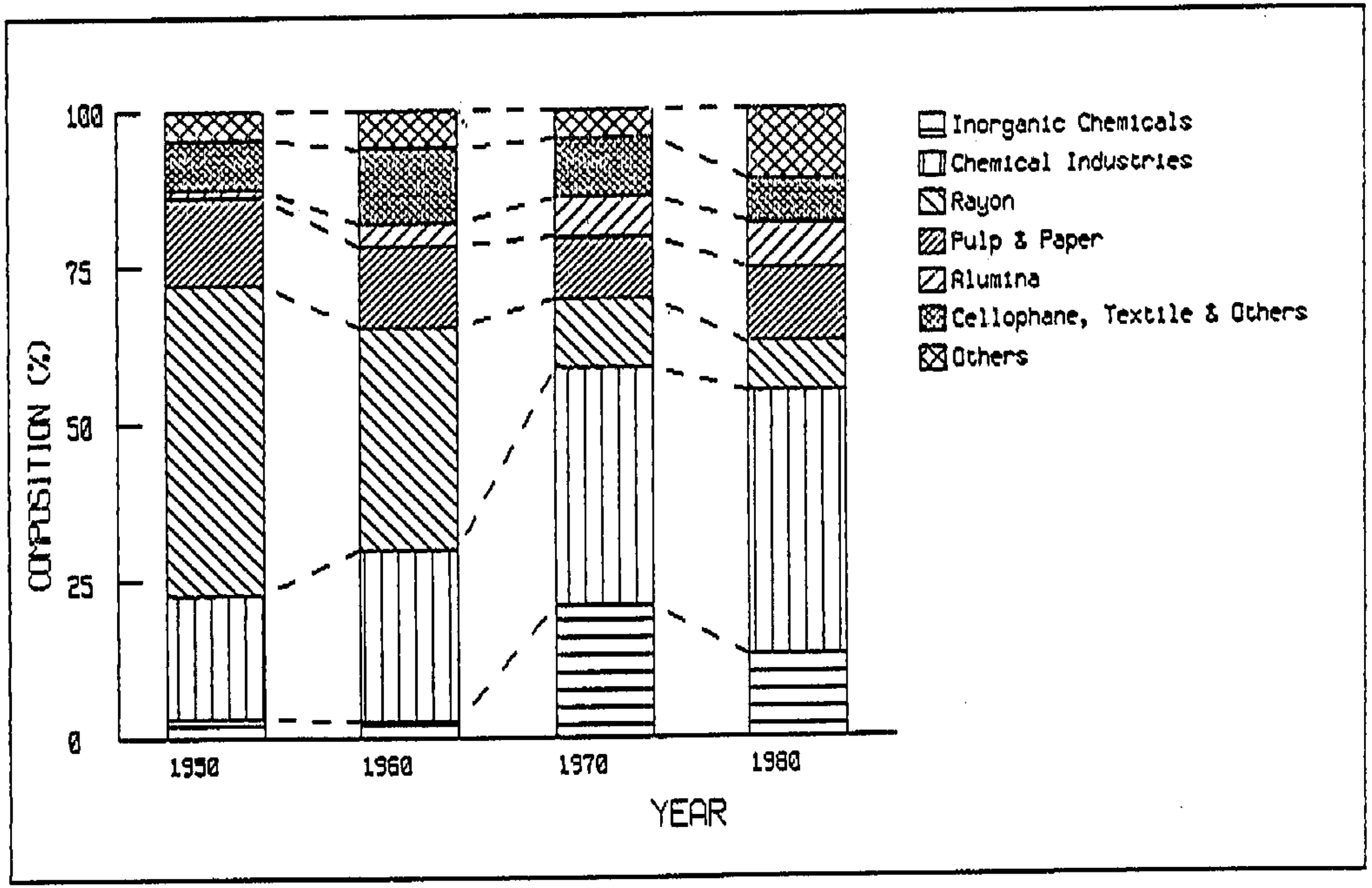


Figure AII-1.4 COMPOSITION OF CAUSTIC SODA CONSUMPTION IN JAPAN

Table AII-1.2 CONSUMPTION OF CAUSTIC SODA IN JAPAN

(Unit: 1,000 ton)

		1950	1955	1960	1965	1970	1975	1980
Rayon		116	254	297	313	295	217	228
Pulp & Paper		33	72	113	143	256	300	348
Cellophane		4	8	25	49	69	47	36
Alumina		3	12	29	61	165	155	204
Textile Ind.		9	31	56	61	50	43	60
Chemical Industries	Soap & Detergent	10	34	40	46	60	50	57
	Dyestuff & Its Intermediate	15	37	61	98	133	60	78
	Tar Ind.	2	4	8	9	11	13	9
	Inorganic Chemicals	7	11	21	117	545	416	377
	Chlor/Alkali Ind.	4	3	13	36	97	90	75
	Organic Chemicals		2	6	17	42	30	37
	Sodium Hypochlorite	-	3	5	30	99	132	136
	Petro Chemicals	-	-	2	20	79	89	79
	Others	15	18	95	205	469	661	734
	Total	53	112	251	578	1,535	1,541	1,582
M. S. G		4	8	13	39	100	64	74
Petroleum Refinery		2	4	9	16	32	31	30
Others		11	37	51	44	122	393	327
Total		235	538	844	1,304	2,624	2,791	2,889

Table AII-1.3 PRODUCTION OF CAUSTIC SODA AND CHLORINE CONSUMPTION IN JAPAN

(Unit: 1,000 ton)

			1950	1955	1960	1965	1970	1975	1980
Soda Ash			184	339	533	759	1,252	1,066	1,304
Caustic Soda	Conversion		99	241	195	61	-	-	-
	Elect- lolysis	D	66	119	159	167	153	914	2,022
		M	69	181	535	1,120	2,651	2,093	1,006
		T	135	300	693	1,287	2,804	3,007	3,028
Grand total			234	541	889	1,348	2,804	3,007	3,028
Hydrochloric Acid	Production		143	225	387	509	682	702	573
	(as CL)		53	81	136	179	239	245	201
Liquid Chlorine	Production		20	74	156	228	444	614	749
	(as CL)		21	76	158	229	446	617	752
Ca-hypo Chlorite (Liquid)	Production		24	171	358	396	436	236	148
	(as CL)		2	17	33	37	40	21	13
Ca-hypo Chlorite (Solid)	Production		52	30	8	3	1	-	-
	(as CL)		20	11	3	1	-	-	-
H.T.H	Production		3	5	6	10	24	23	37
	(as CL)		4	8	9	12	30	25	36
Na-hypo Chlorite	Production		-	15	31	161	546	800	842
	(as CL)		-	2	4	21	71	104	109
Other	(as CL)		18	68	276	714	1,693	1,655	1,593
Recovered			na	3	16	82	116	80	99
Total			118	263	619	1,193	2,519	2,667	2,704

Table AII-1.4 PRODUCTION OF FIBER IN JAPAN

(Unit: 1,000 ton)

Year	Synthetic Fiber				Rayon				Natural Fiber		
	Nylon	Acrylic	Polyester	Total	Rayon	Cupura	Acetate	Total	Cotton	Wool	Silk
1950	-	-	-	-	111	4	0	115	238	32	11
1955	8	-	-	8	323	6	3	332	419	84	17
1960	40	22	22	84	400	16	18	434	564	134	18
1965	118	84	97	299	437	21	40	498	567	155	19
1970	303	263	309	875	429	30	53	512	526	182	21
1975	278	243	445	966	311	24	56	391	460	142	20
1980	318	353	625	1,296	340	26	67	433	504	119	16

Table AII-1.5 PRODUCTION OF TYPICAL INORGANIC CHEMICALS AND ITS CONSUMPTION OF CAUSTIC SODA AND SODA ASH IN JAPAN

(Unit: ton)

			1960		1965		1979		Standard Unit Consumption
			Quantity	Unit Consumption	Quantity	Unit Consumption	Quantity	Unit Consumption	
Sodium bi chromate	Production		17,955	-	38,309	-	48,645	-	
	Consumption	NaOH	-	-	-		23,000	0.473	
		Na_2CO_3	15,715	0.875	34,190	0.892	13,000	0.267	0.860
Sodium sulphite	Production		13,345	-	25,159	-	49,582	-	
	Consumption	NaOH	2,779	0.208	42,132	1.670	103,000	2.077	
		Na_2CO_3	8,048	0.603	4,976	0.197	4,000	0.081	0.699
Sodium tripoly phoshate	Production		11,612	-	63,151	-	132,721	-	
	Consumption	NaOH	3,975	0.342	25,216	0.399	54,000	0.407	or (0.680)
		Na_2CO_3	2,496	0.215	23,374	0.370	43,000	0.323	0.870
Sodium silicate	Production		167,053	-	278,995	-	860,959	-	
	Consumption	NaOH	4,007	0.024	15,143	0.054	66,000	0.076	or (0.260)
		Na_2CO_3	35,544	0.213	44,351	0.158	110,000	0.127	0.350

2.2 Structure of World Demand for Caustic Soda

2.2.1 Structure of world demand for caustic soda

World production of caustic soda is estimated to be 33-35 million tons of which the United States produces about a third or 10 million tons, West Germany, Russia and Japan each produce about 3 million tons, China produces 2 million tons, France produces 1.4 million tons and England produces 1 million tons, together accounting for about 70% of total world output. Because demand in these countries for vinyl chloride resins and chlorinated solvents is influenced by trends of the economic cycle, demand for caustic soda in turn has been influenced and in recent years the change of production in the United States has been 2 million tons while that in Japan, West Germany, France and others has been 20,000 - 30,000 tons. This has influenced the price of caustic soda in world markets.

The pattern of demand by world region is shown in the following table. From this it is evident that Canada and the Scandinavian countries use about 50% of their caustic soda in the paper and pulp industries while in the more highly developed industrial countries about 50% is consumed in the chemical industry.

CONSUMPTION PATTERN OF CAUSTIC SODA IN THE WORLD

(%)

	Chemicals	Pulp	Alumina	Rayon	Other	Total
United States	47	19	5	3	26	100
Canada	21	47	9	3	20	100
Japan	54	11	8	9	18	100
Other Asia and Africa	14	13	27	8	38	100
Scandinavia	13	60	-	6	21	100
Other Western Europe	50	4	6	7	33	100
Latin America	9	23	27	5	36	100
U.S.S.R.	18	2	7	18	55	100
World	31	14	9	8	38	100

2.2.2 Case studies of the United States and India

Two countries having different industrial structures, the United States and India, have been selected as the objective of case studies. Their patterns of caustic soda consumption are shown in the following tables.

CONSUMPTION PATTERN OF CAUSTIC SODA IN U.S.A.

(%)

	A	B
Organic Chemicals	32.7	49.7
Inorganic Chemicas	10.2	
Soap and Detergent	6.0	6.3
Alumina	6.0	-
Petroleum Refining	4.6	4.9
Pulp and Paper	20.5	20.4
Textile	3.8	-
Rayon and Cellulose	4.0	4.3
Food Processing	2.0	-
Other	10.2	14.4
Total	100.0	100.0

(Source) A. E.I. Dupont 1978
B. Journal of Electro Chemical Society
Annual Report 1981

CONSUMPTION PATTERN OF CAUSTIC SODA IN INDIA

(Unit: 1,000 ton, %)

	1977		1982	
	Quantity	Share	Quantity	Share
Pulp and Paper	120.9	18.4	170.9	17.9
Cotton	48.0	7.3	61.0	6.4
Rayon	108.0	16.4	144.4	15.1
Soap	70.8	10.8	90.0	9.4
Detergent	30.8	4.7	52.0	5.4
Aluminium	40.0	6.1	60.0	6.3
Fertilizer	13.2	2.0	27.1	2.8
Petroleum Refining	16.4	2.5	22.4	2.3
Hardened Oil	3.6	0.5	4.7	0.5
Organic chemical	54.0	8.2	100.0	10.5
Other	152.3	23.1	223.7	23.4
Total	658.0	100.0	956.2	100.0
Chlorine Demand	445.3		665.9	
(as Caustic Soda)	490.0		732.0	

(Source) Chemical age of India, Vol. 31, No.1 (1980)

Demand for caustic soda in India, in comparison to that in the United States as well as Japan shows a relatively small share is consumed by the chemical industry, but that consumed by the rayon industry is high. This may be presumed to reflect a relatively undeveloped synthetic textile industry and general chemicals industry, this condition being due to absence of a developed petrochemical industry. Discussion regarding chlorine is made in the appropraite section elsewhere in this report but demand for chlorine, in caustic soda equivalent, is 490,000 tons in 1977 and 732,000 in 1982, and the shortfall is supplied by conversion of soda ash.

2.2.3 International comparison of the pattern of demand for caustic soda

The demand pattern for caustic soda as discussed above may be compared with the situation in Indonesia as follows:

(%)

	World 1975	USA 1981	India 1977	Japan 1980	1/ 1975	Indonesia 1980
Inorganic Chemical	10	11	2	-		5
Organic Chemical		33	8	-		-
Soap and Detergent		6	15	-		51
Chemicals	31	(50)	(25)	55	14	(51)
Alumina	9	5	6	7	27	-
Pulp	14	20	18	12	13	11
Petroleum Refining	-	5	3	1	-	3
Rayon	8	4	16	8	8	-
Textile	-	3	7	2		10
Food		2				20
Other	38	11	25	15	38	5
Total	100	100	100	100	100	100

(Note) 1/ Asia and Africa except Japan

In comparison to other countries, the share consumed by the soap and detergent industry is high.

Chapter 3 Chlorine

3.1 Structure of Demand for Chlorine in Japan

Industrial products which are made by using chlorine are shown in Figure AII-1.5.

To a great extent much of the chlorine consumed in the 1950, as is shown in Table AII-1.6, was used to make hydrochloric acid, bleach, and liquefied chlorine which combined accounted for 85% of demand, while the remining 15% was used to make disinfectant, carbon tetrachloride, and monochlor acetic acid. But thereafter a shift took place in chlorine demand, due to increase in demand for vinyl chloride and development of the petrochemical industry. There was a decline in the share of demand derived from hydrochloric acid, bleach and other older uses in favor of a higher share for organic chloride compounds, which by 1970 consumed nearly 70% of demand.

Analytic breakdowns of chlorine demand are given as Table II-1.7 and Figure AII-1.6. The demand which would be dependet on petrochemical raw materials uses other raw materials when the petrochemical industry is undeveloped. This is the case for the products listed below. Whereas the demand for chlorine by the products below accounted for only about 5% of demand in 1950, because of the conversion to the petrochemical products which increased the demand for the products due to the lower cost and the share of chlorine demand by these produts grew to exceed 50% by 1980. Thus, development of the chlorine industry is greatly depended on the petrochemical industry.

Ethylene	:	Polyvinyl Chloride, Chlorinated Solvent
Propylene	:	Propylen oxide, Allyl Chloride
Benzen, toluene	:	T.D.I, M.D.I.
Others	:	Chloroprene

Because demand for caustic soda did not grow to the extent that demand for chlorine did, in order to eliminate the problem of over-supply caustic soda, production of cuastic soda by conversion of soda ash which had continued up to 1968 was discontinued. The grwoth of demand for caustic soda and chlorine are compared in Figure AII-1.7.

The chlorine-using industry which thus grew in accompaniment with the petrochemical industry, however, came to face difficulty because of loss of competitiveness by Japanese products as compared with impots of chlorine-using products. This was due to the high cost of etylene and electric power in Japan, as well as Japan's need to rely heavily on imported materials such as raw material salt. Beside this, caustic soda made in japan came to be unsalable in export markets because of its high price. For these reasons, future growth can not be expected to be on the same order as it was in the past.

Note: The reason for the sharp increase in production of liquefied chlorine since 1975 is that because of the change in caustic soda production methods, from the mercury process to the diaphragm process, the chlorine gas generated contained high density oxygen gas. So that there were the industries which used liquefied chlorine for the purpose of separating oxygen from chlorine.

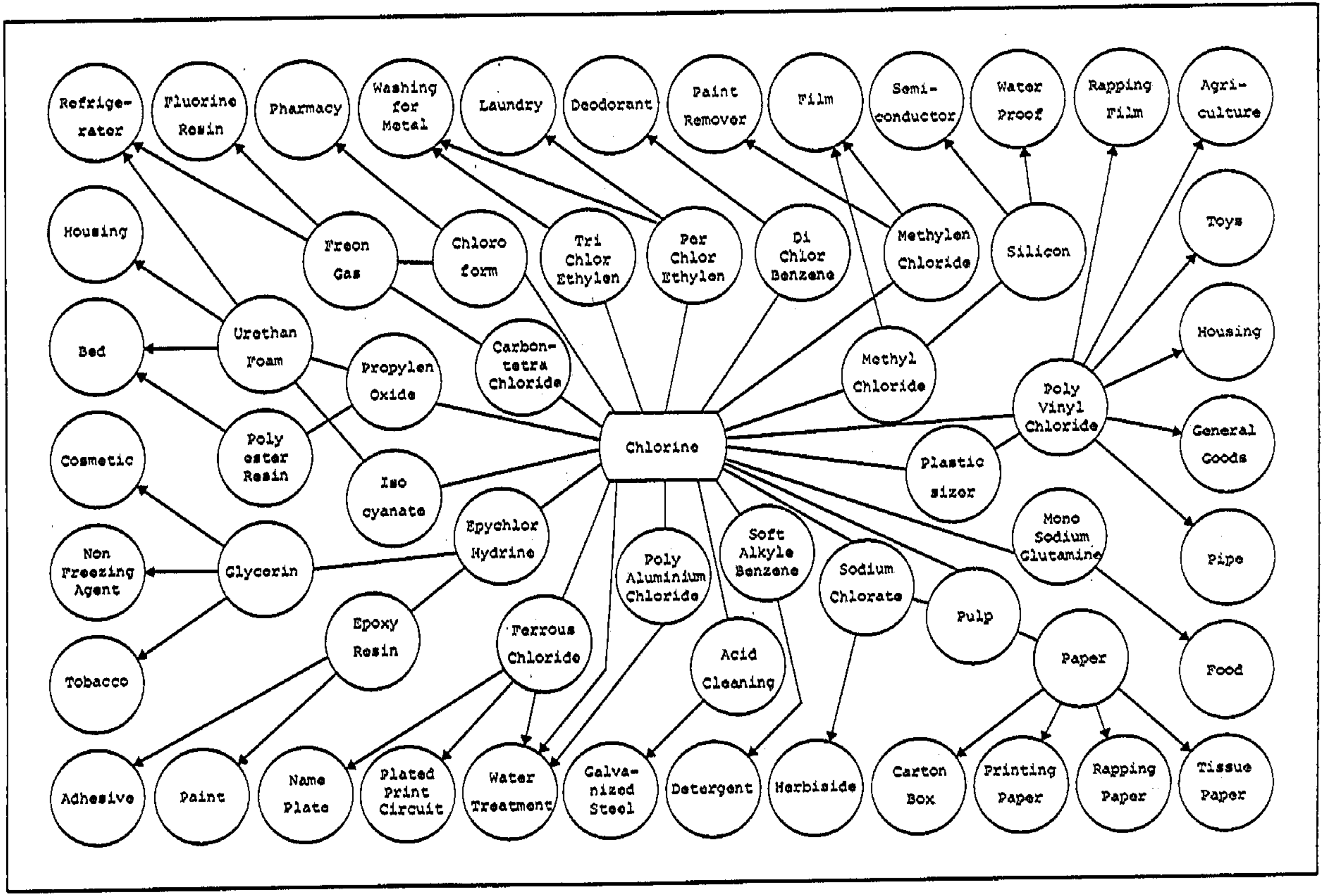


Figure AII-1.5 RELATED PRODUCTS OF CHLORINE

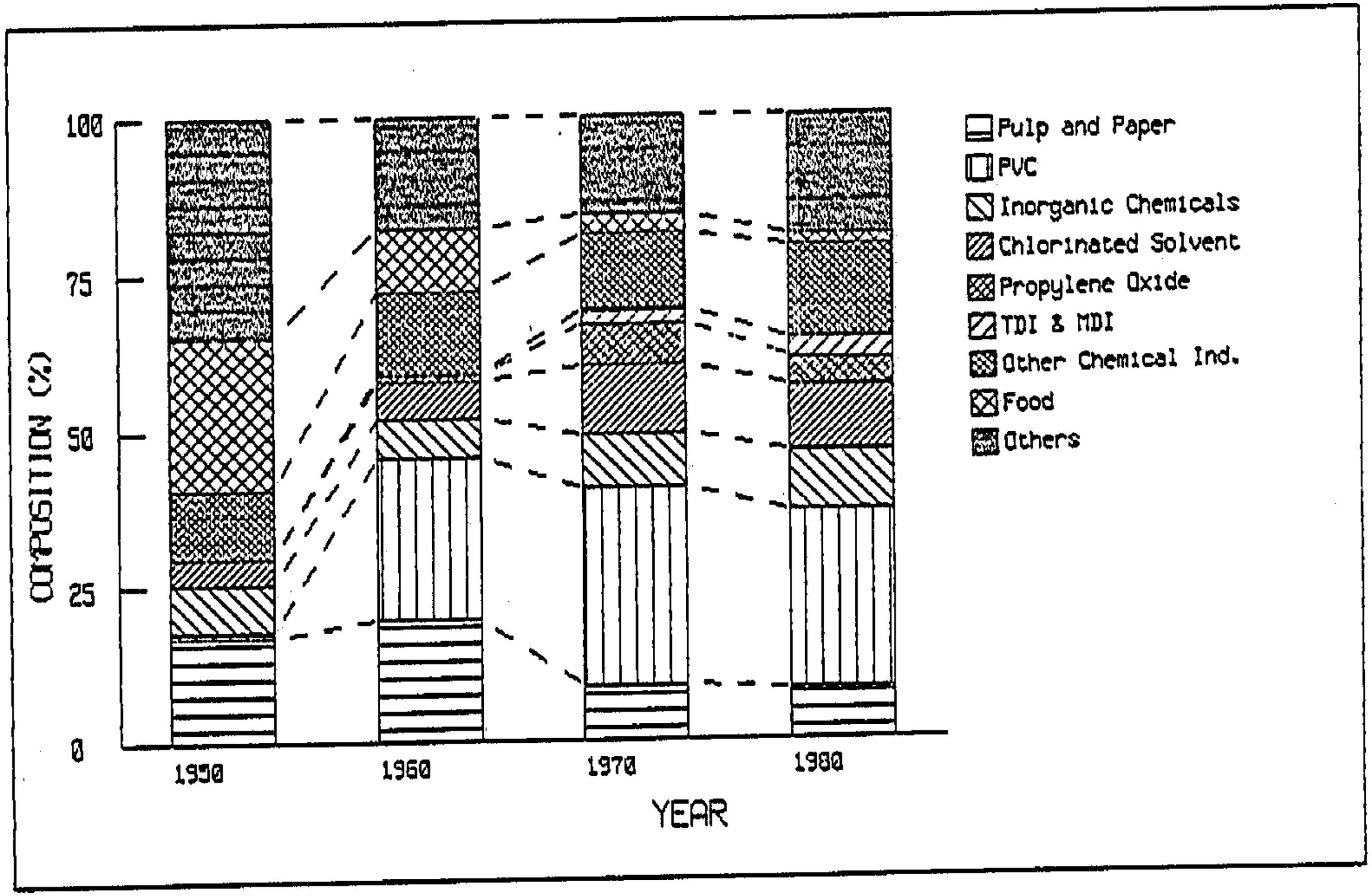


Figure AII-1.6 COMPOSITION OF CHLORINE CONSUMPTION IN JAPAN

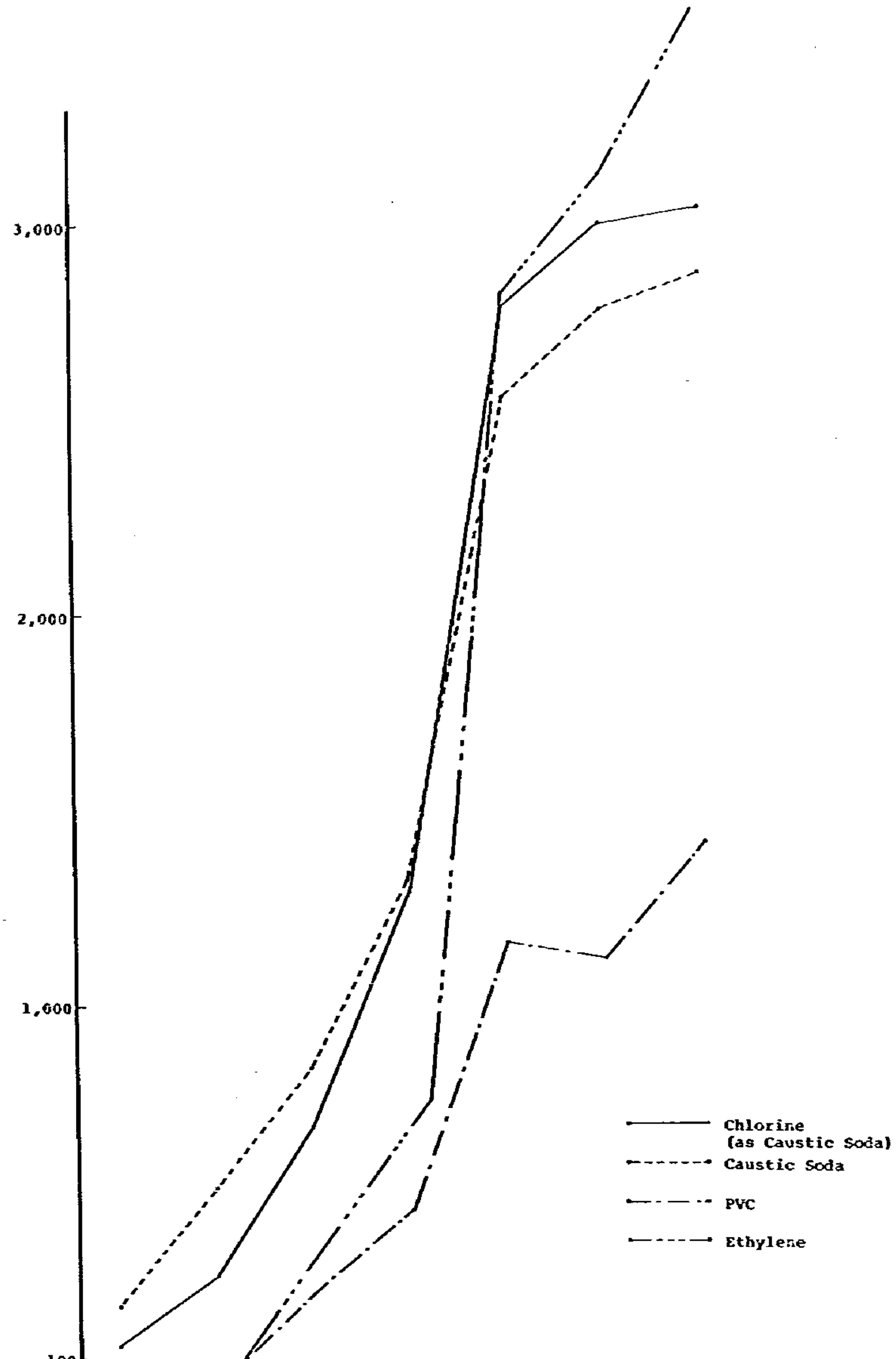


Figure AII-1.7 GROWTH OF CL/NaOH IN JAPAN

Table AII-1.6 CHLORINE CONSUMPTION AND CHLORINE RELATED PRODUCTS IN JAPAN

(Unit: 1,000 ton)

		1950		1955		1960		1965		1970		1975		1980	
		Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%
Hydrochloric acid		53	44.9	81	31.9	136	22.1	179	15.0	239	9.5	246	9.2	201	7.4
Bleaching chemicals		27	22.9	39	15.3	48	7.7	70	5.8	140	5.6	153	5.6	158	5.8
Liquid Chlorine		20	16.9	66	26.0	157	25.4	229	19.2	445	17.6	617	23.1	752	27.9
Other Chlorine Comp.		18	15.3	68	26.8	276	44.8	714	60.0	1,693	67.3	1,655	62.0	1,593	58.9
Total		118	100	254	100	617	100	1,192	100.0	2,517	100	2,671	100	2,703	100
Bleaching Chemicals	Na hypo	0		2		4		21		71		104		109	
	Ca hypo	2		17		32		36		39		21		13	
	Solid	19		11		3		1		1		0		0	
	H.T.H.	6		8		9		13		29		28		36	
Production of Related Chemicals	Ethylen	0		0		78		777		3,295		3,548		3,872	
	E.D.C	0		0		0		2		1,331		1,752		1,910	
	V.C.M.			n.a		n.a		n.a		1,306		1,296		1,531	
	Trichlor ethylen			5		19		55		113		85		82	
	Perchlor ethylen			-		2		21		50		48		64	

Table AII-1.7 CHLORINE CONSUMPTION FOR CHLORINE RELATED PRODUCTS IN JAPAN

(Unit: 1,000 ton)

	1950		1955		1960		1965		1970		1975		1980	
	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%	Q'ty	%
Pulp and Paper	20	16.9	69	25.6	123	19.6	144	11.6	238	8.8	217	7.4	252	8.3
Polyvinyl Chloride	1	0.8	30	11.2	165	26.2	317	25.4	852	31.7	894	30.6	868	28.7
Food	29	24.5	43	16.0	63	10.0	70	5.6	81	3.0	61	2.1	59	1.9
Chlorinated Solvent	5	4.2	10	3.7	37	5.9	163	13.1	305	11.3	290	10.0	307	10.2
Chloro Methane	-		1	0.4	9	1.4	29	2.3	56	2.1	85	2.9	127	4.2
Insectiside	3	2.5	12	4.5	20	3.2	44	3.5	20	0.7	15	0.5	9	0.3
Penta Chlor Phenol	-		-		6	1.0	21	1.7	16	0.6	-		-	
Propylen Oxide	-	-	-	-	6	1.0	76	6.1	181	6.7	207	7.1	147	4.8
T.D.I & M.D.I	-	-	-	-	-	-	24	1.9	53	2.0	79	2.7	92	3.0
Dye Stuff and Intermediate	9	7.7	17	6.3	29	4.6	53	4.3	93	3.5	90	3.1	104	3.4
Metal Titanium	-	-	9	3.3	7	1.1	8	0.6	8	0.3	8	0.3	12	0.4
Plastisizer	-	-	1	0.4	5	0.8	11	0.9	32	1.2	20	0.7	24	0.8
Diphenyl Chloride	-	-	-	-	2	0.3	3	0.2	12	0.4	-	-	-	-
Mono Chlor Acetic Acid	1	0.8	2	0.7	6	1.0	10	0.8	13	0.5	18	0.6	25	0.8
Chloroprane	-	-	-	-	-	-	12	1.0	26	1.0	44	1.5	48	1.6
Allylchloride	-	-	-	-	-	-	2	0.2	54	2.0	79	2.7	98	3.2
Inorganic Chemicals	9	7.7	15	5.6	39	6.2	102	8.2	234	8.7	258	8.9	284	9.5
Others	41	34.9	60	22.3	112	17.7	157	12.6	416	15.5	549	18.9	574	18.9
Total	118	100	269	100	629	100	1,246	100	2,690		2,914	100	3,032	100
Recovered	-		6		29		135		289		324		428	
Ground Total	118		263		600		1,111		2,401		2,590		4,604	
As caustic Soda	135		303		693		1,290		2,799		3,010		3,028	
Demand of Caustic Soda	235		529		843		1,302		2,631		2,791		2,890	

3.2 Demand Trends of Chlorine-using Products in Japan

(a) Hydrochloric acid

Production of hydrochloric acid from ordinary salt and sulphuric acid, by the Le Blanc Process, was initiated in 1791, making this a relatively old chemical product, which is very widely used in industry.

The trend of Japanese demand for hydrochloric acid is shown in Table AII-1.8; the major uses are for production of monosodium glutamate and general chemicals and it is also used for pre-processing of steel before galvanizing or tinplating. Although sulphuric acid was used in the past, it has been replaced in many uses by hydrochloric acid due to desire to make effective use of hydrochloric acid obtained as a byproduct of organic chloride production, which enabled the price of hydrochloric acid to be lowered.

In the inorganic chemical industry it is used for making products including polyaluminum chloride and iron chloride.

Other than the above-mentioned demand areas, it is thought that there are no areas of high-growth demand.

(b) Chlorinated bleaches

There are three commercial forms of calcium hypochlorite which are aqueous calcium hypochlorite with 8% effective chlorine, calcium hypochlorite with 35% effective chlorine, and high test calcium hypochlorite with 65% or 70% effective chlorine. The uses of each are given in Table AII-1.9.

In addition to occupying the most prominent position of the three, in general, calcium hypocholorite can also be considered as a means of storing chlorine but because it readily decomposes under conditions of high humidity and high temperature, users had to accept the inconvenience of handling it in solution, this led to their gradual conversion to use of the 8% effective chlorine type and at present the high-test type is no longer in production.

Also no further addition to demand for clacium hypochlorite is expected through substituting by sodium hypochorite to avoid caustic soda in surplus. Moreover, high-test calcium hypochlorite is expensive compared to aqueous solution of calcium or sodium hypochlorite and this has resulted in its limitation to only a few special uses; almost all of it that is produced is for export.

Consumption of chlorine in bleach may be compared as in the following table. In view of the need to use surplus caustic soda, the safety, and the ease of handling, sodium hypochlorite, after being used to a negligible extent for bleaching chemicals in 1950, experienced an increase in demand and is now far more important than calcium hypochlorite.

BLEACHING CHEMICALS USED IN JAPAN

	1950		1980	
1/	Quantity	%	Quantity	%
Bleaching Powder	19,055	77.4	0	0.0
H.T.H.	3,189	12.9	39,868	25.2
Calcium Hypochlorite	2,118	8.6	12,324	7.8
Sodium Hypochlorite	282	0.1	105,921	67.0
Total	24,644	100.0	158,113	100.0

1/ Consumed chlorine for each products.

(c) Liquefied chlorine

As is shown by Table AII-1.10, in addition to the paper and pulp industry which consumes about half of liquefied chlorine produced, it is used for making inorganic chemicals, disinfection of city water, and processing of waste water. Other than these uses, in Japan, for the purpose to loan chlorine to each other among the producers in electrolysis industry, much chlorine is liquefied since it is unable to transport gaseous chlorine. In addition to these uses, in Japan, the government had the mercury process for prodcution of caustic soda replaced by use of the diaphram process, leading to a higher concentration of oxygen in chlorine produced. In the chlorinated reaction of perchlor ethylene, trichlor ethylene and trichlor ethane, etc., which accompanies loss of raw materials and danger to the safety operation if oxgen is contained in gaseous chlorine, the demand for liquefied chlorine has increased for the use by vaporizing (see Table AII-1.11). No factors which could lead to a rapid increase in demand for liquefied chlorine can be identified.

(d) Other uses of chlorine in the chemical industry

Regarding uses other than the above-mentioned hydrochloric acid, chlorinated bleach, and liquefied chlorine, the following should be noted (see Table AII-1.13).

Prior to 1960, coal-derived acetylene, benzene and toluene were chlorinated, and the growth in demand for vinyl chloride produced from acetylene made a major contribution to the expansion of chlorine-using industry. At this time chlorinated solvents such as carbon tetrachloride (and also perchlor etylene and triclor ethylene) were being produced by carbon bisulfide and acetylene as raw materials.

Although there was an increase in demand for benzene and toluene based chlorine compounds in keeping with the growth and development of the economy, the extent of this grwoth was not great.

In contrast to this, in accordance with the expansion of the petrochemical industry, vinylchloride converted the raw material from acetylene to ethylene and in the case of chlorinated solvents there was a change from acetylene and carbon bisulfide as raw materials to ethylene or monovinyl chloride.

In addition there was development of chlorine-using products such as propylene oxide and allyl chloride made from propylene and chloroprene rubber made from C_4.

Production quantities of ethylene and electrolytic process caustic soda (chlorine) since 1960 are compared in Table AII-1.12 and as can be seen from Figure AII-1.8 there is a clear relationship between production of the two.

Because it is extemely difficult to convey chlorine as a gas, the older electrolytic process plants were located inland, near the paper and pulp mills which were the source of demand, but later in addition to the locating of chlorine plants near ethylene plants at the same time they were expanded in scale and during the 1960's, over a 10-year period, they increased by a multiple of about 4.

At the present time the only compounds for which high growth can be expected are the urethane-based toluen di isocyanate (TDI) and diphenyl methan di isocyanate (MDI). Chlorinated paraffin is being used as a plasticizer for vinyl chloride, and in some other cases (notably electric cable sheaths) due to it resist burning. Because of the competition with dioctyl phthalate and other bromated noncombustible plasticizers, production has gradually declined since 1970, to a level in 1980 which was 40% lower than that of 1970.

Inorganic chloride compounds, similar to organic chloride compounds, and with the exception of sodium hypochlorite, are not likely to experience substantial growth in demand. In fact there has been a cessation of production of a number of products, such as ammonium chloride, calcium chloride and potassium chlorate. Growth of demand can be expected, however, for ferrous chloride, for waste water treatment, and printed circuit board manufacturing.

Thus, the demand for chemical products using chlorine has increased mainly in proportion to the demand for ethylene and propylene produced in the petrochemical industries, and it would be no exaggeration to say that the chlorine and caustic soda industries could not have developed without the production of ethylene.

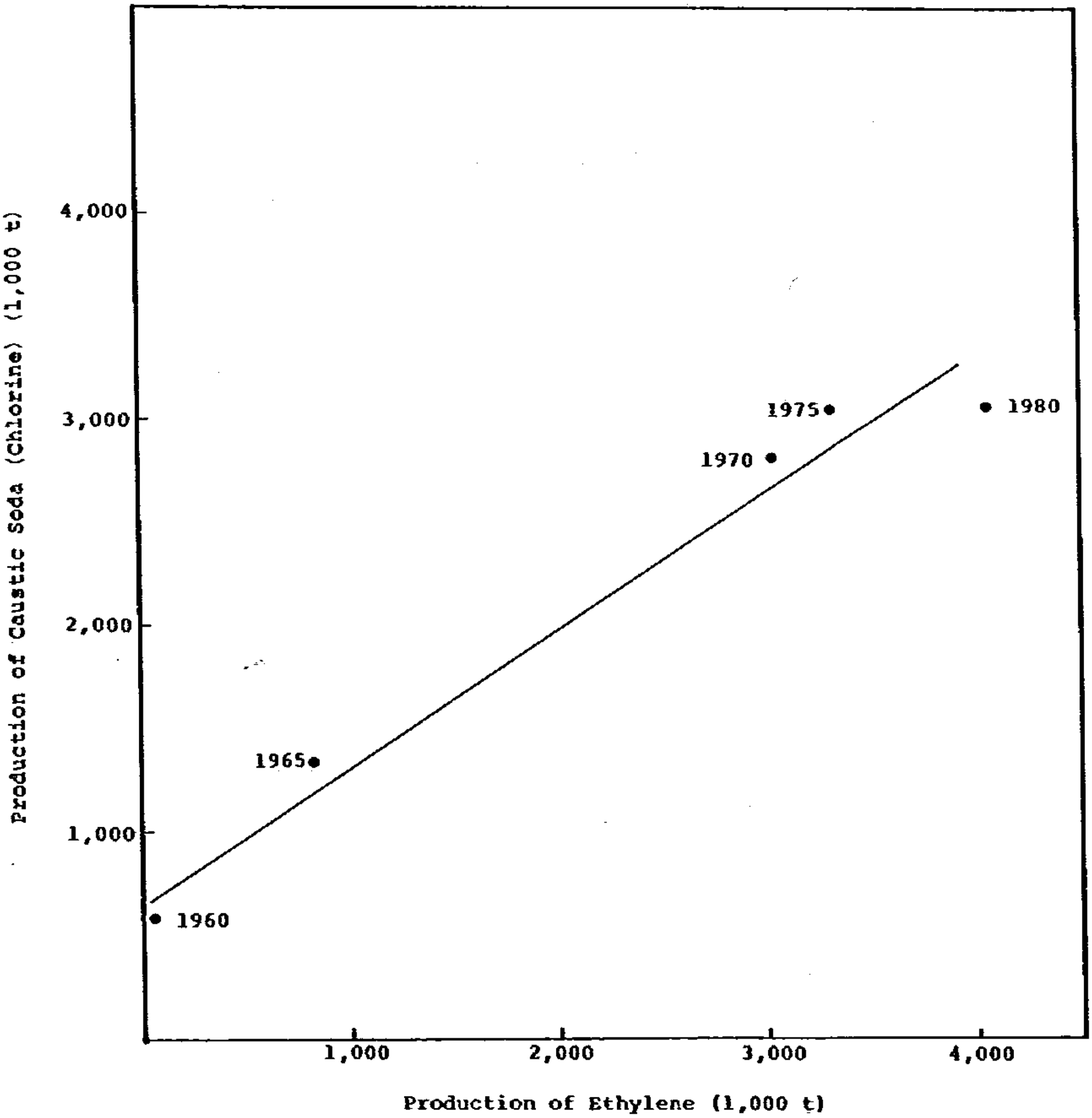


Figure AII-1.8 CO-RELATION OF CAUSTIC SODA PRODUCTION VS. ETHYLENE PRODUCTION

Table AII-1.8 CONSUMPTION OF HYDROCHLORIC ACID IN JAPAN

(Unit: ton)

	1950	1955	1960	1965	1970	1975	1980
Say Bean Sauce	176,980	52,145	54,834	42,656	29,592	53,220	52,372
Sodium Glutamine		73,597	126,026	155,823	200,312	121,949	116,642
Chemical Industry	38,287	63,902	139,662	327,967	617,985	814,785	864,591
Sanitary Goods	2,931	2,531	3,096	3,949	4,272	2,407	1,860
Steel Industry	4,295	25,278	47,337	62,315	164,288	94,737	108,692
Textile	1,606	3,982	3,850	7,182	13,300	4,706	4,747
Food Industry	n.a	4,554	5,454	12,747	16,203	25,604	33,629
Pulp and Paper	295	1,612	9,706	14,407	25,241	28,094	52,900
Others	17,645	9,205	30,608	31,813	101,124	258,750	278,200
Total	142,039	236,806	420,573	658,859	1,172,317	1,404,252	1,513,713
By-Product	-	82,432	34,760	149,280	492,024	702,210	940,091
Synthetic	142,309	228,286	385,813	509,579	680,293	702,042	573,622

Table AII-1.9 DEMAND OF BLEACHING CHEMICALS IN JAPAN

(Unit: ton)

		1950	1955	1960	1965	1970	1975	1980
Bleaching Powder	Pulp and Paper	44,168	22,140	5,209	1,254	246	0	0
	Other	8,764	8,320	2,393	1,796	674	0	0
	Total	52,932	30,460	7,602	3,050	920	0	0
H.T.H	Pulp and Paper	488	132	36	226	473	233	49
	Export	1,448	1,762	3,486	6,661	13,409	17,001	25,988
	Textile	316	2,786	1,804	393	377	496	96
	Other	647	700	928	3,105	9,613	8,397	10,111
	Total	2,899	5,344	6,254	10,385	23,872	26,127	36,244
Calcium Hypo Chlorite (8%)	Pulp & Paper	n.a	153,088	318,089	269,640	389,877	244,131	128,166
	Textile	n.a	9,735	18,571	17,965	9,769	0	0
	Other	n.a	7,245	19,897	108,141	35,504	7,421	
	Total	23,542	170,068	356,557	395,746	435,150	251,552	148,053
Sodium Hypo Chlorite (12%)	Chemical Ind.	n.a	n.a	n.a	n.a	264,060	n.a	292,332
	Pulp & Paper					137,226		228,108
	City Water					12,129		31,029
	Waste Water					1,092		27,565
	Other					117,903		235,744
	Total	2,176	16,115	33,469	157,878	532,410	798,415	814,778

Table AII-1.10 DEMAND OF LIQUID CHLORINE IN JAPAN

(Unit: ton)

	1950	1955	1960	1965	1970	1975	1980
Pulp and Paper	9,407	43,404	91,338	113,139	191,706	190,884	221,734
Water and Waste Water	3,548	4,790	8,182	18,701	33,671	58,385	63,120
Chemical Industry							
P. V. C.	851	8,289	11,947	11,799	9,376	16,748	23,064
Organic Chemical & Other	3,709	8,407	9,048	34,350	46,465	202,708	
Total	4,560	16,696	42,604	80,757	178,954	338,511	431,921
Metal Titanium	-	7,885	551	1,729	2,254	3,348	5,692
Other	2,214	1,534	13,032	13,962	36,164	23,192	26,810
Total	19,639	74,309	155,707	228,288	442,749	614,320	749,278

Table AII-1.11 DEMAND STRUCTURE OF CHLORINE FOR TYPICAL ORGANIC CHEMICALS IN JAPAN

(Unit: 1,000 ton)

	Total Chlorine Deman			Liquid Chlorine			Gas Chlorine		
	1973	1975	1979	1973	1975	1979	1973	1975	1979
Carbon Tetra Chloride	80	78	62	10	26	24	70	52	38
Perchlor Ethylen	79	70	86	25	37	45	54	33	41
Tri Chlor Ethylen	128	99	102	-	12	22	128	87	80
Tri Chlor Ethane	25	43	69	2	17	34	23	26	35
Chloro Methane	67	85	118	26	48	57	41	37	61
Propylen Oxide	211	207	162	12	35	33	199	172	129
Total	590	582	599	75	175	215	515	407	384
Consumption Ratio	100	100	100	13	30	36	87	70	64

Table AII-1.12 PRODUCTION OF CAUSTIC SODA (ELECTOROLYSIS) AND ETHYLENE IN JAPAN

	Electorolysis Caustic Soda						Ethylene Production (1,000 t/y)
	Capacity (t/m)			Production (1,000 t/y)			
	M	D	Total	M	D	Total	
1950	7,326	9,495	16,821	69	66	135	-
51	8,184	11,415	19,599	78	82	160	-
52	10,927	12,801	23,728	96	70	166	-
53	12,288	13,343	25,631	132	93	224	-
54	14,545	13,701	28,246	148	97	245	-
55	17,345	13,842	31,187	181	119	300	-
56	18,710	15,207	33,917	240	141	381	2
57	27,552	16,282	43,834	285	131	416	11
58	34,835	17,496	52,331	296	126	422	29
59	35,340	17,539	52,879	410	150	560	44
1960	41,643	16,531	58,174	535	159	694	78
61	61,972	16,642	78,614	658	156	814	107
62	71,859	17,596	89,455	712	148	860	231
63	73,948	17,444	91,392	840	170	1,010	345
64	82,457	17,872	100,329	1,037	179	1,216	504
65	111,007	18,720	129,727	1,121	167	1,288	776
66	120,720	19,139	139,859	1,305	187	1,492	1,064
67	132,848	19,245	152,093	1,572	193	1,765	1,368
68	161,400	18,223	179,623	1,847	195	2,042	1,792
69	189,014	18,453	207,467	2,138	199	2,337	2,399
1970	204,163	17,293	221,456	2,652	153	2,805	3,086
71	278,184	13,915	292,099	2,778	126	2,904	3,536
72	299,090	13,703	312,793	2,938	140	3,078	3,851
73	304,974	14,987	319,961	3,072	142	3,214	4,170
74	300,417	16,374	316,791	2,854	213	3,067	4,175
75	289,927	38,460	328,387	2,092	914	3,006	3,399
76	172,005	203,629	375,634	1,204	1,636	2,840	3,802
77	145,622	230,736	376,358	1,139	1,742	2,881	3,978
78	141,409	294,082	375,491	1,084	1,638	2,722	4,387
79	137,668	233,923	371,591	1,063	2,149	3,212	4,783
1980	131,245	251,984	383,229	1,005	2,023	3,028	4,175

Table AII-1.13 CHLORINE CONSUMPTION IN JAPAN

(Unit: ton)

	1950	1955	1960	1965	1970	1975	1980
Hydrochloric Acid	52,980	81,178	135,643	179,323	239,369	245,512	200,942
Bleaching Chemicals	26,583	37,029	43,954	48,893	69,247	48,727	49,023
Liquid Chlorine	20,424	66,408	157,390	229,346	445,009	616,736	751,500
Carbon Tetra Chloride	3,089	2,900	6,879	35,668	52,155	51,919	51,905
Ammonium Chloride	2,790	2,790	1,671	-	-	-	-
P.V.C & Vinyliden Chloride	780	30,220	153,202	302,081	866,438	895,396	865,021
Tetra Chlor Titanium	0	850	6,307	6,425	5,618	4,717	6,606
Potacium Chlorate	493	2,610	1,619	1,994	2,833	2,372	-
Sodium Chlorate	-	-	-	9,803	12,481	n.a	1,489
Calcium Chlorate			10,781	8,328	5,985	-	1,851
Ferrous Chloride			-	1,792	5,719	-	11,298
Bromine	147	1,080	1,386	3,180	7,498	10,532	14,937
Calcium Chloride	171	n.a	n.a	38	-	-	-
Sodium Hypo Chlorite	283	1,500	4,351	20,701	70,500	103,794	108,992
Other Inory Chemicals	178	1,420	1,570	7,005	16,005	23,359	15,116
Chlor Picric Acid	183	1,080	-	5,148	8,101	-	9,168
Mono Chlor Benzene	2,873	4,500	5,006	7,344	13,369	10,444	12,846
Di Chlor Benzene	345	2,240	10,062	20,389	35,811	27,914	26,139
Tri Chlor Benzene	-	-	-	4	954	-	1,000
Mono Chlor Acetic Acid	572	1,470	2,345	3,980	5,341	7,430	11,654
Org. Inter Mediate	695	920	7,260	13,207	20,095	31,276	23,298
B. H. C	756	9,060	14,772	27,830	8,697	14,884	816
D. D. T	-	-	-	3,368	2,330	-	-
D. D	-	-	-	1,058	-	-	-
P. C. P	n.a	333	5,911	18,489	12,429	-	-
P. Chlor Phenol	-	-	-	-	-	-	-
Chlor/P.C	-	-	-	165	1,040	-	-
Per Chlor Ethylen	-	460	3,772	31,618	55,687	33,216	35,540
Tri Chlor Ethylen	1,556	6,600	26,477	73,166	150,006	86,751	67,640
Ethylen Oxide	173	2,750	3,248	-	-	-	-
Methylen Chloride	-	1,070	3,431	24,172	35,495	29,663	23,959
Chlor Diphenyl	-	320	1,904	3,295	12,268	-	-
Chloro Form	-	-	-	1,250	7,420	-	6,453
Chloro Parafin	-	-	-	2,850	12,843	-	7,634
Propylen Oxide	-	n.a	5,127	75,537	171,519	-	118,845
T.D.I & M.D.I	-	-	31	18,729	53,063	-	91,791
Chlorinated Rubber	-	-	-	893	2,321	-	2,075
Tetra Chlor Ethane	-	-	n.a	134	n.a	-	-
Chloro Plane	-	-	-	6,891	18,946	-	16,193
Bis Phenol	-	-	-	345	461	-	-
Allyl Chloride	-	-	-	1,816	-	-	69,839
Epichlor Hydrine	-	-	-	-	12,385	-	19,104
Benzyle Chloride	-	-	-	-	4,465	-	2,584
Total	115,071	258,788	614,099	1,199,255	2,443,903	2,244,642	2,625,258

3.3 Structure of World Chlorine Demand

3.3.1 Structure of world chlorine demand

The structure of world chlorine demand by region by major use category may be summarized as follows:

WORLD CHLORINE CONSUMPTION BY MAJOR END USE (1975)

(Unit: %)

	Chemical	Pulp and Paper	Other	Total
Japan	90	7	3	100
Other Asia and Africa	80	6	14	100
United States	79	12	9	100
Canada	41	54	5	100
Scandinavia	35	62	3	100
Other Western Europe	96	3	1	100
Latin America	66	19	15	100
U.S.S.R	87	6	7	100
World	81	11	8	100

Demand as broken down by specific chemical use is as follows:

BREAK-DOWN OF WORLD CONSUMPTION OF CHLORINE BY CHEMICAL USE

Vinyl Chloride	26%	(21%)
Chlorinated Solvent	25%	(20%)
Inorganic Chemical	17%	(14%)
Propylene Oxide	8%	(7%)
Fluorocarbon	7%	(5%)
Others	17%	(14%)
Total	100%	(81%)

In countries such as Canada and the Scandinavian nations which have large pulp industries, the share of caustic soda consumed by those industries is high, similar to the case for chlorine. In the more industrially developed countries, the share of consumption in the chemical industry is highest of all.

3.3.2 Case studies: America and India

The pattern of chlorine consumption in America is as follows:

CONSUMPTION PATTERN OF CHLORINE IN USA

	1978 1/		1981 2/
	1,000 S.T	%	%
Vinyl Chloride Monomer	2,280	20.6	18.5
C_1 Chloro Carbon	1,090	9.8	-
C_2 Chloro Carbon	1,330	12.0	12.0
Propylene Oxide	940	8.5	7.5
Other Organic Chemicals	980	8.8	-
Other Oxygenerated Organics	450	4.1	-
Inorganic Chemicals	1,210	10.9	6.0
Pulp and Paper	1,140	10.3	10.5
Water and Waste Water	550	5.0	5.5
Organic Chemicals	-	-	16.5
Fluoro Carbon	-	-	7.5
Chloro Methane	-	-	4.0
Others	1,105	10.0	12.5
Total	11,075	100.0	100.0

(Notes) 1/ Du Pont
2/ Journal of Electro Chemical Society, Annual Report, 1981

The share of annual consumption is estimated differently by different sources but may be represented as follows:

Vinyl Chloride Monomer	20%
Organic Chemicals	45%
Inorganic Chemicals	8%
Steel, Pulp	10%
Water and Waste Water	5%
Others	12%
Total	100%

The structure of demand in India is as follows:

CONSUMPTION PATTERN OF CHLORINE IN INDIA

	1978		1982	
	Quantity 1,000 t	Share %	Quantity 1,000 t	Share %
Vinyl Chloride	53.0	11.9	84.0	12.0
Chloro Methane and Other Chlorinated Carbon	12.0	2.7	24.0	3.6
B.H.C.	23.4	5.3	42.3	6.3
D.D.T.	6.0	1.3	13.5	2.0
Pulp and Paper	88.0	19.8	137.0	20.6
Bleaching Powder	10.0	2.2	20.0	3.0
Water Treatment	15.0	3.4	20.0	3.0
Ammonium Chloride	12.2	2.7	32.6	4.9
Titanium Oxide	2.7	0.6	4.5	0.7
Textile	144.0	32.3	183.0	27.5
Insecticide	10.0	2.2	15.0	2.3
Hydrochloric Acid and Others	69.0	15.6	90.0	13.5
Total	445.3	100.0	665.9	100.0

(Source) Chemical age of India,
Vol. 31 No.1, 1980

The capacity of vinylchloride plants in India is seen as 114,000 t/y in 1980, and since it is also thought that ethylene capacity is 130,000 t/y, LDPE capacity is 100,000 t/y, and HDPE capacity is 42,000 t/y, it may be said that the petrochemical industry is still in an undeveloped state, and that vinyl chloride is being produced by the ethylene as well as the acetylene processes. Therefore the quantity of chlorine consumed in the chemical industry must be low, and the reason that textiles have a large share is the consumption of chlorine for production of disolving pulp for the rayon companies is thought to be included therein. As this normally is included in the "paper and pulp" classification, if such an inclusion is assumed, paper and pulp accounts for about 50% of total chlorine consumption.

In addition to there still being production of DDT and BHC insecticides, it should be noted that ammonium chloride is being produced.

As is mentioned in the section on caustic soda, chlorine-using industry in India is still thought to be undeveloped, and caustic soda is produced through conversion of soda ash.

3.3.3 Comparison of the patterns of chlorine demand

The patterns of chlorine demand discussed up to this point may be compared as follows:

CHLORINE CONSUMPTION PATTERN IN THE WORLD

(Unit: %)

	World 1975	U.S. 1978/1981	Japan 1980	India 1977	Asia & Africa 1975 1/	Indonesia 1980
Pulp & Paper	11	10	8	20	6	33
Textile	-	-	-	32	-	-
Vinyl Chloride	21	20	29	12		
Chlorinatecl Salv.	(20)		10			
Propylene Oxide	(7)		5			
T.D.I & M.D.I			3		80	
Allyl Chloride			3			
Other	(19)		11			
Total	46	45	32	12		0
Inorganic Chemical	14	8	10	21		0
Other	8	17	21	3	14	67
Total	100	100	100	100	100	100

(Note) 1/ Except Japan

As is evident from this comparison, the pattern of consumption in Indonesia is radically different from that which exists elesewhere, and this may be considered to be a sign of the present developing state of basic chemical production in the country.

APPENDIX II-2 FEASIBILITY FOR NEW PRODUCTION OF CHLORINE DERIVATIVE PRODUCTS IN INDONESIA

(1) Import of chlorine compounds

In Indonesia the production of chlorine has been restricted within the level of the demand of the chlorine due to the undeveloped chlorine utilizing industry and therefore, the production of caustic soda has been largely lower than the demand, resulting in the import of caustic soda at the sacrifice of the variable foreign currency.

In order to tide over the difficult situation it is necessary to develop the chlorine utilizing industry into that well balanced with the caustic soda industry because there is a potential demand for the caustic soda. In view of the above, consideration is given in this chapter to the feasibility for achieving the domestic production of the chlorine related industrial products which are presently imported and to the synergistic effect on the replacement of the import from the side of the demand concurrently.

The recent statistics of the import of the main chlorine utilizing products in Indonesia are shown in Table AII-2.1. No principal organic chlorine compounds other than vinyl chlorine monomer are found among the imports while ammonium chloride and calcium chloride form the major part of the imports as inorganic compounds.

Consideration is given below to the development of the chlorine utilizing industry centering around PT. ISI from both long-term and short-term viewplints.

(2) Petrochemcial industry and its long-term plan

The development of the related industries is indispensable to the development of the chlorine utilizing industry. Especially the development of the petrochemical industry which enables getting its products, ethylene and propylene, as raw materials is a key to the development of the chlorine utilizing industry.

However, it is very difficult to always transport a great amount of chlorine because of its characteristics and even in the advanced countries electrolysis plants are usually established adjacently to ethylene centers.

Plants for aromatic organic chlorine compounds are established adjacently to electrolysis plants because of the relatively small production of the compounds.

In Indonesia the aromatic plan as well as the ethylene center plan has not yet been given any prospect for actualization because the construction for both was decided to be postponed in 1983. Thus, at present the project to produce vinyl chloride and chlorine type solvents which are to be included in the products of the chlorine utilizing industry is uncertain, and the participation of PT. ISI in the electrolysis plant including the relocation of the site will have to be considered at the time when both the ethylene and aromatic plans becomes fixed.

Granted that vinyl chloride is produced at Waru plant of PT. ISI using imported ethylene, it is difficult to produce chlorine on a scale meeting the production of vinyl chloride at the area which is more than 20 km distant from Surabaja harbor and is adjacent to thickly housed district. The long-term development plan requires taking long-term measures for getting a site which provides a cheap electric power and cheap raw salts of high purity as well as constructing a electrolysis plant at least on an international scale as a plant annexed to the ethylene center or the vinyl chloride monomer plant.

It is not also yet a time to produce aromatic chlorine compounds (chloro benzene, benyl chloride, etc.) using imported raw materials because the demands are small within Indonesia.

Chloroparaffins, obtained by chlorinating n-paraffins with 10 - 14 carbon atoms, have various products with chlorine content of 40% to 70% which are used as raw materials for extreme-pressure additives, blending agents of cutting oil, plasticizers for vinyl chloride and soft type detergents. The use of plasticizers for vinyl chloride, competitive with that of D.O.P. (dioctyl phthalate), has a tendency toward decline because of the disadvantageous price and useability for various purposes. When soft type detergents are synthesized from n-paraffin and benzen, a synthetic process including chlorination or dehydrogenation of n-paraffin is employed. Soft type detergents are not produced in Indonesia presently and it being uncertain now which process will be used even if they are produced in future, they can not be considered as production items.

(3) Inorganic chlorine industry and its short-term plan

Considering the products which can be produced in the existing plant to increase the chlorine utilization at PT. ISI, ammonium chloride, zinc chloride and calcium chloride are recommended from the viewpoint of the market scale, the availability of raw materials, relatively easy construction of plants and also the easy production technology. The scale of the demand for each product in Indonesia is described below:

(a) Ammonium chloride

The process and the use for ammonium chloride are described in (iv). In Indonesia ammonium chloride is mainly used for dry cells and galvanized iron plates and is all imported. The import amount and the CIF price in the past are as shown in Table AII-2.1. It is estimated that 10,000 tons of ammonium chloride was annually consumed in the past three years, among which 90% was consumed for dry cells and galvanized iron plates while the rest 1,000 tons was consumed for other use.

i) Dry cell industry

The production of dry cells in Indonesia according to the budget 1983/1984 is as follows:

	Production (Unit: million)	Increase Rate against the Previous Year (%)	GNP Increase Rate (Net) (%/year)
1977	442.0		
1978	420.0	-5.0	
1979	462.0	10.0	6.3
1980	526.7	13.8	9.9
1981	563.6	7.0	7.6
1982	576.6	2.3	

The dry cell industry estimates the annual average increase rate at about 5.5%. The dry cell manufacturers in Indonesia are three companies including PT.ABC, PT. Union Carbide Indonesia and PT. National Gobel and each market share is estimated to be 60%, 30% and 10%, respectively and each ammonium chloride consumption is estimated to be 2,600 tons, 1,300 tons and 500 tons, respectively. Although a certain maker presumes that the production of the dry cells will increase in excess of GNP increase rate in future too, the annual production increase rate is estimated to be 5% by 1990 and 3% after that in consideration of the past actual results and the possible production of other kinds of dry cells (for example, alkali cell and lithium cell). Then, the amount of ammonium chloride to be consumed for dry cells is estimated to be as shown in Table AII-2.2.

ii) Galvanized iron plates industry

Ammonium Chloride is used before steel structure which were pickled are galvanized. Besides, it is used when steel pipes, steel poles, etc. are galvanized for corrosion prevention. For example, PT Fumira, which has the capacity of 6,000 t/m and presently manufactures 3,000 t/m of galvanized plates, consumes 150 tons of ammonium chloride and besides, PT Pabrik Pipe Indonesia, PT Sermani Steel Corp., etc. also consume it. The total consumption is estimated to be about 5,000 t/year.

The production tendency of related products in which galvanized steel plates are considered to be used at least partly in Indonesia is as follows:

	Year Unit	'77/ '78	'78/ '79	'79/ '80	'80/ '81	'81/ '82	'82/ '83
1. Galvanized iron plate	1,000 tons	185.0	185.0	250.0	294.2	301.5	316.7
2. Steel pipe	"	120.0	118.3	129.5	153.8	243.0	282.5
3. Water & gas transfer pipe	"	45.0	47.3	47.3	63.1	102.0	122.2
4. Conduit pipe	"	60.0	66.0	75.3	60.2	109.6	115.1
5. Spiral steel pipe	"	15.0	5.0	7.0	30.5	31.4	46.2

Some makers in the galvanized steel plate industry tend to decrease the consumption of ammonium chloride through the process improvement and consider shifting the production of galvanized steel plates to that of colored steel plates in future. Therefore, estimating the annual increase rate in future to be 2%, the demand is assumed as shown in Table AII-2.2. Summing up the demands for dry cells and galvanized steel plates, the total demand of ammonium chloride is shown in Table AII-2.2.

iii) Expected ammonium chloride production at PT. ISI

Assuming that ammonium chloride production facilities are to be newly constructed concurrently with the expansion of electrolytic caustic soda production faciltiies, the amount of the product to be selled by PT. ISI was estiamted and is shown in Table AII-2.3. The consumption of hydrochloric acid and chlorine at PT. ISI estimated from these expected figures is as described below.

iv) Properties, use and process of ammonium chloride

1. Properties

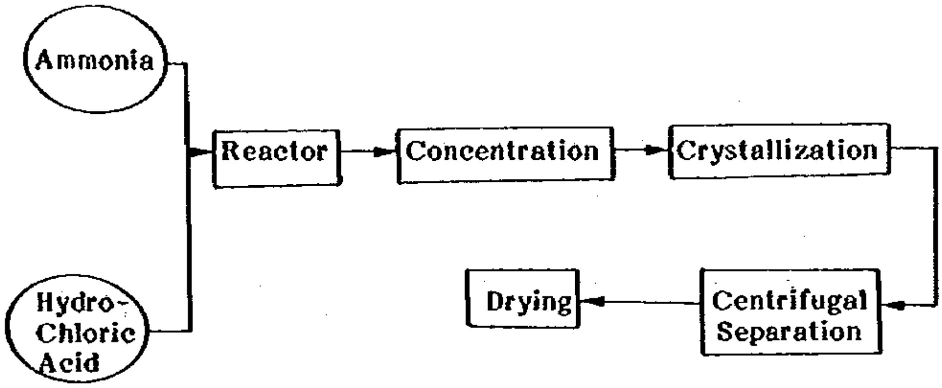
Chemical formula: NH_4Cl, Molecular weight: 53.49.
Colorless, odorless crystal or crystal powder.
Slightly hygroscopic. Sp.Gr.: 1.53.
Decomposes at 337.8°C.

2. Use

Dry cell, Galvanized steel plate, Synthetic resin, Leather tanning.

3. Process

Hydrochloric acid is charged into an reactor, into which ammonia gas is blown to have a reaction occur. After concentration, ammonium chloride which was deposited is separated from the mother liquor and the crystal is dried.



4. Required amount of raw materials

Required amount of raw materials per 1 ton of the product:

Hydrochloric acid (33% solution)	:	2,100 kg
Ammonia	:	320 kg

5. Product specification

The product specification in Japan is as follows:

(Unit: %)

	For General Use	For Dry Cell
Ammonium Chloride	98.9 and above	99.0 and above
Water	0.7 and below	0.5 and below
Iron	0.02 and below	0.0005 and below
Heavy metal (as Pb)	-	0.005 and below
Sulfuric acid ion	-	0.02 and below
Ignition residue	0.4 and below	0.4 and below

(b) Zinc chloride

Zinc chloride is produced by reacting zinc or zinc scraps with hydrochloric acid. Zinc chloride is used for galvanized steel plates and dry cells as ammonium chloride. It is used for an activator for active carbons, a deoxidizer for light metal rolling, etc. Zinc chloride seems to be included in the category of other chlorine compounds (CCN

CODE 2830900) on import statistics and the exact import amount is unknown. Zinc chloride is produced by PT.ANEKA KIMIA and PT.CHIMANGIS and the latter produces zinc chloride using the hydrochloric acid purchased from PT.Soda Sumatra and the residue or the off-spec products of zinc oxide. All the products are supplied to Union Carbide Indonesia as the material for dry cells.

i) Dry cell industry

There are three dry cell manufacturers as mentioned in the paragraph on ammonium chloride. Among them PT.ABC imports and consumes 2,200 tons of zinc chloride per year and Union Carbide purchases about 1,000 tons of zinc chloride from PT.Chimangis. PT.National Gobel is presumed to consume about 300 tons of zinc chloride. Therefore, a total of 3,500 tons of zinc chloride is presumed to be consumed in the industry.

ii) Galvanized steel plates and other industries

The amount of zinc chloride used for galvanized steel plates and other galvanized products is estimated to be about 3,000 tons and that used for active carbons and others is estimated to be 500 tons. Therefore, a total of 7,000 tons of zinc chloride is presumed to be consumed. (see Table AII-2.4)

iii) Expected zinc chloride production at PT.ISI

Among the estimated 7,000 tons of zinc chloride consumption, 1,000 tons of zinc chloride is produced by PT.CHIMANGIS and some of it is produced by PT.ANEKA KIMIA but the actual state of its production can not be grasped. Therefore, assuming that a half of the consumption of zinc chloride is produced by the existing makers, the expected production of PT. ISI was estimated as below (as for the availability of raw material zinc, PT. ISI is in the same condition as the two existing companies but as for hydrochloric acid which is the other raw material, PT. ISI produces it in its own plant, and the possibility of PT. ISI's participation in the market is considered to be high.). (see Table AII-2.5)

(Notes) Zink oxide has been produced by PT.chimangis and PT.Methoxide since 1973 and therefore, it is presumed that zinc chloride could adequately be produced by using the residue from the process and zinc residue from galvanized steel plate manufacturing factories.

iv) Properties, use and process of zinc chloride

1. Properties

Chemical formula: $ZnCl_2$, Molecular weight: 136.28.
Colorless cubical crystal,
Specific gravity: 2.91 (25/4°C),
Melting point: 313°C, Boiling point: 732°C

Remarkably deliquescent. Absorbs moisture in the air in a short time and becomes liquid.

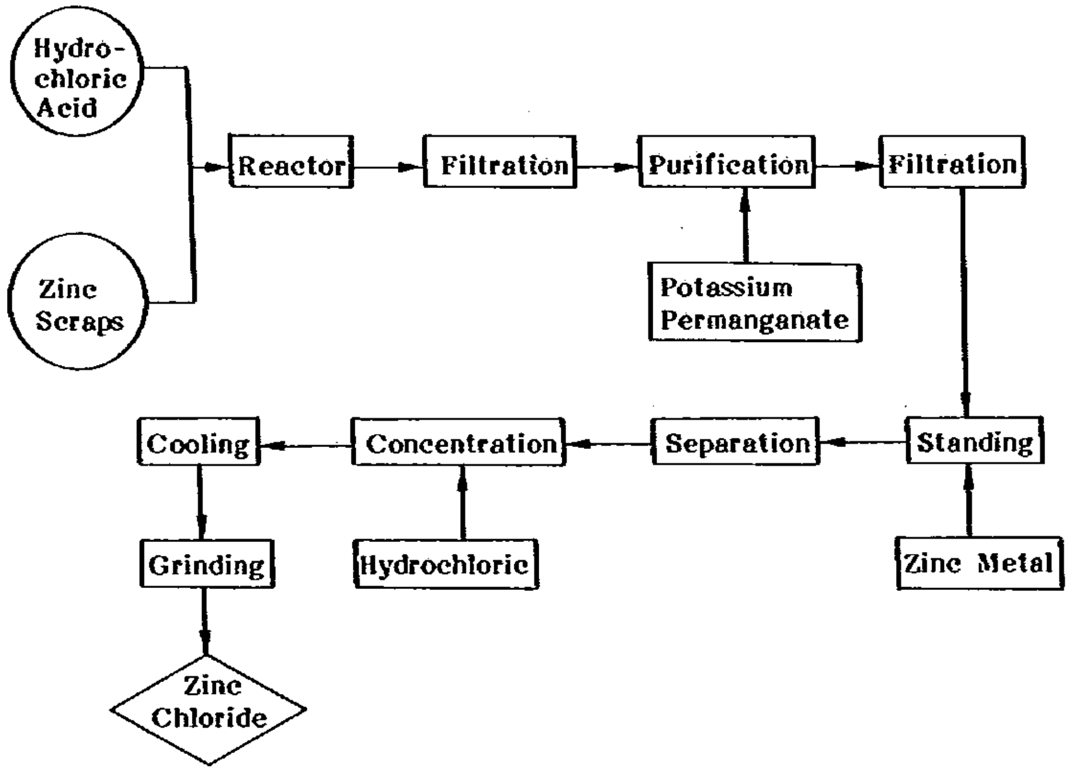
2. Use

Pretreating agent for galvanization. Activator in manufacturing active carbons. Electrolyte of dry cell.

3. Process

Zinc residue is dissolved into hydrochloric acid in a dissolving tank. After separating the insoluble matters by filtration, potassium permanganate is added to settle the insoluble matters such as iron, manganese, etc. The contents are pourred into a settler and slices of zinc metal are added to replace and settle heavy metals. The solution is then concentrated by heating until most of the water evaporates and the zinc chloride becomes a fused state as shown in the following equation. The concentrate is transferred to a grinder, where it is ground under stirring and cooling, and the product is obtained.

$$Zn \text{ (or } ZnO) + 2\ HCl = ZnCl_2 + H_2 \text{ (or } H_2O)$$



4. Required amount of raw materials

Required amount of raw materials per 1 ton of the product:

Zinc scraps (as 100%) : 600 kg
Hydrochloric acid (as 35%) : 1,850 kg

5. Product specification

The product specification in Japanese industrial Standard is as follows:

		Grade A	Grade B
Zinc chloride	%	96.0 and above	90.0 and above
Basic salt (ZnO)	%	2.0 and below	2.0 and below
Sulfate (SO_4)	%	0.01 and below	0.2 and below
Lead	%	0.001 and below	-
Copper	%	0.001 and below	-
Iron	%	0.003 and below	0.01 and below
Alkali (Sulfate)	%	1.0 and below	1.5 and below

(c) Calcium chloride

Calcium chloride is easily obtained by reacting hydrochloric acid with lime stones or slaked lime. The actual quantity of imported calcium chloride in recent years in Indonesia is about 5,000 tons per year and the import quantity by year is as follows:

	Quantity (Ton)	Unit Price ($/T)
1978	1,516	178
1979	1,763	181
1980	1,844	359
1981	4,294	300
1982	5,007	253
1983	5,015	233

(Notes) Quantity for 1983 is an estimate based on the actual quantity from Jan. through Nov.

(Source) Import Statistics of Indonesia

Calcium chloride is used for dust prevention and thawing of roads and also as a quick curing agent for concrete. Besides, recently it has been used as a pouring and filling agent for a well when an oil well or a natural gas well was dug. In America about 10% of the demand of about 100 million tons was consumed for digging oil or natural gas wells in 1973 and about 20% in 1981. Formerly in Japan too calcium chloride was synthesized from hydrochloric acid and lime stones, but afterward as the soda ash synthesis process was developed, the calcium chloride produced as a by-product in the process came to be utilized and the synthesis of calcium chloride was suspended. On the other hand, in America because of the change of the soda ash production from the synthetic process to the natural one, calcium chloride became short in quantity partially by the reason mentioned above and there came a tendency to produce calcium chloride by utilizing the hydrochloric acid produced as a by-product in synthesizing organic chlorides (especially TDI and MDI).

The amount of imported calcium chloride in Indonesia had been 2,000 tons per year until 1980 but has sharply increased after 1981. This is probably due to the same fact that calcium chloride is used when oil or natural gas wells are dug as that in America mentioned above. At present it is impossible to forecast to what direction the production and the digging technology for crude oil and natural gas in Indonesia tend, but it is considered that at least the current demand for calcium chloride may increase but can not decrease.

i) Possible Production at PT. ISI

Although it is difficult to forecast the consumption of calcium chloride as mentioned above, the chlorine requirement was calculated assuming that 5,000 tons of calcium chloride corresponding to the current consumption neglecting an increase is produced at PT.ISI as shown in Table AII-2.6

FORECAST Of PRODUCTION OF CALCIUM CHLORIDE

(Unit: ton)

	Forecast Production	Consumption of Hydrochloric Acid	Consumption of Chlorine
1987	500	800	270
1988	1,000	1,600	530
1989	2,000	3,200	1,060
1990	3,000	4,800	1,590
1991	4,000	6,400	2,110
1992	5,000	8,000	2,640
1993	5,000	8,000	2,640
1994	5,000	8,000	2,640
1995	5,000	8,000	2,640
1996	5,000	8,000	2,640
1997	5,000	8,000	2,640
1998	5,000	8,000	2,640
1999	5,000	8,000	2,640
2000	5,000		2,640

Notes:
- Consumption of hydrochloric acid (33%): 1,600 kg/ton of $cacl_2 \cdot 2H_2O$ (raw material lime stone)
- Consumption of chlorine: 330 kg/ton of hydrochloric acid

ii) Properties, use and process of calcium chloride

1. Properties

Chemical formula: $CaCl_2$, Molecular weight: 118.

Colorless deliquescent crystal.

Specific gravity: 2.152.

Usually traded as di-hydrate (75% as calcium chloride)

2. Use

Refrigerant for refrigeration

Curing agent for cement

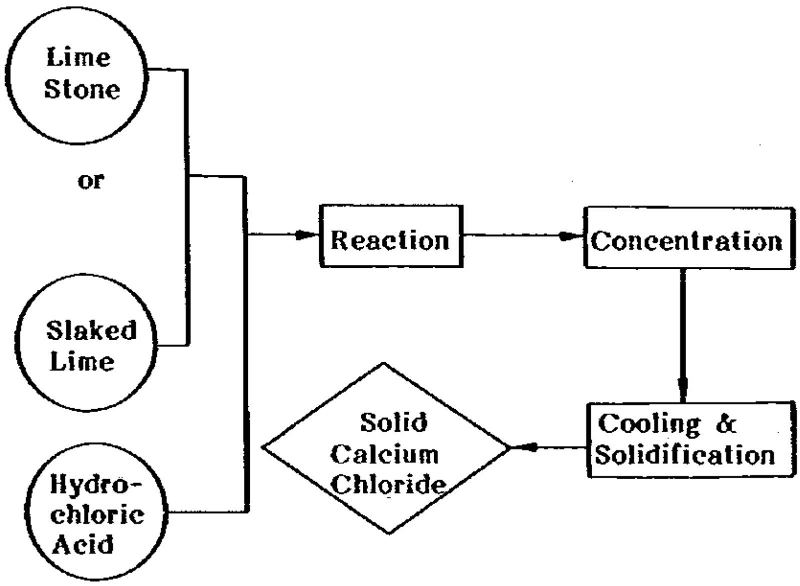
Enhanced oil recovery

3. Process

A) Lime stone or slaked lime is reacted with hydrochloric acid. After the reactant solution obtained is heated and concentrated, the concentrate is cooled and then it solidifies and becomes a product as follows.

$CaCO_3 + 2HCl + H_2O = CaCl_2 \cdot 2H_2O + CO_2$

$Ca(OH)_2 + 2HCl = CaCl_2 \cdot 2H_2O$



B) Obtained as a by-product in manufacturing high test hypochlorite.

4. Required amount of raw materials

The amount of raw materials required for 1 ton of calcium chloride dihydrate:

Lime stone	:	700 kg
(Slaked lime)	:	(510 kg)
Hydrochloric acid (35%)	:	1,500 kg

(4) Outline of other inorganic chlorine utilizing products

The outline of other chlorine compounds including hightest bleaching powder, iron chloride, aluminium chloride and chlorate which utilize chlorine or hydro-chloric acid is described below. The description of these products is limited only to the outline of the process and others because it was impossible to grasp them quantitatively based on the Indonesian statistics. PT. ISI is expected to fully examine the quantitative state in future.

(a) High test bleaching powder (High test calcium hypochlorite)

i) Properties

White powder or tablet. Hygroscopic.

The main components are $Ca(ClO)_2 \cdot 2H_2O$ and $Ca(ClO)_2 \cdot 1/2\ Ca(OH)_2$. Its available chlorine is 99.3% teoretically but usually 60 - 70% due to calcium chloride formed in the reaction process. When dissolved into water, it leaves free lime.

ii) Use

It is widely used for bleaching pulps and fibers; stelilizing, decoloring and deironing supply and drainage water; decomposing agents for cyanogen compounds; deironing agents in manufacturing inorganic chemicals. As shown in Table AII-2.7, its unit price converted to chlorine is very high - 4.2 times as high as liquefied chlorine and 1.5 times as high as calcium bleaching liquor and sodium breaching liquor. In America it is 22 times as high as liquefied chlorine. Thus, in Japan the use is extremely restricted to the cases.

1. Where the high pressure gas law makes it difficult to store the liquefied chlorine,

2. Where there are no sites adequate for storing sodium hypochlorite (or calcium hypochlorite),

3. Where a factory (e.g. using a cyanogen type of plating liquid) in a city area has no sites adequate for treating the effluent, and

4. Where used for special purposes (e.g. stelilizing pools attached to hotels).

The consumption especially in the case 3 mentioned above has been increasing due to the strengthened pollution control, etc. while that in other cases has been decreasing. (see Table AII-2.8)

In Indonesia no reasons meeting the above are found, though there is a difficulty in transportation. Thus, it can be forecasted that there will be some demands for the high test bleaching powder but any reasons justifying substantially the use of the high test bleaching power are not found.

It is necessary to have consumers widely informed of how to use, cheapness, convenience, etc. concerning Ca-hypochlorite, Na-hypochlorite and liquefied chlorine in future.

(Notes) Actually the survey team faced such an scene as mentioned above.

iii) Process

The high test bleaching power is produced by fractionating the crystal of calcium hypochlorite obtained by reacting lime milk with chlorine according to the following equation:

$$2Ca(OH)_2 + 2Cl_2 = Ca\ (ClO)_2 + CaCl_2 + 2H_2O$$

Generally the product is a double salt of $Ca(OCl)_2 \cdot 2H_2O$ and $Ca(OCl)_2 \cdot 1/2\ Ca(OH)_2$. As found from the reaction equation, mixing of $CaCl_2$ into the product is inevitable and the existence of $CaCl_2$ decomposes the effective chlorine, of which decomposition is further promoted by the hygroscopicity of $CaCl_2$.

$$Ca(OCl)_2 + CaCl_2 + 2H_2O = 2Ca(OH)_2 + 2Cl_2$$

$$Ca(OCl)_2 + CaCl_2 + 2CO_2 = 2CaCO_3 + 2Cl_2$$

Therefore, in order to get more stable high test bleaching power by changing the $CaCl_2$ into an inactive NaCl, the $CaCl_2$ is double-decomposed with sodium hypochlorite.

$$CaCl_2 + 2NaClO = Ca(OCl)_2 + 2NaCl$$

or a compound consisting of NaOH and $Ca(OH)_2$ in a mol ratio of 2:1 is chlorinated.

$$2NaOH + Ca(OH)_2 + 2Cl_2 = Ca(OCl)_2 + 2NaCl + 2H_2O$$

The former method gives a product with available chlorine of 60% while the latter 70% and above.

Most of the chlorination conditions are know-how of the individual companies. Because the lime milk of 35 - 40% is chlorinated at a high temperature (45 - 50°C), the slaked lime easily decomposes unless it contains few impurities such as iron, manganese, etc. Moreover, in order to obtain the product which does not easily decompose, sodium hypochlorite is used to remove $CaCl_2$ which was formed as a by-product. The manufacturing cost becomes high because of its expensive equipment cost including a fluidized dryer to prevent the decomposition in drying.

iv) Required amount of raw materials

The amount of raw materials required for 1 ton of the product, which is not officially reported, is roughly estimated as follows:

Chlorine : 1,100 kg
Slaked lime : 1,000 kg

v) Product specification

The specification of high test bleaching powder only indicates available chlorine as 60% and as 70% and above, and the typical examples of analysis are shown below:

ANALYSIS OF H.T.H

	A	B	C
Available chlorine	61.65	67.25	73.38
NaCl	0	6.18	14.72
$CaCl_2$	9.72	2.69	1.66
$CaCO_3$	3.01	6.22	2.77
$Ca(OH)_2$	22.0	4.42	3.55
H_2O	2.50	10.70	0.79

(b) Ferric chloride

i) Properties

Chemical formula: $FeCl_3 \cdot 6H_2O$, Molecular weight: 270.3.
Yellowish brown, deliquescent crystal.
Slightly smells of hydrochloric acid. In trading 38% product as $FeCl_3$ circulates.

ii) Use

Etchant for plated printed circuit. Water treatment for waste water.

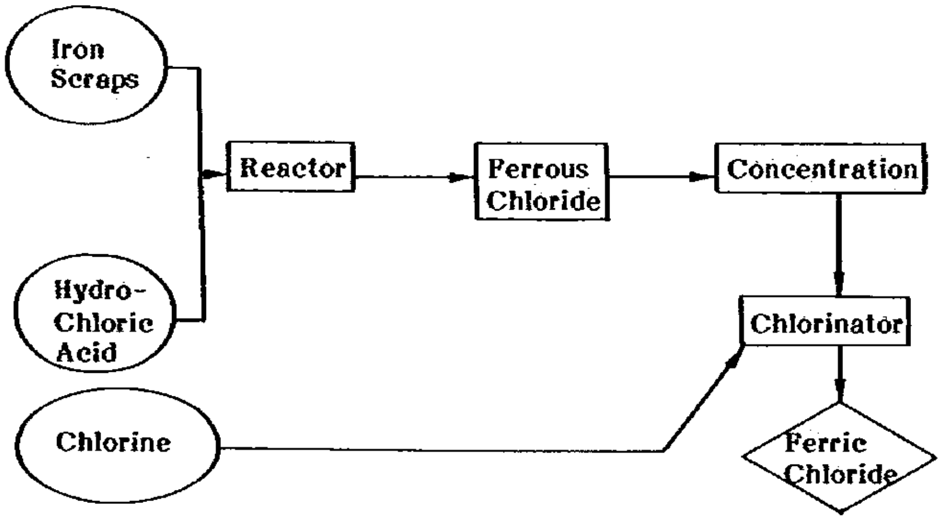
iii) Process

Iron scraps are charged into a reactor and to the contents hydrochloric acid is added to have a reaction occur. Then, the iron scraps dissolve into the hydrochloric acid with evolving hydrogen, and ferrous chloride is formed.

$$Fe + 2HCl = FeCl_2 + H_2$$

After the reactant liquid is heated and concentrated, chlorine gas is blown into the liquid. Then, a reaction occurs and gives ferric chloride.

$$2FeCl_2 + Cl_2 = 2FeCl_3$$



Usually it is sold as a 38% solution without being concentrated.

iv) Required amount of raw materials

The required amount of raw materials per/ton of the product of 38% solution:

Iron scraps (90%)	:	138 kg
Hydrochloric (35%)	:	800 kg
Chlorine	:	100 kg

v) Product specification

The product specification in Japan is as follows:

	A	B	C
Specific Gravity (Baume 15/4°C)	40° & above	45° & above	48° & above
Ferric Chloride ($FeCl_3$) %	37° & above	41° & above	44° & above
Ferrous Chloride ($FeCl_2$) %	0.30 & below	0.25 & below	0.20 & below
Free Acid (as HCl) %	0.50 & below	0.25 & below	0.25 & below

(c) Aluminium chloride

i) Properties

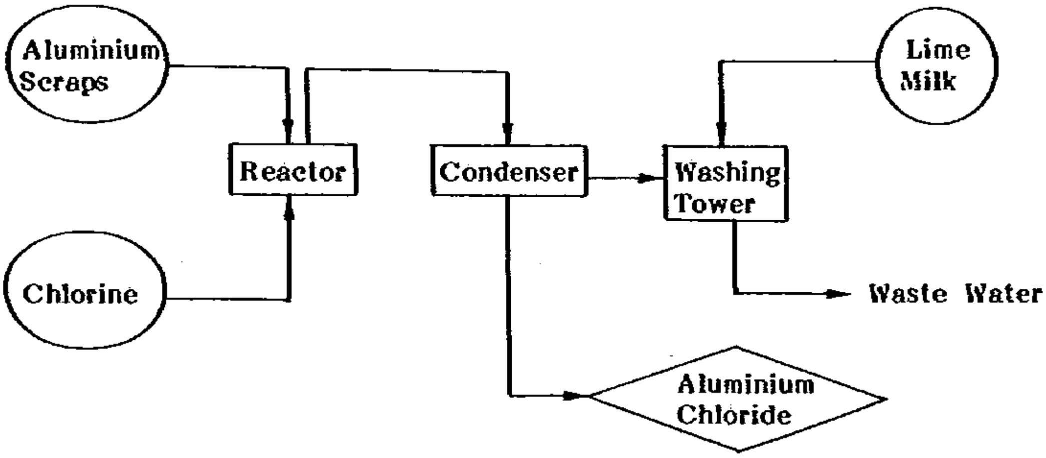
Chemical formula: $AlCl_3$, Molecular weight: 133.34.
Pure one is colorless, ordinary one is grayish white or yellow to greenish yellow lump or powder.
Deliquescent. Fumes in the wet air and smells of hydrochloric acid.
Specific gravity: 2.44,
Melting point: 190°C (at 2.5 atm.),
Boiling point: 182.7°C (at 755 m/m Hg)

ii) Usage

Catalyst for organic synthetic reactions.
Cracking catalyst in oil refining. Polymerization catalyst for synthetic rubbers and plastics.

iii) Process

Aluminium scraps are charged into a reactor, and then chlorine is blown into the reactor which was heated in advance to have a reaction take place.



$$2Al + 3Cl_2 = 2AlCl_3$$

As the temperature is maintained by the reaction heat after the reaction starts, heating is not needed. Aluminium chloride which formed in the reaction sublimates and is introduced into a condenser, where it is cooled and condenses, and then it is collected and becomes a product. The spent gas is discharged after neutralized by lime milk.

iv) Required amount of raw materials

The amount of raw materials required for 1 ton of the product:

Aluminium scraps	:	250 kg
Chlorine	:	850 kg

(d) Chlorate compounds

Chlorate compounds include sodium chlorate, potassium chlorate, calcium chlorate, etc. (see Figure AII-2.1)

i) Properties

1. Sodium chlorate

Colorless, pillar-shaped crystal or granule.

2. Potassium chlorate

Colorless, lustrous, rhombic plate crystal or white lump or powder. Very soluble in water. A strong oxidizing agent forming an explosive compound with a combustible substance.

3. Calcium chlorte

Deliquescent monoclinic crystal. Very soluble in water. A oxidizing agent.

ii) Use

1. Sódium chlorate

Herbicide, raw material for chlorine dioxide for bleaching paper pulps and raw materials for sodium perchlorate and ammonium perchlorate.

2. Potassium chlorate

Main compounding agent for matches and fireworks.

3. Calcium chlorate

Raw material for chlorine dioxide for bleaching paper pulps, herbicide and raw material for potassium chlorate.

iii) Process

Both sodium chlorate and potassium chlorate are manufactured by the electrolytic process but a chemical process which utilizes chlorine is described here. Production flow diagrams for chlorate compounds on chemical processes are shown in Figure AII-2.1. In the chemical processes these compounds are manufactured by reacting slaked lime and caustic soda with chlorine through hypochlorites except potassium chlorate, which is manufactured by double decomposition of sodium chlorate or calcium chlorate with potassium chloride not using caustic potash.

iv) Required amount of raw materials

The amount of raw materials required for 1 ton of each chlorate compound is roughly as follows:

	Slaked Lime	Chlorine	Caustic Soda	Potassium Chloride	Calcium Chlorate
Sodium Chlorate		2,350	2,700		
Potassium Chlorate	4,000	3,100			
Potassium Chlorate				620	850
Calcium Chlorate	2,500	2,350			

v) Product specification standard

1. Sodium chlorate — 99.9% and above
   Sodium chlorate — 0.5% and below
   Sodium chloride — 0.30% and below
   Water-insoluble matters — 0.10% and below

2. Potassium chlorate

   Potassium chlorate — 99.5% and above
   Potassium chloride — 0.10% and below
   Loss by drying — 0.10% and below
   Water-insoluble matters — 0.10% and below

3. Calcium chlorate

It is usually sold as a solution of about 40%. No specification standard have officially been published.

Figure AII-2.1 FLOW OF HYPOCHLORITE, CHLORITE AND CHLORATE

$$M{\cdot}OH + Cl_2 \longrightarrow M{\cdot}ClO + M{\cdot}Cl$$
$$M{\cdot}ClO + Cl_2 \longrightarrow M{\cdot}ClO_3 + M{\cdot}Cl$$
$$M{\cdot}ClO_3 + M'{\cdot}Cl \longrightarrow M'{\cdot}ClO_3 + M{\cdot}Cl$$
$$M{\cdot}ClO_3 + HCl \longrightarrow M{\cdot}ClO_2 + Cl_2 + M{\cdot}Cl$$

M·M' -------- Ca, Na, K

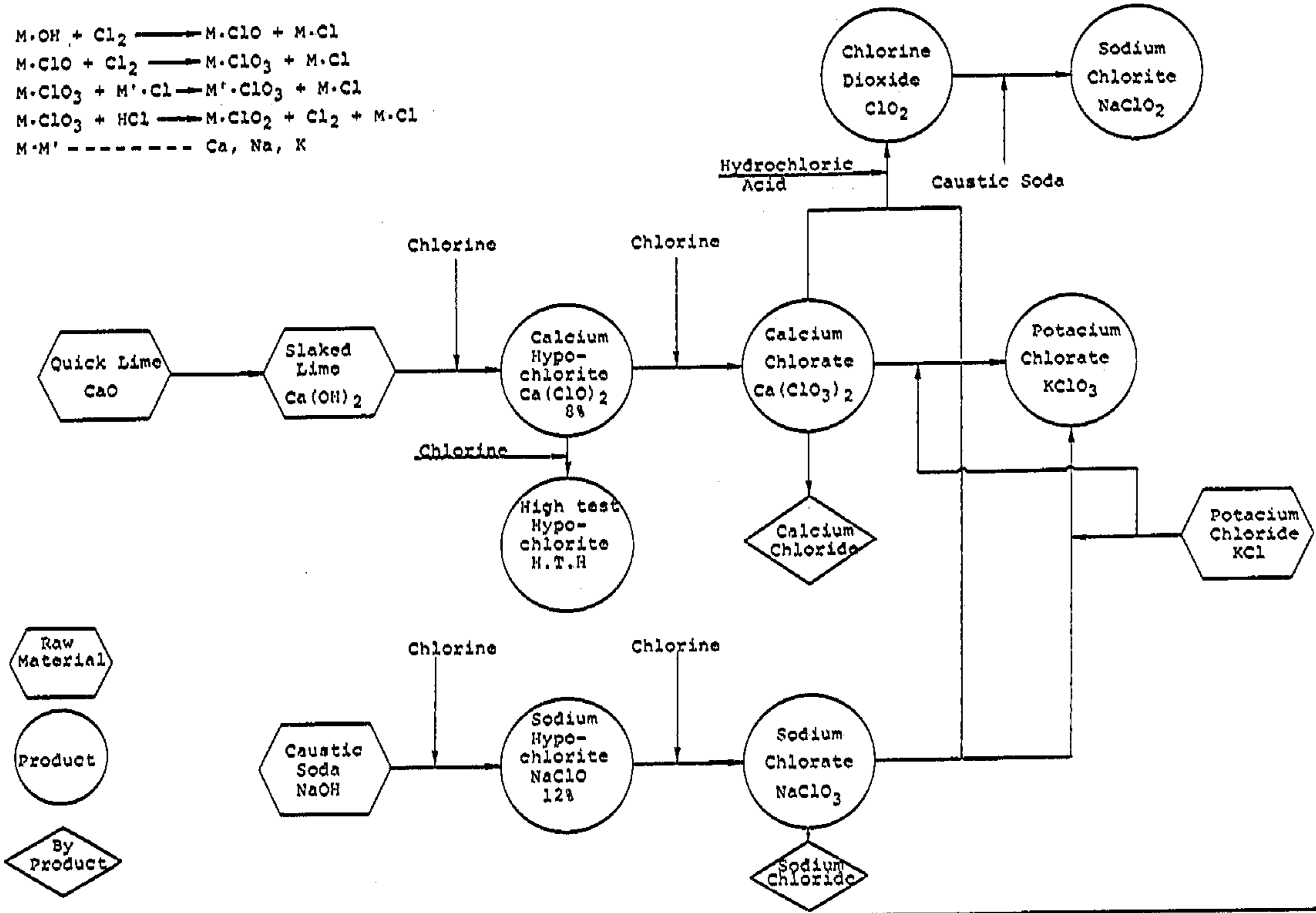


Table AII-2.1 IMPORT OF CHLORINATED COMPOUND IN INDONESIA

(Unit: $/T)

		1978	1979	1980	1981	1982	1983[1/]
Mono vinyle chloride	Q'ty unit price	na	28,965 570	38,457 737	42,988 541	50,775 488	45,483 557
Tri chlor Ethylen	Q'ty unit price	na	na	na	389 2,752	396 773	438 939
Benzyle chloride	Q'ty unit price	na	na	na	16 8,086	4 1,495	3 1,446
Tetra chlor ethylen	Q'ty unit price	na	na	na	75 536	34 590	1 410
Mono chlor benzene	Q'ty unit price	na	na	na	154 1,062	199 981	139 8,868
Dichler benzene	Q'ty unit price	na	na	na	64 962	133 561	24 711
Trichlor benzene	Q'ty unit price	na	na	na	154 733	182 861	105 900
Other haloge nated comp.	Q'ty unit price	43,499 454	10,607 707	3,872 454	2,894 1,537	4,370 1,320	4,510 2,472
Chlorine	Q'ty unit price	398 1,086	217 786	118 928	194 1,241	108 1,144	93 801
Hydrochloric acid	Q'ty unit price	1,482 671	1,553 699.20	2,767 402	952 486	383 692	281 766
Ammonium chloride	Q'ty unit price	7,802 211	9,151 232	9,228 258	11,254 262	8,562 286	10,450 315
Calcium chloride	Q'ty unit price	1,516 178	1,763 181	1,844 359	4,294 300	5,007 253	4,597 233
Other chloride and oxychloride	Q'ty unit price	3,656 -	3,641 -	3,787 -	5,637 -	5,978 -	3,398 -
Sodium hypochlorite	Q'ty unit price	284 470	214 276	394 314	127 789	285 1,054	194 6,921
Chlorates & perchlorate	Q'ty unit price	na	2,121 582	2,025 700	1,889 1,398	2,153 649	3,180 598

(Note) Up to November

(Source) Import Statis of Indonesia

Table AII-2.2 PAST AND FUTURE CONSUMPTION OF AMMONIUM CHLORIDE

	Import		Dry Battery (ton)				Galvanized Steel	Other	Total	PT.ISI Sales	
	Quantity	Unit Price	A, B, C	Union Carbide	National Gobel	Total				Share	Quantity
	ton	$/ton								%	ton
1978	7,802	211									
1979	9,151	232									
80	9,228	258									
81	11,254	262									
82	8,562	286	2,600	1,300	500	4,400	5,000	1,000	10,400	-	
83	11,400	315				4,600	5,100	1,000	10,700	-	
84						4,800	5,200	1,000	11,000	-	
85						5,100	5,300	1,000	11,400	-	
86						5,400	5,400	1,000	11,800	-	
87						5,600	5,500	1,000	12,100	10	1,300
88						5,900	5,600	1,000	12,500	20	2,500
89						6,200	5,700	1,000	12,900	30	3,870
1990						6,500	5,800	1,300	13,600	40	5,440
91						6,700	5,900	1,300	13,900	50	6,950
92						6,900	6,100	1,300	14,300	55	7,900
93						7,100	6,200	1,300	14,600	55	8,000
94						7,300	6,300	1,300	14,900	55	8,200
95						7,500	6,500	1,300	15,300	60	9,200
96						7,700	6,600	1,300	15,600	60	9,400
97						8,000	6,700	1,300	16,000	60	9,600
98						8,200	6,800	1,300	16,300	65	10,600
99						8,500	7,000	1,300	16,800	65	10,900
2000						8,700	7,100	1,300	17,100	65	11,100

(Source) Unico Estimate

Table AII-2.3 FORECAST FOR PRODUCTION OF NH_4CL AND CONSUMPTION OF HCL & CL

(Unit: ton/year)

Year	NH_4CL Production	HCL Consumption	CL Consumption
1987	1,300	2,700	900
88	2,500	5,250	1,740
89	3,870	8,130	2,680
1990	5,440	1,400	3,770
91	6,950	4,600	4,820
92	7,900	6,590	5,450
93	8,000	6,800	5,550
94	8,200	7,220	5,680
95	9,200	9,320	6,380
96	9,400	9,740	6,510
97	9,600	0,160	6,650
98	10,600	22,260	7,340
99	10,900	22,890	7,550
2000	11,100	22,310	7,690

(Notes) Unit consumption of Hydrochloric acid (33%)
2,100 kg/ton of Product

Unit consumption of chlorine
330 kg/ton of Hydrochloric acid

(Source) Unico Estimate

Table AII-2.4 DEMAND FORECAST OF ZINC CHLORIDE

(Unit: ton)

	Dry Battery	Steel	Others	Total	Supply Domestic	Supply Import
1983	3,500	3,000	500	7,000	3,500	3,500
84	3,700	3,060	500	7,260	3,630	3,630
85	3,860	3,120		7,480	3,740	3,740
86	4,050	3,180		7,730	3,870	3,860
87	4,250	3,250		8,000	4,000	4,000
88	4,470	3,310		8,280	4,140	4,140
89	4,690	3,380	500	8,570	4,290	4,280
1990	4,930	3,450	800	9,180	4,590	4,590
91	5,070	3,510	800	9,380	4,690	4,690
92	5,220	3,590	800	9,610	4,810	4,800
93	5,380	3,660	800	9,840	4,920	4,920
94	5,650	3,730	800	10,180	5,090	5,090
95	5,930	3,800	800	10,530	5,270	5,260
96	6,110	3,880	800	10,790	5,400	5,390
97	6,300	3,960	800	11,060	5,530	5,530
98	6,480	4,040	800	11,320	5,660	5,660
99	6,680	4,120	800	11,600	5,800	5,800
2000	6,880	4,200	800	11,880	5,940	5,940

Gross Rate: Battery 5%/year until 1990
3%/year after 1991

Steel 2%/year through the period

(Source) Unico Estimate

Table AII-2.5 FORECAST OF POSSIBLE MARKET OF ZINC CHLORIDE FOR PT. ISI

(Unit: ton, %)

	Estimate import amount	PT.ISI		Requirement of Hydro-chloric acid	Convertion to chlorine
		Share	Production		
1987	4,000	10	400	790	260
88	4,140	20	900	1,780	590
89	4,280	30	1,300	2,530	830
90	4,590	40	1,800	3,600	1,200
91	4,690	50	2,300	4,500	1,500
92	4,800	55	2,600	5,130	1,690
93	4,920	60	3,000	5,820	1,920
94	5,090	65	3,300	6,520	2,150
95	5,260	70	3,700	7,250	2,390
96	5,390	75	4,000	7,960	2,630
97	5,530	80	4,400	8,720	2,900
98	5,660	85	4,800	9,500	3,130
99	5,800	90	5,220	10,300	3,390
2000	5,940	90	5,350	10,530	3,480

Note 1: Consumption of hydrochloric acid (33%)
1,970 kg/ton of product

2: Consumption of chlorine
330 kg/ton of hydrochloric acid

Table AII-2.6 FORECAST FOR PRODUCTION OF CALCIUM CHLORIDE FOR PT.ISI

(Unit: ton)

	Demand in Indonesia	PT.ISI			
		Share %	Production	Consumption of hydro-chloric acid	As chlorin
1987	5,000	10	500	800	270
88	"	20	1,000	1,600	530
89	"	40	2,000	3,200	1,060
1990	"	60	3,000	4,800	1,590
91	"	80	4,000	6,400	2,110
92	"	5,000	5,000	8,000	2,640
93	"	5,000	"	"	"
94	"	5,000	"	"	"
95	"	5,000	"	"	"
96	"	5,000	"	"	"
97	"	5,000	"	"	"
98	"	5,000	"	"	"
99	"	5,000	"	"	"
2000	"	5,000	"	"	"

Note 1. Consumption of hydrochloric acid (33%)
1,600 kg/ton of $CaCl_2 \cdot 2H_2O$

2. Consumption of chlorine
330 kg/ton of hydrochloric acid

Source: Unico Estimate

Table AII-2.7 UNIT PRICE OF BLEACHING CHEMICALS IN JAPAN

		Year	Shipped Q'ty ton	Amount 1,000 yen	Unit Price Yen/ton	
						as Cl_2
	Total	1980 1981 1982	38,279 36,173 34,552	9,215,605 9,312,276 9,259,035	240,773 257,437 267,973	
	Domestic	1980 1981 1982	13,363 9,806 11,251	2,090,609 1,586,276 1,833,035	156,447 159,930 162,921	240,687 246,046 250,647
	Export	1980 1981 1982	24,916 26,367 23,301	7,125,448 7,744,040 7,426,084	285,961 293,700 318,698	336,425 451,846 490,304
	Export for Indonesia	1980 1981 1982	1,767 1,627 2,036	387,880 343,830 461,979	219,692 211,318 266,927	
Calcium hypochlorite ave. Cl_2 8%		1980 1981	112,178 97,243 90,706	1,377,357 1,244,458 1,173,474	12,278 12,797 12,937	153,479 159,967 161,714
Sodium hypochlorite ave. Cl_2 12%		1980 1981 1982	786,183 770,964 779,326	15,279,591 15,739,990 16,395,469	19,435 20,416 21,038	161,959 170,133 175,316
Liquid chlorine		1980 1981 1982	477,527 445,536 449,379	27,062,786 26,374,197 26,910.305	56,672 59,196 59,883	

(Note) 230 Yen = 1US$

(Reference) U.S. Price (Chemical Marketing Reporter)

	1979	1983
H.T.H	400,110 Yen/ton	608,388
Liquid Chlorine	37,040 "	41,360

(Source) Japan Export & Import Statistics

Table AII-2.8 CONSUMPTION PATTERN OF BLEACHING CHEMICALS IN JAPAN

(Unit: ton)

	Ca-hypochlorite soln (8%)				High test hypochlorite (65%)				Na-hypochlorite soln (12%)				Chlorine Total		Share of H.T.H (%)	
	1970		1980		1970		1980		1970		1980					
	Q'ty	as Cl_2	Q'ty	as Cl_2	Q'ty	as Cl_2	Q'ty	as Cl_2	Q'ty	as Cl_2	Q'ty	as Cl_2	1970	1980	1970	1980
Steel Ind.	5	1	4,172	334	-	-	-	-	2,011	241	11,221	1,346	242	1,680	-	-
Petroleum	-	-	-	-	-	-	-	-	-	-	690	83	-	83	-	-
Aluminium	686	55	-	-	-	-	-	-	118	14	318	38	69	38	-	-
Glass ware	-	-	-	-	-	-	-	-	16	2	896	108	2	108	-	-
Chemical Ind.	69,086	5,526	10,739	859	5,567	3,619	1,017	661	264,060	31,687	292,332	35,080	40,832	36,600	2.5	1.8
Rayon	8,377	670	3,926	314	-	-	-	-	10,402	1,248	12,522	1,503	1,918	1,817	-	-
Textile	1,392	111	-	-	409	266	96	62	38,263	4,591	14,392	1,727	4,968	1,789	5.4	1.2
Pulp & Paper	347,432	27,794	128,166	10,253	449	292	49	32	137,226	16,467	228,108	27,372	44,553	37,657	0.7	0.1
Cellophane	-	-	-	-	-	-	-	-	17,243	2,069	9,483	1,138	2,069	1,138	-	-
Food Ind.	-	-	-	-	396	257	96	62	5,548	666	19,807	2,377	923	2,439	27.8	6.7
Sanitary Good	-	-	-	-	116	75	1,269	825	11,218	1,346	12,857	1,543	1,421	2,368	4.9	58.0
City Water	6	1	-	-	84	55	1,586	1,031	12,129	1,455	31,029	3,723	1,511	4,754	3.6	68.2
Waste Water	1,520	122	637	51	1,197	778	3,920	2,548	1,092	131	27,565	3,308	1,031	5,907	23.5	77.0
Other	7,067	565	413	33	2,245	1,459	2,223	1,445	34,894	4,187	153,558	18,427	6,211	19,905	23.5	7.2
Total	435,553	34,844	148,053	11,844	10,463	6,801	10,256	6,666	532,410	63,889	814,778	97,773	105,534	116,283	6.4	5.7
Share % as Cl_2		33.0		10.2		6.4		5.7		60.6		84.1	100	100		

APPENDIX TO PART III

APPENDIX III-1 PRINCIPLES AND OUTLINES OF ELECTROLYZING PROCESSES, MERCURY, DIAPHRAGM AND MEMBRANE

1. Mercury Process

As shown in Figure AIII-1.1, saturated brine is electrolyzed in an electrolyzer equipped with graphite anode or titanium anode of which surface is coated with precious metal compounds such as ruthenium dioxide; and mercury cathode which flows on a steel plate.

On electrolysis, chlorine ions are discharged on the anode surface and chlorine gas evolved;

$$Cl^- \longrightarrow Cl + e \longrightarrow \frac{1}{2} Cl_2$$

and sodium ions are discharged and deposited on mercury surface and produced sodium amalgam.

$$Na^+ + Hg + e \longrightarrow NaHg$$

Sodium amalgam is separated completely with brine at the end of an electrolyzer, and enters to a decomposer. Then sodium amalgam is decomposed with water in the presence of accelerator such as graphite grains into caustic soda and hydrogen. Mercury free from the sodium amalgam, returns to the electrolyzer.

$$NaHg + H_2O \longrightarrow NaOH + \frac{1}{2} H_2 + Hg$$

The depleted brine which is separated in the electrolyzer has low sodium chloride content. After dechlorination, the brine returns to a brine salulator. Raw salt is dissolved with the depleted brine, purified, and supplied again to the electrolyzer.

Characteristics of mercury process and its problems are as follows:

(1) Since concentration of caustic soda solution as high as 50% can be easily produced through the decomposer without any evaporation process.

(2) High purity caustic soda can be obtained.

(3) On the other hand, theoretical decomposition voltage of the process is higher than diaphragm or membrane process. And power consumption is higher than other two processes. Therefore, the process is not suitable for such a region where electricity cost is high.

(4) Secure countermeasures shall be provided to prevent environmental problems from mercury.

2. Diaphragm Process

As shown in Figure AIII-1.2, an electric cell is separated by a diaphragm into anode and cathode compartment. Saturated brine is supplied to anode compartment and brine percolated through a large number of micro pore of an asbestos diaphragm into cathode compartment. Percolation rate is controlled by maintaining liquid level in the anode compartment higher than that in the cathode compartment.

On electrolysis, chlorine ions are discharged on the anode surface and chlorine gas evolved as same as mercury process;

$$Cl^- \longrightarrow Cl + e \longrightarrow \frac{1}{2} Cl_2$$

And hydrogen ions dissocieated from water are discharged on the cathode surface and elove hydrogen gas and more hydroxyl ions. That is, hydrogen gas and caustic soda are produced in the cathode compartment.

$$H^+ + e \longrightarrow H \longrightarrow \frac{1}{2} H_2$$

or

$$H_2O + e \longrightarrow OH^- + \frac{1}{2} H_2$$

The diaphragm plays role to isolate chlorine produced in the anode, and hydrogen produced in the cathode, to prevent explosion caused by mixing both substances. Moreover, it prevents back migration of hydroxyl ions from catholyte to anolyte which descrease cathode current efficiency. Graphite or titanium coated with precious metal compounds such as ruthenium dioxide is used for the anode, and mild steel net, perforated plate or nickel plated cathode etc. is used as a cathode. The diaphragm is made by vacuum deposition on the cathode from alkaline slurry solution of asbestos fibers and others, that is so-called "Vacuum Deposited Diaphragm". In addition, cathodes coated with asbestos paper or asbestos cloth are also used.

Catholyte produced by the diaphragm process contains 10% to 12% caustic soda and 13% to 15% sodium chloride, so it is necessary to concentrate them by a evaporative concentrator. In evaporation, sodium chloride is gradually salting out, and separated the deposited salt and obtained clear 50% caustic soda solution. However, above concentrated caustic solution contains about 1% sodium chloride. Recovered salt returns to the brine satulator and dissolved in water with raw salt feed to make saturated brine.

Characteristics of diaphragm process and its problems are as follows:

(1) Purification of brine in the process is not so severe as in mercury process or membrane process. However, Mg^{2+}, Ca^{2+}, Fe^{3+} in the anolyte reacts with hydroxyl ion from catholyte and form magnesium, calcium, and ferric hydroxide on the catholyte side of the diaphragm may cause blocking problem in the long run. Therefore, impurities in brine are controlled to a limited range. For instance, Mg^{2+} in brine is controlled less than 5 ppm.

    In the diaphragm process, since all of anolyte continuously transferred to catholyte and depleted brine does not occur, and dechlorination procedure is omitted.

(2) Theoretical decomposition voltage is low, and power consumption is smaller than mercury process. However, the process

consumes large amount of steam for evaporative concentration of anolyte, and it is desirable to obtain inexpensive steam from economical aspect.

(3) Evaporative concenration facility and deposit salt separation and recovery equipment is necessary.

(4) Quality of caustic soda from the process is inferior when compared with that of mercury process or membrane process.

(5) Asbestos dust is harmful for human body, so local ventilation facility is necessary.

3. Membrane Process

As shown in Figure AIII-1.3, a cell is separated into anode and cathode compartment by sodium ion perm selective membrane. The anode and the cathode are set in their own compartment. Saturated brine is supplied continuously to anode compartment and water is supplied continuously to cathode compartment. As is the case of diaphragm process, chlorine is evolved on the anode, and hydrogen and caustic soda produced on the cathode by electrolysis.

$$Cl^- \longrightarrow Cl + e \longrightarrow \frac{1}{2} Cl_2$$

$$H_2O + e \longrightarrow OH^- + \frac{1}{2} H_2$$

As cation exchange membrane (perm-selective membrane) almost impermeable to chloride ion, the produced caustic soda solution contains only trace level of chloride ion. Sodium ions permutate the membrane and transfer from anode compartment to cathode together with small quantity of water due to the electric field.

As the brine discharged from the electrolyzer contains free chlorine, the brine is to be dechlorinated before return to the brine satulator where raw salt is fed. The solution is purified and charged to the electrolyzer.

Caustic soda concentration in catholyte produced by the process is about 20% to 35%.

Characteristics of membrane process and its problems are as follows:

(1) Theoretical decomposition voltage is as same as diaphragm process, but membrane process is more preferable to minimize distance of the electrodes. Moreover, by the use of new materials which have low membrane resistance, low anodic over voltage and low cathodic over voltage and others, the actual cell voltage of membrane electrolyzer has been remarkably lowered. Therefore, power consumption of the process is lowest among three processes.

(2) High purity caustic soda solution can be obtained as same as mercury process.

(3) Harmful materials which cause environmental problems are not used.

(4) The process is able to operate smoothly and steadily.

(5) To concentrate catholyte solution more than 35%, evaporative concentration apparatus is necessary. However, the capacity of the apparatus may be smaller than that of the diaphragm process and also does not need deposited salt recovery equipments. In evaporative concentration of catholyte to 50%, steam required is less than diaphragm process.

(6) To operate the process in a good condition, it is necessary to use highly purified brine which contains extremely small Mg^{2+}, Ca^{2+}, $Fe^{2+(3+)}$, and free chlorine concentrations. For this purpose, secondary purification of brine contains chelating resin treatment and others should be provided.

(Note) See Table III-3.1 "Comparison among Mercury, Diaphragm, and Membrane Process."

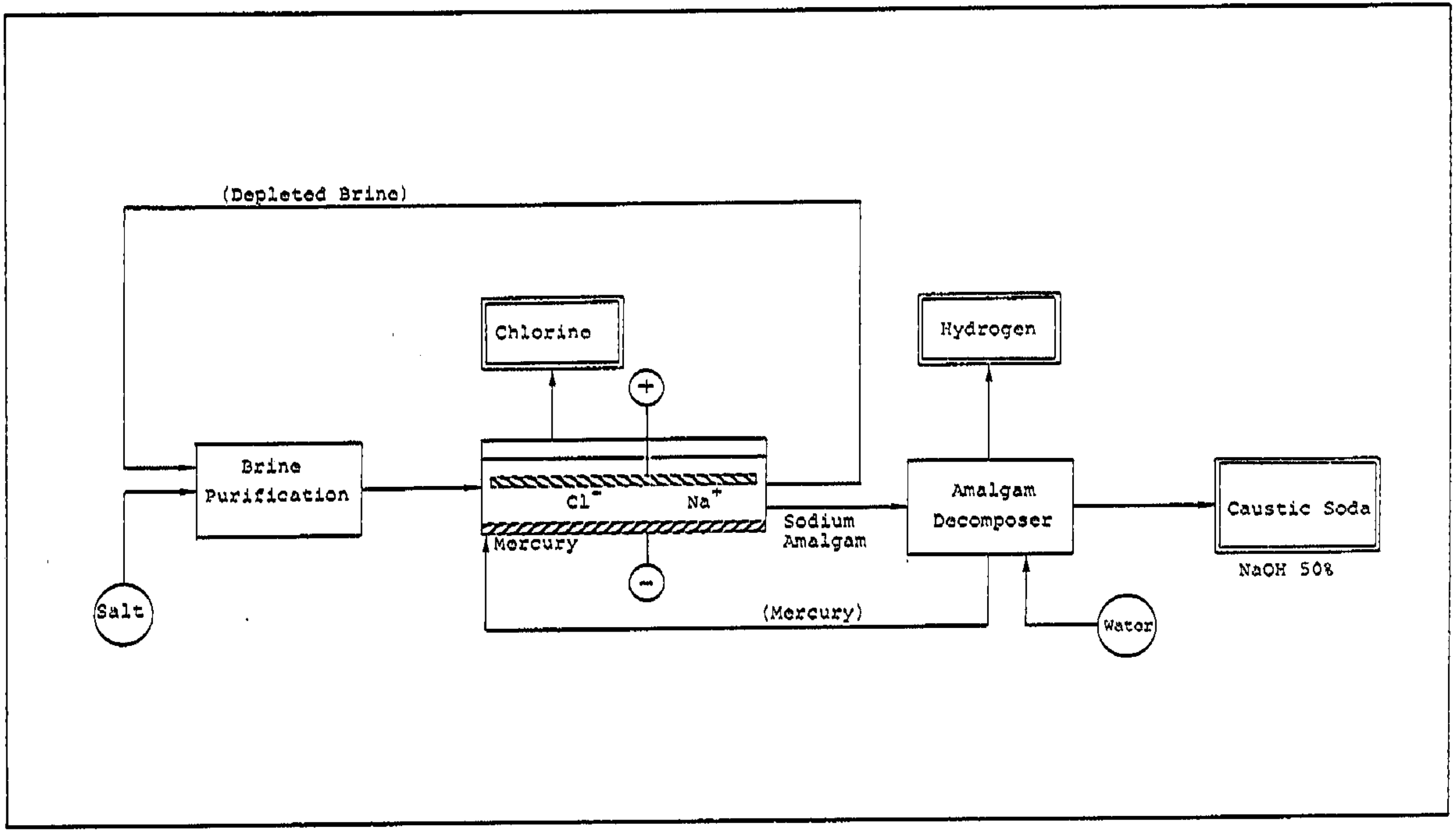


Figure AIII-1.1 PRINCIPLE OF MERCURY PROCESS

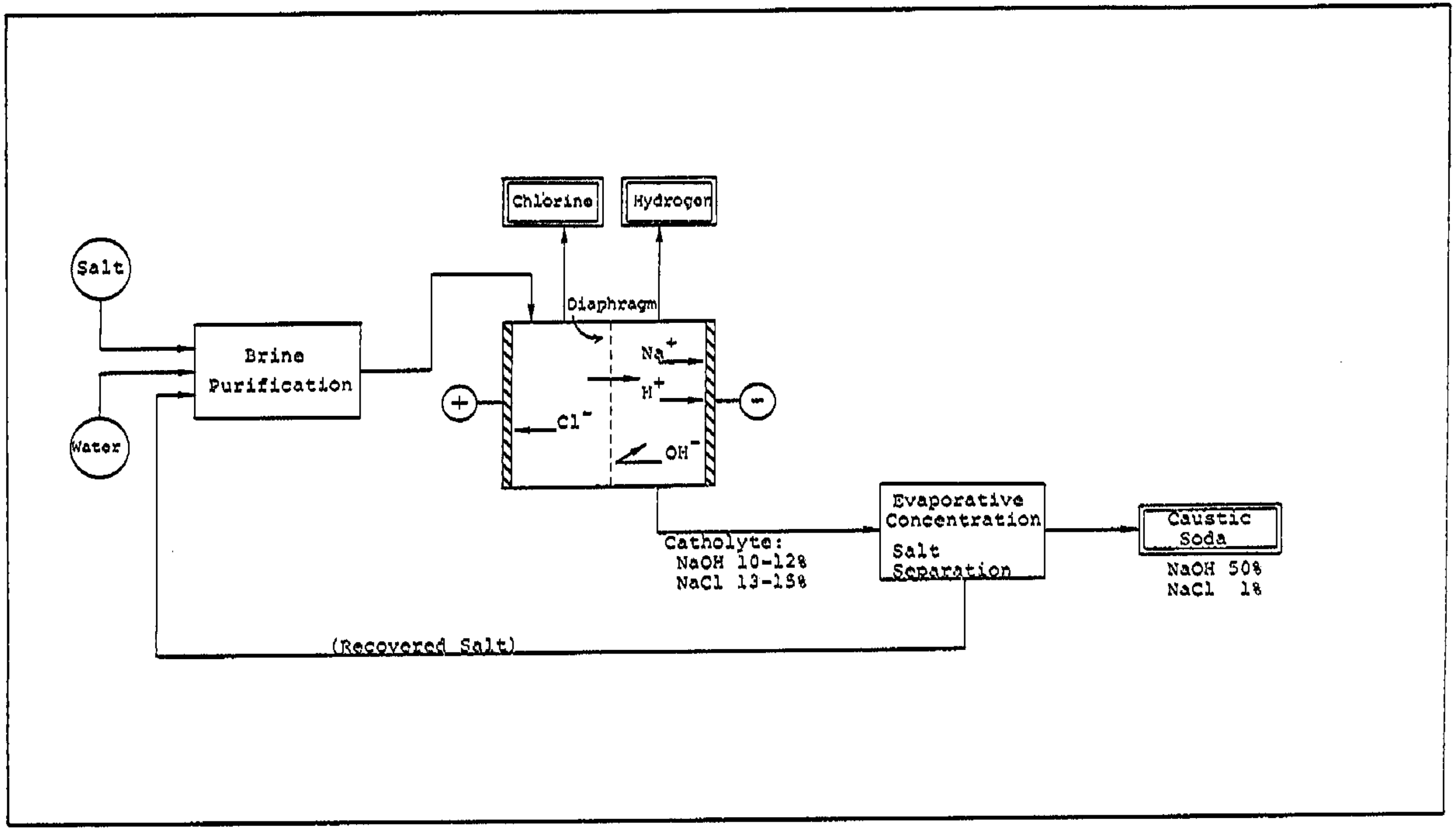


Figure AIII- 1.2 PRINCIPLE OF DIAPHRAGM PROCESS

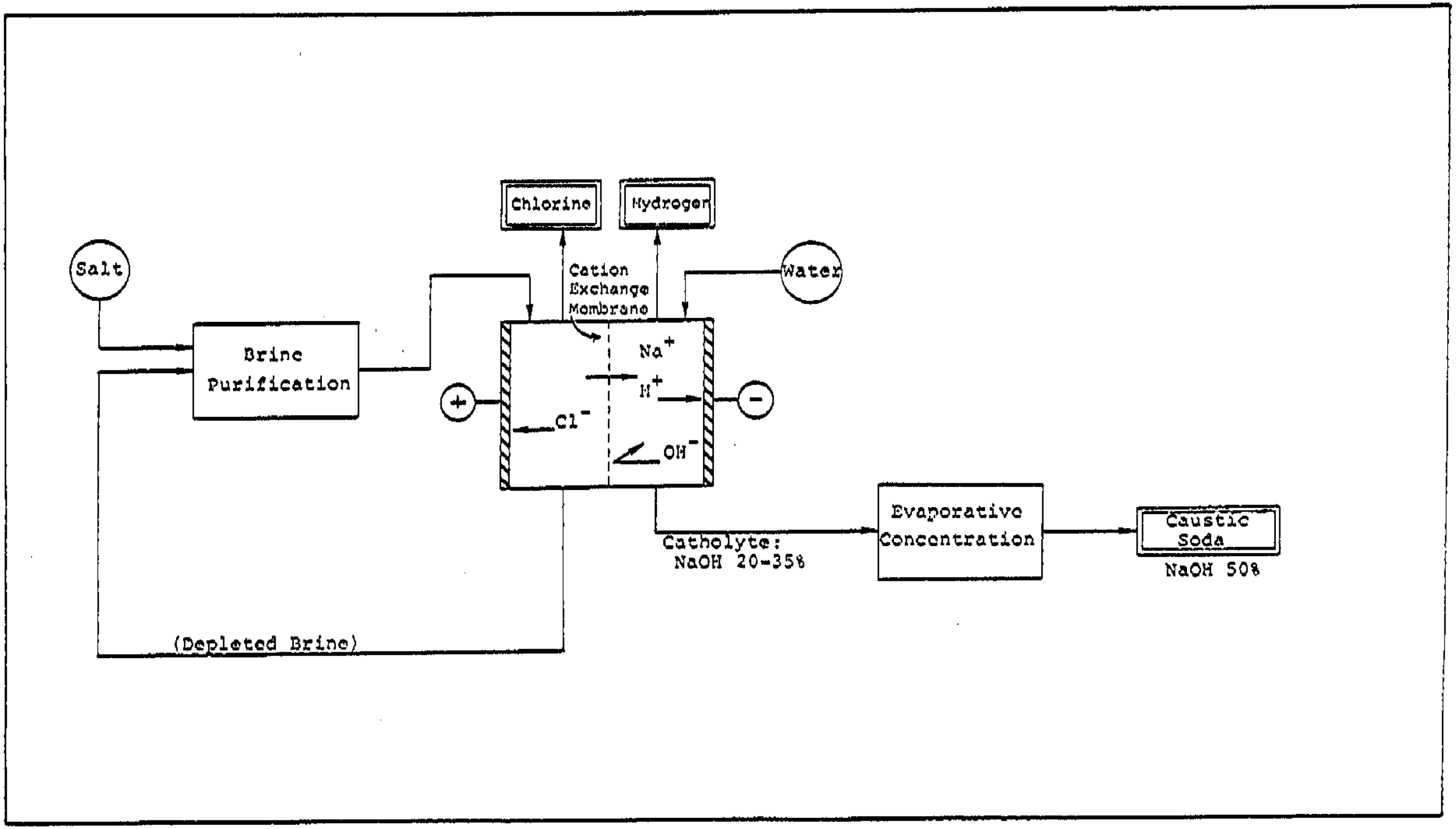


Figure AIII-1.3 PRINCIPLE OF MEMBRANE PROCESS

APPENDIX TO PART V

Table AV-1.1 UNIT PRICE OF MATERIALS AND UTILITIES

(Unit: Rp)

	1981	1982	1983
Materials			
Raw Salt (kg)	28.6	32.9	32.4
$Ca(OH)_2$ (kg)	31.5	37.1	42.1
Utilities			
Electricitiy (kWh)	26.9	35.6	48.8
Fuel (Diesel) (l)	47.4	68.1	138.3
Lub-Oil and Chemicals			
$BaCl_2$ (kg)	405.6	405.3	410.4
Na_2CO_3 (kg)	183.5	175.2	199.4
$Al_2(SO_4)_3$ (kg)	120.8	122.4	187.3
H_2SO_4 (kg)	130.0	206.3	210.4
Precipitant (kg)	227.1	230.0	449.5
Lub-oil (l)	650.0	572.7	570.7
Others			
Mercury (kg)	11,011	-	11,827
Freon-22 (bottle)	150,238	151,110	178,820
Anode (pcs)	745,225	83,230	-
Self Use (MRp/y) (NaOH, HCl)	183,105	123,726	468,372

Table AV-1.2 VARIABLE COST PER PRODUCT

(1,000 Rp/ton of product)

	1981	1982	1983
NaOH			
Raw Salt	57.6	65.8	67.9
Electricity	101.9	137.7	146.5
Fuel	5.5	8.4	28.1
Sub-total	165.0	211.9	242.5
BaCl2	4.7	2.6	3.4
Na2CO3	1.9	1.4	3.1
Al2(SO4)3	1.7	1.6	2.7
Flocculator	0.5	0.3	0.7
Lub-Oil	1.6	1.7	2.4
Sub-total	10.4	7.6	12.3
Mercury	1.7	-	15.7
Anode	3.6	13.3	-
Sub-total	5.3	13.3	15.7
Total	180.7	232.8	270.5
L-CL			
H2SO4	9.2	17.7	19.6
Freon-22	3.6	2.6	2.9
Total	12.8	20.3	22.5
BLC			
Ca(OH)2	50.8	40.0	26.9

Table AV-1.3 SALARIES AND WAGES AND SOCIAL WELFARE

	1981 MRp/y	1981 (MRp/P)	1982 MRp/y	1982 (MRp/P)	1983 MRp/y	1983 (MRp/P)
Board of Director						
Nos. of Persons		9		9		9
Salaries & Wages	25,386	(2,821)	32,740	(3,638)	26,446	(2,938)
Social Welfare	7,267	(807)	7,884	(876)	9,206	(1,023)
Manager						
Nos. of Persons		24		24		23
Salaries & Wages	38,576	(1,607)	49,359	(2,057)	51,482	(2,238)
Social Welfare	17,799	(742)	17,798	(742)	18,313	(796)
Supervisor						
Nos. of Persons		37		37		37
Salaries & Wages	45,160	(1,221)	59,685	(1,613)	70,754	(1,726)
Social Welfare	34,895	(943)	33,278	(899)	34,826	(849)
Foreman						
Nos. of Persons		55		55		55
Salaries & Wages	40,499	(736)	46,946	(854)	62,061	(1,128)
Social Welfare	45,986	(836)	43,763	(796)	40,966	(745)
Operator						
Nos. of Persons		134		128		128
Salaries & Wages	80,306	(599)	85,963	(672)	113,937	(890)
Social Welfare	102,462	(765)	97,344	(761)	91,192	(712)
Total						
Nos. of Persons		259		253		256
Salaries & Wages	229,927	(888)	274,693	(1,086)	324,680	(1,268)
Social Welfare	208,409	(805)	200,067	(791)	94,503	(760)

(Note) Salaries and wages comprise salaries & allowances, overtime, meal & call out, production incentives and daily wages & honorarium.

Social welfare comprises medical treatment, honoraruim for physician, foods allowance, social welfare allowance, pension premium, back service for pension, recreation & sports and working cloth.

Table AV-1.4 ALLOCATION OF PERSONNEL

Year		Board of Director	Manager	Supervisor	Foreman	Operator	Total
1981	NaOH	-	-	4	7	62	73
	HCC	-	-	1	2	8	11
	KC	-	-	1	1	4	6
	BLN	-	-	-	1	2	3
	BLC	-	-	2	4	2	8
	General	9	24	29	40	56	158
	Total	9	24	37	55	134	259
1982	NaOH	-	-	4	7	60	71
	HCC	-	-	1	2	8	11
	KC	-	-	1	1	3	5
	BLN	-	-	-	1	2	3
	BLC	-	-	2	4	2	8
	General	9	24	29	40	53	155
	Total	9	24	37	55	128	253
1983	NaOH	-	-	5	7	60	72
	HCC	-	-	1	2	8	11
	KC	-	-	1	1	3	5
	BLN	-	-	-	1	2	3
	BLC	-	-	2	4	2	8
	General	9	23	32	40	53	157
	Total	9	23	41	55	128	256

Table AV-1.5 MAINTENANCE AND REPAIRING COST

(Unit: 1,000 Rp)

		1981	1982	1983
1.	Road & Field	-	-	-
2.	Buildings	1,445	2,152	12,366
3.	Machinery & Equipment	197,764	110,608	208,504
4.	Motor Car	2,887	3,116	4,328
5.	Transportation	-	-	-
6.	Furniture & Fixture	-	-	-
	Total	202,096	115,876	225,198

Table AV-1.6 FIXED ASSETS AND DEPRECIATION

(Unit: Million Rp)

Year		Historical Acquisition Cost	Accumulated Depreciation	Book Value	Depreciation
1981	1. Land	683	-	683	-
	2. Road & Field	28	3	25	2
	3. Buildings	681	80	601	39
	4. Machine & Equipment	3,892	966	2,925	463
	5. Car	17	7	10	7
	6. Transportation	30	4	26	3
	7. Furniture & Fixture	62	37	25	20
	Total	5,392	1,097	4,295	534
	8. Inventories 1/				28
1982	1. Land	683	-	683	-
	2. Road & Field	28	5	23	1
	3. Buildings	683	117	566	39
	4. Machine & Equipment	3,955	1,418	2,538	468
	5. Car	21	9	11	6
	6. Transportation	43	12	31	19
	7. Furniture & Fixture	128	69	59	30
	Total	5,541	1,630	3,912	563
	8. Inventories 1/				48
1983	1. Land	683	-	683	-
	2. Road & Field	28	7	21	1
	3. Buildings	683	154	530	39
	4. Machine & Equipment	4,154	1,893	2,262	486
	5. Car	22	9	13	3
	6. Transportation	59	21	38	9
	7. Furniture & Fixture	131	97	34	43
	Total	5,762	2,180	3,582	583
	8. Inventories 1/				38

(Note) 1/ A five percent of the value of inventories (raw material and finished goods) is depriciable due to PT. ISI accounting system.

Table AV-1.7 ADMINISTRATIVE COST

(Unit: 1,000 Rp/y)

	1981	1982	1983
I. Office & Insurance			
1. Insurance 1/	13,229	14,503	27,627
2. Office Expenses	16,189	20,892	23,197
Total	29,418	35,395	50,824
II. Sales Expenses	13,599	15,862	17,350
III. General Expenses			
1. Official Tours	27,289	18,085	20,715
2. Services/Official Meetings	9,602	7,948	6,368
3. Upgrandings for Employees	2,593	5,230	2,070
4. Bounded Warehouse	16,851	19,506	25,677
5. Official Company Housing	11,435	18,712	29,933
6. Taxes	4,426	4,427	9,724
7. Cooperation Funds	5,378	7,913	8,930
8. Company Car Expenses in JKT	1,500	750	500
9. Board of Director Expenses	9,450	13,610	10,920
10. Board of Commissioner Expenses	14,187	13,446	13,210
11. Management Expenses	2,179	3,260	2,500
12. Shareholder's General Meetings	5,194	1,882	3,168
13. Backservice for Pensioner' Fund	27,406	27,406	27,406
14. Others	5,910	4,175	8,151
Total	143,401	146,350	169,272

(Note) 1/ a. 0.6% for fire and explosion on the value to be insured:

- Buildings of warehouse, electrolizer and liquid chlorine
- Imported machinery and equipment

b. Insurance for car accident.

c. 1.5% of value of inventory including finished goods and spare parts. No insurance on raw salt.

Table AV-1.8 CURRENT ASSETS

(Unit: 1,000 Rp)

	1981	1982	1983
Current Assets			
1. Cash on Hand	46,614	1,318	12,738
2. Cash in Bank	201,497	86,119	107,488
3. A/C Receivables			
Gross	708,349	910,697	1,486,013
Provisions for Bad Assets (Less)	(11,510)	(11,510)	(11,510)
Net A/C Receivables	696,839	899,187	1,474,503
4. Other Receivables	192,040	119,054	84,360
5. Prepaid Expenses	4,789	4,789	-
6. Inventories			
- Materials	155,789	111,099	144,746
Depreciation (Less)	(27,855)	(48,006)	(38,318)
Other Materials	433,409	427,838	508,188
Net Material Inventory	561,343	490,931	614,617
- Work in Process	1,114	1,927	1,798
- Finished Goods	56,639	154,859	86,218
Total Inventories	619,096	647,717	702,633
7. Prepaid Income Tax	120,461	144,322	167,958
Total Current Assets	1,881,336	1,902,506	2,549,680

Table AV-1.9 CURRENT LIABILITIES AND NET WORKING CAPITAL

(Unit: 1,000 Rp)

	1981	1982	1983
Current Liabilities			
1. A/C Payable (Materials)	157,198	168,651	613,852
2. Short Term Portion of Long Term Debt	350,000	730,000	-
3. Other A/C Payable	265,344	343,096	395,784
4. Accrued Expenses Payable (Utilities)	148,348	311,590	376,561
5. Accrued Taxes Payable	265,157	261,940	367,590
6. Accrued National Development Funds (DPS Payable during company status as P.N.)	131,152	111,152	111,152
7. Guarantee Fees Deposits by Customers for Containers	37,577	45,000	45,000
Total Current Assets	1,354,776	1,971,429	1,909,939
Net Working Capital			
Current Assets	1,881,336	1,902,506	2,549,680
Current Liabilities	1,354,776	1,971,429	1,909,939
Net Working Capital	526,560	(68,923)	639,741

Table AV-1.10 DIRECT PRODUCTION COST ALLOCATION TO EACH PRODUCT

Year		General	NaOH (40%)	HCL (33%)	L-CL (99%)	BLN (12% CL)	BLC (8% CL)
1981	(1) Variable Cost	-	1,113.1	-	11.3	-	61.7
	(2) Salaries & Wages	138.2	66.2	10.4	4.8	2.6	7.7
	(3) Social Welfare	126.0	59.9	8.8	4.3	2.3	7.1
	(4) Maintenance Cost	4.3	88.6	5.9	95.4	4.7	3.2
	(5) Depreciation	63.1	380.5	32.6	48.9	1.5	7.6
	Total (MMRp/y)	331.6	1,708.3	57.7	164.7	11.1	87.3
	MRp/ton 1/	-	272.9	5.95	185.5	7.3	71.9
1982	(1) Variable Cost	-	1,535.7	-	21.1	-	60.9
	(2) Salaries & Wages	169.6	75.7	12.0	6.0	3.0	8.4
	(3) Social Welfare	128.0	52.4	7.8	4.0	1.9	6.0
	(4) Maintenance Cost	5.3	81.6	2.3	25.5	1.4	-
	(5) Depreciation	88.0	384.7	32.6	48.9	1.5	7.6
	Total (MMRp/y)	390.9	2,130.1	54.7	105.5	7.8	82.9
	MRp/ton 1/		322.9	4.86	101.8	21.6	53.9
1983	(1) Variable Cost	-	1,783.0	-	23.9	-	67.7
	(2) Salaries & Wages	185.3	98.8	15.8	8.0	3.9	12.9
	(3) Social Welfare	126.7	49.4	7.5	3.8	1.5	5.6
	(4) Maintenance Cost	16.7	147.2	28.8	19.7	7.7	5.1
	(5) Depreciation	89.0	395.4	40.7	48.9	1.58	7.6
	Total (MMRp/y)	417.7	2,473.8	92.8	104.3	14.6	98.9
	MRp/ton 1/	-	375.1	8.4	97.9	24.8	23.4

(Note) 1/ Only NaOH is stated as 100%, and the others are done as per-ton cost of those products.