Oleochemical Base Fluid Development

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ABSTRACT

For over a decade, synthetic lubricants have been identified as a true field of growth and opportunities. An attempt will be made to demonstrate to what extent the actual developments followed market-research predictions. The path to a commercially successful base fluid is lengthy, risky and costly. A summary is given on the business environment in which developments take place as well as internal and external pressures on such development activities. Although the oleochemical industry provides essential "chemical backbones" for lubricant base esters, compounds of petrochemical origin are needed to design the proper molecule. Moreover, the petrochemical industry provides its own versions of synthetic base fluids. A picture is drawn on the relative position of oleochemical-versus petrochemical-derived base fluids.

Amongst the steady flow of pubications from research institutes, consultants, etc., on promising new fields of speciality chemicals, synthetic lubricants have been among the forerunners for growth and future profitability.

Reports and articles published during the last decade revealed headings such as: "outlook for synthetics appears glowing", "synlube sales in EEC to double", "US-Markt fuer synthetische Schmiermittel waechst ueber durchschnittlich", and "synlubes gain dramatically". Naturally, these statements attract attention from executives and officers eagerly searching for new fields of growth and promising future profitability. However, is the apparent glitter of future markets reflected by the inside story?

By studying the forecasts closely, it rapidly emerges that past and more recent estimates of synlube consumption and future growth differ widely. The obvious difficulties faced by market researchers are best illustrated by quoting some examples (see Table I).

A choice has to be made of the products to be included. By "synthetic base fluids," one refers to products that differ widely in chemical composition: polyglycols, poly-alpha olefins, diesters, polyolesters, phosphate esters, silicones, etc.

The picture is further complicated by the availability of lubricating oils in the form of: (a) full synthetics, based on one or two blends of the synthetic base fluids already mentioned, and (b) semisynthetics, blends of mineral and synthetic base fluids. The classification aircraft, automotive and industrial, is generally accepted as the main subdivision for the numerous applications of lubricants. But does one include brake fluids, compressor oils, metal processing oils, hydraulic fluids, etc.?

Clearly the lack of agreement in the definition of synthetic lubricants makes it extremely difficult to compare available data. Even more difficult is the evaluation of growth expectations. Most forecasts are based on speculative assumptions.

TABLE I

Synlube Consumption Forecast

For the USA (million gallons/yr)		
Hull and Co. (1976)	1976/51	1986/122
Ozimek (1972)	1976/31.5	1986/75
Chem Systems (1978)	1977/39.5	1987/110
Humko Sheffield (1980)	1976/53	1985-86/92
For Western Europe (thousand metric tons/yr)		
Chem Systems	1982/119	1987/190
Frost and Sullivan	1980/81	1990/97

Although we do not wish to confuse you further, you may be interested to learn the results of our market research.

Since Unichema International's main centers for production and development are located in Western Europe, we feel most confident in assessing the Western European market for synthetic base fluids. The 1981 markets are shown in Table II.

TABLE II

Western European Market for Synthetic Base Fluids 1981 (thousand tons)

	Aviation	Automotive	Industrial	Total
Poly-alpha olefins		5	0.5	5.5
Esters	6	6	12	24
Phosphate esters			4.5	4.5
Polyglycols		6	30	36
Others		2	27	29
Total	6	19	74	99

Whereas our estimate on current consumption seems a compromise between the figures presented by Chem Systems, and Frost and Sullivan, we arrive at substantially less favorable expectations on future growth rates: aviation – no growth, polyolesters to increase against diesters; automotive – overall growth 5-10%, price/performance to dictate the future relationship poly-alpha olefins versus polyolesters; industrial – 3-5%.

These growth rates place synthetic base fluid consumption by the end of the decade at ca. 125,000 metric tons/year; 75,000 metric tons/year less than predicted by the studies already mentioned. We base our less optimistic views on:

–general lower level of development in view of escalating cost versus commercial rewards,
–lower sales of finished products,
–increasing competition in end-product markets in particular with the semisynthetics,
–lower acceptance rate by the consumer.

The last aspect can best be illustrated by comparing prices of finished crankcase lubricants for the main Western European countries (Table III).

The considerably higher cost of synthetic lubricants will continue to make it difficult to convince the consumer of the financial benefits he can achieve by using synthetic lubricants – particularly in a depressed economic environment.

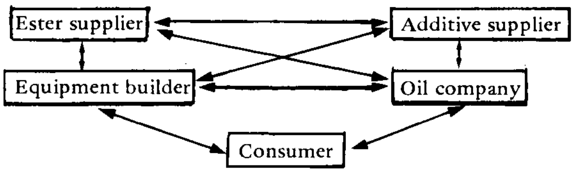
Drawing conclusions from recently published articles in magazines and market research reports, it seems that our ideas on growth are increasingly shared by other experts in the field. Growth rates of 5-10% for synthetics in automotive applications are now quoted – compared with 15% and more in the past. Notwithstanding the fact that growth rates will be less than indicated in earlier reports, the market nevertheless seems strong, possessing a healthy potential for innovation.

To determine the necessary conditions for successful entry by an oleochemical producer, one must analyze the structure of the business, the forces working on the business, plus the risks involved. Scheme 1 best summarizes

TABLE III

Consumer Prices for Finished Lubricating Oils per Liter

	U.K.	West Germany	France
Fully synthetic oil	£ 3.50	DM. 16-18	FF. 50
Semisynthetic oil	p.m.	DM. 10-12	FF. 40
Good mineral oil	£ 1.20	DM. 8-9	FF. 20
Rate *fully synthetic* mineral oil	3.5	2	2.5



SCHEME 1. Market Structure.

the structure of the base fluid market and the industrial groups active in this business.

A close examination shows the industry:

—to be highly complex, with the base fluid supplier having to maintain considerably more channels of communication than just with his customers;

—to know a high degree of backward and forward integration;

—to be committed to international and national standards with many committees covering all aspects of performance.

Hence the obvious need for joint development programs covering all aspects of lubricant development, thus enabling one to keep development costs in proportion. Further complications occur due to variations in the balance of "power or influence," depending on the field of application(s), i.e., automotive, industrial, aviation, and major equipment builders tending to offer their own brands.

For a new entrant in this industry, it is vital to achieve credibility and to become a recognized member of the structure and development cycle. Costs to achieve this are high because:

—a qualified team is needed (marketing, development) to generate knowledge and to ascertain that others know the company has it,

—specialized performance testing and analytical equipment has to be purchased,

—plant lay-out and plant management have to be able to deal with the strict quality requirements typical of this industry.

Consequently, after 2-3 years of high internal costs and many pitfalls, the new entrant has not been able as yet to generate (any) sales. In addition, the base fluid supplier needs to become engaged, alone or in partnership, with an oil or additive supplier, in costly engine testing. Particularly with synthetic lubricants, the aspects of performance products apply: "The chemistry is only of secondary importance. Of prime importance is the performance of the base fluids. Moreover, it must be proved."

Table IV provides a summary of possible internal and external cost to obtain product approval for an ester-based synthetic lubricant. (The presence of basic equipment and development personnel is assumed!)

Next to the complexity of the market, the high cost of development and the long time between start and completion of a new development, the "unforeseen" can affect the project. Examples experienced recently are:

TABLE IV

Development Cost to Commercial Sales

	Internal ($)	External ($)
Aviation	50,000	500,000 to > 1 million
Automotive	100,000	250,000-500,000
Industrial	35,000	150,000

TABLE V

Main Ester Raw Materials

Oleochemical	Petrochemical
Sebacic acid (C_{10}-di)	Adipic acid (C_6-di)
Azelaic acid (C_9-di)	TMP
Dimer acid (C_{36}-di)	NPG
C_6-C_8-C_{10}-C_{12}-monoacids	PE
C_{16}-C_{18}-monoacids, unsaturated	C_8-C_{10}-alcohols
C_7-C_9-monoacids	C_7-C_9-monoacids

—additive technology may advance to counter the development concept,

—the cost effectiveness is destroyed by changes in raw material prices,

—fuel prices may develop to undermine the basic concept,

—new engines may need alternative lubrication systems or lubricant qualities, making present products obsolete.

Synthetic base fluid suppliers can only achieve commercial success in this high cost, risky business if they show a high degree of stamina and creative thinking.

Synthetic base fluids are clearly a speciality business. Therefore, merely being in the oleochemical industry is no guarantee of success, although a certain raw material position may help. In addition, all synthetic ester-based fluids so far possess a petrochemical backbone. This is illustrated in Table V.

To appreciate further the oleochemicals/petrochemicals relationship in the synthetic lubricant business, one must also understand its historic development.

Synthetic lubricants found their first important use in the aviation field; turbine engine lubricants. The base fluids were oleochemical derivatives, diesters (sebacates, azelates). However, with the emerging large potential in automotive applications, true petrochemical synthetic base fluids entered the picture. The main and very important contender for this market segment are now poly-alpha olefins (PAO). Taking into account the favorable cost of PAO, the integrated position of the majors in the oil industry (oil, chemicals, fuel, lubricating oils), it should not come as a surprise that, especially in the all-important automotive market, we see leading positions of synlubes derived 100% from petrochemical feedstocks. Examples are Mobil I and Castrol RS. However, the present commercial position of these lubricants is the result of development activities commenced more than 5 years ago. In that period, PAO were considerably cheaper compared to their main competitor, polyol ester. (These esters contain monofunctional acids available from the oleochemical industry.)

Figure 1 shows the price development of the three main alternatives for synthetic automotive lubricants. Although the graph illustrates why so much effort went into lubricants on a PAO-basis, it equally indicates a possible revival of interest in polyolesters. The cost advantage of PAO over polyolesters has almost disappeared over the last 3 years. Undoubtedly the new situation will affect the growth

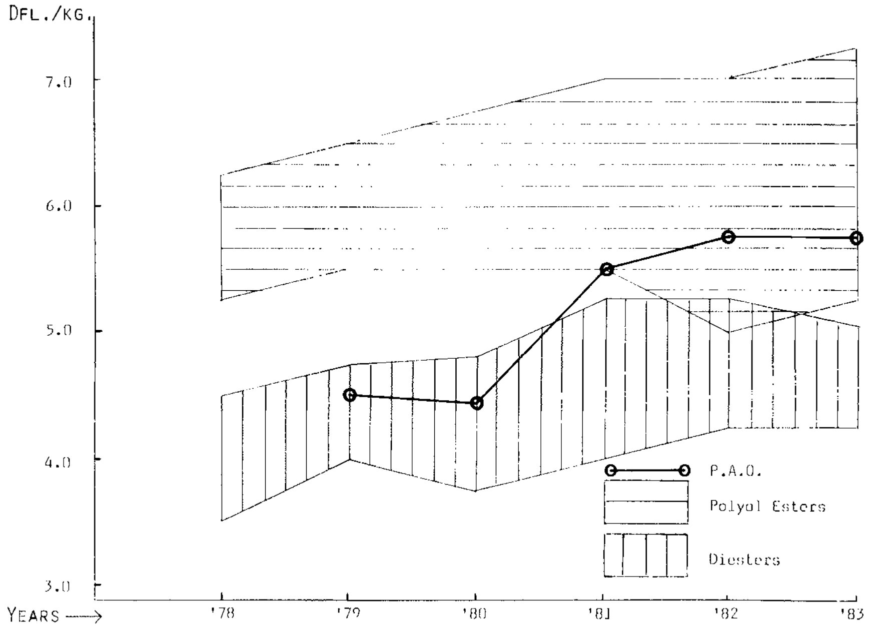


FIG. 1. Price development of esters and poly-alpha olefins for synthetic automotive lubricants (Western Europe).

scenarios of these two base fluids.

Although the change in relative costing seemed to improve prospects for oleochemical-based fluids, the future of di- and polyolesters in each of the many segments of the synthetic lubricant business largely remains crystal ball watching. Close contacts, alertness, flexibility and adequate responses to changes will continue to dictate the chance of success in this industry.

Important aspects to consider for present development programs are:

—the relative price developments in 1984/1985,
—the security of supply,
—the captive status of oil companies,
—advances in additive technology,
—engine builder trends,
—developments in cost of crude oil and fuels,
—consumer spending power,
—legislation and importance of energy conservation,
—cost of developments in relation to the future commercial benefit (product registration).

Antimicrobial Agents Derived from Fatty Acids

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ABSTRACT

The author reviews his research, since 1966, for the ideal germicide. The relationship between structure of fatty acids, their corresponding esters, and antimicrobial activity is presented. Saturated fatty acids have their highest activity when the chain length is twelve carbons (C_{12}) long; monounsaturated fatty acids reach their peak with palmitoleic acid ($C_{16:1}$); the most active polyunsaturated fatty acid is linoleic. *Trans* isomers are not active against microorganisms. The esterification of fatty acids to monohydric alcohols leads to inactive derivatives, whereas esterification to polyhydric alcohols increases biological activity. Examples of glycerol and sucrose esters are reviewed. In general, the lauroyl derivatives are the most active. A few examples of esters as active pharmacological agents against organisms causing bovine mastitis are presented as well as the use of monolaurin (Lauricidin®) as cosmetic and food preservatives. The safety and efficacy of fatty acid esters as potential germicides offer new and expanded roles for oleochemicals.

INTRODUCTION

"If all the drugs in the pharmacopoeia save three were dumped into the ocean, it would be so much better for the patient and so much worse for the fish." — Wendell Homes

These words by an American physician are prophetic and "foresaw" the problems of today's environmental contamination. The chemical industry has helped create a veritable arsenal of weapons against microorganisms and insects. In our narcissism with this extraordinary technology developed since the early part of the 1900s, the specter of danger to ourselves and the environs was overlooked. It is only in the past few years that *Silent Springs* (1) and other similar publications started to warn us of our folly.

Today, questions about our chemical world are being raised by government, industry and consumers. How can we continue to battle the microorganisms which damage crops, are responsible for so many diseases, and in general cause much mischief to man, and not add to the problem? Sulfa drugs and antibiotics certainly have been useful — but at a price. The administration of these powerful agents has created side effects which have become more a part of the problem than the solution. The growing resistance of microorganisms to germicides is but one example.

The solution to this ever-growing problem of using chemicals to eradicate disease and pestilence is to "return to nature": to find natural (nontoxic) agents which will kill bacteria, fungi, etc., but will do little or no harm to