Detergent Raw Material Trends in Western Europe[1]

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ABSTRACT AND SUMMARY

Household detergent sales during 1975 in Western Europe totaled more than $4 billion and are expected to continue to grow at approximately 3 to 4 percent annual increments during next decade. There is a trend toward more uniform formulations, but factors affecting future market growth include washing practices and conditions that vary from nation to nation. Demand for surfactants is dominated by LAS, accounting for 80 percent of total synthetic actives used in laundry detergent, with increasing use of linear alcohol ethoxylates. Environmental considerations, cost, and energy savings are factors in a trend toward less use of phosphate, compensated by greater use of LAS or ethoxylate or both to maintain cleaning performance. New investment in detergent raw materials is more likely for detergent alcohols and alpha olefin derivatives, and not in LAB.

INTRODUCTION

In 1975 the detergent industry in Western Europe achieved the sale of some 4.7 million metric tons (10.3 billion lb) of household detergents (liquids and powders) worth over $4 billion. The main synthetic surfactants supplied to this industry in Western Europe were 400,000 tons (880 million lb) of linear alkyl benzene and 115,000 tons (250 million lb) of detergent alcohol derivatives (ethoxylates and ethoxysulfates) worth over $350 million (Fig. 1).

A steady growth to the present size of the detergent industry in Western Europe has been achieved over the last decade with adequate supplies of detergent raw materials and intermediates at the time they were required. I attempt to analyze the specific conditions prevailing in Western Europe as to how the development of the detergent industry over the past decade has influenced the raw materials supply pattern and to highlight the major factors determining future requirements of surfactants with the associated challenges facing the petrochemical industry in Western Europe.

[1]The Soap and Detergent Association 1977 Annual Meeting and Industry Convention, Boca Raton, FL.

CURRENT STATUS

Finished Detergents

It is perhaps worth remembering that Western Europe, with a population over 334 million, is composed of some 15 countries with different washing habits and requirements of cleanliness and whiteness, giving rise to different detergent formulations. This situation has led to a variety of specific heavy-duty and light-duty laundry products in almost every European country which, from the basic soap formulations in the early 50s, has become a sophisticated market with high foam, controlled foam, and low foam liquids and powders.

The majority of my observations are centered in the fabric washing sector where important general trends have emerged which have had a determining impact on detergent formulations. The dishwashing liquid sector, in both volume and innovation, has had less impact on the emerging pattern of the surfactant industry. The main factors are the following.

Water hardness: although there are some areas in Western Europe which have soft water (Norway in particular), the majority of households wash with hard water. Approximately 50% of the water is above 250 ppm calcium carbonate, 40% between 100 and 250 ppm, and only 10% is below 100 ppm.

These relatively large amounts of hard water used in Western Europe have resulted in almost every individual country in a high usage of detergents containing high levels of complexing agents such as tripolyphosphates (STPP). Formulations of heavy duty powder contained up to 60% of STPP in 1974 with typical levels between 40% and 50%.

Washing temperatures: It is current practice in most European countries to wash almost at the boil. Because of

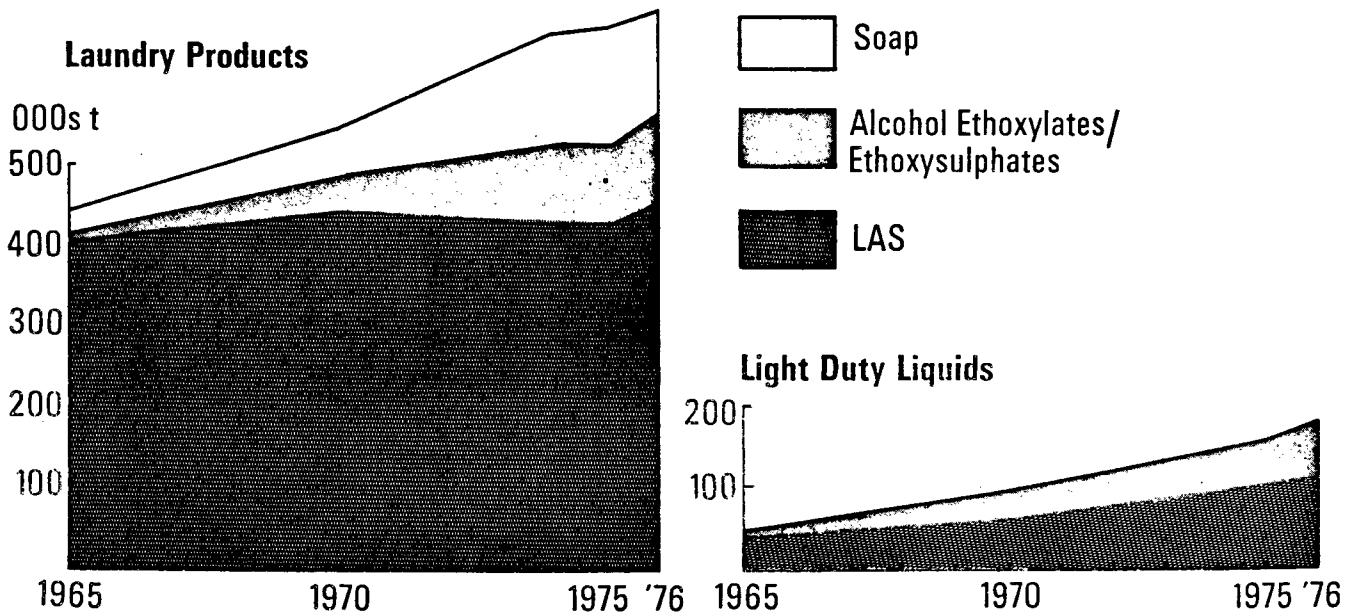

FIG. 1. Surfactants consumption for detergent formulations-Western Europe.

TABLE I

Washing Machines—1974
Western Europe
(From *Consumer Europe Publication* 1976)

Ownership	73%	
Front Loading	85%	(Great Britain 40%)
		(Spain 55%)
Top Loading	15%	

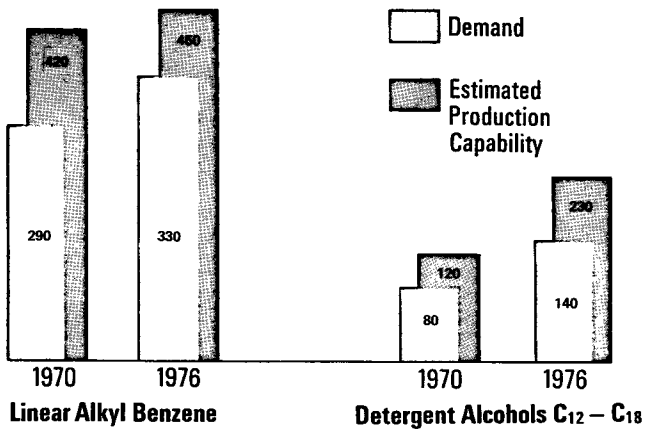

FIG. 2. Supply/demand-Western Europe.

this most of the washing machines used in Europe are equipped with automatic electric heating units that can bring the temperature of the wash water up to 95 C with the washing process starting with cold water.

Washing machines: In Europe, front loading washing machines with a horizontal rotating drum have been developed mainly because they require relatively small quantities of water to bring the wash more quickly to the boil and to minimize heating costs. As a consequence, the load/liquor ratio is rather high (1 kg of cloth for 5 liters of water or 1 lb/0.6 U.S. gallon).

Twin tub machines and top loading automatics are widely used only in Britain and Spain, whereas other European countries employ front loading types leading to the necessity of having controlled foam formulations (Table I). This has had a definite impact on the surfactant types required to perform under these conditions—as will be explained later.

Detergent formulations: (a) *Heavy duty.* Because of the factors mentioned, ternary blends with controlled foam properties, using a mixture of soap, alkylbenzene sulfonates and detergent alcohol ethoxylates as the main surfactants, have developed rapidly in Western Europe over the last decade. These formulations today account for some 70% of the total laundry products although the development of such blends varies from one country to another, particularly in the U.K. where controlled foam powders account for only 40% of the laundry market. The total active matter level in the products is relatively low (between 10-15% by wt) but high phosphate content prevails. The main ingredients of a typical heavy duty detergent powder are as follows:

surfactant		10—50% by wt
composed of:	Soap	30%
	LAS	40%
	Ethoxylate	30%
sodium tripolyphosphate		30—50% by wt
sodium perborate or percarbonate		20—30%
sodium silicate		3—5%

The high temperature washing conditions allow perborate or percarbonate bleaching agents to be incorporated into the formulation.

TABLE II

Detergent Consumption
Western Europe

1. Household Detergents (Light and Heavy Duty)	
1965	6.3 kg/capita
1970	9.3 kg/capita
1975	11.7 kg/capita
2. Surfactants	
1965	1.2 kg/capita
1970	1.6 kg/capita
1975	2.0 kg/capita

Many variations of this typical formulation exist depending on local conditions, particularly the amount and type of detergent alcohol ethoxylate so that the ratio between the three surfactants may vary significantly. However, formulations of heavy duty laundry detergents are tending to be more standardized throughout Europe.

(b) *Light duty.* Light duty products for fabric washing and dishwashing may be powders or liquids. A large market for powders still exists in countries like France and Italy although the development of liquids has been quite spectacular over the last ten years. Formulations have come to a more unified type: high active content (30% to 40% by wt) blends of LAS/ethoxysulphate (70/30) are now well established in most countries of Europe.

Detergent Raw Materials and Intermediates

The rapid development of washing machines in Western Europe during the last decade combined with the formulations mentioned previously has led to an increasing demand for detergents. Over the past 10 yr, an average annual growth rate of some 7% has been maintained for laundry products except in 1975 when demand remained static during the economic recession. It is worthwhile looking in more detail as to what happened this year, when considering the future.

For the detergent raw material side, the rapid switch from high foaming powders containing relatively high levels of LAS to low active ternary blends has resulted in a much slower growth of LAB than previously expected. Investments in LAB during the period 1965-70 (taking over from hard alkylate because of environmental problems) were geared to an anticipated higher demand. As a result, an overcapacity in LAB from the early seventies has prevailed in Western Europe. The eight LAB producers claim a total name-plate capacity of some 540,000 tons (1.2 billion lb) although when taking feedstock availability into account (n-paraffins and/or olefins), a more realistic capacity is probably around 450,000 tons (990 million lb). Nevertheless, the total demand is only 75% of the estimated capacity available leaving room for further growth in LAB without supply problems for the next few years to come (Fig. 2).

Another consequence of the development of ternary blends has been the rapid growth of nonionics and in particular, detergent alchol ethoxylates which had an average annual growth rate of 17% during the period 1965-75. This has been made possible by the new linear synthetic alcohols plants in Europe as well as ethoxylation capacities also installed during this period. In this respect, Shell has been a major contributor to these investments. Again, over-optimistic demand forecasts resulted in investments in synthetic alcohols with five synthetic producers adding capacity to the existing natural alcohol production, which resulted in the present capacity of some 240,000 tons (530 million lb) of detergent alcohols against an estimated total demand of some 140,000 tons (308 million lb).

Overall, it can be summarized that the present demand for surfactants in Western Europe is still dominated by LAS

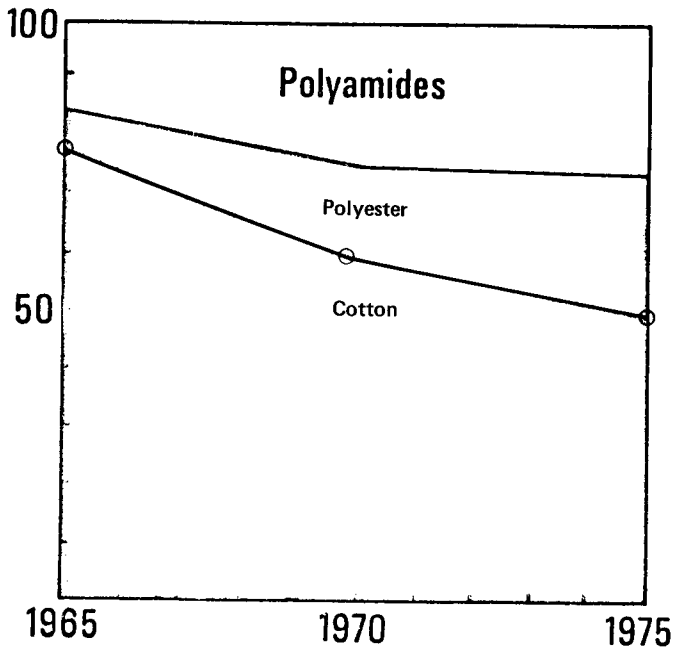

FIG. 3. Relative importance of textile fibers consumption for household fabrics-Western Europe (from *National Statistics).*

which accounts for some 80% of the total synthetic active used in laundry detergents. However, fast growing linear alcohol ethoxylates have established themselves as a significant constituent of the synthetic active matter.

FUTURE PROSPECTS

The main factors which will affect the future demand for surfactants used in household formulations can be deduced from the various points made previously without having to resort to speculation.

Market Growth

A slow-down in market growth for finished detergents for fabric washing can be expected in the near future for the following reasons: (a) The washing machine market approaches saturation with household ownership in most countries of Western Europe reaching the 80% level.

(b) More care is now taken by the housewife to have a full washload, thereby reducing detergent consumption. This trend was certainly noticed in 1975 shown by a static detergent consumption. Although the expenditure on laundry products by the housewife is small (in the order of $40/family/year), price consciousness of the housewife will be a dominant factor in inflationary times.

(c) Population growth rates are small (below 0.5%).

However, a trend towards more clothing articles per capita combined with increased washing frequency, will favor greater detergent usage. From an average detergent consumption of 12 kg/capita (26 lb/capita) in 1975 in Europe compared to some 18 kg/capita (40 lb/capita) in the U.S. at similar rates of usage per weight of laundry, higher usage is possible (Table II).

It is generally accepted that the above factors will result in finished detergents for fabric washing growing at an annual rate of 3-4% in Western Europe.

Washing Temperatures

With the washing process starting from cold water to almost on the boil, by the electrical heating systems, energy consumption is quite high and is noticeable through the electricity bill each householder receives. Therefore, there is incentive to reduce washing temperatures as long as the cleaning effect remains statisfactory.

In addition, synthetic fibers are being used more widely,

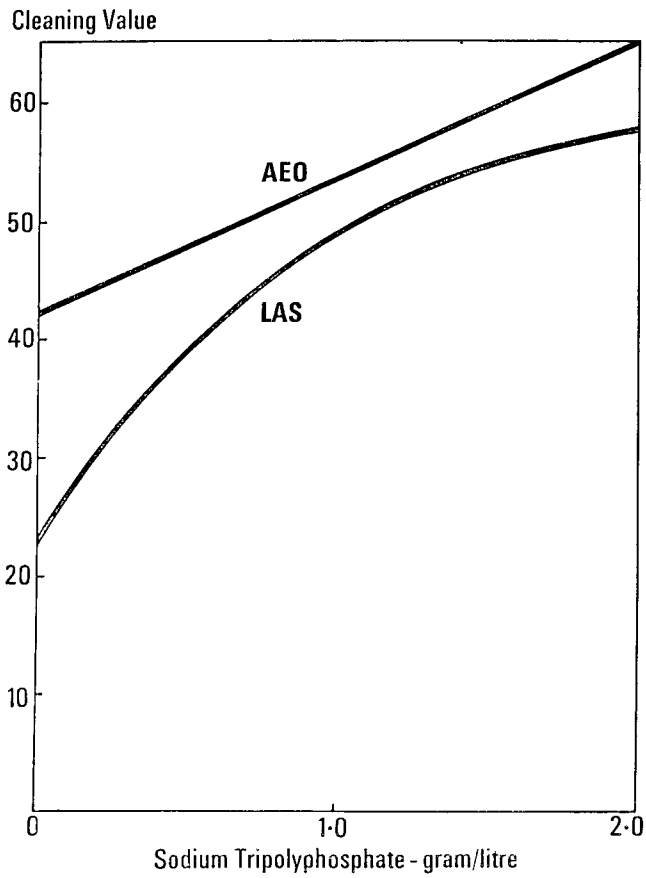

FIG. 4. Soil removal from finished polyester/cotton: Krefeld soil 1 g active matter/liter, water hardness 300 ppm as Ca Co_3, temperature 45 C.

particularly polyester/cotton blends. Such fabric cannot be washed at the boil (Fig. 3).

As a consequence, washing temperatures are already being reduced and washing at 50/60 C will become common practice in a few years' time even taking into account the inevitable slow process of change.

By using alcohol ethoxylates, the formulation's good performances at low temperatures can be achieved. Many products are already advertised for use in all temperature conditions but perhaps products with increased ethoxylate content will develop to allow better cleaning in these conditions.

Formulation—Phosphate Contents/Surfactant Contents

There is already a trend for reducing phosphate contents in formulations for two basic reasons.

(a) *Environmental considerations:* Although no legislation is in force, voluntary reduction by the industry in Sweden has taken place. In Germany a new law gives the power to the government to control the use of phosphates in the future.

(b) *Cost and energy savings:* Although in Western Europe 50% of the phosphate production is carried out by the so-called wet route, the other 50% goes through the elemental phosphorus step which is energy intensive.

However, a move towards reducing the phosphate content of laundry powders will lead to a reduction in the cleaning performance since phosphates not only act as a sequestering agent but also make a positive contribution to the total detergency of the formulation. The effect of reducing the phosphate content on soil removal from polyester/cotton blends by LAS and linear alcohol ethoxylate is shown in Figures 4 and 5. The importance of a high phosphate content for good cleaning by LAS is clearly evident. With alcohol ethoxylate, a 30% reduction in the

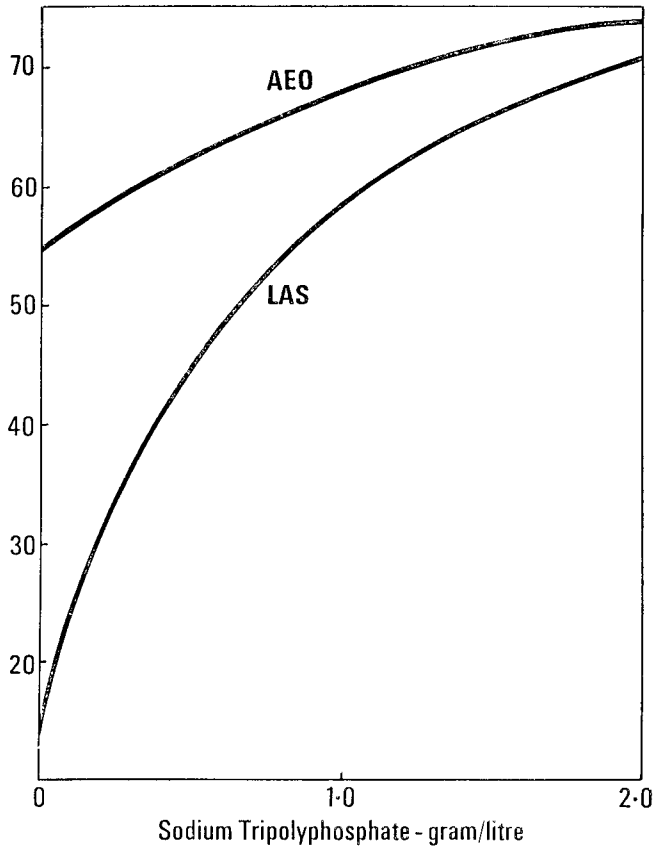

FIG. 5. Soil removal from permanent press polyester/cotton: Shell Radio-labelled sebum 0.25 g active matter/liter, water hardness 300 ppm as Ca Co3, temperature 45 C.

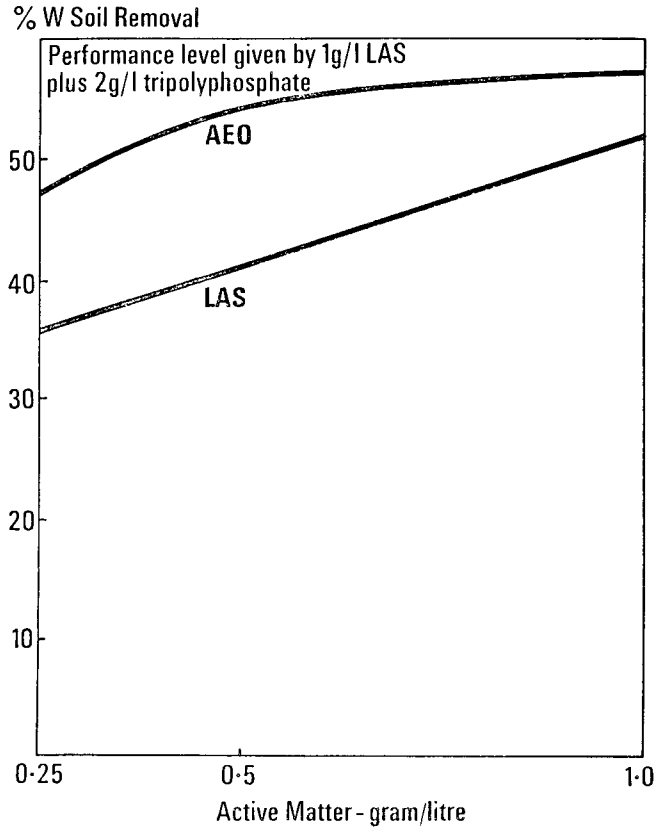

FIG. 6. Soil removal from polyester/cotton: Shell radio-labelled sebum 0.5 g sodium tripolyphosphate/liter, water hardness 300 ppm as Ca Co3, temperature 45 C.

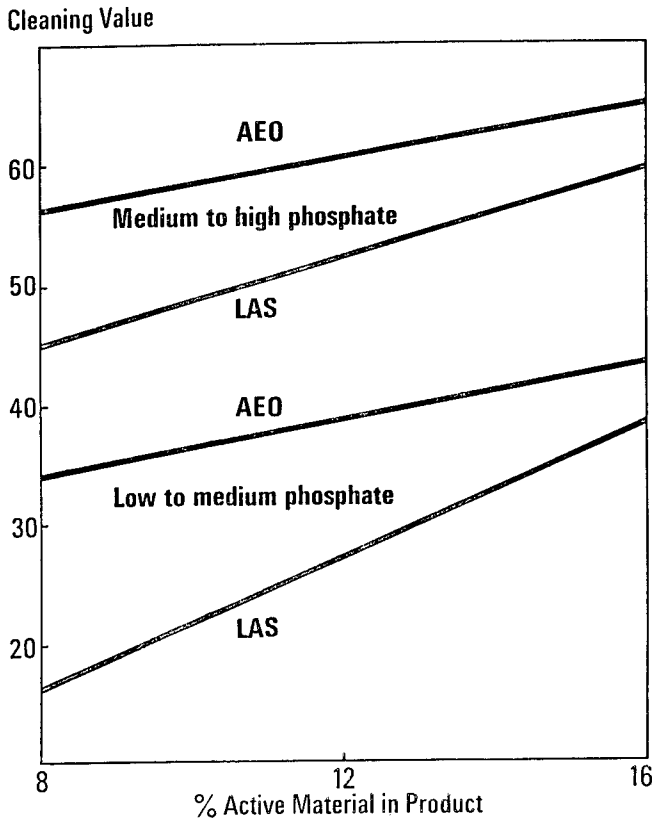

FIG. 7. Soil removal from cotton: Krefeld soil, water hardness 300 ppm as Ca Co3, temperature 60 C.

phosphate content gives a performance equivalent to high phosphate/LAS formulation.

The lowering of cleaning performance consequent upon a reduction in the phosphate content can be compensated by an increase in the active matter content, as shown in Figure 6. Increasing LAS content also improves the performance but alcohol ethoxylates remain superior. Similar trends are also evident from the cotton detergency data presented in Figure 7.

Summarizing the loss in cleaning performance consequent upon a reduction in phosphate content can be compensated by an increase in the amount of surfactant used with a marked preference to alcohol ethoxylates.

Bearing in mind the low surfactant content of existing laundry products, any reduction in phosphate content must be compensated for by increasing the usage of LAS and/or ethoxylates in order to maintain performance. We predict that such a trend will develop in Western Europe. With LAB readily available in an over supply position and costing less than other components in the formulation, it is likely that this trend will develop allowing good propsects for LAB in the next few years. This would also allow formulation costs to be in line with price and inflation controls prevailing in most Western European countries.

For even further improvement in performance, the alcohol ethoxylate content will increase more or perhaps new formulations, either liquids or powders, containing high levels of surfactants both LAS and alcohol ethoxylates will develop.

Future Surfactant Demand

From the above, a growing demand for surfactants as a consequence of changing washing conditions can be expected in the next few years. From a cost point of view, LAB may be preferred as long as adequate capacity is available in Western Europe to meet the additional demand. Although it is difficult to predict the exact date the present Western European capacity of LAB will be fully utilized,

TABLE III

Comparison Olefin Processes

Feedstock	n-paraffin/wax		Ethylene	
Commodity	no		yes	
Special crude oils required	yes		no	
Process	Dehydrogenation	Wax cracking	Polymerization (Ziegler type)	Oligomerization (SHOP)
Low amounts of by-products	xx	x	xx	xxx
Product quality	xx	x	xxx	xxx
Product flexibility	x	x	x	xxx
Low fuel consumption	x	x	xx	xxx
Low ethylene utilization			xx	xxx
Alpha olefins		xx	xx	xx

there is enough capacity from plants in operation to cope with an optimistic growth for some years, and LAB is likely to continue playing its major role in detergent formulations in Western Europe. At the same time, developments of nonionics based on alcohol ethoxylates are likely to continue in view of the significant performance benefits gains under the coming new washing conditions. Again, sufficient alcohol capacity is already installed to meet this higher demand.

Overall, ternary blends, which are the established formulations for laundry products, are likely to continue to be the basic type of formulation but with higher active contents than at present. However, a higher share of the laundry market may be taken by improved performance products based essentially on alcohol ethoxylates.

New Investments in Detergent Raw Materials

When present capacity for both LAB and detergent alcohols becomes fully utilized in Western Europe (probably during the first half of the 80s) new investments in plants to manufacture detergent raw materials have to be considered although a temporary deficit could be met with imported material.

The basic feedstocks for primary linear alcohols and linear alkyl benzenes are n-paraffins, internal, alpha olefins, and benzene. It is useful to assess the most economical way of producing one of the major feedstock in a new plant—linear olefins—which can be derived either from n-paraffins, n-wax, or ethylene. The processes involved are essentially the following:

Paraffin/wax based	Ethylene based
Wax cracking	Polymerization (Ziegler type)
Dehydrogenation n-paraffins	Oligomerization (Shell Higher Olefins Process-SHOP)

A comparison of these processes can be summarized in Table III.

The present differences in the value of the various cuts of the barrel used in these processes (naphtha, kerosene, gas oil, and fuel oil), which favor fuel/gas oil related processes today are forecast to reduce owing to a combination of higher industrial activity coupled with an increase of secondary refinery processing (e.g. conversion of fuel oil to middle distillates). Also, ethylene, in contrast to n-paraffins, can nowadays be produced from a broad spectrum of petroleum fractions, which enables at all times the use of the most economical cut of the barrel depending on the prevailing market situation.

From an in-depth study of the economics for the various processes available, we have concluded that oligomerization processes giving specific olefin cuts from ethylene are to be preferred for future investment provided all products are carrying detergent feedstock values. Shell's process, with its technology (SHOP) based on novel ethylene oligomerization, meets this proviso and is confidently believed to constitute the most economic way available today for producing detergent range olefins. In addition, oligomerization processes make available alpha olefins which can be converted into a range of active matters other than alcohols and LAB, as compared to internal olefins, which are exclusively produced when using the paraffin dehydrogenation route.

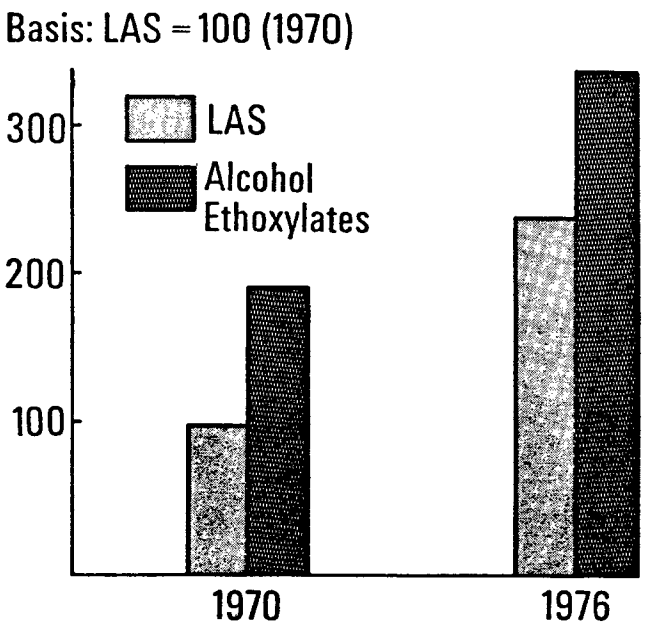

FIG. 8. Relative prices—LAS/alcohol ethoxylates.

Downstream from these olefins the choice between building additional capacity for LAB, detergent alcohols or other detergent intermediates like alpha olefin sulfonate (AOS) has to be made. The relative cost/performance between the derived surfactants (LAS, AOS, and detergent alcohol ethoxylates) and the greater flexibility in use shown by the latter will be the determining factors. Already in Europe the relative prices between LAS and ethoxylates are close enough and the formulation know-how good enough to allow the development of alcohol ethoxylates (Fig. 8).

Should a new plant be built, the profited manufacturing cost of LAS would be appreciably above today's market prices in Western Europe so that new investment in LAB would cause the relative costs of LAS and alcohol ethoxylates to narrow significantly. However, the cost of AOS is lower than that of LAS when both are produced on new plants. Bearing in mind the performance benefit of alcohol ethoxylates over LAS and the cost benefit of AOS over LAS, it is anticipated that new investments in Western Europe will be in detergent alcohol and alpha olefin derivatives and not in LAB.

CONCLUSION

The formulating of detergents in Western Europe to satisfy changing washing conditions and environmental standards has presented both intermediate suppliers and detergent manufacturers with a real challenge over the past decade. This challenge has been met by maintaining a dynamic development with good technical cooperation between suppliers and customers.

Although sufficient capacity of detergent raw materials should allow the Western European detergent industry to continue its development for the rest of this decade, new investments in detergent feedstock should become necessary in the early eighties if innovation, technical progress, and growth in laundry products are to continue. The challenge for the suppliers is to make available at the appropriate time to the detergent industry the raw materials this industry will require. Attractive and competitive economics of future investments will be essential in a market which becomes more and more cost conscious. New technology is available to meet the innovation and growth required by the industry, allowing further improvements in detergency. •

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