Base Fluids for Lubricants

Non-water-miscible cooling, metalworking and industrial lubricants consist mainly of hydrocarbons, to which various additives are added to improve stability at high-pressures, lubrication, wetting and ageing properties. Mineral oil fractions are traditionally used as hydrocarbons. However, new high-performance metalworking processes, increase demands on resiliency, and oil change intervals in hydraulics and transmissions create the need for different performance levels and properties from lubricants. It is also important that oil products should not affect the health of workers, or the environment. To meet these requirements, modern hydrocarbon base fluids that are more efficient and less problematic than mineral oils in respect to the above are being used.

Mineral oil raffinates

The hydrocarbons obtained directly from crude oil still make up the majority of base fluids used, due to the lower price. With the help of various physical (distillation, extraction) and chemical (hydrogenation) processes, mineral oil fractions are obtained from crude oil which consists predominantly of saturated hydrocarbons (paraffin), branched, unbranched (iso- or n-paraffin) or cyclic structure (naphthenic). Due to reasons of oxidation stability, admixtures of unsaturated hydrocarbons (olefins, acetylenes) as well as unsaturated cyclic and polycyclic aromatics are undesirable for toxicological reasons. These substances are largely, but not completely, removed during the refining process. The broad spectrum of structure and size of the hydrocarbon molecules of a mineral oil fraction causes a comparatively high tendency to evaporate. This tendency to evaporation cannot be positively influenced by the addition of additives.

Example foaming properties. Air release: 60 seconds

Hydrocrack oils

One method to refine petroleum hydrocarbons is the production of hydrocracking oils. For this purpose, crude paraffin, or the residue from vacuum distillation, is split into shorter molecules in the presence of hydrogen and with the use of catalysts at temperatures of up to 450°C and pressures of up to 300 bars. At the same time, the aromatic compounds contained are split and hydrogenated. Hydrocrack oils therefore have a lower aromatic content than mineral oils. Since this process produces compounds with more favourable properties (paraffin) from compounds with poor viscosity-temperature properties and low lubricity (naphthenic, aromatics), the products produced in such a way have a higher viscosity index and better lubricity than mineral oils. Another advantage of hydrocracking oils is their lower evaporation and fogging rate due to the more homogeneous molecular size distribution, which can reduce hydrocarbon emissions at the workplace.

Example foaming properties. Air release: 29 seconds

Gas-to-Liquid (GTL) oils

These base oils are not produced from crude oil but are synthesized from gas (often methane gas). In the gas-to-liquid process, natural gas is converted into a synthesis gas by adding steam and oxygen. The produced synthesized gas is the base product for the Fischer-Tropsch process, which in turn converts the synthesized gas into liquid hydrocarbons. This is done by a catalytic process in which carbon dioxide, carbon monoxide and hydrogen are converted. The resulting base oils rank qualitatively between hydrocracking oils and polyalphaolefins. These base oils are often referred to as Group III+ oils.

Example foaming properties. Air release: 15 seconds

Polyalphaolefins

Comparable to premium engine oils, industrial lubricants and coolants with minimal evaporation, a high flash point at low viscosity, a high viscosity index and excellent shear and ageing stability can only be achieved by using synthetic polyalphaolefins (PAO´s). The thermal decomposition of mineral oil in the presence of hydrogen produces ethene, from which a linear olefin, usually 1-decene, is produced with the help of catalysts by the olefin synthesis. This is oligomerized in a further catalyzed reaction step, i.e. two, three or more olefin molecules are bound together. By this procedure nearly pure hydrocarbons of a certain polymerization grade are produced as well as unsaturated compounds, which are responsible for the oxidation or aging of the products. Due to the consistent composition, the evaporation rate of PAO´s is considerably lower compared to comparable mineral or hydrocrack oils, and the tendency to misting is also reduced.

Example foaming properties. Air release: 12 seconds

Ester oils

In addition to hydrocarbons, carboxylic acid esters are also used as base liquids. These can be divided into synthetic products and those of natural origin (vegetable oils, animal fats). Their tendency to evaporate is even lower than that of PAO´s. Natural esters are biodegradable, but their ageing properties are low. The oxidation stability of lubricants based on synthetic esters is considerably better when selected appropriately, since saturated esters with a high degree of purity are available. However, these compounds are often less biodegradable. Also, the stability against hydrolysis (in the presence of water the ester splits into alcohol and acid) can be improved by using sterically hindered synthetic esters. A general problem with ester-based lubricants is their limited compatibility with elastomers and paints. In particular, the low-viscosity esters used for low-viscosity metalworking oils or spindle oils behave very aggressively towards many sealing and insulating materials.

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The right fluid can significantly impact performance, productivity, and it also has a role to play in worker protection. Machine and process type, filtration method, production volumes, machine cleanliness requirements and of course, budget, should all be considered. Once you have identified the most suitable base oil type, you can start looking at the best additive package for meeting your specific performance requirements.

For assistance, please contact our technical team on 01745 814 777