NORAC®
ADDITIVES
A PETER GREVEN GROUP COMPANY

SPECIALISTS for ester lubricants

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Welcome to the lubricant brochure from Norac Additives! In the dynamic world of the lubricant industry, the choice of the right base oils and their properties plays a crucial role in the performance, efficiency and sustainability of lubricants. Our long-term experience in the oleochemical industry combined with Peter Greven's experience in the lubricants sector makes us a strong partner for your sustainable base oil!

Within the broad portfolio of esters, polyol and complex esters are the key products. Discover how our high-quality products meet the demands of the lubricant industry while offering environmentally friendly alternatives.

LIGALUB
Sustainable Ester Lubes

LIGALUB®	Esters
LIGASTAR® & COAD®	Metallic Soaps
LIGACID®	Fatty Acids

ESTER BASE OILS

Biolubricants

Base oils for biolubricants need to fulfil special requirements with biogenic share and biodegradability being two key criteria. The biogenic share is determined by radiocarbon dating. Our **LIGALUB**® products offer a high biogenic share and meet the requirements of most common laws and certification schemes.

Biodegradability is predominantly measured according to OECD 301 (B, D, D or F). A product is considered biodegradable if at least 60 % has been degraded after 28 days. Almost all products of our esters are easily biodegradable according to OECD 301 B. **LIGALUB**® base oils are perfectly suitable for the production of biolubricants.

Certifications

Our product portfolio covers different certifications. For example, we have RSPO or NSF certified alternatives available.

The RSPO (Roundtable on Sustainable Palm Oil) is a non-profit organization dedicated to promoting sustainable palm oil production worldwide. To achieve this goal, it has developed and implemented four certification schemes that are increasingly recognized across various industries. We have RSPO Mass Balance (MB) certified products available.

NSF International is an independent organization that establishes public standards and certification schemes to safeguard food, water, consumer products, and the environment. One area of focus is the certification of non-food compounds-substances used in food production that may come into contact with food. Our **LIGALUB**® product range features NSF HX-1 certified esters, suitable for H1 lubricants that are allowed for incidental food contact.

CERTIFIED SUSTAINABLE PALM OIL™ RSPO
MIXED
Contributes to the production of certified sustainable palm oil.
www.rspo.org
RSPO-1106171

NSF

PRODUCT PERFORMANCE

The performance of our natural, sustainable esters for the lubricant industry is our main focus. In our well-equipped, state-of-the-art laboratory we carry out tests tailored to the special industry needs.

Within our product portfolio the broad range of standard products is supplemented by a variety of specialties. Additionally, we create customer specific products in close collaboration with our customers. Due to our longterm experience and modern production lines we have a lot of possibilities to amend the characteristics of our products in a way that meets our customer's requirement.

Throughout the following pages we will outline some important analytical methods and their results which enable an assessment of the performance of different products or product groups.

Viscosity

Viscosity describes the flow properties of a lubricant and is therefore an important parameter for choosing the right product. It is dependent on temperature and can be affected by special additives. The International Standards Organisation (ISO) defined viscosity classes for industrial oils. This definition according to ISO VG (viscosity group) was established as a standard.

In table 1 we list some of our esters grouped by ISO VG.

Table 1: Viscosity of LIGALUB® products by ISO VG

ISO VG	Product
ISO VG 22	LIGALUB 19 TMP
ISO VG 32	LIGALUB L 111
ISO VG 46	LIGALUB 18 TMP A LIGALUB 25 TMP LIGALUB L 102
ISO VG 68	LIGALUB L 110
ISO VG 100	LIGALUB L 105
ISO VG 220	LIGALUB L 109 | LIGALUB L 109 D LIGALUB L 112
ISO VG 320	LIGALUB L 103 | LIGALUB L 103 D LIGALUB L 108 | LIGALUB L 108 D

Oxidation stability

With high temperatures, synthetic ester lubricants can be damaged by oxidative and/or thermal decomposition. During decomposition a lubricant can be split into volatile components with low molecular weight. Additionally, a polymerisation of the lubricant is possible. Both side effects of oxidation are unwanted and lead to a loss of lubricity. To avoid these negative consequences, it is recommended to use esters suitable for high-temperature applications.

The results of RPVOT for selected **LIGALUB**® products can be seen in figure 1. They show that the saturated TMP complex ester LIGALUB L 102 and the saturated NPG ester LIGALUB 63 NPG exhibit very good oxidation stability.

Hydrolysis stability

In the course of hydrolysis, an ester can be split into its components. This reaction can be catalysed by acids, bases or copper. As a result, the synthesis of a lubricating grease, for example, cannot proceed completely and thus no lubricatable grease is produced. The presence of water can also have a disruptive effect on other applications.

The hydrolysis stability test results of selected products are shown in figure 2. It can be seen that, in general, the unsaturated esters exhibit a better performance compared to the saturated ones. Furthermore, the used alcohol plays an important role: The more polyvalent the alcohol used, the better the hydrolysis stability.

Fig. 1: Oxidation stability according to RPVOT

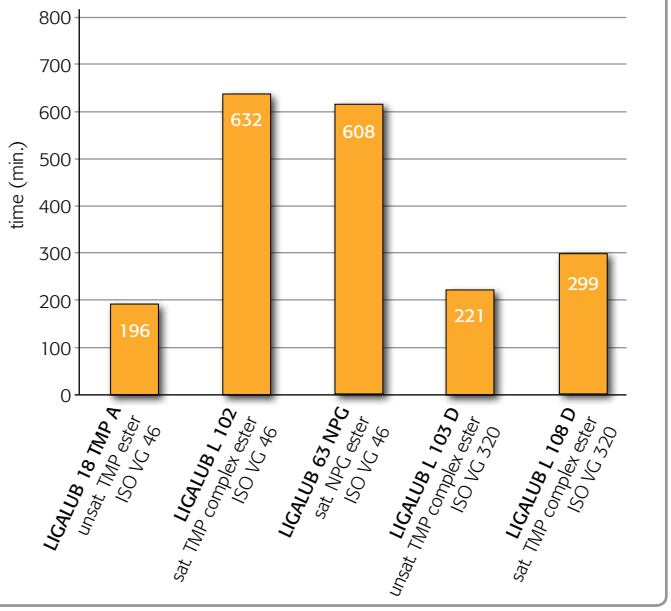
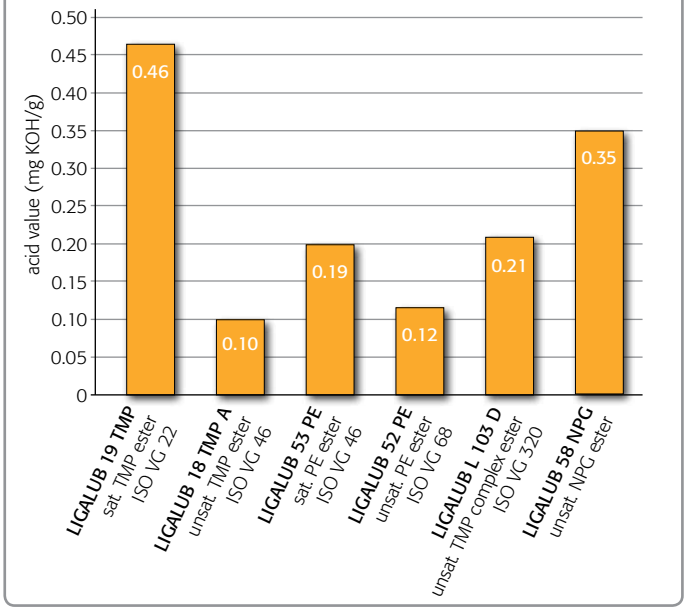


Fig. 2: Hydrolysis stability according to Rolls Royce Test



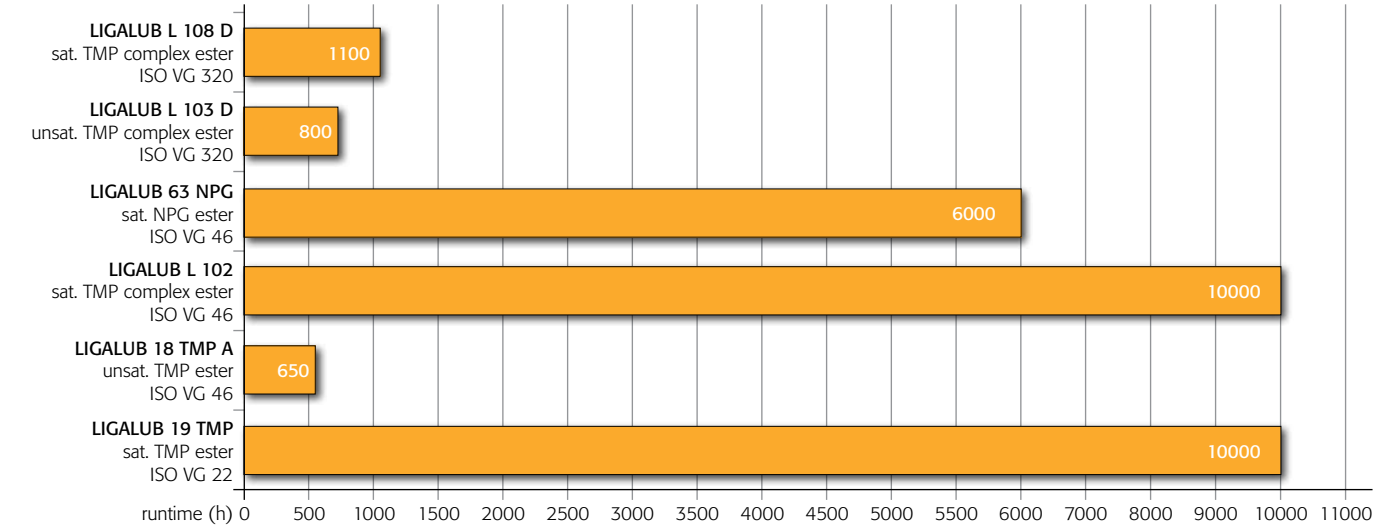
PRODUCT PERFORMANCE

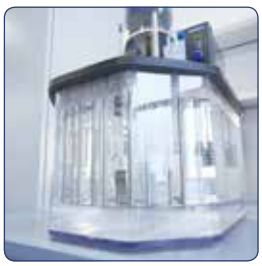
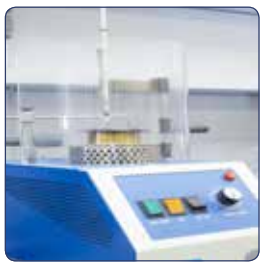
Ageing behaviour

The Turbine Oxidation Stability Test (TOST) is an ageing test for lubricants according to DIN EN ISO 4263. If hydraulic fluids and lubricants are used for a long time (several 1000 hours) the risk of oil ageing, which can cause muddy or varnish-like deposits, rises. To guarantee stable products despite ageing process, the TOST examines the ageing behaviour of turbine, gear and hydraulic oils as well as HFC and synthetic fluids.

We determine the ageing behaviour of our **LIGALUB**® esters according to TOST in our laboratory. Figure 3 shows the results for selected products. Especially LIGALUB L 102, our saturated TMP complex ester of ISO VG 46, and LIGALUB 19 TMP, our saturated TMP ester of ISO VG 22, provide excellent performance.

Fig. 3: Ageing behaviour according to TOST



Demulsibility

The demulsibility of an oil describes its ability to demix after forming an emulsion with water. Demulsibility requirements are strongly dependent on the application area of the product. While good demulsibility is a basic requirement for some lubricants, an example being hydraulic oils, others might need a medium to low demulsibility, which might be the case for cooling lubricants or stern tubes for marine applications.

In figure 4 you can find the proportion of aqueous, oil and emulsion phase in ml. The values were measured maximum 20 minutes after 40 ml base oil and water were mixed. They show that our product portfolio can cover a broad range of requirements when it comes to demulsibility.

Evaporation loss

The evaporation loss of a lubricant is caused by highly volatile components, but also by thermal decomposition and the associated formation of short-chain components. Besides an increase in viscosity it can also lead to higher lubricant consumption. Due to these negative effects lubricants with low evaporation loss are preferred.

Evaporation loss is measured according to Noack method at 250 °C and air circulation over a period of one hour. Figure 5 shows that all products perform very well with values way below the ones of mineral oils, some of which are even in the double-digit percentage range.

Fig. 4: Demulsibility according to DIN ISO 6614

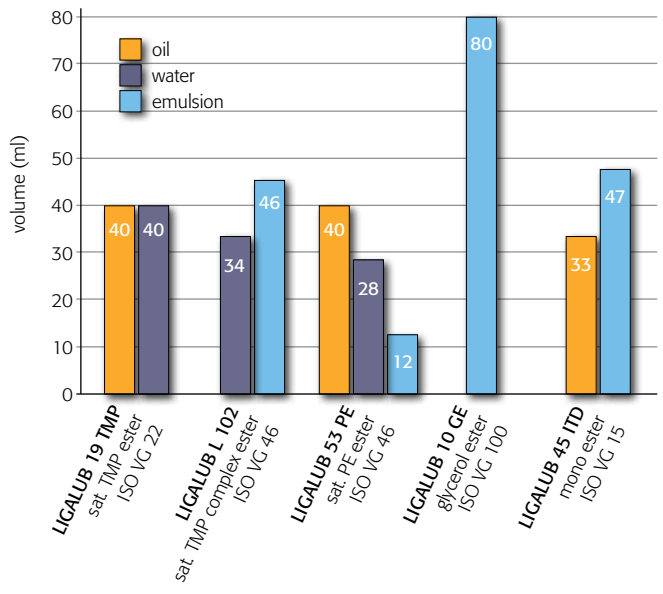
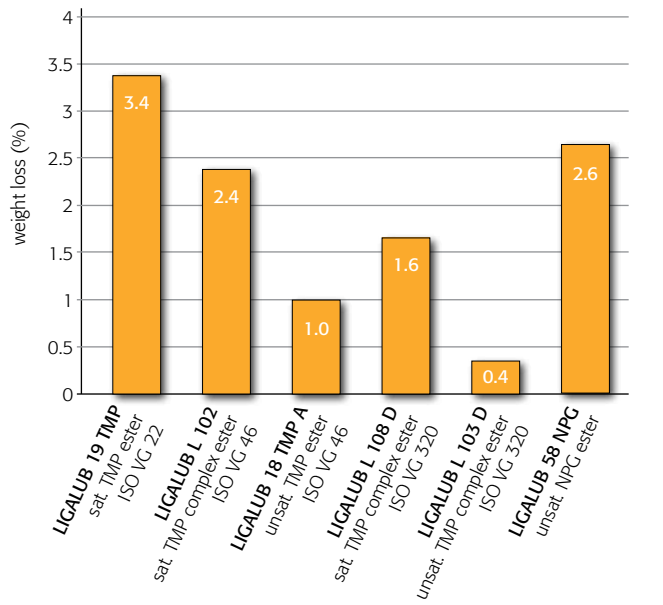


Fig. 5: Evaporation loss according to Noack method



PRODUCT PERFORMANCE

Pour point

At low temperatures esters tend to thicken and therefore to increase in viscosity. The oils are expected to keep their characteristics even with low temperatures as an increase in viscosity during longer storage at negative temperatures can cause substantial problems. Due to this requirement, we test and optimise the cold behaviour of our **LIGALUB**® products. An important indicator for this is the pour point of a liquid. It states the temperature at which a sample of the liquid, under defined conditions, barely exhibits flow properties.

The results of selected products can be found in figure 6. They show that our **LIGALUB**® product range can cover all pour point requirements, whether low or high.

Long-term cold behaviour

In order to determine the cold behaviour of our esters in approximation to the real cold behaviour, their performance in the negative temperature range is documented by a long-term study. The lower the viscosity stays during the test the better is the result. The typically required viscosity is 4500 mm²/s.

The long-term cold behaviour of four different **LIGALUB**® products of ISO VG 46 is shown in figure 7. While LIGALUB 18 TMP A shows a typical viscosity increase, the complex ester LIGALUB L 102 seems to be stable at low temperatures before it becomes solid as well. Also LIGALUB 63 NPG, which starts with a higher initial viscosity, becomes solid. LIGALUB 25 TMP was especially developed for low temperature applications and is characterised by its consistent viscosity.

Fig. 6: Pour point according to DIN ISO 3016

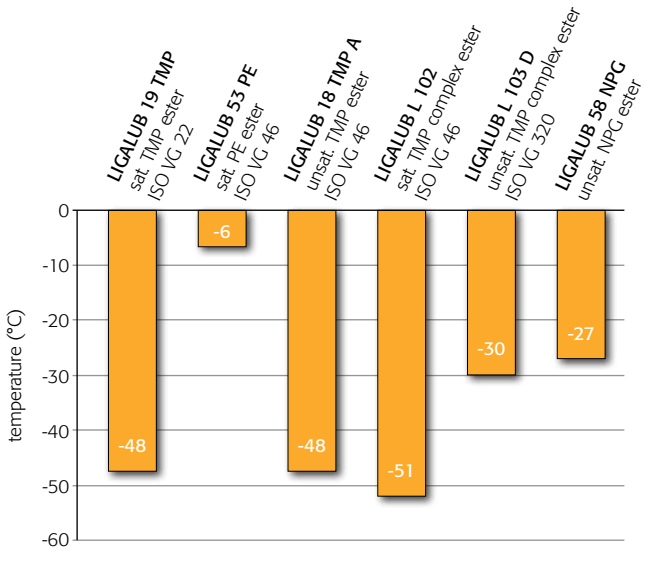
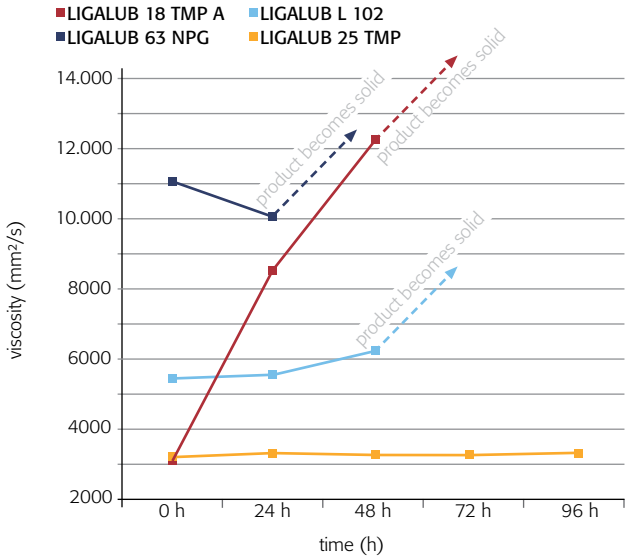


Fig. 7: Long-term cold behaviour at -30 °C



PRODUCTS & APPLICATIONS

Our synthetic **LIGALUB**® esters form a broad portfolio of base oils with different characteristics. They can be used in all kinds of lubricants and are our key product group for the lubricant industry.

Furthermore, we offer high-quality fatty acids and metallic soaps which can be used as additives for lubricants.

LIGACID® fatty acids exhibit an outstanding adhesion to metallic surfaces and can, under the right conditions, form a metallic soaps layer with the basic material. This enables lubrication in the border area where base oils are not effective anymore and high pressure additives are not effective yet.

LIGASTAR® metallic soaps influence the structure of a base oil and are particularly important as viscosity increasers for lubricants.

The application areas of the lubricant industry are as diverse as our products. Therefore, the requirements can vary greatly from one area to the other.

On the following pages we give you an overview of possible applications and the products which are, from our experience, particularly suitable for them.

Greases

As solid or semi-solid lubricants, greases consist of a base oil (65 – 95 %), thickener (5 – 35 %) and additives. The thickener acts as a sponge and releases the liquid lubricant component under load in order to guarantee an appropriate lubrication.

As greases are commonly used in areas of loss lubrication, synthetic esters based on oleochemistry are preferred base oils for environmentally friendly products. High viscosity complex esters and low viscosity polyol ester or mixtures of both are very suitable for this application. Applicable esters offer good biodegradability, good thermal and hydrolytic stability as well as outstanding lubricating properties.

Metallic soaps are particularly suitable as thickener for bio greases as they are solely based on natural and renewable raw materials. More than 60 % of greases are based on lithium or lithium complex soaps as thickener, but also calcium and aluminium soaps are indispensable. As we offer a high flexibility when it comes to the modification of our soaps we can meet various customer requirements.

Product recommendation

LIGASTAR LI 600 | LIGASTAR LI 12 OXY | LIGASTAR AL D2
as thickener

LIGALUB L 108 D | LIGALUB L 103 D | LIGALUB 18 TMP A
as base oil





APPLICATION AREAS

Hydraulic oils

Hydraulic oils transfer energy – mainly volume flow or pressure – within hydraulic systems. Besides lubrication of the hydraulic system in order to reduce wear they act as corrosion and deposit protectors. Additionally, they offer a cooling effect while the hydraulic system is in operation.

Esters for hydraulic oils need to exhibit a good ageing behaviour paired with excellent oxidation stability and good compatibility with metallic components. Polyol and complex esters meet these requirements with saturated variants more frequently used. The viscosity class of the used products is often between ISO VG 22 and ISO VG 100 as those are the commonly used ones for hydraulics.

Product recommendation

LIGALUB 19 TMP LA

LIGALUB 18 TMP LA

LIGALUB L 102

Industrial oils

Industrial oils cover a broad range of different lubricant types such as gear oils or chain oils.

Gear oils are mandatory for the lubrication of spaces between the different components of a gear, for example gearwheels. They reduce the wear of the components by lowering the friction. Furthermore, they protect against corrosion and carry the generated heat away in order to cool the gear.

Chain oils ensure the mobility of the chain links while the chain is used – often for power transmission within a system. At the same time, they reduce the wear of the chain to a minimum.

The base oil requirements are similar to those of hydraulic oil applications. Good wear stability as well as temperature and oxidation stability are particularly demanded. Therefore, polyol and complex esters are also perfectly suitable as base oils for industrial oils.

Product recommendation

LIGALUB 58 NPG

LIGALUB 18 TMP

LIGALUB L 110

Metal working fluids

Metal working fluids (MWF) are often referred to as cooling lubricants. They are mainly used to cool down tool and material while simultaneously reducing the friction between them to minimise the wear of the tool. Metal working fluids can be divided into two categories: water-miscible and non-water-miscible cooling lubricants.

Water-miscible cooling lubricants often consist of more than 90 % water. They have a stronger focus on cooling than on lubricating effect and can be distinguished in water-soluble and emulsifiable metal working fluids. With water-soluble systems glycerol and poly–ethylene glycol esters are predominantly used while polyol esters, mainly the unsaturated ones, are preferred for cooling lubricant emulsions. In addition, high viscosity complex esters can be used as additives for lubricity improvement.

Non-water-miscible cooling lubricants (also known as neat oils) are composed of more than 70 % base oil with appropriate additivation and are often used for applications where excellent lubricating properties are needed, for example during the production of particularly high-quality surfaces. They are characterised by good lubricity, high pressure absorption capacity and good corrosion protection. Furthermore, they are almost germ-free and bacteria resistant. Commonly used base oils are mono and polyol esters.

Product recommendation

Water soluble MWFs: LIGALUB 10 GE | LIGALUB PEG 400 MO
Emulsifiable MWFs: LIGALUB 58 NPG | LIGALUB 56 PE
Neat Oils: LIGALUB 45 ITD | LIGALUB 53 PE

Engine oils

Engine oils are used in every kind of engine to reduce corrosion-related and mechanical wear. Due to the high operating temperatures, it is important that the oil has a low evaporation loss.

As many engine oils are still mineral oil based they to do not have a good performance when it comes to evaporation loss. Therefore, synthetic esters are used as additives to improve the evaporation loss. An additional advantage of synthetic esters are their very high viscosity indices which lead to less change in viscosity at higher temperatures compared to the use of petrochemical products. Unsaturated polyol esters are particularly suitable for this application.

Product recommendation

LIGALUB 52 PE
LIGALUB 18 TMP A

APPLICATION AREAS

Within the lubricant industry, there are certain areas of application that place very specific requirements on lubricants described before. These are often areas with particularly strict environmental regulations, which also apply to the lubricants used. Examples for such applications are the marine or the agriculture and forestry sector.

Marine

The use of lubricants is also inevitable for smooth operations in the marine sector. Due to the direct water contact and the fact that waters are highly affected by the loss of lubricants and fuel, this sector is in the constant focus of the supervisory authorities. The industry is, therefore, asked to establish products with a positive environmental profile. With the European eco-labelling scheme and the vessel general permit (VGP), which is effective since December 2013, regulatory requirements were established that lubricants have to fulfil besides the mere performance requirements.

Our LIGALUB® range offers base oils of ISO VG class 22 to 1000 which are perfectly suitable for use in the marine sector. The products enable lubricant manufacturers to meet the requirements of the VGP but also the respective performance needs for applications such as hydraulic and gear oils, greases or stern tubes. Our esters are characterised, in particular, by good water miscibility, high hydrolysis stability and biodegradability.

Product recommendation

LIGALUB L 103 D
LIGALUB L 108 D
LIGALUB L 101

Agriculture and forestry

Agriculture and forestry sectors mainly use EU Ecolabel certified lubricants as the probability of direct contact of the lubricant with the environment is very high.

Our product portfolio offers LuSC listed esters which make it much easier for a lubricant to be awarded with the EU Ecolabel. Due to their high biogenic share and the good biodegradability in combination with very good cold stability our **LIGALUB**® esters of ISO VG class 22 to 1000 are perfectly suitable for this sensitive area.

Product recommendation

LIGALUB 25 TMP
LIGALUB L 102
LIGALUB L 105

PRODUCT OVERVIEW

METALLIC SOAPS with typical values

Product	Description	Ash %	Metal content %	Moisture %	Free fatty acid %	Melting point (°C)
LIGASTAR AL D2	Aluminium salt of a technical stearic acid	10.0–11.0	4.7–5.8	< 2	3.0–5.0	~ 165
COAD 13 D	Calcium salt of a technical stearic acid	9.5	6.6–6.9	2.5	0.5	155
LIGASTAR CA 12 OXY	Calcium salt of a hydroxy stearic acid	8.5–9.9	6.1–7.1	< 3	< 1	135–147
LIGASTAR LI 600	Lithium salt of a technical stearic acid	4.7–5.4	2.2–2.5	< 0.5	< 2	190–210
LIGASTAR LI 12 OXY	Lithium salt of a hydroxy stearic acid	4.5–5.4	2.1–2.5	< 0.5	0.5	> 200

FATTY ACIDS with typical values

Product	Description	AV (mg KOH/g)	SV (mg KOH/g)	IV (gl2/100g)	CP (°C)	Melting point (°C)
LIGACID OW	liquid, unsaturated fatty acid	199–205	200–206	90–100	< 10	–
LIGACID SG 3	solid, saturated fatty acid	195–205	189–208	< 3	–	55–65
LIGACID SG 10-12	solid, mainly saturated fatty acid	195–207	202–210	10–12	–	47–57
LIGALUB FSO	special, saturated fatty acid	172–185	180–192	< 4	–	72–78

PRODUCT OVERVIEW

ESTERS with typical values

Description	Product	Viscosity 40° C (mm^2/s)	Viscosity 100° C (mm^2/s)	VI	AV (mg KOH/g)	SV (mg KOH/g)
Mono ester	LIGALUB 45 ITD	~16	~4.0	> 160	< 0.5	110–135
Glycerol ester	LIGALUB 10 GE	85–105	~11.0	~100	< 1.0	165–177
Glycerol ester	LIGALUB 12 GE	40–50	~8.0	~170	< 1.0	178–182
Glycerol ester	LIGALUB 13 GE	33–40	~8.0	~220	< 0.2	185–195
Polyol ester	LIGALUB 18 TMP	40–50	~9.0	> 180	< 1.5	178–187
Polyol ester	LIGALUB 18 TMP A	42–50	~10.0	> 180	< 1.0	178–187
Polyol ester	LIGALUB 18 TMP LA	42–50	~10.0	> 180	< 0.2	178–187
Polyol ester	LIGALUB 19 TMP	17–21	~4.5	> 140	< 0.3	300–320
Polyol ester	LIGALUB 19 TMP LA	17–21	~4.5	> 140	< 0.1	300–320
Polyol ester	LIGALUB 20 TMP	38–45	~8.0	~180	< 1.0	220–250
Polyol ester	LIGALUB 25 TMP	42–50	~9.0	> 180	< 0.5	198–205
Polyol ester	LIGALUB 52 PE	60–70	~12.0	~190	< 1.0	185–195
Polyol ester	LIGALUB 53 PE	28–35	~6.5	~150	< 0.3	315–335
Polyol ester	LIGALUB 56 PE	90–110	~13.0	~180	< 1.5	170–190
Polyol ester	LIGALUB 58 NPG	23–28	~6.0	~220	< 1.0	170–180
Polyol ester	LIGALUB 63 NPG	42–50	~8.0	~155	< 1.0	170–185
Unsaturated complex ester	LIGALUB L 101	900–1100	~100.0	> 190	< 1.0	250–280
Unsaturated complex ester	LIGALUB L 103	290–350	~40.0	> 180	< 1.0	250–270
Unsaturated complex ester	LIGALUB L 103 D	290–350	~43.0	> 180	< 1.0	178–188
Unsaturated complex ester	LIGALUB L 109	200–240	~29.0	> 180	< 1.0	235–250
Unsaturated complex ester	LIGALUB L 109 D	200–240	~29.0	> 180	< 1.0	175–190
Unsaturated complex ester	LIGALUB L 110	62–74	~13.0	> 180	< 1.5	195–205
Saturated complex ester	LIGALUB L 102	42–50	~8.0	~160	< 0.5	320–335
Saturated complex esterr	LIGALUB L 105	105-120	~15.0	~160	< 0.5	330–360
Saturated complex ester	LIGALUB L 107 D	500–550	~52.0	~160	< 1.0	290–310
Saturated complex ester	LIGALUB L 108	290–350	~35.0	~160	< 0.5	360–380
Saturated complex ester	LIGALUB L 108 D	290–350	~35.0	~160	< 0.5	250–270
Saturated complex ester	LIGALUB L 111	28–35	~6.0	~150	< 0.5	310–330
Saturated complex ester	LIGALUB L 112	200–240	~27.0	~150	< 1.0	360–380

* UVCB criterion
= readily biodegradable

	IV (gI_2/100g)	OH number (mg KOH/g)	CP (°C)	PP (°C)	Flash point (°C)	Biodegradability*	Biogenic share
	< 2	< 10	< 10	< 8	> 180		57
	< 90	245–265	< 15	< 10	> 200		100
	100–130	75–90	< 5	< 0	> 250		100
	105–125	< 5	< 0	< -20	> 310		100
	< 90	< 20	< -15	< -35	> 310		84
	< 90	< 14	< -20	< -40	> 310		85
	< 90	< 5	< -20	< -40	> 310		85
	< 1	< 5	< -20	< -40	> 250		81
	< 1	< 5	< -40	< -40	> 250		81
	< 20	< 15	< 3	< 0	> 280		84
	< 80	< 10	< -20	< -50	> 290		89
	< 90	< 10	< -10	< -20	> 300	**	98
	< 1	< 5	< 0	< 0	> 280		93
	80–90	115–140	< -10	< -20	> 300		95
	80–90	< 10	< -10	< -20	> 260		90
	< 2	< 10	< -15	< -30	> 270	**	91
	< 65	< 15	< -30	< -20	> 300		74
	< 70	< 15	< -30	< -30	> 320		62
	85–95	< 15	< -20	< -20	> 310		89
	< 80	< 15	< -20	< -20	> 280		73
	< 100	< 15	< -20	< -20	> 310		85
	< 80	< 15	< -20	< -35	> 300		85
	< 1	< 10	< -40	< -40	> 260		71
	< 1	< 10	< -30	< -40	> 260		63
	/	< 15	< -40	< -30	> 260		75
	< 1	< 15	< -30	< -30	> 260		62
	/	< 10	< -30	< -30	> 260		89
	< 1	< 10	< -30	< -30	> 250		76
	< 1	< 10	< -30	< -30	> 250		63

** The biodegradability of this products has not been determined yet.
(State: 04/2021)

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