THE REPUBLIC OF INDONESIA SURVEY REPORT

ON

# PETROCHEMICAL INDUSTRY DEVELOPMENT

## VOL. V SYNTHETIC DETERGENT

OCTOBER 1974



Prepared for
JAPAN INTERNATIONAL
COOPERATION AGENCY
by
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## Abbreviations

| | |
|---|---|
| AB | Alkylbenzene |
| ABS | Acrylonitrile-butadiene-styrene for polymer |
| ABS | Alkyl Benzene Sulfonate |
| AD | Acetic Acid |
| AG | Aromatic Gasoline (Pyrolysis Gasoline) |
| BR | Butadiene Rubber |
| B-B | Butan, Butadiene Residue |
| BTX | Benzene, Toluene, Xylene |
| CHP | Cumene Hydroperoxide |
| CCW | Circulating Cooling Water |
| CPP | Cast Polypropylene Film |
| CR | Chloroprene Rubber |
| C-X(CHX) | Cyclohexane |
| DEG | Diethylene Glycol |
| DMT | Dimethyl Terephthalate |
| DOP | Dioctyl Phthalate |
| E | Ethylene |
| EG(MEG) | Ethylene Glycol |
| EO | Ethylene Oxide |
| EP | Electric Power |
| EPDM | Ethylene-propylene-diene-methylene Linkage |
| EDC | Ethylene Di-chloride |
| EVA | Ethylene-vinyl Acetate Copolymer |
| FG | Fuel Gas |
| FO | Fuel Oil |
| FRP | Fiber Reinforced Plastic |
| FW | Filtered Water |
| GP | General Purpose (Polystyrene) |
| HDPE | High Density Polyethylene |
| HI | High Impact (Polystyrene) |
| IR | Isoprene Rubber |
| IIR | Butyl Rubber |
| LAB | Linear Alkylbenzene |

| | | |
|---|---|---|
| LDPE | Low Density Polyethylene | |
| LNG | Liquefied Natural Gas | |
| LPG | Liquefied Petroleum Gas | |
| MI | Melt Index | |
| M-xylene (Xylene) | Mixed Xylene | |
| NBR | Nitril Rubber | |
| NG | Natural Gas | |
| NGL | Natural Gas Liquid | |
| NR | Natural Rubber | |
| OPP | Oriented Polypropylene Film | |
| PP | Polypropylene | |
| PS | Polysterene | |
| PTA | Pure Terephthalic Acid | |
| PVC | Polyvinyl Chloride | |
| PW | Polished Water | |
| p-Xylene (P-X) | Paraxylene | |
| SBR | Styrene-butadien Rubber | |
| SM | Styrene Monomer | |
| TPA (TA) | Terephthalic Acid | |
| UV | Ultra-violet | |
| VCM | Vinyl Chloride Monomer | |
| | | |
| DCF | Discounted Cash Flow | |
| Exchange Rate | 1971 | 1US$=360 Yen |
| | | 1US$=415 Rupiah |
| | After the End of 1973 | 1US$=300 Yen |
| | | 1US$=415 Rupiah |
| GDP | Gross Domestic Product | |
| GNP | Gross National Product | |
| IRR | Internal Rate of Return | |
| $(DL.) | U.S.$, unless Particularly Remarked | |
| ROI | Return on Investment | |

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Volume V

## Chapter 1. Conclusion and Recommendation

Indonesian demands in 1973 for synthetic detergents are estimated to be approximately 40,000 tons, of which approximately 10,000 tons are powder detergents, and remaining 30,000 tons are so called cream detergents.

Demand in the years 1980 and 1985 for synthetic detergents inclusive of powder and cream are estimated to be 90,000 tons and 150,000 tons. Required alkylbenzene for this production will be 17,000 tons and 27,000 approximation (Chapter 3).

Economics on the assumption of startup of the alkylbenzene production plants having design capacity of 15,000 tons in 1977 and 1980 respectively were thoroughly studied. As a result, in each occasion a high internal rate of return was obtained (Chapter 4).

For the production of 15,000 tons of alkylbenzene, it requires 18,200 tons of propylene and 7,000 tons of benzene. Start-up date in 1977 or 1980, whichever, mainly depends on the availability of materials, especially of propylene, based on which, the selection of the plant site should be made.

It is desired to make a detailed 2nd stage economic study for the alkylbenzene plant, including the selection of the plant site.

## Chapter 2. General Introduction

### 2-1 Background of the Survey and the Purpose

According to the UNIDO's Phase I report, consumption of synthetic detergent in Indonesia in 1971 was 7,000 t/y (estimated), required alkylbenzene for this estimate is 500 t/y.

The minimum economic scale of the alkylbenzene production plant is 5,000 t/y, thus the construction of an alkylbenzene production plant, at least within the next decade is unfeasible.

In view of the recent increase of national income in Indonesia, resultant increase in demand for soaps, and the recent trend of rising prices for natural fats and oils, it is again necessary to review the demand for synthetic detergents.

The present report, contemplates the possibility of constructing an alkylbenzene plant, from a different point of view, by making required surveys of the demand in Indonesia for synthetic detergent.

### 2-2 Policy on the Survey and the Practical Method Adopted

#### 2-2-1 Estimation of total demands for detergent and soap

Total demand for detergent and soap in Indonesia, up until 1985, was macroscopically forecast by the International Cross

Section Method using the GDP as the explanatory variable.

2-2-2 Estimation of synthetic detergent demand

The demand for synthetic detergent can be correlated with number of electric washers, but it is not easy to make a future forecast of it through the past statistics because of a lack of detailed records of the Indonesian popularization of electric washing machines. Subsequently, a case study of demand, presuming a switchover to synthetic detergent was made.

2-2-3 Studies on economics of alkylbenzene production plant

An alkylbenzene production plant having a capacity of 15,000 t/y was assumed inclusive of the production apparatuses for tetramer, and cost calculations were performed on a 1979 basis.

## Chapter 3. Synthetic Detergent Market Survey and Demand Forecast

### 3-1 Situation on Indonesian Detergent Demand

#### 3-1-1 General situation

In view of its inherent coconut oil production, soap is being used as a major cleansing agent in Indonesia with very little use of synthetic detergent. This is mainly due to the low rate of spreading into nation of the electric washing machine in short. As it has introduced from 1971 to 1972 the creamy (paste-form) synthetic detergent, a rapid growth was set out, Indonesia is now transforming herself to a great synthetic detergent consuming country with huge potential market.

#### 3-1-2 Production of the synthetic detergent and the demand situation

Powder synthetic detergent makers (those companies possessing a capability of sulfonation and dry-spray)

| | Capacity |
|---|---|
| Unilever (100% foreign investment company) | 10 - 12,000 t/y |
| Rhoda Mas | 6,000 |
| Chemin Foenitz | 6,000 |

Besides the above there are about 40 companies of paste-form detergent makers run by the overseas Chinese, and these are also soap makers from the coconut oil. Of the mentioned 40 companies, 5 are said large-scale makers, but all of them are with the predisposition production capacity to medium and small companies. Sales of synthetic detergents in 1973 estimated by a Japanese trade firm,

| | |
|---|---|
| Powder detergents | 10,000 tons |
| Paste detergents | 30,000 tons |
| | 40,000 tons |

Most of the activator used is hard alkylbenzene with a small amount of soft alkylbenzene merely due to the shortage of hard alkylbenzene. By calculating of quantities of alkylbenzene used from the above figures, it will result in a quantity of about 7,200 tons. (The bases for said calculation are -

20% alkylbenzene sulfonate in the powder and
30% alkylbenzene sulfonate in the paste

3-1-3 Background of cream detergents

Except for small numbers of households, most washing is done utilizing river water, where the dissolution speed of powered detergents in the water is very slow and inefficient as the powdered detergents float away. However, this problem is resolved by paste detergents, and, at the same time, high cleansing effect can be expected. Conventional soaps could be used without difficulty, but soaps have lower cleansing power, coconut oil price has risen, auxiliary materials such as caustic soda, etc. are in very short supply, thus soap price and consumption are affected considerably. Fortunately, small and medium soap makers could operate also as makers of cream detergents, and this contributed to the rapid growth and popularity of paste detergents from 1971 - 1972.

Rapid dissemination of the electric washing machine is not expected in Indonesia under present conditions resulting in only small demand for powder detergents. Therefore, the use of cream detergents will be growing at more rapid rate in this market.

3-2 Demands Forecast for Synthetic Detergents

As described earlier, historically the detergents, especially the powder detergents, have grown together with the dissemination of the electric washing machine in the European countries the United States and Japan. Annex II-1 gives the situation in Japan as an example. Suppose that this correlation is applied to Indonesia, it seems that during the 1970s the demands for synthetic detergents will not exceed 20,000 t/y.

However, it seems that the appearance of cream detergent in place of soaps has broken long-accepted concepts on synthetic detergents, viz., major raw material coconut oil for the soaps is being predominantly subsidized and backed under the guidance of the Government the priority to foodstuffs, thus it would be a good point to see whether coconut oil would be supplied to the conventional soap industry to an extent that would fully meet production requirements, which could be more truly considered the national income growth. Moreover, synthetic detergents made from raw material alkylbenzene have strong cleansing power for the price and are easily usable, thus it is almost impossible to go back to the old soaps once synthetic detergents are widely introduced. Even if cream detergents would be replaced by the powder detergents like other industrial countries as the electric washing machine is disseminated in the future, consumption growth of cream detergent will be greatly expected for the time being.

### 3-2-1 Forecast of total detergent demands

Production of soap in Indonesia is said to amount to approximately 130,000 to 200,000 t/y, which is converted to about 1.1 to 1.7 kg per capita consumption, and which is roughly 8 - 15 kg in major European countries and in the United States in comparison. (Shown in Table V-1) Considering the difference in climates for every country and some other living environments, the two figures compared indicate that in Indonesia there is also greater anticipation that future demands on soaps and detergents would become rather great.

However, as shown in Figure V-1, the demands for soaps and other detergents do not show so close a correlation with the country's economic account. This illustrates the fact that at the present no sufficient data is obtainable to carry out a cross section analysis. If we are to make estimations on overall demands[1)] in Indonesia alone through roughly estimated curve on Figure V-1, and multiplied by estimated population both 1980 and 1985 would show a total consumption of about 1,000,000 t/y, which is greater than that of Japan in 1970 and about 70% of the United States. Judged from the current status, the demands would be about 1/3 - 1/2 of the figure.

Note: In regard to GDP future predictions, refer to Volume IV, Table IV-10.

### 3-2-2 Forecasts of synthetic detergent demands

Different from soap production which is already traditional, synthetic detergents are a part of the chemical industry which, has a higher correlation with the economic account. Figure V-2 shows the relations between per capita synthetic detergent consumption in various OECD countries and per capita GDP, where the regression equation becomes as follows:

$$\log q = -0.6376 + 0.4714 \log u \quad (r \simeq 0.6798)$$

where, q stands for per capita consumption (kg) of synthetic detergents, and u likewise GDP (1965 price in US$).

Indonesian consumption of synthetic detergent is estimated to be approximately 40,000 t/y at present, from which per capita consumption of about 0.3 kg is derived, and based on this the following hypothesis is made to forecast future demands:

(1) 1970 demands for synthetic detergents are 0.3 kg.

(2) At the per capita GDP rate of US$1,000 (on 1965 price), it will exactly match with the per capita figure of 6 kg on the cross section graph in various OECD countries (Figure V-3).

(3) Until then the demands will fluctuate (refer to the same Figure) on the line connecting with the above (1) and (2).

Estimated by this method, per capita demands in 1980 and 1985 become respectively 0.6 kg and 0.9 kg, which converted into the total quantity also become respectively 90,000 tons and 150,000 tons, and for which the required alkylbenzene will be about 17,000 tons and 27,000 tons respectively.

## Table V-1 Per Capita Consumption of Soaps and Synthetic Detergents vis Per Capita GDP in OECD Countries (1970)

(Unit: 1 000 MT)

| Country Name \ Classification | Soaps | | | | Synthetic Detergents | | | | Soaps & Synthetic Detergents Consumption | Per Capital annual Consumption(Kgs) | | | Per Capita GDP (US$) (1965 Constant Price) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Production | Imports | Exports | Consumption | Production | Imports | Exports | Consumption | | Soaps | Synthetic Detergents | Total | |
| W. Germany | 142.4 | 3.1 | 9.7 | 135.8 | 659.7 | 6.1 | 23.8 | 642.0 | 777.8 | 2.23 | 10.78 | 13.06 | 2,267 |
| Austria | 9.0 | 1.1 | 0.2 | 9.9 | 48.4 | 5.5 | 0.6 | 53.3 | 63.2 | 1.33 | 7.17 | 8.50 | 1,582[1] |
| Belgium | 42.5 | 8.1 | 4.0 | 46.6 | 134.2 | 24.7 | 56.3 | 102.3 | 149.2 | 4.82 | 10.60 | 15.42 | 2,020 |
| Denmark | 15.6 | 1.4 | 2.0 | 15.0 | 36.9 | 13.7 | 22.9 | 27.7 | 42.7 | 3.05 | 5.63 | 8.68 | 2,992[2] |
| Spain | 149.7 | 1.1 | 5.0 | 145.8 | 151.8 | 8.9 | 2.2 | 158.5 | 304.3 | 4.38 | 4.78 | 9.14 | 786[1] |
| Finland | 7.2 | 2.2 | 0.1 | 9.3 | 28.8 | 13.5 | 1.3 | 41.0 | 50.3 | 1.98 | 8.73 | 10.71 | 2,162[1] |
| France | 132.0 | 4.5 | 17.7 | 118.8 | 481.2 | 34.6 | 37.0 | 473.8 | 597.6 | 2.34 | 9.43 | 11.77 | 2,450 |
| Ireland | 5.2 | 0.7 | ... | 5.9 | 8.6 | 13.8 | 0.5 | 21.6 | 27.5 | 2.01 | 7.34 | 9.35 | ---- |
| Italy | 152.4 | 3.8 | 10.9 | 145.3 | 427.0 | 20.8 | 2.3 | 445.5 | 590.8 | 2.71 | 8.30 | 11.01 | 1,326 |
| Norway | 11.0 | 1.2 | 1.0 | 11.2 | 24.8 | 13.6 | 1.0 | 37.4 | 48.6 | 2.89 | 9.64 | 12.53 | ---- |
| Holland | 24.9 | 5.7 | 6.1 | 24.5 | 128.7 | 44.4 | 34.0 | 139.1 | 163.6 | 1.88 | 10.69 | 12.57 | 2,445 |
| Portugal | 68.4 | 0.1 | 2.6 | 65.9 | 32.1 | 4.8 | 4.8 | 32.1 | 98.0 | 6.84 | 3.34 | 10.18 | ---- |
| England | 265.9 | 0.3 | 29.4 | 236.8 | 552.0 | 19.7 | 112.2 | 459.5 | 696.3 | 4.25 | 8.25 | 12.50 | 1,842 |
| Sweden | 17.5 | 2.6 | 1.9 | 18.2 | 42.1 | 26.2 | 8.6 | 59.7 | 77.9 | 2.26 | 7.42 | 9.68 | ---- |
| Turkey | 43.4 | ... | ... | 43.3 | 26.3 | 1.6 | ... | 27.9 | 71.2 | 1.23 | 0.79 | 2.02 | ---- |
| Canada | 32.0 | 2.7 | nd | 34.7 | 153.9 | nd | nd | 158.9 | 193.6 | 1.62 | 7.42 | 9.04 | 2,910 |
| America | 476.3 | 1.4 | 11.8 | 465.9 | 2,562.8 | 0.7 | 87.6 | 2,475.9 | 2,941.8 | 2.27 | 12.05 | 14.32 | 3,817 |
| Japan | 151.0 | 2.9 | 1.7 | 152.2 | 697.8 | 4.4 | 9.9 | 692.3 | 844.5 | 1.47 | 6.67 | 8.14 | 1,527 |

NOTE by Japanese Association: (1) Sales quantity on the data issued by U.S. Dept of Agriculture (2) MITI data (3) Finance Ministry data

All The others are OECD data, and synthetic detergents are the total of both powder and liquid detergents, provided, however, Ireland, Holland, Sweden & Turkey are only powder detergent.

(4) 1969. "..." stands for very little.
"nd" stands for data not publicized yet.

Source: The Japan Oil & Fat Processing Industry Association
United Nations, Monthly Bulletion of Statistics

NOTES:
1) 1964 Constant Price
2) 1963 Constant Price

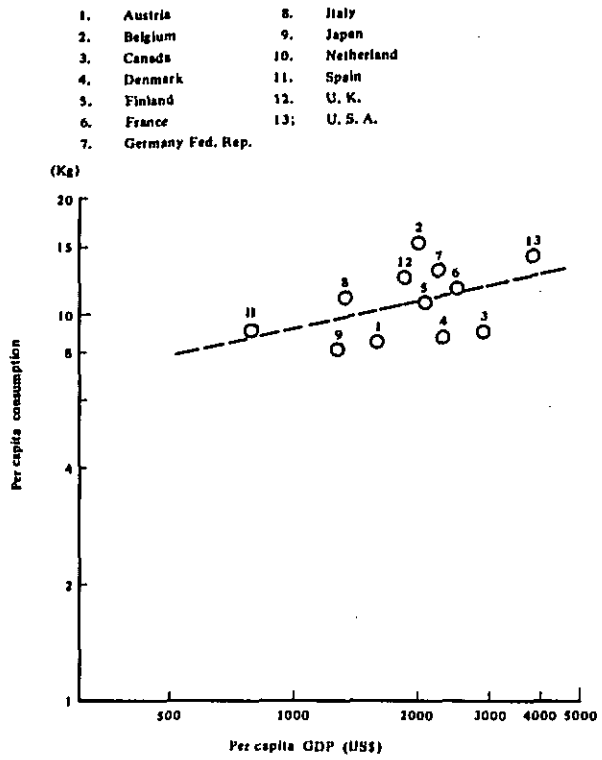


Figure V-1 Relationship between Per Capita Consumption of Total Detergent and Per Capita GDP

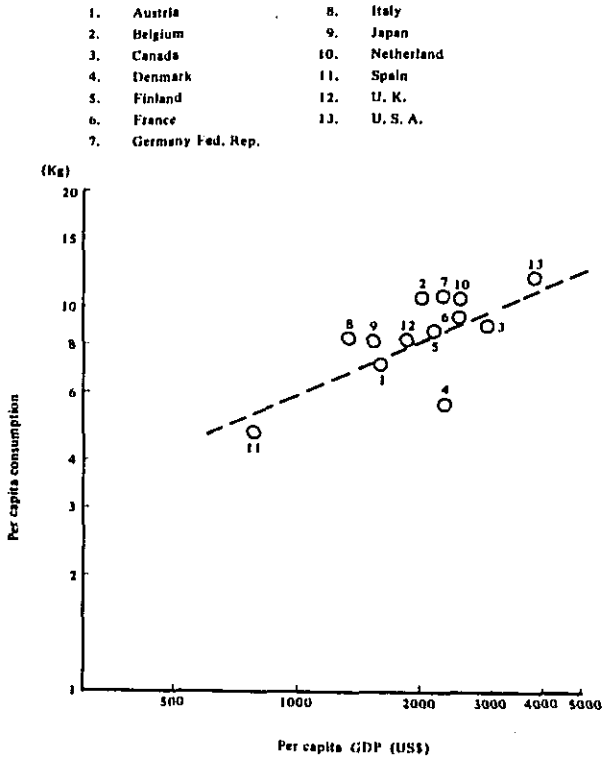


Figure V-2 Relationship between Per Capita Consumption of Shythetic Detergent and Per Capita GDP

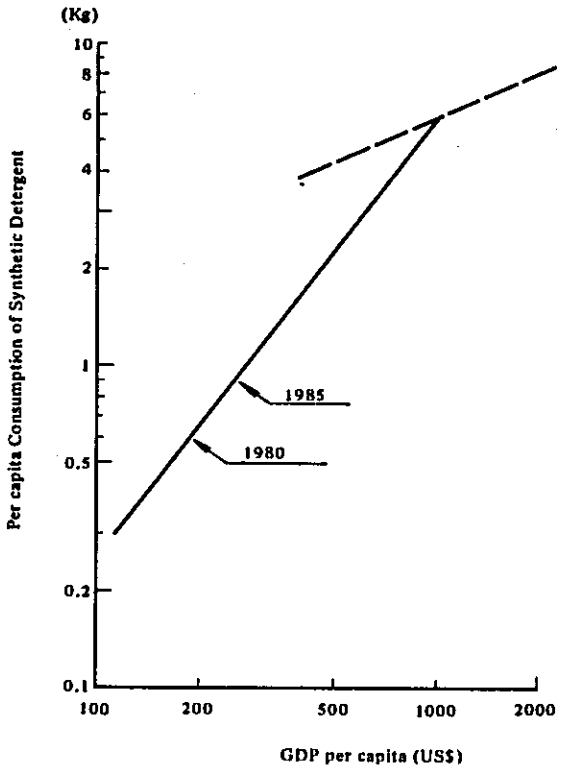


Figure V-3 Prediction of Synthetic Detergent Consumption in Indonesia

As shown in Table V-1, soap production in various OECD countries, except the United States; approx. 500,000 tons, is in the range of roughly 100,000 - 200,000 tons. Maximum Indonesian soap production is nearly 200,000 tons and growth is foreseen in the future as it will be substituted by synthetic detergent, and cream detergent, etc., thus it is predicted that in the early part of the 1980s Indonesia may require roughly 200,000 tons of synthetic detergent.

In the case, in 1980 construction of more than a 15,000 ton alkylbenzene plant would be possible in Indonesia.

## Chapter 4. Economic Calculation on Alkylbenzene Plant

### 4-1 Basic Data for the Economic Calculation

#### 4-1-1 Construction and operational plans

Alkylbenzene demands in Indonesia are estimated in 1980 to be about 17,000. Therefore, supposing that a production plant having a capacity of 15,000 t/y is constructed respectively in 1977 or in 1980, the following two cases were studied:

| | Case I | Case II |
|---|---|---|
| Start of construction | July 1974 | July 1977 |
| Completion of construction | June 1976 | June 1979 |
| Initial test operation and operational preparation | June - Dec. 1976 | June - Dec. 1979 |
| Startup of operation | January 1977 | January 1980 |

4-1-2 Process data

Process data of the plant is as follows:

(1) Raw material unit:

| | |
|---|---|
| Propylene | 1.211 |
| Benzene | 0.466 |

(2) Utilities consumption:

| | |
|---|---|
| Electricity | 140 KWH/t |
| Steam | 0.816 t/t |
| Cooling water | 228 t/t |
| Fuel | 5,550 x $10^3$ Kcal/t |

(3) Others

| | |
|---|---|
| Catalyst and chemicals cost | 18 $/t |

(4) Deduction of by-products 120 $/t

(5) Operators 20 persons

Notes: 1) Alkylbenzene shall include 2 process, viz., production of propylene tetramer (dodecene) and production of dodecyl benzene.

2) Prices of (3) and (4) are 1980 prices.

4-1-3 Total investment

Total investment amount in 1977 is as follows. 1980 price is derived by multiplying an escalation factor of 7% a year.

| | (In million US$) |
|---|---|
| (1) Production facilities acquired price | 14.0 |
| (2) Auxiliary facilities acquired price ( (1) x 0.30 ) | 4.2 |
| (3) Operational preparation cost (Costs of raw materials, utilities loss and personnel during the test operation period.) | 0.5 |
| (4) Monetary interest during construction period | |

| | | |
|---|---|---|
| | 7.5%/year X 1 year | 1.4 |
| A | Total fixed capital | 20.1 |
| B | Working capital * | 2.0 |
| C | Total investment amount | 22.1 |

Note: * Required funds for raw materials, two months product stock, accounts receivables and 9-day accounts payable.

4-1-4 Product price and variable cost

Product price and variable cost as evaluated for 1980 are given below. Product prices are taken from Table V-2(1); raw material prices and utilities costs are taken from those of Volume II, Part 3:

(1) Product price 690 US$/t

(2) Raw material price:

| | |
|---|---|
| Propylene | 139 US$/t |

(3) Utilities price:

| | | |
|---|---|---|
| Electricity | 0.0583 | $/KWH |
| Steam | 4.6 | $/t |
| Cooling water | 0.004 | $/t |
| Fuel | 0.014 | $/t |

4-1-5 Fixed cost calculation method

(1) Depreciation cost - Total fixed capital shall be depreciated during 10 years on the fixed installment method and the residual value is regarded to be nil.

(2) Repairs and maintenance costs - Shall be 3%/year of the acquired price for production facilities.

(3) Taxes, dues and insurance premiums - Shall be 1% p.a. of the depreciation balance (book value) of the acquired prices for production and auxiliary facilities.

(4) Monetary interest - 70% of the total fixed capital shall be produced by a loan with an interest rate of 7.5%/year. Working capital shall be procured entirely by a loan with an interest rate of 12%/year.

(5) Personnel cost - Average personnel cost for the operator during 1980 shall be US$2,242 per head.

(6) Various expenditures - Shall be the same amount as the annual personnel cost.

(7) Administration cost - Shall be 3% (annual) of the total sales amount.

4-1-6 Premises of economic calculations

(1) Repair and maintenance costs, personnel cost, various expenditures out of exfactory price, variable cost factor and fixed cost factor shall be rising 7% annually for the economic calculations.

(2) Refunding of the loan shall be withheld during 5 years (which corresponds to 3-year unredemption after the startup), with a 7-year equal installment repayment of the principal.

(3) Corporate income tax shall be exempted for 5 years after start-up, and from the 6th year shall be applied at 45% of the before-tax profits.

(4) All products shall be directed to the domestic market, and the yearly operational ratio shall be entirely on a level of 100%.

(5) Internal rate of return shall be calculated by the following equation:

$$F + W = \sum_{t=1}^{n} \frac{Rt}{(1+r)^t} + \frac{W}{(1+r)^n}$$

where:

F: Total fixed capital W: Working capital

t: Number of years, taking the start up year as 1.

n: Period of economic calculation, 10 years on this occasion.

$R_t$: Profit at the 't' year, viz.

(Total annual sales) - (Total annual costs)

provided, that depreciation cost and monetary interest are not included in the annual costs for the calculation of internal rate of return.

4-2 Results of Economic Calculation

Results of calculation were given in Table V-2(2) and (3). Case I of the 1977 startup and Case II of the 1980 startup are both extremely high in their internal rate of return, all of which indicated 20%. The reason that there is no change in the internal rate of return is that we have considered the case of sale prices rising with commodity prices even if the startup date were delayed. In case there is only a small price increase, the internal rate of return of the later construction will have a lower rate influenced by the rise in construction cost.

The calculation results between internal rate of return and costs are given in Tables IV-2(2) and (3).

## Table V-2(1) The Calculation of DCF Rate of Return on Investment

THE CALCULATION OF DCF RATE OF RETURN ON INVESTMENT — PJNO.= 41 PJNAME=NESIA PC

Operation start in 1977

| | YEAR | INVESTMENT | WORKING CAPITAL | INCOME BEFORE TAX | INCOME TAX | INCOME AFTER TAX | INTEREST | DEPRECIATION | NET CASH FLOW | DISCOUNT RATE | (CASH) PRESENT VALUE | (INV.) PRESENT VALUE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *1 | | | | | | | | | | |
| 0 | 1976 | 20127. | 2026. | 0. | 0. | 0. | 0. | 0. | 0. | 1.0000 | 0. | 22153. |
| 1 | 1977 | 0. | 0. | 1169. | 0. | 1169. | 1300. | 2013. | 4482. | 0.8363 | 3748. | 0. |
| 2 | 1978 | 0. | 0. | 1628. | 0. | 1628. | 1219. | 2013. | 4860. | 0.6994 | 3399. | 0. |
| 3 | 1979 | 0. | 0. | 2061. | 0. | 2061. | 1138. | 2013. | 5211. | 0.5849 | 3048. | 0. |
| 4 | 1980 | 0. | 0. | 2018. | 0. | 2018. | 1057. | 2013. | 5088. | 0.4891 | 2782. | 0. |
| 5 | 1981 | 0. | 0. | 3007. | 0. | 3007. | 906. | 2013. | 5986. | 0.4090 | 2448. | 0. |
| 6 | 1982 | 0. | 0. | 3785. | 1703. | 2082. | 755. | 2013. | 4849. | 0.3421 | 1659. | 0. |
| 7 | 1983 | 0. | 0. | 4315. | 1942. | 2373. | 604. | 2013. | 4990. | 0.2861 | 1427. | 0. |
| 8 | 1984 | 0. | 0. | 5108. | 2298. | 2809. | 453. | 2013. | 5275. | 0.2392 | 1262. | 0. |
| 9 | 1985 | 0. | 0. | 5699. | 2565. | 3134. | 302. | 2013. | 5449. | 0.2001 | 1090. | 0. |
| 10 | 1986 | -0. | -2026. | 6401. | 2881. | 3521. | 151. | 2013. | 5684. | 0.1673 | 951. | -339. |
| | | *2 | *3 | | | | *4 | | | *5 | | |
| | TOT | 20127. | 0. | 35852. | 11389. | 24463. | 7883. | 20127. | 52473. | 0.4157 | 21814. | 21814. |

Notes: Price forecast of alkylbenzene

Future price forecasts were done by the internal rate of return ratio, and costs are given in Table IV-16(2).

(1) Unit consumption

| | |
|---|---|
| Propylene unit as against the dodecene | 1.275 |
| Dodecene unit as against the dodecylbenzene | 0.95 |
| Benzene unit as against the dodecylbenzene | 0.47 |

(2) Prices on raw materials and products in Japan

(¥/Kg)

| | 1971 | 1974 |
|---|---|---|
| Propylene | 18.0 | 56.7 |
| Benzene | 24.1 | 61.0 |
| Alkylbenzene | 80.4 | - |

(3) Model for Japanese exfactory price

$P_n = 88.50(1.07)^{n-4} + 69.07(1.05)^{n-1} - 21.80(1.03)^{n-1} + 2.84$

where 'n' stands for the number of years making 1971 to be 1.

## Table V-2(2) Cost Estimation Data of Alkylbenzene in 1977 (Case I)

| | | | | | |
|---|---|---|---|---|---|
| PRODUCT | AL-BENZENE | | | | |
| PLANT CAPACITY | | | | 15,000 (t/y) | |
| ANNUAL PRODUCTION | | | | 15,000 (t/y) | |
| TIME OF CONSTRUCTION | | | | 1974. 06 | |
| STREAM FACTOR | | | | 1.00 | |
| INVESTMENT | | | | | |
| PROCESS PLANT | | | | 17,200 ($) | |
| INTRST. DRG CONSTR. | | | | 1,210 | |
| PRE-OPE. EXPENSE | | | | 705 | |
| CAPITAL TOTAL | | | | 24,265 | |
| PRODUCT STOCK | | | | 742 | |
| BY-PRODUCT STOCK | | | | 375 | |
| RAW MATERIALS STOCK | | | | 794 | |
| PDCT. CREDIT SALES | | | | 1,192 | |
| BY-PDCT. CREDIT SALES | | | | 555 | |
| RAW MATERIALS DEBT | | | | -1,173 | |
| WORKING CAPITAL | | | | 2,484 | |
| TOTAL INVESTMENT | | | | 26,749 | |
| PRODUCTION COST | | | | (Unit: $10^3$ US$) | |
| | UNIT CONS/PROD | UNIT PRICE | ANNUAL QUANTITY | ANNUAL COST | UNIT COST |
| PROPYLEN | 1.211 (t/t) | 0.139 | 18,165 | 2525 | 0.17 |
| BENZENE | 0.466 (t/t) | 0.320 | 6,990 | 2237 | 0.15 |
| MAIN RAW MATERIALS | | | | 4762 | 0.32 |
| POWER | 0.14 (MKWH/t) | 0.0583 | 2,100 | 122 | 0.01 |
| STEAM | 0.816 (t/t) | 0.0046 | 12,240 | 56 | 0.00 |
| FUEL | 5.55 (MMKcal/t) | 0.00375 | 83,250 | 312 | 0.02 |
| C.W. | 0.228($10^3$t/t) | 0.04 | 3,420 | 137 | 0.01 |
| CAT'ST | 1 | 0.022 | 15,000 | 330 | 0.02 |
| UTILITIES | | | | 958 | 0.06 |
| BY-PRO | -1 | 0.15 | -15,000 | -2249 | -0.15 |
| TOTAL VARIABLE COST | | | | 3469 | 0.23 |
| WAGES | | | | 45 | 0.00 |
| REPAIRING COST | | | | 515 | 0.03 |
| DEPRECIATION | | | | 2427 | 0.16 |
| FIXED ASSET TAX | | | | 243 | 0.02 |
| GENERAL OVERHEAD | | | | 45 | 0.00 |
| OTHER FIXED COST | | | | 137 | 0.01 |
| TOTAL FIXED COST | | | | 3411 | 0.23 |
| TOTAL SALES COST | | | | 310 | 0.02 |
| TOTAL COST | | | | 7191 | 0.49 |
| PROFIT & LOSS | | | | 3159 | 0.21 |
| SALES TOTAL | | | | 10,350 | 0.69 |
| R.O.I. (NET PROFIT BEFORE TAX/TOTAL INVESTMENT) | | | | 0.1297 | |
| I.R.R.(INTERNAL RATE OF RETURN ON INVESTMENT) | | | | 0.1999 | |

## Table V-2(3) Cost Estimation Data of Alkylbenzene in 1980 (Case II)

| | | | | | |
|---|---|---|---|---|---|
| PRODUCT | AL-BENZENE | | | | |
| PLANT CAPACITY | | | | 15,000 (t/y) | |
| ANNUAL PRODUCTION | | | | 15,000 (t/y) | |
| TIME OF CONSTRUCTION | | | | 1974, 06 | |
| STREAM FACTOR | | | | 1.00 | |
| INVESTMENT | | | | | |
| PROCESS PLANT | | | | 14,00 ($) | |
| OTHER ASSETS | | | | 4,200 | |
| INTRST. DRG CONSTR. | | | | 1,404 | |
| PRE-OPE. EXPENSE | | | | 523 | |
| *FIXED CAPITAL | | | | 20,127 | |
| *WORKING CAPITAL | | | | 2,026 | |
| TOTAL INVESTMENT | | | | 22,153 | |
| PRODUCTION COST | | | | (Unit: $10^3$ US$/t) | |
| | UNIT CONS/PROD | UNIT PRICE | ANNUAL QUANTITY | ANNUAL COST | UNIT COST |
| PROPYLEN | 1.211 (t/t) | 0.113 | 18,165 | 2053 | 0.14 |
| BENZENE | 0.466 (t/t) | 0.261 | 6,990 | 1824 | 0.12 |
| RAW MATERIAL | | | | | |
| POWER | 0.14 (MKWH/t) | 0.0476 | 2,100 | 100 | 0.01 |
| STEAM | 0.816 (t/t) | 0.00376 | 12,240 | 46 | 0.00 |
| FUEL | 5.55 (MMKcal/t) | 0.00306 | 83,250 | 255 | 0.02 |
| C.W. | 0.228 ($10^3$t/t) | 0.0327 | 3,420 | 112 | 0.01 |
| CAT'ST | 1 | 0.0180 | 15,000 | 270 | 0.02 |
| UTILITIES | | | | 783 | 0.05 |
| BY-PRO | -1 | 0.12 | -15,000 | -1799 | -0.12 |
| TOTAL VARIABLE COST | | | | 2860 | 0.19 |
| WAGES | | | | 37 | 0.00 |
| REPAIRING COST | | | | 420 | 0.03 |
| DEPRECIATION | | | | 2013 | 0.13 |
| FIXED ASSET TAX | | | | 201 | 0.01 |
| GENERAL OVERHEAD | | | | 37 | 0.00 |
| OTHER FIXED COST | | | | 112 | 0.01 |
| TOTAL FIXED COST | | | | 2819 | 0.19 |
| TOTAL SALES COST | | | | 252 | 0.02 |
| TOTAL COST | | | | 5931 | 0.40 |
| PROFIT & LOSS | | | | 2469 | 0.16 |
| SALES TOTAL | | | | 8,400 | 0.56 |
| R.O.I. (NET PROFIT BEFORE TAX/TOTAL INVESTMENT) | | | | 11.15 | |
| I.R.R. (INTERNAL RATE OF RETURN ON INVESTMENT) | | | | 19.58 | |

ANNEX I. Synthetic Detergents

At present many varieties of surfactants have been developed and put to use on a wide scale. More than 70% of surfactant demands are for the purpose of cleansing, which is being called, "detergent".

It is needless to mention that detergent soaps are being used for the purpose of cleansing. However, these cleansing agents, compared with soaps which are made from natural raw material tallow and coconut oil, perform better than said soaps and can be made available in great quantity, cheaply after chemical synthesis, and are called, "synthetic detergents".

In the present report, we would like to make observations on the background transiting from the soaps to the synthetic detergents, and fully recognize the current problems in Europe, the U.S. and Japan, thus we like to think of the future synthetic detergents. Further we would like these observations be of some assistance in developing thoughts on the detergent industries in South East Asian countries under development, especially Indonesia.

## I-1 Historical Background of the Synthetic Detergent Development

### I-1-1 *Transition from soaps to synthetic detergents*

Table AV-1 is the production statics for soaps and detergents in the United States, and the Figure AV-1 is the statics of Japan. The reason for the rapid increase from a certain boundary point of detergent production and demand may be attributed to the change and betterment in the life style as a result of the scientific development in short. Specifically the following points could be named:

Table AV-1 Production of Soaps and Synthetic Detergents in the U.S.A.

| | Soap | Synthetic Detergent | |
|---|---|---|---|
| | $10^3$ tons | $10^3$ tons | % |
| 1935 | - | 0.9 | - |
| 1940 | 1,485 | 14 | 0.9 |
| 1950 | 1,127 | 496 | 30.6 |
| 1960 | 479 | 1,502 | 75.8 |

(1) Pervasion of electric washing machine. Development and progress of chemical science and the industries thereof.

(2) Synthetic detergents are not only used for washing and cleansing, but are directed to many other fields such as vegetables, fruits, plates and dishes; and moreover, for the cleansing of buildings, roads, automobiles, machinery, etc. and the applications are still rapidly broadening.

(3) Synthetic detergents outperform soaps in respect of various usages.

(4) Cleansing capability of synthetic detergents has much improved as a result of function of the builder, etc.

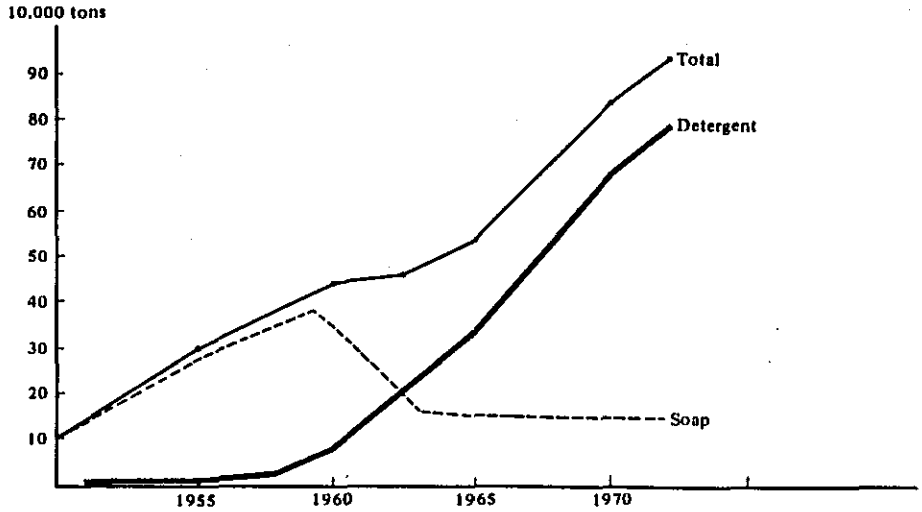


Figure AV-1 Production of Soaps and Synthetic Detergents in Japan

The debut of the electric washing machine caused a cleansing revolution in the home. The production in Japan of washing machines during 1949 was less than 400, five years later in 1954 300 times, after ten years, 1959, the production jumped 3,000 times; and production. increases and growth of detergent usage have been proportional. As given in Figure AV-1, the case of Japan, the usage of soap almost reached its lowest point, approx. 20%, in about 1963. Since then the curve is gradually lowering. The sudden price rise on detergents as a result of the 'oil shock' caused some turbulence over the synthetic market, but in the light of much higher prices on the raw materials for soaps, viz., natural oils and fats, prevailed thereupon, the mentioned lowering trend will not be changed rapidly.

For the purpose of making required price comparisons between synthetic detergents and soaps, refer to Figures AV-2 - AV-5.

As given earlier, respective major raw materials have a considerable fluctuation both in quantity and in price, it is presently impossible to make future price forecasts, and it is possible that the price situation could be entirely reversed.

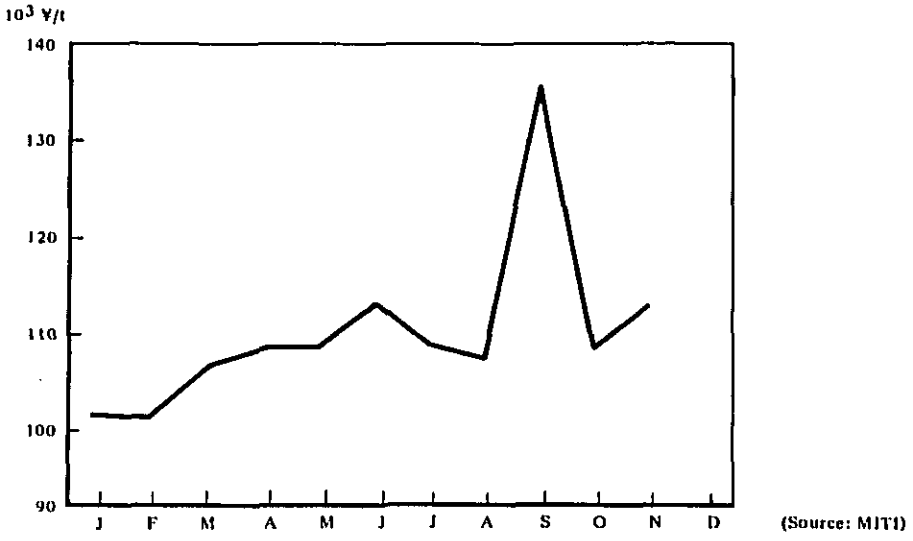


Figure AV-2 Price of Synthetic Detergent (powder) in Japan (1973)

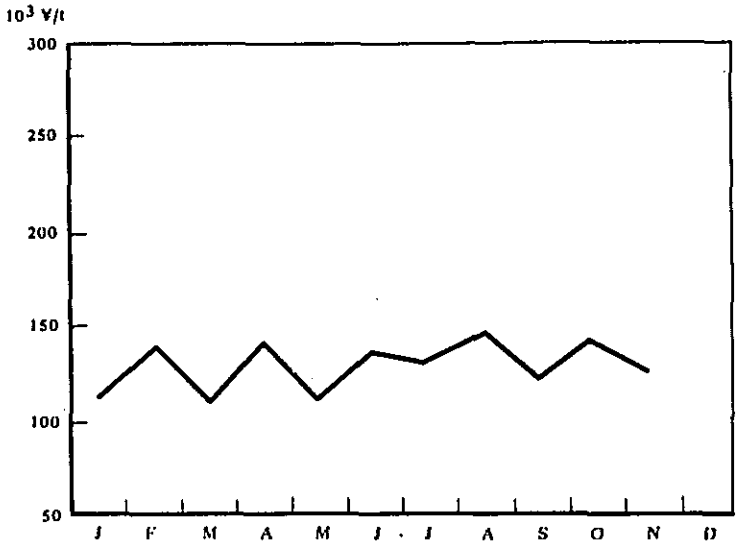


Figure AV-3 Price of Synthetic Detergent (liquid) in Japan (1973)

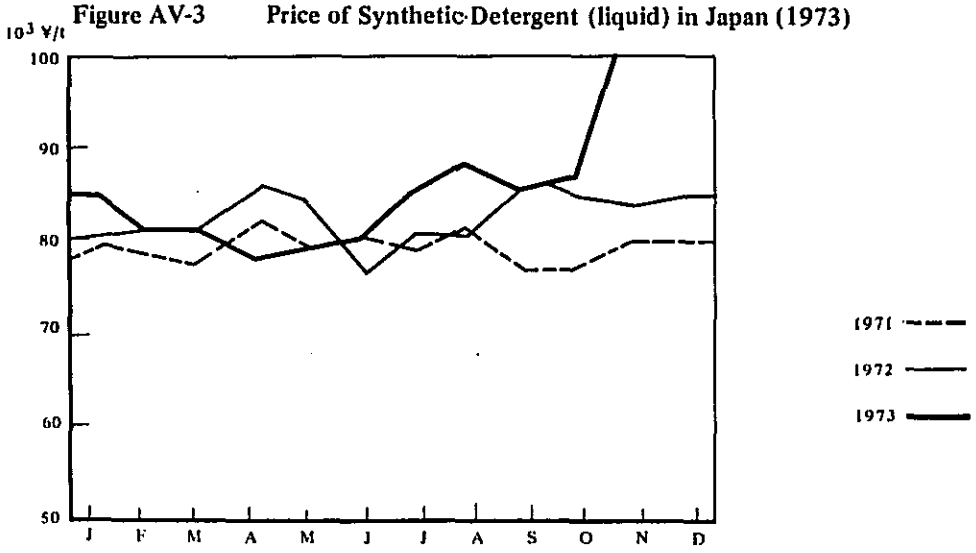


Figure AV-4 Price of Powdered Soaps in Japan (1971/1973)

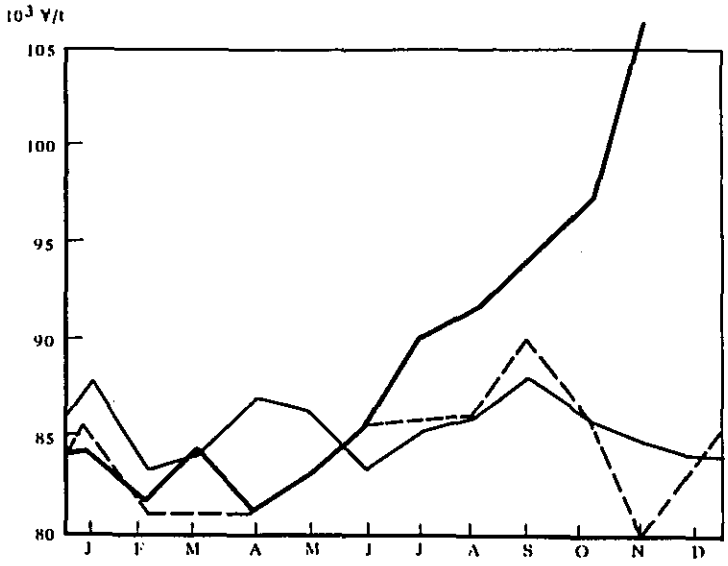


Figure AV-5 Prices of Bar Soaps in Japan (1971/1973)

## I-2 Characteristics of Synthetic Detergents

Earlier mention was made about the reason and background of the rapid and phenomenal growth of the synthetic detergents driving the soaps away from the old stable position during a 10 year period. In substance, the real reason is the excellent characteristics, properties and performances of the synthetic detergents for securing the mainstay position as the cleansing agents, viz., synthetic detergetnts have none of the defects of soaps. Furthermore, as a result of the remarkable technical progress in synthesizing various types of different activators are made selectable in conformity with the application field, and the effect of activator is increased by virtue of development of various builders. In other words, with synthetic detergents various compoundings with different components are possible, and can exhibit much greater performance than soaps in respective field. Synthetic detergents can thus exhibit better characteristics and better cleansing performance than natural soaps by virtue of the overall compounding techniques and by the selection of activators.

Now, let us introduce excellent properties of the activators used for the synthetic detergent materials, which are, therefore, in other words, the capability to avoid the defects of natural soaps:

(1) Resistance to hard water

(2) Resistance to acid and alkalis

(3) Easy and simple solubility

(4) Capability of making simple cleansing and washing in clean water

(5) No maleffect on the textiles

## I-3 Kind and Usage of the Synthetic Detergents

There are various methods of classifying synthetic detergents, which are rather complicated, but the summarization will be made:

(1) Classification by the concentration of hydrogen ion:

- Synthetic detergents
  - Weak alkali detergents
  - Neutral detergents

(2) Classification by the major ingredients:

- Synthetic detergents
  - Anionic detergents
    - Mineral oil detergents (aklylbenzene sulfonic acid salts)
    - Higher alcohol detergents (higher alcohol sulfuric acid salts etc.)
  - Non-ion detergents (alkylphenol, higher alcohol EO added substance, etc.)

(3) Classification by usage:

Detergents for washing, detergents for kitchen, detergents for household, etc.

(4) Classification by the form:

Powder, liquid, tablets, paste, etc.

## I-4 Material of Activator Used for Detergents and the Production Method

Of the above classifications, alkylbenzene sulfonic acid salts (ABS, LAS) are detergents of mineral oil series sharing 80% of total detergents usage, thus whenever a reference is made to detergents, in most instances, it signifies LAS. A simple production method of major activator materials is described below, and Table AV-2 exhibits a list of representative activators derived therefrom.

Table AV-2 Characteristics of Surface Active Agent Used as Detergent

| | Structural Formula | Applications | | |
|---|---|---|---|---|
| | | Kitchin Use | Textile Use | Shampoo Use |
| Liner-alkylbenzene-sulfonate (LAS) | R-⟨⟩-$SO_3Na$ | E | G | F |
| Alkyl sulfate | $R-O-SO_3Na$ | G | E | E |
| α-Olefin sulfonate (AOS) | $R-CH=CH-(CH_2)_n-CH_2-SO_3Na$ ($C_{15}$ - $C_{18}$) | G | E | G |
| Alkyl-sulfonate (SAS) | $R-SO_3Na$ (R: $C_{14}$ - $C_{17}$) | E | G | G |
| Alkyl-ether-sulfate | $R-O-(C_2H_4O)_n.SO_3Na$ (R: $C_{12}$ - $C_{14}$) | E | G | E |
| Polyoxyethylene alkylphenylether | R-⟨⟩-$O-(C_2H_4O)_n.H$(R $C_9$) | G | G | F |
| Polyoxyethylene alkylether | $R-O-(C_2H_4O)_nH$ (R: $C_{12}$ - $C_{14}$) | G | G | F |

Notes : E; excellent, G; good F; fair

(1) Alkylbenzene

(A) Hard alkylbenzene (dodecyl benzene)

R = CH + Propylene tetramer ⟨⟩ ⟶ Dodecyl benzene

(B) Soft alkylbenzene (Isoalkylbenzene, linear alkylbenzene, normal alkylbenzene)

$n.\ RH + Cl_2 \longrightarrow n.R - Cl + HCl$

normal paraffine

$n.R - Cl +$ ⟨⟩ $\xrightarrow{AlCl_3}$ Linear alkylbenzene

$n.RCH = CH_2 +$ ⟨⟩ $\xrightarrow{HF}$ Linear alkylbenzene

(2) Higher alcohol

(A) Natural alcohol (saponification distillation of the sperm oil)

(B) Reduced alcohol (natural fat, natural fatty acid, or high-pressure reduction of its lower alcohol ester, or reduction of metallic sodium)

(c) Synthetic alcohol (by Ziegler process)

$$Al(C_2H_5)_3 + n\text{-}C_2H_4 \rightarrow Al\leftarrow\begin{matrix}R_1\\R_2\\R_3\end{matrix} + O_2 \rightarrow Al\leftarrow\begin{matrix}OR_1\\OR_2\\OR_3\end{matrix} \rightarrow \begin{matrix}R_1OH\\R_2OH\\R_3OH\end{matrix}$$

$$RCH = CH_2 + CO + H_2 \rightarrow R'CH_2CH_2CH_2OH + R'' - \underset{\displaystyle CH_2OH}{\overset{\displaystyle |}{CH}} - CH_3$$

(3) $\alpha$ - olefin

There are two production methods for $\alpha$-olefin, viz.; ethylene polymerization process and wax decomposition process.

Table AV-2 gives comparisons of adaptability of activators derived from the above mentioned substances.

I-5 Soft-type and Hard-type Alkylbenzenes

As mentioned above, those having side-chain type alkyl radical are called hard-type alkylbenzene, and linear ones are called soft-type. The nomenclature is given by the high or low microbe decomposing capability. Hard-type alkylbenzene is not, biodegradable. As a result, it causes pollution of rivers and streams (public nuisance). This being the case, and despite its good cleansing capability, the hard-type alkylbenzene was driven out during the past 5 - 6 years from Japan in spite of higher prices on soft-type alkylbenzene, thus for home-use, hard alkylbenzene was completely replaced by soft. The same thing can be said about Europe, where except for two or three cases, a similar situation existed earlier than in Japan. In both cases,it is noteworthy that there were strong administrative measures by all Government authorities to switch from hard-type to soft-type alkylbenzene.

ANNEX II. Demand of Synthetic Detergents

II-1 Demand Structure of Synthetic Detergents

Trends on the production ratio between soaps and synthetic detergents in Japan are shown in Figure AV-6, and moreover, as given in Table AV-3, the rate of use for soaps nowadays is less than 20%. Classified soap uses, the soaps for bathing use are, on the contrary, gradually increasing year after year; powder and solid soaps for cleaning and decreasing - both combined have less than a 15% share of soap production according to the 1972 statistics. Synthetic detergents, on the other hand, are exhibiting a remarkable increase. Production and the structure by the product form in 1972 are given in Table AV-4.

Table AV-3 Trend of Per Capita Consumption of Soaps and Synthetic Detergents in Japan

(Unit: kg)

| | Soaps | Synthetic Detergents | Total |
|---|---|---|---|
| 1967 | 1.57 | 5.01 | 6.58 |
| 1968 | 1.52 | 5.42 | 6.94 |
| 1969 | 1.49 | 6.11 | 7.60 |
| 1970 | 1.47 | 6.67 | 8.14 |
| 1971 | 1.38 | 6.80 | 8.18 |
| 1972 | 1.37 | 7.29 | 8.66 |

Table AV-4 Production of Synthetic Detergent in Japan (1972) (Unit: tons)

| | | | |
|---|---|---|---|
| Home-use synthetic detergent | Mineral oil series | Powder | 477,230 |
| | | Liquid | 150,485 |
| | | Others | 308 |
| | | Total | 628,023 |
| | Higher alcohol series | Powder | 38,058 |
| | | Liquid | 32,695 |
| | | Others | 47 |
| | | Total | 70,800 |
| | Others | Powder | 1,150 |
| | | Liquid | 3,435 |
| | | Others | 415 |
| | | Total | 5,000 |
| Industrial-use synthetic detergent | Mineral oil series | | 66,686 |
| | Higher alcohol series | | 13,961 |
| | Total | | 80,647 |
| Total | Mineral oil series | | 694,709 |
| | Higher alcohol series | | 84,761 |
| | Others | | 5,000 |
| | Grand total | | 784,470 |

II-1-1 Primary factors of demand increases for synthetic detergents

Looking at various developing countries, the changes in cleaning style as a result of the betterment of living standards, spreading and pervasion of the electrical washing machine are primary factors. As it is clearly seen from Table AV-5, the same thing can be said of the rapid increase in consumption of synthetic detergents which coincided with the rapid increase in demand for electric washing machines in Japan.

Table AV-5 Trends in Shipment of Electric Washing Machines and Production of Synthetic Detergents

| | Production | Shipment |
|---|---|---|
| 1957 | 845,564 | 891,687 |
| 1958 | 998,309 | 981,640 |
| 1959 | 1,189,034 | 1,147,351 |
| 1960 | 1,528,997 | 1,521,497 |
| 1961 | 2,161,072 | 2,092,477 |
| 1962 | 2,445,486 | 2,365,915 |
| 1963 | 2,664,455 | 2,676,253 |
| 1964 | 2,644,150 | 2,552,914 |
| 1965 | 2,234,981 | 2,411,218 |
| 1966 | 2,503,022 | 2,534,541 |
| 1967 | 3,116,699 | 3,092,413 |
| 1968 | 3,699,579 | 3,586,533 |
| 1969 | 4,181,740 | 4,129,953 |
| 1970 | 4,348,662 | 4,322,815 |
| 1971 | 4,149,361 | 4,256,973 |
| 1972 | 4,203,972 | 4,215,685 |

Next, what about the relations with the soaps relating to the raw materials? As the living standards keep improving, and viewed from overall performance, all concerned will switch to synthetic detergents as a natural course of action. Much more true if considered with the skyrocketing price rise on natural oils and fats thereby lessening the price gaps between the synthetic detergents. Conclusively, all developing countries will follow the same change-over patterns as happened with the advanced countries - An improved living standard (pervasion of the electric washing machine) may be the greatest primary factor.

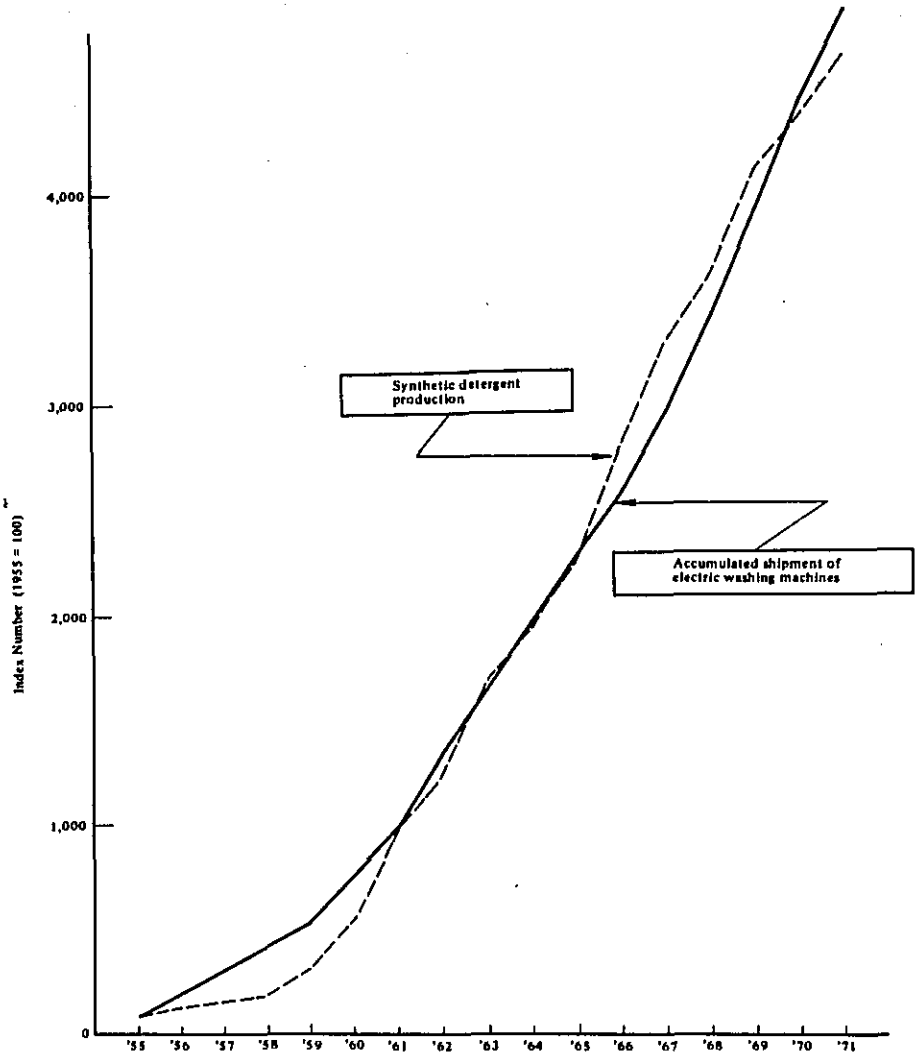


Figure AV-6 Trends in Shipment of Electric Washing Machines and Production of Synthetic Detergent

II-1-2 Status by country of synthetic detergent consumption

According to 1970 statistics, per capita detergent consumptions are given for major countries in Table V-1 from which we will see that Japanese per capita detergent consumption is still lower, compared with the European countries and United States. Therefore, if considerations are given to the difference in ways of living, consumption in Japan will go up further on a per capita basis. On the contrary, viewed in developing countries, it is noted that detergent use is very closely correlated with living standards there (Shown in Table AV-6).

II-1-3 Synthetic detergents in the natural oil and fat producing countries

During 1972 approximately 1,500,000 tons of natural oil and fats were used in Japan, of which about 130,000 tons were used for soaps and only 20,000 tons for the higher alcohol of synthetic

Table AV-6 Per Capita Consumption of Soaps and Synthetic Detergents in Developing Countries (1966)

| Name of Country | Kg/per capita |
|---|---|
| China (Mainland) | 1.8 |
| India | 1.1 |
| Indonesia | 0.8 |
| Malaysia | 3.9 |
| Philippines | 0.3 |
| Singapore | 2.2 |
| Thailand | 0.9 |
| Taiwan | 3.2 |
| Iraq | 4.8 |
| Iran | 2.2 |
| Republic of S. Africa | 7.6 |
| Kenya | 3.5 |
| Libya | 4.0 |
| Brazil | 3.4 |
| Chile | 3.9 |
| Mexico | 5.0 |

detergents, but on the contrary, imagine, 1,150,000 tons were consumed for foodstuffs. Thus, in view of the foodstuff shortage and price increases natural oils and fats are primarily used for foodstuff. Therefore, in Japan natural alcohol prepared from natural oils and fats is being replaced by synthetic alcohol. It is doubtful that the same thing could be said about natural oil and fat producing countries, where prices on oils and fats have risen about 3 - 5 times compared with the beginning of the last year.

There may be some price fluctuation, but it is not expected that prices will go below previous levels. In view of this, these producing countries may find it more beneficial to import synthetic detergents rather than making previous soaps from the natural oils and fats, and they shall have to direct oils and fats to foodstuff uses dependent upon the situation. As the electric washing machine pervades, sooner or later, in conformity with the betterment of the living standards, the switchover pattern from the soaps to detergents will be the same with the path which European countries and the United States once followed. Like petroleum producing countries did during the recent 'oil shock', they might take up their oils and fats as strong weapons for money earning purposes through exports oversea and appropriate earned money to the fund of cultural country construction, and they may produce by themselves synthetic detergents in place of the soaps or may import instead.

Major usages and kinds of oils and fats are as follows:

(1) Animal oils and fats:

| | |
|---|---|
| Tallow | Soaps, foodstuffs, fatty acid |
| Lard, milk fat | foodstuffs |
| Whale oil | Foodstuffs, plasticizer, activator, perfume |
| Fish oil | Foodstuffs, fatty acid, paint and ink |

(2) Vegetable oils and fats:

| | |
|---|---|
| Dry oils | Paint, ink and foodstuffs |
| Semi-dry oils | Foodstuffs |
| Non-dry oils | Foodstuffs, cosmetics, rolling oil, activator |

(3) Vegetable oils:

| | |
|---|---|
| Coconut oil | Foodstuffs, soaps, synthetic detergents, fatty acid |
| Palm oil | Foodstuffs, soaps |
| Palm-kernel oil | Foodstuffs, soaps |

These natural products are greatly affected by the price fluctuations and the status during the past 2 - 3 years are given in the following Figures AV-7 through AV-10.

Although it is not shown in the Figures, all fats and oils have had an extremely conspicuous price rises during the period from the end of 1973 to 1974.

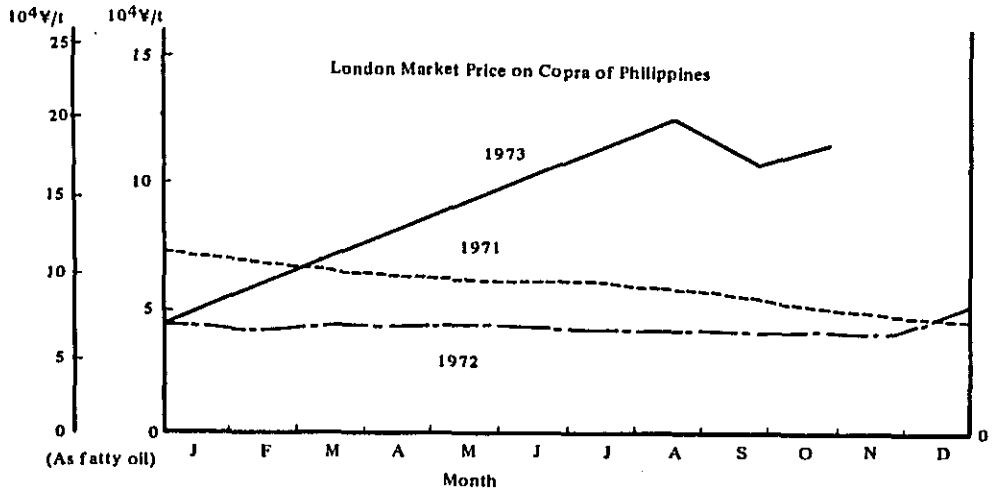


Figure AV-7 Price of Coconut Oil

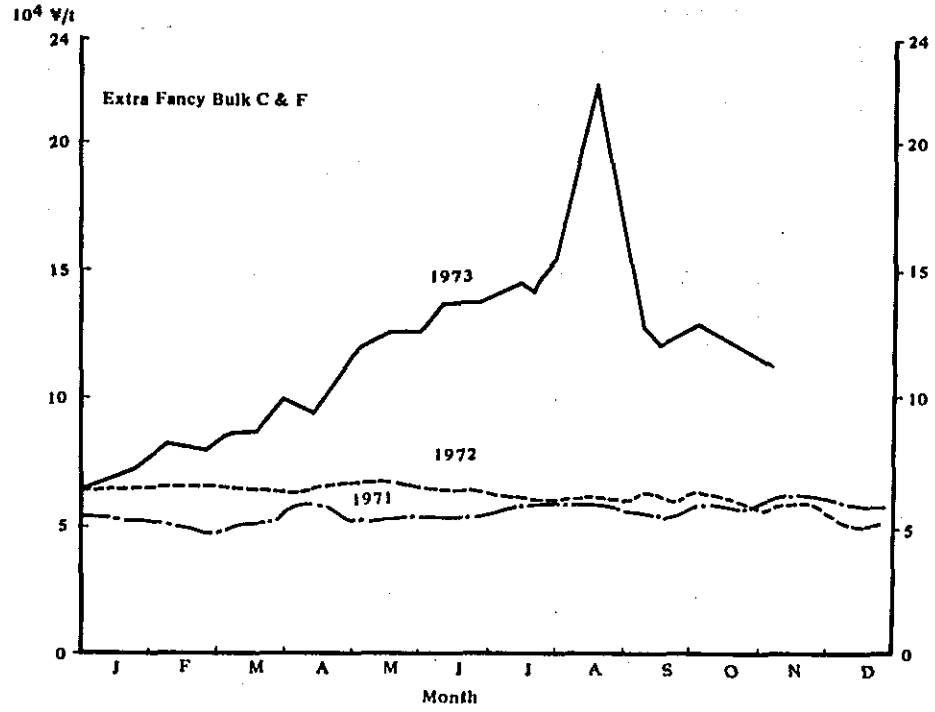


Figure AV-8 Price of Beef Tallow

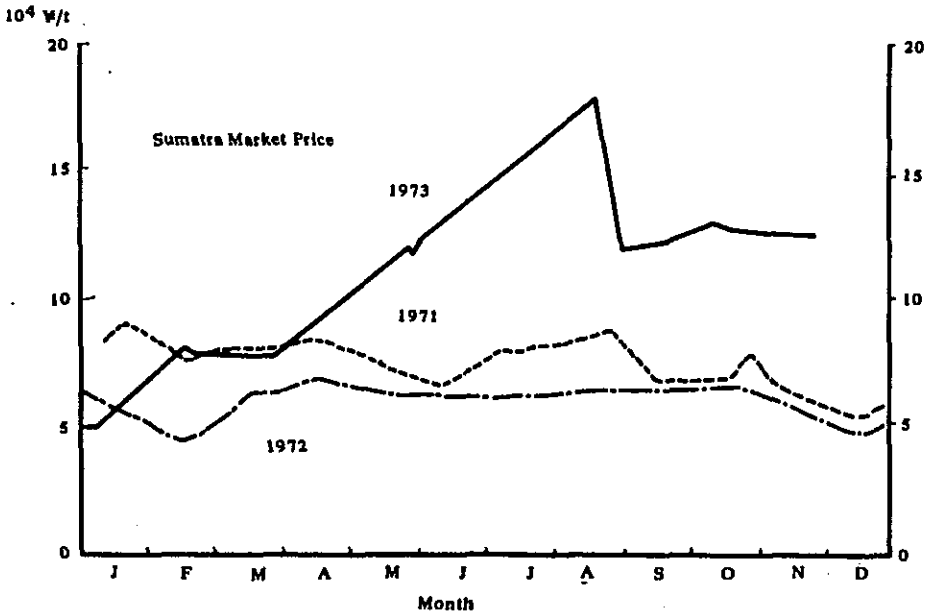


Figure AV-9 Price of Palm Oil

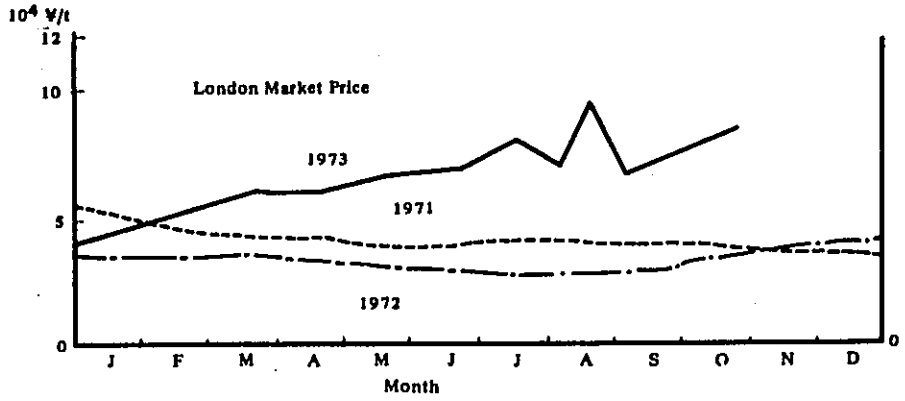


Figure AV-10 Price of Palm Kerne Oil

II-2 Problematic Points on Synthetic Detergents and Future Direction

The toxicity is much talked about on the soft alkylbenzene which is currently holding the major position as the active ingredient of synthetic detergents so that some anxieties exist, and, at the same time, activities of new activating substances, especially the movement to higher alcohol is very brisk.

Hereinafter, based on the information obtained from LAB, higher alcohol makers and commercial firms, status of the detergent activator is analyzed and forecast.

II-2-1 Soft alkylbenzene (LAB)

(1) Toxicity problem

Skin chapping and deformation, etc. are being pointed to by some scholars and have been much talked about as social problems during the past 2 - 3 years. Skin chapping, some conspicuous symptoms are recognized on those people with allergic inclination, thus the toxicity is not deniable to some extent, so LAB usage for kitchen use liquid detergents is being gradually lowered. On the other hand, in respect to LAB toxicity absorbed through the skin or orally much has been said about the possibility of causing a deformation. The results of various experiments done by LAB makers and Government research institutes, etc., enabled then to present supporting rebuttals, substantiating the lack of toxicity, and consumers are also aware of the matter.

In view of recent social tendencies about such chemical articles, the antagonizing persistence may semi-permanently continue inclusive of the subject LAB toxicity, but it should be all right for all concerned to regard LAB as low cost, excellent item enabling it to be a major ingredient in powdered synthetic detergents as before.

An other problem is fish poisoning, which is related to the degradability of LAB, and further the matter of benzene nucleus. Correlated with the phosphorus from the builder, the strengthening and expansion of sewage disposal facilities in the future may become inevitable.

At this time there is no anxiety whatever on LAB toxicity, but no LAB makers, nor any detergent maker is resting on such a non-toxicity contention as there still is no 100% substantiation proving non-toxicity from a purely scientific standpoint. Moreover, consumers are still regarding it to be an undesirable commodity inasmuch as it contains a benzene nucleus. Therefore, manufacturers are not expecting LAB keep to growing as before, which may relate to an expansion problem of LAB in the future, and will be described in detail later.

(2) Current status on production and shipment in Japan

The following figures are the current production capacity of domestic LAB makers in Japan. Estimating LAB production during the coming 2 - 3 years through NP shipments, will result as follows:

| LAB Production Actuals | | Production Capacity of LAB Makers in Japan | |
|---|---|---|---|
| 1971 | 95,500 t/y | Mitsubishi Yuka | 27,000 t/y |
| 1972 | 105,900 | Nippon Atlantic | 25,000 |
| 1973 | 108,400 | Nissan Conoco | 33,000 |
| 1974(Est.) | 114,000 (taking 5% increase over previous year) | Nisseki Detergent | 29,000 |
| | | Total: | 114,000 t/y |

Note: Through NP shipments for LAB, calculation was made at the rate of 0.85 per unit material.

There are some differences depending on each maker concerning the original material unit so that there remain some doubt as to the accuracy of the back-calculation from NP, and with the lower growth rate of 5%, the LAB production for the current year will have to be done on a full capacity basis.

Production and shipment of LAB are almost equal. In 1973, of about 110,000 tons of LAB shipments, about 20,000 tons were directed to the export market. The domestic demand will have to be covered from limited production quantity, thus exports are expected to become about half that of the previous year. Under such circumstances, LAB will be in short supply during the next year. (In respect to LAB expansion a detailed description will be given later.)

In conclusion, LAB is not expected to have a larger growth rate than the 10% shown during the past several years, but still the natural growth for powdered detergents may be for the moment, and during several years to come, met by LAB which will hold the main strength in the detergents field. Annual growth rate is considered to stay at about 5%.

(3) Expansion problem

Fundamental policies and attitudes taken by the LAB makers are that they would make cuts from exports thereby meeting the domestic demand to somehow avoid the expected shortage coming 1 - 2 years from now. On the contrary, however, some LAB makers are considering that there is a limitation in the cutting of export

lots if such an export is based on long-term contract with the buyers, thus LAB will be in very short supply shortage by the end of 1973.

Therefore, if there are no problems about LAB toxicity and expecting that higher alcohol will be in rather short supply the LAB expansion must have started with an expansion target of next spring, but scheduling is left open because no final conclusion has been reached.

Nippon Atlantic has an expansion plan to double its capacity to 50,000 t/y capacity, but it may take some time before they reach a decision because of the toxicity problem and because of a very cautions attitude toward making the best judgement on the activating ingredients, such as higher-alcohol, etc.

II-2-2 Higher alcohol

(1) Production capacity and shipment status on synthetic higher alcohol

The production capacity for higher synthetic alcohol for detergents is given below. Mitsubishi Yuka will be starting up after this summer; and until that time they will import higher synthetic alcohol to meet domestic demands.

| Primary alcohol | | Secondary alcohol | |
|---|---|---|---|
| Nissan Kagaku | 20,000 t/y | | |
| Mitsubishi Kasei | 7,500 | Nisshoku Kagaku | 7,500 t/y |
| Mitsubishi Yuka (under construction) | 20,000 | | |
| Total: | 47,500 t/y | | |

Secondary alcohol from Nisshoku Kagaku is being sold in the non-ionic activator field to be added to EO, thus it is not sold in original form.

There is only a small amount of data to show latest shipment, but through available data and information, the following estimation could be made:

| | 1972 | 1973 |
|---|---|---|
| Home Use | 7,000 tons | 8,000 tons |
| Shampoo<br>Liquid detergents | 5,000<br>6,000 ) | 11,500 tons |
| Sub-total | 18,000 | 19,500 |
| Industrial Use | 15,000 | 17,500 |
| TOTAL | 33,000 tons | 37,000 tons |

Note: The above tabulation does not include deliveries of secondary alcohol and EO additive, but it does include the alcohol prepared from natural fats and oils of about 20,000 tons.

Viewed from production capacity, shipments of synthetic higher alcohol (primary) are far from sufficient, viz., further production capacity is available. In view of the extremely high increase in price and shortage of natural fats and oils, this natural higher alcohol may be substituted for synthetic higher alcohol. With advancement into fields where LAB is not undesirable, a great deal of growth can be anticipated in the future.

(2) Competition between snythetic alcohol and natural alcohol

If the prices on naturally available fats and oils are stable and low, then cheap higher alcohol could be manufactured, but, as mentioned elsewhere, the price rise was phenomenal during the last 1 ~ 2 years, and to make the situation more difficult, there is no expectation of lower prices in the future. Therefore, synthetic alcohol may be a substitute for use in detergents, in place of naturally available alcohols.

Taking the prices into account, natural oils and fats are very easily susceptible to the weather conditions resulting in unstable production quantity and constantly remaining in short supply. Because of the world-wide foodstuff shortage, the natural oils and fats are presumably better directed to food uses, hence it is conceivable that synthetic higher alcohol will not be mal-affected by natural alcohol in the future.

(3) Competition between synthetic higher alcohol and LAB

1) At present the use of LAB as the major activator ingredient is not expected to change.

2) A shortage of LAB will be felt from the latter part of 1975. However, it is not yet known whether there will be an expansion of production capacity.

3) LAB shortages will be tentatively covered by export cuts, and such cuts will provide limited relief due to increasing domestic demands. Therefore, if no LAB expansion is made, higher alcohol will be used.

4) There is not any competition between synthetic alcohol and LAB. However, in liquid detergents for the use in kitchen LAB will be taking the place of synthetic alcohol.

5) Synthetic higher alcohol is now taking the place of natural alcohol, especially the "Dovanol" alcohol of Mitsubishi Yuka which is superior to any other synthetized alcohol on the market and will have continuing sales growth.

6) Secondary alcohol is steadily growing and its share in the market is in industrial areas where nonylphenol is being utilized, however, there might be come competition with synthetic primary alcohol.

7) Integrating all the above, in the worst case, LAB will operate at full capacity, and alcohol of Mitsubishi Yuka and secondary alcohol from Nisshoku Kagaku will show smooth growth using nonylphenol as the raw material. Therefore, nonylphenol production capacity will have to be expanded by the middle of next year at the latest.