1
Lubricants and Their Market

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1.1
Introduction

The main task and most important function of lubricants are to reduce friction by lubricants and offer wear protection, which extends machine runtimes and thereby protects raw materials. In some cases, the relative movement of two bearing surfaces is possible only if a lubricant is present. At present times when sustainability has become a driving force in the industry, saving energy and resources as well as cutting emissions have become central environmental matters. Therefore, the scarcity of resources and the responsibility towards future generations are also a particular focus of corporate action. Lubricants are increasingly attracting public awareness, because they support sustainability targets in economic, ecological and social areas. Lubricants make a contribution to the sparing use of resources and thereby to sustainability. Their task of reducing friction reduces the amount of energy input required and in this way saves emissions. Their task of wear protection extends the service life of equipment and saves resources. Scientific research has shown that up to 1% of gross domestic product could be saved in terms of energy in Western industrialized countries if current tribological knowledge, that is the science of friction, wear and lubrication, was just applied to lubricated processes.

Apart from important applications in internal combustion engines, vehicle and industrial gearboxes, compressors, turbines or hydraulic systems, there are a vast number of other applications which mostly require specifically tailored lubricants. This is illustrated by the numerous types of greases or the different lubricants for chip-forming and chip-free metalworking operations which are available. About 5000–10 000 different lubricant formulations are necessary to satisfy more than 90% of all lubricant applications.

If one thinks of lubricants today, the first type that comes to mind is mineral oil-based lubricant. Mineral oil continue to constitute quantitatively most important component of lubricants. Petrochemical components and increasing

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derivatives of natural, harvestable raw materials from the oleo-chemical industry are finding increasing acceptance because of their environmental compatibility and some technical advantages.

On average, lubricants consist of about 90% base oils and 10% chemical additives and other components on a volume basis, while on a value base the respective ratio is estimated to be around 80:20.

The development of lubricants is closely linked to the specific applications and application methods. As a simple description of materials in this field makes little sense, the following sections will consider both lubricants and their application.

1.2
Lubricants Demand

Lubricants today are classified into five product groups: automotive oils, industrial oils, greases, metalworking fluids (including corrosion preventatives) and process oils. Process oils are included as raw materials in processes, but above all as plasticizers for the rubber industry. Their only link with lubricants is that they are mineral oil products resulting from the refining of base oils, but they often distort lubricant consumption figures. Therefore, they will not be covered in this book.

Interestingly, the breakdown by product groups in the past 15 years only slightly changed. 56% of all lubricants still go into automotive oils (e.g. engine oils, gear oils and transmission fluids), which continue to be the prevailing product group and largely dictate what will be available (or not) for making other products. Only 26% are industrial oils, with the rest comprising process oils, lubricating greases, metalworking fluids and corrosion preventatives.

The global lube market volume (without marine oils) was at around 36 million tonnes at the turn of the millennium and more or less quite stable until 2008. Then lubricants demand on a worldwide basis plunged by more than 10% year-on-year to just around 32 million metric tonnes in 2009. Since 2010 the worldwide market consumption showed a partial recovery in light of the partly unexpected rapid economic growth, to nearly reach the 36 million tonnes level again in 2015. Thus, one could think that not much happened market volume-wise between 2000 and 2015 (Chart 1.1).

However, the underlying regional lube market dynamics of the past 15 years were enormous in terms of quantity and quality. The Asia-Pacific region together with Africa and the Middle East accounted for a little more than one-third of global volume in 2000 and now makes more than half of it, as a result of growing industrialization and motorization and consequently higher consumption. The mature markets of Western Europe and North America experienced a continuous move to more quality lubricants, which resulted in extended oil change intervals and consequently lower demand per year. Asia-Pacific today consumes twice the lubricants amount per year than North America (Chart 1.2).

Since 1975, quantitative lubricant demand has significantly detached itself from gross national product and also from the number of registered vehicles. This quantitative view, which at first glance shows a continuous decline in lubricant

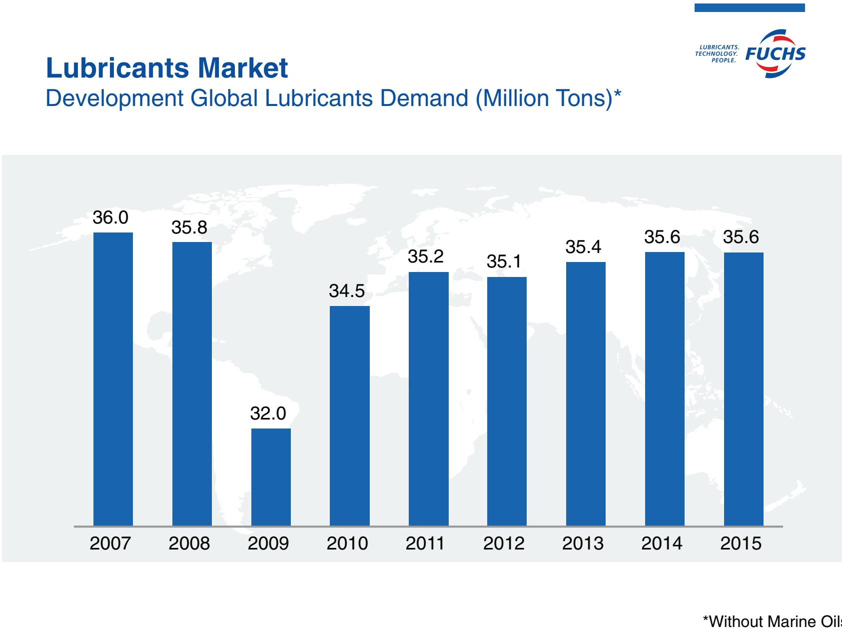

Chart 1.1 Development global lubricants demand [1–6].

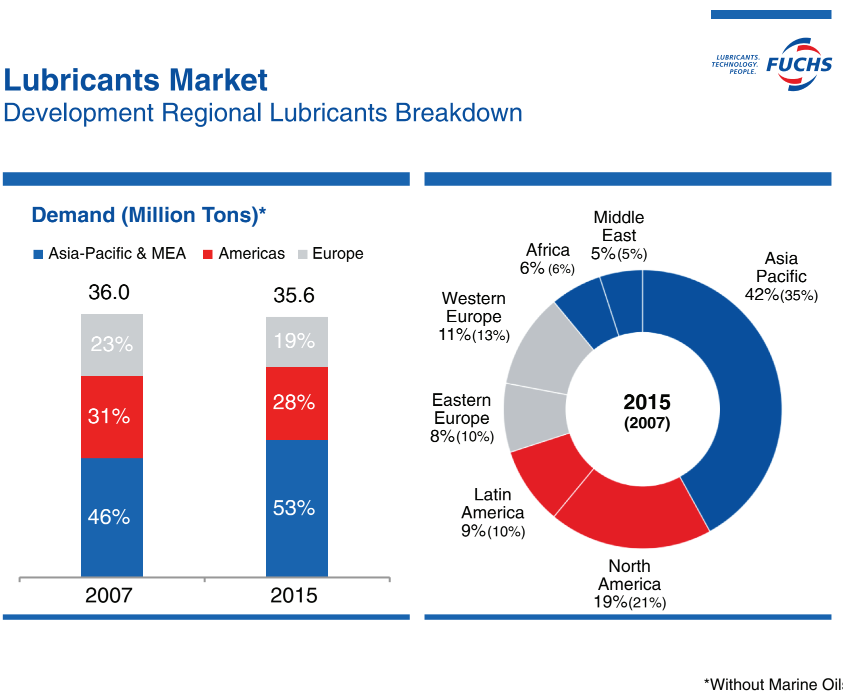

Chart 1.2 Development regional lubricants breakdown [1–6].

volumes, gives an inadequate impression of the significance of the lubricants business today. In almost all areas, products now have a longer life and offer greater performance, that is specific lubricant consumption has declined but specific revenues have increased noticeably. This is also confirmed by the volumetrically very important group of engine oils: The doubling of requirements with extended oil change intervals in recent years has quadrupled the cost of such oils. The efforts to increase the life of lubricants are not based on the wish to reduce lubricant costs. Much more important is the reduction of service and maintenance costs which result from periodic oil changing or regreasing.

As about 50% of the lubricants sold worldwide end in and thus pollute the environment, every effort is made to minimize spillages and evaporation. An example is diesel engine particulate emissions, about a third of which are caused by engine oil evaporation. These high lubricant losses into the environment were behind the development of environment-friendly lubricants which are thoroughly covered in this book.

A further incentive to reduce specific consumption is the ever-increasing cost of disposal or recycling of used lubricants. But this again creates new demands on lubricants because reduced leakage losses means less topping-up and less refreshing of the used oil. The new oils must therefore display good ageing stability.

Another consequence of the aforementioned developments was that global per capita consumption decreased from around 9 to 5 kg per year between 1970 and 2015, that is the increase in lubricant demand (+7%) did not keep up with the worldwide growth in population (+90%) during this period; in other words, the compounded annual growth rate (CAGR) of world population between 1970 and 2015 was 1.6% and 10 times higher than the CAGR of global lubricants demand, which amounted to just 0.16% in this time frame (Chart 1.3).

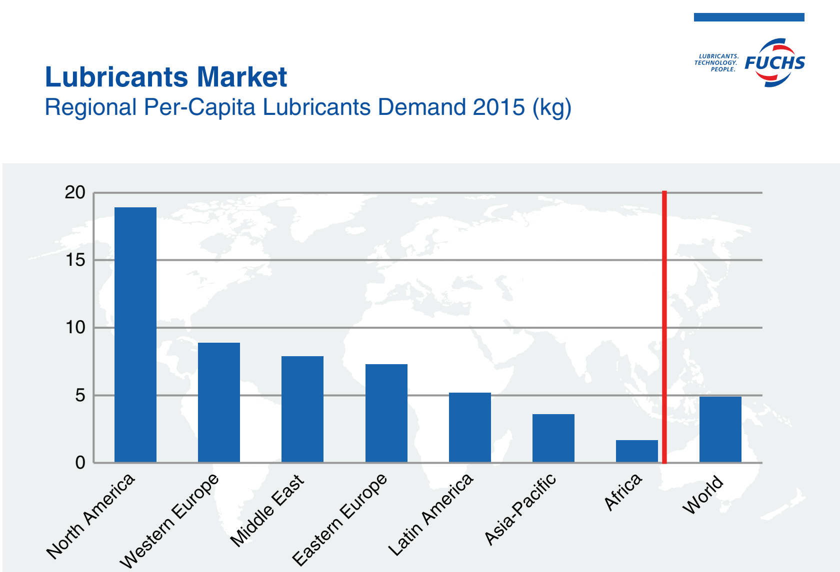

Chart 1.3 Regional per capita lubricants demand [3,4,6].

Bearing in mind the growth potential in Asia where per capita consumption in some areas is still extremely low (2015: India 1 kg) and a continuing reduction in volumes or stagnation in Western industrialized countries, overall a modest global growth is forecast. The growth in value will be more pronounced because the rapid globalization of technologies will promote high-value products even in the developing and emerging lubricant markets such as India and the machines and plants used in these countries will be similar or identical to those used in the developed industrialized countries.

1.3 Lubricants Competitor Landscape

The structure of the global lubricants industry changed significantly between the mid-1990s and 2005. Towards the end of the 1990s, the petroleum industry was affected by a wave of mergers and acquisitions (M&A). These created new and larger lubricant structures at the merged companies. The principal reasons for these mergers were economic factors in crude oil extraction and refining which resulted in lower refining margins.

The number of manufacturers (with lubricants production over 1000 tonnes per year) decreased by close to 60% or in nominal terms by around 1000 players from around 1700 to just above 700 market participants at the end of 2005.

On the one hand, there are vertically integrated petroleum companies whose main business objective is the discovery, extraction and refining of crude oil (Majors). Lubricants account for only a very small part of their oil business. In 2005, there were about 130 such national and multinational oil companies engaged in manufacturing lubricants, with the focus on high-volume lubricants such as engine, gear and hydraulic oils.

The consolidation and concentration proceeded much stronger on the level of the small-sized and independent lube manufacturers (Independents), with technological, safety-at-work and ecological considerations along with the globalization of lubricant consumers playing an important role and critical mass becoming increasingly important in company strategies. Their number halved between 2000 and 2005 to around 600 players, down from around 1200 at the beginning of the millennium. These 590 independent lubricant companies view lubricants as their core business, focusing on specialties and niches, where apart from some tailor-made lubricants, comprehensive and expert customer service is part of the package. They mainly concentrate on the manufacturing and marketing of lubricants. The independent lubricant manufacturers also generally purchase raw materials on the open market from the chemical and oleo-chemical industry and their mineral base oils from the large petroleum companies and they rarely operate base oil refineries (Chart 1.4).

Consolidation nowadays proceeds rather slowly. In case there are deals, then they are mostly on a high-value basis. However, there are other driving forces in the competitive landscape of the industry today: The vertically integrated mineral oil

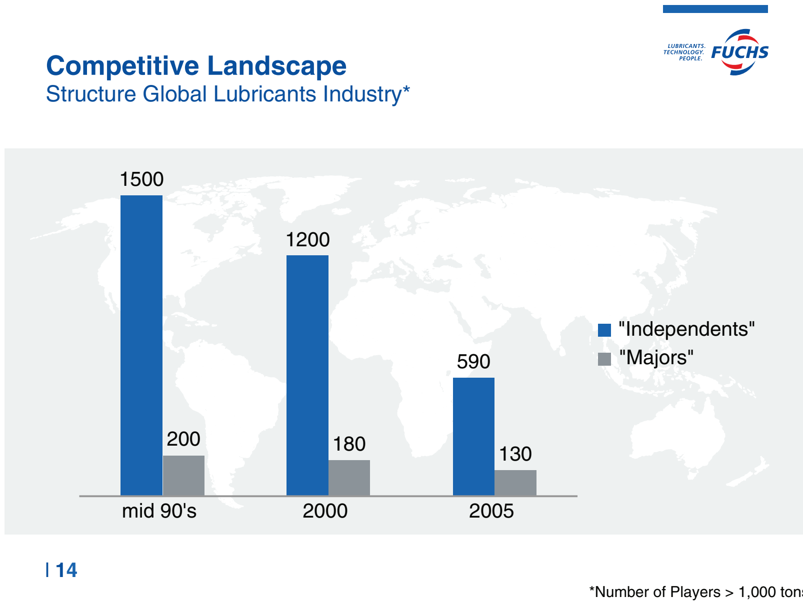

Chart 1.4 Structure global lubricants industry [1,3,4,6].

companies of the 'old world' concentrate on big volume business and retract from niches. New and growing market participants enter the scene. Large oil companies restructure their lube businesses as stand-alone subsidiaries. National Oil Companies in China, South Korea and Russia, for example, go global. Companies, so far mostly known as raw material suppliers to the lubricants industry, go for vertical/forward or lateral diversification steps and Private Equity comes into play (Chart 1.5).

The aforementioned merger and acquisition activities changed the ranking of the top 15 lubricant manufacturers in the past 15 years:

- EXXON and SHELL switched leading positions, after Shell acquired PENNZOIL
- FUCHS gained 3 positions in the top 15 ranking and made it into the top 10 as number 9
- GULF OIL, PERTAMINA and PETRONAS newly came into the top 15 ranking, while INDIAN OIL, AGIP and REPSOL had to leave it.

At the end of 2015, the top 15 manufacturers share two-thirds of the worldwide lube market, while the rest of more than 700 manufacturers share the other half.

The production of simple lubricants normally involves blending processes but specialties often require the use of chemical processes such as saponification (in the case of greases), esterification (when manufacturing ester base oils or additives) or amidation (when manufacturing components for metalworking lubricants). Further manufacturing processes include drying, filtration, homogenizing, dispersion or distillation. Depending on their field of activity, lubricant manufacturers invest between 1 and 5% of their sales in research and development (Chart 1.6).

Chart 1.5 Driving forces global lubricants industry.

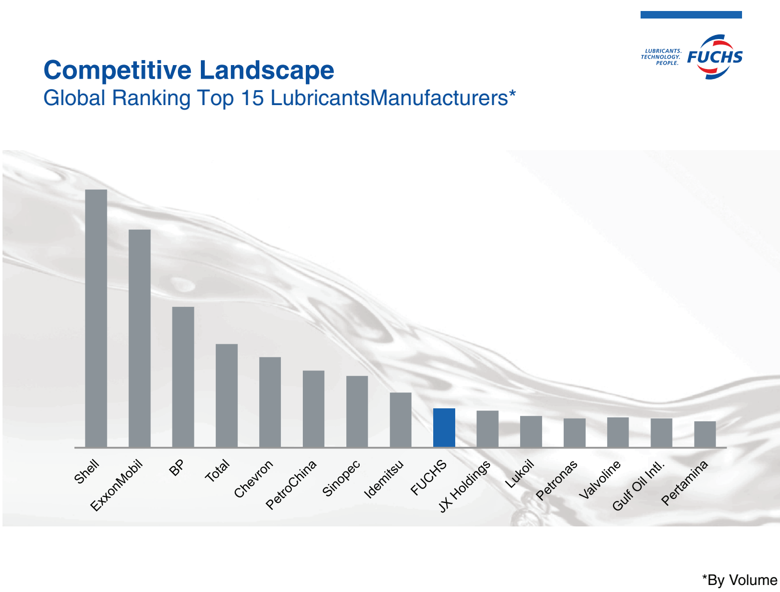

Chart 1.6 Global ranking top 15 lubricants manufacturers [1,3,4,6].

1.4
Lubricant Systems

Apart from the most common lube oils, the many thousands of lubricant applications necessitate a diverse number of systems which is seldom equalled in other product groups.

The group next to oils are emulsions, which as oil-in-water emulsions are central to water-miscible cutting fluids (Chapter 14), rolling emulsions and fire-resistant HFA hydraulic fluids (Chapter 11). In these cases, the lubricant manufacturer normally supplies a concentrate which is mixed with water locally to form an emulsion. The concentration of these emulsions with water is generally between 1 and 10%. The annual consumption of such emulsions in industrialized countries is about the same as all other lubricants together. From this point of view, the volumetric proportion of these products (as concentrates) is significantly underrated in lubricant statistics with regard to the application engineering problems they create and their economic significance.

The next group of lubricant systems are water-in-oil emulsions. Their most important application is in metal forming. These products are supplied ready-to-use or as dilutable concentrates. Fire-resistant HFB fluids are designed as water-in-oil emulsions too (invert emulsions).

In some special cases, oil-in-oil emulsions are developed as lubricants and these are primarily used in the field of metalworking.

Water-based solutions in the form of non-dispersed systems are sometimes used in chip-forming metalworking operations.

Greases (Chapter 16) are complex systems consisting of base oils and thickeners based on soaps or other organic or inorganic substances. They are available in semiliquid form (semifluid greases) through to solid blocks (block greases). Special equipment is required for their production (grease-making plants). A group of products closely related to greases are pastes.

Solid lubricant suspensions normally contain solid lubricants in stable suspension in a fluid such as water or oil. These products are often used in forging and extrusion as well as other metalworking processes. Solid lubricant films can also be applied as suspensions in a carrier fluid which evaporates before the lubricant has to function.

Solid lubricant powders can be applied directly to specially prepared surfaces.

In the case of dry-film lubricants (Chapter 17), solid lubricants are dispersed in resin matrices. Dry-film lubricants are formed when the solvent (principally water or hydrocarbons) evaporates.

Molten salts or glass powder are used for hot forming processes such as extrusion. These are normally supplied as dry powders and develop lubricity when they melt on the hot surface of the metal.

Polymer films are used when special surface protection is required in addition to lubricity (e.g. the pressing of stainless steel panels). Together with greases, these products are also used to some extent in the construction industry.

An intermediary field between materials and lubrication technology is the wide area of surface treatment to reduce friction and wear. While the previously mentioned dry-film lubricants are an accepted activity of the lubricants industry, chemical coatings are somewhat controversial. These coatings are chemically bonded to the surface of the metal. They include oxalation and phosphating (zinc, iron and manganese). In cases when such coatings adopt the carrier function of an organic lubricant, the entire system could be supplied by the lubricant manufacturer. If the chemical coating is not designed to be supplemented with an additional lubricant coating (e.g. dry film on phosphatized gear), it will probably be supplied by a company which specializes in surface degreasing and cleaning.

Even more different from traditional lubricants are metallic or ceramic coatings which are applied with CVD (chemical vapour deposition) or PVD (physical vapour deposition) processes. They also sometimes replace the EP functions of the lubricants (Chapter 6). Such coatings are increasingly being used together with lubricants to guarantee improved wear protection in extreme conditions and over long periods of time.

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