Lubricants for screw compressors

8.2.1 General Information

- Introduction
- The main functions of a lubricant
- Types of lubricants available from ALMiG
- Terminology
- Comparison of mineral oil-based and synthetic lubricants

8.2.6 HC synthesis lubricant ALUB blue S+

- Basic information
- Advantages of **ALUB blue S+**
- Technical data

8.2.8 Synthetic lubricant ALUB syn S

- Basic information
- Advantages of **ALUB syn S**
- Technical data
- Other key advantages

8.2.12 Biodegradable lubricant ALUB green S

- Basic information
- Advantages of **ALUB green S**
- Technical data
- Draining condensate into the public waste water system

8.2.14 Synthetic compressor oils in compliance with NSF H1 for the foods, beverages and pharmaceuticals industries, ALUB food H1

- Basic Information
- Advantages of **ALUB food H1**
- Technical data
- Compressor lubricants in the food industry

Introduction

Air compressors occupy such an important position in many industries that production losses can result if they malfunction. For this reason, they must be reliable, economical and safe to operate.
Lubrication has a significant impact on the way compressors behave. Therefore to ensure reliable, economical and safe operation it is particularly important to choose a lubricant carefully and use it correctly.

The main functions of the lubricant in a screw compressor

- to remove heat generated in the compression process;
- to lubricate bearings;
- to prevent contact between metal parts/wear protection;
- to seal (minimise losses through reverse flow);
- to protect against corrosion.

Lubricants available from ALMIG

ALUB blue S+	Air compressor lubricant based on special basic oils resulting from HC synthesis
ALUB syn S	synthetic air compressor lubricant based on special poly-alfa-olefins
ALUB green S	mineral oil free, biologically degradable air compressor lubricant based on synthetic esters
ALUB food H1	Synthetic air compressor lubricant which is also licensed for use in the food, beverage and pharmaceutical industries.

Terminology

Viscosity (VI)

Viscosity and the viscosity index are two of the most important aspects of compressor lubricants. The greater the VI of a lubricant, the less it changes with temperature and the wider the temperature range within which it can be used.

A compressor lubricant is chosen on the basis of its viscosity in relation to the specific conditions under which it will be used. If the lubricant is too viscous, excessive friction losses can result, impairing the efficiency and safety of the system. It also makes it more difficult for gas bubbles to escape. Low viscosity on the other hand means that the lubricating layer is thinner, causing more wear to bearings and increasing reverse flow losses.

Demulsibility

The ability of a lubricant to separate from water is called demulsibility in accordance with DIN 51599 or ASTM 1401. Water content of more than 0.2% in a lubricant is generally regarded as damaging and a reason to replace the lubricant. Water content of several per cent should be avoided at all costs, as it encourages the formation of rust and residues and deposits from micro-organisms. The greater the demulsibility, the lower the proportion of lubricant remaining in the condensate.

Foaming

Excessive foaming impairs lubrication. It encourages oxidation due to the large amount of air dispersed throughout the lubricant and can cause lubricant to be lost. It also prevents the lubricant from circulating properly which prevents adequate lubrication. In purely mineral oil-based lubricants, the durability of the foam is a function of the viscosity and the surface tension (which depends, among other things, on the degree of refining). Thin lubricants can create foam with large bubbles which usually disappear rapidly, whereas small, finely distributed bubbles form in highly viscous lubricants which make the foam very stable. Increases in temperature make the foam less stable, often. To assess the tendency to create foam, the volume and stability of the foam will measured as stipulated in ASTM D892 and DIN 51566.

Air release - removing gases

The degree to which the lubricant can release air dispersed in it depends on the temperature of the lubricant and is essentially a property of the base material. Additives cannot improve this property of the lubricant. Mineral oil-based lubricants can under normal conditions contain up to 10% of their volume of air in solution. Rising pressure allows more air to be held. As the pressure falls, the air is released again in the form of small bubbles. If the air dispersed in the oil only escapes slowly or if air dissolved in the cooling fluid separates out too slowly, the compressor might malfunction (if the pressure is released too quickly, foam forms). Dispersed air and high temperatures can also result in the diesel effect - combustion products form and the lubricant ages.

Ageing and stability at higher temperatures

The conditions to which the lubricant is subjected during compression encourage oxidation. With high temperatures and a high oxygen content the lubricant nebulises, presenting a large surface for reaction which can lead to chemical changes - ageing - in the oil. As a consequence of ageing, the lubricant becomes darker in colour, viscosity increases and corrosive acids, residues and deposits form. These can resemble varnish, rubber or sludge and result in the system breaking down during operation. Ageing lubricant disperses inadequately, forms foam, does not prevent corrosion and results in more wear on the machinery. The rate at which the lubricant ages depends largely on its make up and the extent to which the temperature to which it is exposed rises and for how long. The rate doubles when the temperature increases by 10°C. This rule applies from around 70°C.

Comparison of mineral-oil based and synthetic lubricants

	Mineral oil-based lubricant		***Synthetic lubricant***	
V 40°C	46 mm^2/s		46mm^2/s	
V 100°C	6.8 mm^2/s		7.8mm^2/s	
VI	100		139	
Demulsibility	10 min		5 min	
Air release	6 min		3 min	
Foaming	ml foam after compression has been switched off	ml foam after 10 min	ml foam after compression has been switched off	ml foam after 10 min
Sequ. I	0	0	5	0
Sequ. II	20	0	20	0
Sequ. III	20	0	5	0

In addition to dealing better with foam and air release, synthetic lubricants are also much less likely to present a fire risk than mineral oil-based lubricants. Nowadays, only synthetic formulations are used as cooling fluids for extended periods of operation. If the lubricant is likely to become very contaminated, (from solids or gas) or if the lubricant needs to be replaced frequently due to the ambient conditions, it is more economical to use mineral oil-based products.

ALUB blue S+

ALUB blue S+ is a semisynthetic air compressor oil for use in screw compressors with final compression temperatures ranging up to 110° C (120 °C), manufactured from especially low-evaporation semisynthetic basic oils for optimised maintenance intervals and minimum oil consumption.

Advantages

- **Excellent oxidative and thermal stability**

  → lower tendency to age and acidify

  → less contamination with unwanted gases

  → Oxygen, which has an aggressive impact on the lubricant, is less damaging to our ALUB blue S+ and hence decomposition is inhibited.

  → low rate of decomposition, even at high temperatures

- **Maximum compression temperatures up to 110 °C (120 °C)**

  → viscosity remains stable over long periods of use

- **Low tendency to carbonisation**

  → deposit resistant

- **Low tendency to foam**

  → good thermal release

- **Good air release**

  → which means slower ageing and lower maximum temperatures

- **Good protection against corrosion**

  → machinery lasts longer, keeps its value

- **Excellent protection against EP wear**

  → This minimises wear if during the start-up phase the lubricant film ruptures and metal comes into direct contact with metal

- **Excellent resistance to ageing**

  → breaks in the lubricant chains are delayed.

ALUB blue S+

Properties	***Unit***		***Tested in accordance with***
ISO VG		46	DIN 51 519
Kinematic viscosity ***at 40 °C*** ***at 100°C***	 mm^2/s mm^2/s	 50 8.0	DIN EN ISO 3104
Viscosity index	-	130	DIN ISO 2909
Seal strength at 15°C	kg/m^3	854	DIN 51 757
Cleveland open cup flash point	°C	206	DIN ISO 2592
Pour point	°C	-18	DIN ISO 3016
Demulsibility at 54°C	min	15	DIN 51 599 DIN ISO 6614
FZG A/8,3/90	Breakdown load stage	> 12	DIN ISO 14635 - 1

ALUB syn S

ALUB syn S is a synthetic lubricant which has been developed based on special poly-alfa-olefins for prolonged use in screw compressors in which maximum compression temperatures reach 110 °C (120 °C) and where the lubricant is exposed to high levels of oxidation.

Advantages

- **Excellent oxidative and thermal stability**

  → lower tendency to age and acidify

  → less contamination with unwanted gases

  → Oxygen, which has an aggressive impact on the lubricant, is less damaging to our ALUB syn S and hence decomposition is inhibited

  → low rate of decomposition, even at high temperatures

- **Good demulsibility**

  → Low proportion of condensate in the lubricant which means less rust and fewer residues

- **Maximum compression temperatures up to 110 °C (120 °C)**

  → viscosity remains stable over long periods of use

- **Low tendency to carbonise and vaporise**

  → deposit resistant

- **Low tendency to foam**

  → good thermal release

- **Good air release**

  → which means slower ageing and lower maximum temperatures

- **Good protection against corrosion**

  → machinery lasts longer, keeps its value

- **Excellent cleaning properties**

  → Changing to ALUB syn S removes deposits and contamination

- **Excellent protection against EP wear**

  → This minimises wear if during the start-up phase the lubricant film ruptures and metal comes into direct contact with metal

- **Excellent resistance to ageing**

  → break up of the lubricant chains delayed.

- **Very good viscosity - temperature ratio**

  → functions well at low temperatures

  → lubricant circulation unaffected by low temperatures

  → lubricant rapidly distributed in the pressure chamber even at low temperatures

ALUB syn S

Properties	***Unit***		***Tested in accordance with***
ISO VG		46	DIN 51 519
Kinematic viscosity ***at 40 °C*** ***at 100°C***	mm^2/s mm^2/s	 46 7.8	DIN EN ISO 3104
Viscosity index	-	139	DIN ISO 2909
Seal strength at 15°C	kg/m^3	845	DIN 51 757
Cleveland open cup flash point	°C	260	DIN ISO 2592
Pour point	°C	< -60	DIN ISO 3016
Conradson carbon residue	%	0.02	DIN EN ISO 10 370
Demulsibility at 54°C	min	15	DIN 51 599 DIN ISO 6614
FZG A/8,3/90	Breakdown load stage	> 12	DIN ISO 14635 - 1

Other key advantages of ALUB syn S

I. Increased operating safety

- **Very high self-ignition temperatures**

  → thermal stability is from 50 - 80 °C above comparable mineral lubricants, which reduces the risk of fire

- **Very wide range of operating temperatures**

  → no need for seasonal lubricant replacement

  → stable viscosity even at high temperatures

  → very good cold start at low temperatures

- **Very good thermal conductivity**

  → up to 10% better than comparable mineral oil-based lubricants.

- **No internal residues: the machinery stays clean**

- **Switching to ALUB syn S**

  → cleans up the lubrication circuit

- **A thick, adhesive lubrication film means**

  → better anti-friction properties

  → improved protection against corrosion

  → the film remains intact even after the machine has been at a standstill for some time

- **Low vapour pressure means**

  → up to 50% less lubricant residue in the compressed air

  = less load on the next system downstream with lower proportion of lubricant

- **Does not have a strong tendency to form an emulsion, which means**

  → better lubrication in the compressor system

  → good lubricant / water separation in the condensate

- **Longer lasting systems**

  → more reliability with ALUB syn S

II. Save time and maintenance costs

- **Excellent oxidative stability**

  → longer intervals between changes

- **Longer intervals between changes mean**

  → less waste to dispose off

  → lower disposal costs

- **Up to 15% longer life for the high precision separators**

  → with less residue

  → less contamination of the lubricant

  → less decomposition and corrosion

- **Internal cooler cleaning**

  → ALUB syn S makes it unnecessary to clean the inside of the cooling system as it has a self-cleaning action.

III. Savings on energy costs

- **Low power demand (kW min/m^3)**

  → ALUB syn S reduces energy requirements by up to 2%
  (fewer reverse flow losses, lower internal friction)

- **Less pressure loss on the high precision separators (= additional energy costs)**

  → reduction with ALUB syn S: approximately 15%

  → fewer dirt deposits

- **Effective use of heat throughout the lubrication circuit**

  → with its excellent thermal conductivity, ALUB syn S improves energy yield by up to 10%

ALUB green S

ALUB green S is a synthetic lubricant which has been developed based on special esters for prolonged use in screw compressors in which the maximum compression temperatures reach 110 °C (120 °C) and the lubricant is exposed to high levels of oxidation. It has been developed specially for systems with a permit to drain the condensate indirectly into the public waste water system.

Advantages

- **Based on sustainable raw materials**
- **Classified as "rapidly biologically degradable"**
  → at least 80% biodegrades within 21 days according to CEC tests
- **Long-term resistance to ageing**
  → break up of lubricant chains delayed
- **Excellent protection against corrosion**
  → machinery lasts longer, keeps its value
- **Good air release**
  → which means slower ageing and lower maximum temperatures
- **Low tendency to foam**
  → good thermal conductivity
- **Good protection against wear**
  → FZG > 12
- **Low vaporisation losses**
  → deposit resistant
- **Condensate can be drained off into public waste system**
  → ratio of chemical oxygen demand to biological oxygen demand = ~ 2/1
- **Good demulsibility**
  → Low proportion of condensate in the lubricant which means less rust and fewer residues

ALUB green S

Properties	**Unit**		**Tested in accordance with**
ISO VG		46	DIN 51 519
Kinematic viscosity at 40 °C at 100°C	mm^2/s mm^2/s	46 7.5	DIN EN ISO 3104
Viscosity index	-	130	DIN ISO 2909
Seal strength at 15°C	kg/m^3	954	DIN 51 757
Cleveland open cup flash point	°C	240	DIN ISO 2592
Pour point	°C	-50	DIN ISO 3016
FZG A/8,3/90	Breakdown load stage	> 12	DIN ISO 14635 - 1

Draining condensate into the public waste water system

In principle it is possible to drain condensate from compressors that have been operated with biologically degradable lubricants into the public / municipal waste water system. However, the following points should be taken into account:

Depending on the local authority (the matter is regulated in detail in the bylaws imposed by the relevant local authority) waste water containing hydrocarbons (for example those from mineral oil-based lubricants or esters) can be drained into the public system without a special licence. Depending on the local authority, the upper limit is as a rule between 10 and 20 mg hydrocarbons per litre of effluent. Above this limit a licence is necessary or drainage into the public system is not permitted. There is not a general licence valid for the whole of the Federal Republic. This is not possible because each separate water authority is responsible for issuing the licences. The authority carries out an investigation or makes a decision regarding the draining permit on the basis of information/expert reports.

The basic condition for a permit is that the lubricant is biologically degradable, the chemical oxygen demand and the biological oxygen demand can be proven and the COD/BOD ratio is approximately 2:1. In addition, the sewage treatment facility in which the effluent drains must have a biological stage.

ALUB food H1

ALUB food H1 is a synthetic compressor lubricant approved in conformity with the NSF (previously United States Department of Agriculture) H1 standard for the food, beverage and pharmaceuticals industries.

Advantages

- **NSF H1 licence**

  → approved for incidental contact with food
- **Kosher**

  → no animal products are used in the manufacture of the lubricant
- **Excellent oxidative and thermal stability**

  → lower tendency to age and acidify

  → less contamination with unwanted gases

  → Oxygen, which has an aggressive impact on the lubricant, is less damaging to our ALUB food H1 and hence decomposition is inhibited.

  → low rate of decomposition, even at high temperatures
- **Good demulsibility**

  → Low proportion of condensate in the lubricant which means less rust and fewer residues
- **low tendency to carbonise and vaporise**

  → deposit resistant
- **Low foaming tendency and good air release**

  → good thermal release
- **Good protection against corrosion**

  → machinery lasts longer, keeps its value
- **Excellent resistance to ageing**

  → lubricant lasts longer
- **Very good viscosity - temperature ratio**

  → functions well at low temperatures

  → lubricant circulation unaffected by low temperatures

  → lubricant rapidly distributed in the pressure chamber even at low temperatures

ALUB food H1

Properties	***Unit***		***Tested in accordance with***
ISO VG		46	DIN 51 519
Colour		0.5	DIN ISO 2049
Kinematic viscosity ***at 40 °C*** ***at 100 °C***	 mm^2/s mm^2/s	 46 8,0	DIN EN ISO 3104
Viscosity index	-	140	DIN ISO 2909
Density at 15°C	kg/m^3	830	DIN 51 757
Cleveland open cup flash point	°C	>200	DIN ISO 2592
Pourpoint	°C	< - 62	DIN ISO 3016
Copper corrosion	Degree of corrosion	1-100A3	DIN EN ISO 2160
FZG A/8,3/90	Breakdown load stage	> 12	DIN ISO 14635 - 1

Remarks on compressor lubricants for the food industry

Companies are obliged to monitor their processes on a voluntary basis - from raw material handling through manufacture to packing and shipping out. The objective is to prevent any contact between the food or luxury consumables and other materials. If this contact cannot be prevented, the producer must use an acceptable i.e. harmless “food-grade” lubricant as a precaution. The legal basis for this is the EU Food Hygiene directive 93/94 EU, implemented in Germany in the LMHV (Food Hygiene Regulations) and the HACCP system (Hazard Analysis and Critical Control Points).

Since there are no definitions for Europe, the NSF (previously United States Department of Agriculture) H1 lubricants for incidental food contact have become an international standard. The food industry has agreed to use food grade lubricants in accordance with NSF H1 for critical areas.

There are no legal requirements to ensure that operators use H1 lubricants; however, H1 lubricants are generally considered suitable and state of the art.