KLÜBER LUBRICATION

your global specialist

Sustainability in the chemical industry

Specialty lubricants supporting green chemistry

Green Chemistry – for a sustainable future. Don't miss out on it!

The concept of 'green chemistry' is gaining ground in the chemical industry. For enterprises, it is becoming increasingly important that their products make a contribution towards a sustainable future – and that they are vocal about it.

Klüber Lubrication is part of Freudenberg Chemical Specialities, i.e. it is itself a company in the chemical industry. Consequently we know the challenges you face very well.

What does Green Chemistry mean?

The concept of Green Chemistry describes a chemical industry using an environment-driven approach aiming to reduce environmental and health impact from chemicals, e.g. by minimising pollution or saving energy. Risks stemming both from the products and their manufacture are to be avoided under this approach. Therefore, the concept of Green Chemistry is applied to chemicals right from the design stage. The optimisation of the production processes also play a major role for production companies wanting to make a sizeable contribution to sustainability goals. The choice of a suitable lubricant solution can be an important factor in this context.

The twelve basic principles of Green Chemistry applying today have been around since 1998.

Lubrication solutions contribute to Green Chemistry

Sustainability is part of our DNA. This inspires us to constantly improve our own processes in line with the 12 principles. To measure the progress we make in this field, we have generated our own sustainability matrix.

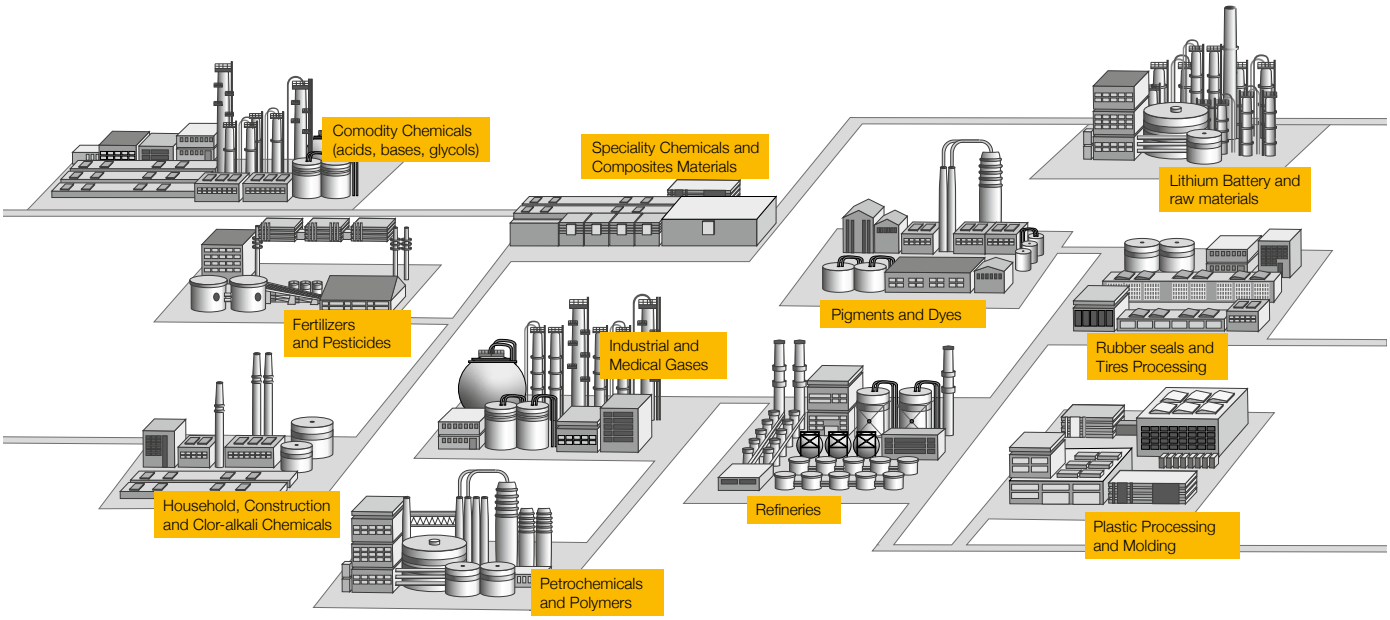
For decades, Klüber Lubrication has been supporting its customers in minimising their ecological footprint. Our high-performance specialty lubricants and individual services offer you major benefits:

– Reliability: This is the decisive factor to be considered when starting a project to optimise your lubrication processes. It is the one aspect that must never be jeopardised.
– Energy efficiency: Energy savings are possible in many of your installations. Give us a chance to prove it!
– Plant availability: The long service lives of our lubricants extend operativeness of your plant and reduce the need for maintenance.
– Safety: Our specialty lubricants and Klübermatic lubricant dispensers offer a maximum of safety in areas exposed to explosion risks.
– Optimisation: We carry out lubricant analyses, oil condition monitoring, equipment labelling and fault analyses.
– Clear overview: We can help you consolidate your lubricant inventory and lay out your lubricant storage site.
– Sustainability: Less waste and lower lubricant consumption.

Ecovadis, a leading provider of sustainability ratings for corporations, has rated our sustainability management with its gold medal. This grades Klüber Lubrication among the best 6 % of over 90,000 companies rated worldwide.

Chemical industry

Lubricating your way to more efficient and reliable operations



Among other things, you will find the right lubricant for the following sample applications, but of course also countless others.

Mechanical seals

Cyrogenic and vacuum pumps

Injection and roto moulding machines

Heat exchangers and heat transfer systems

Air and gas compressors

Tyre mould segments

Open gears on dryers, cooling drums, rotary kilns and grinding mills

Filter press-separation technology

Cooling tower gearboxes and water circulation systems

Thin-film evaporators and short-path evaporators

Gearboxes in agitators, conveyors, elevators

Gearboxes in agitators, conveyors, extruders and mixers

Valves, fittings and flange connections

Turbomachinery

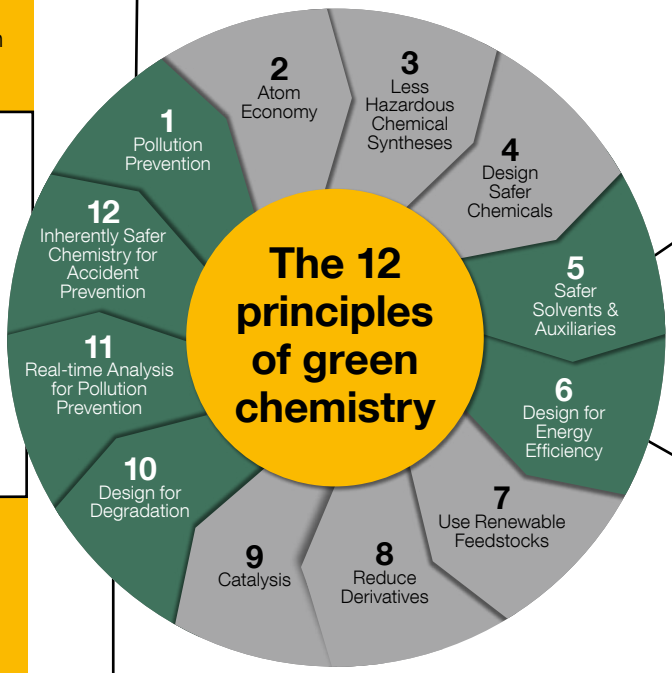
Reactor

This is how we support you in implementing those 12 principles:

The 12 principles of Green Chemistry as defined by the American Chemical Society, outline ways of reducing the impact of chemical production on the environment and human health. They cover all aspects of product development, manufacturing and product use. With its innovative product solutions and individual service, Klüber Lubrication helps you to integrate Green Chemistry better into your processes.

High-quality synthetic lubricants have a longer service life and enable reduced consumption, less waste and lower disposal quantities.

Automatic lubricant dispensers applying the right lubricant ensure accurately timed lubrication, supporting the safety and health of your maintenance team.



Conventional lubricants can be prone to extreme reactions and be dangerous when coming into contact with aggressive media. Special lubricants such as those made of PFPE are chemically inert and can therefore be a smart and safe choice in certain applications.

Oil condition and leakage sensors monitor your installations online and in real time, making the condition of your lubricants and their applications transparent at all times.

Lubricants based on mineral oils have a less favourable viscosity behaviour and are strongly influenced by temperature. Synthetic alternatives have a much better friction coefficient and a higher viscosity index, leading to energy savings of 2-6 % in the application.

For ecologically sensitive applications, biologically degradable lubricants might be used, e.g. EALs (Environmentally Acceptable Lubricants).

Energy efficiency: a burning issue for the chemical industry

By selecting the right lubricant and the right lubrication partner who provides the necessary experience and know-how, companies can achieve two goals in a single step: saving costs and reducing their environmental footprint. With energy prices rising in recent months and years, it is becoming increasingly important for companies to look for areas where they can reduce energy consumption.

Lubricants are often overlooked when it comes to increasing energy efficiency. However, in applications involving gearboxes and compressors, they can play an important role. Here, the right choice of lubricants can save between three and five percent of energy, thereby reducing
the carbon footprint.

Changing lubricants can bring payback in a short time

Most of the steps a company can take to increase energy efficiency will come at a notable cost. Upgrading to newer machines, changing equipment, or installing alternative energy sources like solar panels can be expensive, and it can take years to make up for the costs. With lubricants, on the other hand, payback is immediate and a change can be made much more quickly.

Why should you trust our solutions? We can prove what we claim!

For more and more companies, the certification of energy and resource management plants are increasingly important. To do so, they need a reliable lubricant partner with the experience to deliver energy savings with the right choice of lubricants. At Klüber Lubrication, we can prove energy savings and carry out projects that comply with internationally recognised standards such as the International Performance Measurement and Verification Protocol (IPMVP) or DIN ISO 50015. Another advantage is provided by our detailed energy savings report that can be part of your energy audit documentation.

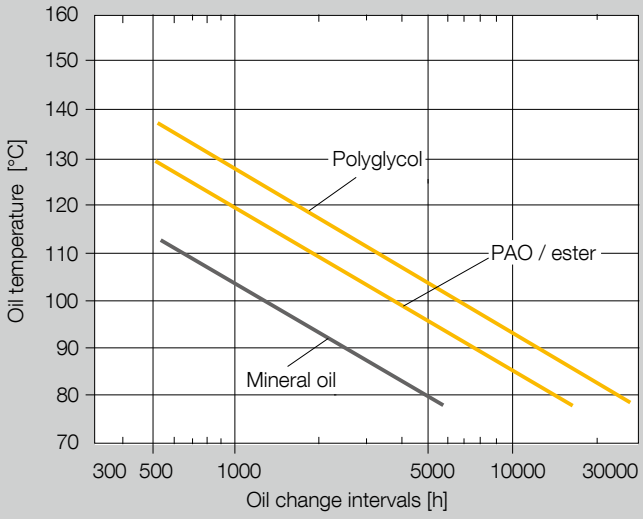
Benefits of synthetic gear oils

In addition to the wide service temperature range, synthetic gear oils offer many advantages compared to mineral oils:
– 3 to 5 times longer oil change intervals under the same thermal conditions
– Higher wear protection
– Better cold start with the same nominal viscosity (ISO VG)
– Oil coolers may not be required due to reduced operating temperatures under full load
– Lower gearing losses due to reduced friction leads to lower energy costs

Oil life time

The prolonged service life of synthetic lubricants and the consequent longer oil change intervals can reduce equipment downtime and save resources. In some cases, lubrication for-life is possible.

Typical oil change intervals



Increases in efficiency caused by lubricants must be proven

Lubricants offer new ways of attaining sustainability goals, lower costs and a better energy balance. The optimisation of energy efficiency by means of lubricants and its quantification or proof of its monetary worth is not straightforward. To gain maximum energy efficiency, it is vital to not only look at the lubricant, but at the system as a whole. Measures such as cleaning, exchanging seals and selecting the optimum viscosity class also play a major role. A valid statement as to the energy efficiency of a lubrication solution can only be made through a before/after comparison. One indicator for improving energy efficiency is the reduction of temperature in the application.

Business case – Energy efficiency was increased in cooling towers in Korea

Cooling towers
Application details:
- 11 cooling cells
- Mineral oil with ISO VG 320 was used in all gearboxes
- Installed power of 36 kW per gearbox

Goal:
- Reduction of total energy consumption and costs

Result:
- **6 %** reduced energy consumption
- Total reduction by **272 MWh** and **161 tons of CO_2** emissions/year
- **17,600 €** total cost savings per year
- Payback time of 4 months

Business case – Significant savings in a specialty gas plant in Thailand

Gas compressor
Application details:
- 2 x turbo compressors: Cameron ASD 6000
- Rated power: 1120 kW & speed of 2978 rpm
- Lubricant volume = 300L (each)

Goal:
- Increase efficiency and reduce energy consumption

Result:
- Extended drain intervals from 2 years to every 3 years
- Total reduction by **46 MWh** and 17 tons of **CO_2** emissions/year
- **19,500 €** savings per year on each compressor
- Return of investment in only 2 months

Safety is rated highly in Green Chemistry

The chemical industry has committed itself to its responsibility for the safety of its product throughout their life cycle and beyond. Klüber Lubrication wishes to support this goal, and its specialty lubricants are in fact making a sizeable contribution. Our lubricants protect machines and installations against wear and breakdown. They help reduce relubrication and maintenance intervals, which means that hazardous tasks have to be performed less often. Special registrations and tests like those of NSF or BAM (German Institute for Materials Research and Testing) underpin the operational safety of our products. We also have approvals from leading manufacturers confirming that our products preventing the formation of chromium (VI) oxide, also referred to as chromium trioxide (CrO3).

Our sliding agents for valves, fittings and installations carrying oxygen

Product	Operating temperature	Upper oxygen pressure limit
Klüberalfa YV 93-1202	up to 60°C	450 bar
	up to 200°C	200 bar
Klüberalfa YV 93-302	up to 60°C	360 bar
	up to 150°C	150 bar
Klübertemp YV 93-302	up to 60°C	100 bar
Klübertemp YV 93-92	up to 60°C	150 bar

Benefits for your application

– High operational reliability in facilities and components used with gaseous or liquid oxygen
– High resistance to oxygen pressure surges
– Compatible with wide range of customary materials
– Wide service temperature range
– Each production batch is tested for its reaction behaviour to oxygen

Klübermatic reduces risk of accidents by up to 90 %

Automatic lubricating systems of the Klübermatic series minimise direct contact between workers and machines, contributing decisively towards occupational safety.
Further benefits in terms of safety are:
– Less time spent in hard-to-access, risky areas
– Lubricating systems prevent direct contact with lubricants that may be harmful to health
– Less accidents caused by slipping on ground contaminated with lubricant

Safety confirmed

– 100 % compliance: e.g with REACH, TSCA and many more
– Quality management: DIN EN ISO 9001, IATF 16949
– Environmental protection and occupational safety: ISO 14001, ISO 45001
– Food-processing industry: ISO 21469, NSF H1, Halal, Kosher

Lab analyses with LuCA: our service to monitor your lubricants

How good is the condition of your specialty lubricants – when is replacement necessary? Is the reliable function of your machines and equipment ensured? By answering these questions, you stay in control, extending the service lives of bearings, chains and gears. This helps prevent unplanned plant downtime, reduce costs and increase efficiency and profitability in production.

To support operation managers and maintenance staff in their efforts, Klüber Lubrication offers the Lubricant Condition Analysis program – LuCA. The service for oil and grease analyses performed in the labs of Klüber Lubrication determines the condition of your lubricants, showing their characteristics, impurities and wear as well as oxidation and ageing. This knowledge is the prerequisite for highly efficient maintenance processes and effective, preventive maintenance according to the principles of risk management and Total Productive Maintenance (TPM).

Longer operating times and more sustainability due to regular oil and grease condition analyses

LuCA supports companies with regular and continuous analyses of the lubrication condition and that of the lubricants used. This enables preventive maintenance: rather than waiting until wear occurs on the components, the user can see from the oil or grease condition how smoothly the tribological system is running. This allows longer maintenance intervals and equipment runtimes to be implemented.

How to use the Lubricant Condition Analysis Program LuCA

Request sampling kit from Klüber Lubrication
Request the sampling kit for drawing and then mail-packing oil and grease samples from your contact at Klüber Lubrication. The kits are designed for simple and clean sampling and bear barcodes for unambiguous allocation of the samples.

Register for lab analysis and send off samples
Scan the barcode or enter the barcode number in the Efficiency Manager to register for sample analysis and provide additional information. You will then be provided with the address of the Klüber Lubrication lab to send the samples to. An automatic reminder will tell you when a lab analysis is due.

Check report
Within a very short time, you will receive a concise report on the condition, impurities and wear detected, plus further data and results concerning the oil or grease analysis. An assessment of the condition of your lubricants is shown in the form of a traffic light rating. The report is provided via the EfficiencyManager. Our experts are always prepared to provide any additional technical advice.

At a glance: lubricant condition analyses with LuCA

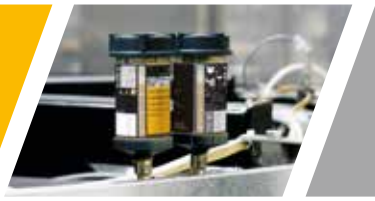
More efficient production, longer equipment runtimes and cost savings due to accurate data indicating lubricant condition preventing lubricant starvation as well as overlubrication.

Basis for preventive maintenance: lab analyses provide information on condition, impurities and wear detected in oils and greases. This helps prevent machine and equipment failure and downtime.

Perfect integration in EfficiencyManager of Klüber Lubrication and your TPM service portfolio (Total Productive Maintenance): lubricant analyses can be requested and are evaluated directly in the service online portal.

Simple and quick analyses facilitated by Klüber Lubrication sampling kits and professionally structured analysis processes in our labs.

For higher profitability and efficiency at work – Klübermatic lubricant dispensers



Lubricant dispensers supply the lubrication point with a set quantity of grease or oil at regular intervals. This keeps your production going. In addition, automatic lubricant dispensers can help to optimise lubricant quantities. They can provide efficient lubrication, applying a sufficient lubricant quantity to the friction point at all times. With a suitable lubricant dispenser and lubricant volumes matching your application, this means that both overlubrication and lubrication starvation are avoided. The friction point is supplied with an optimal lubricant quantity. As it is part of a closed system, it is also protected against harmful effects like those of dust, contamination or moisture.

Equipment availability: Klübermatic helps prevent up to 75 % of rolling bearing failures

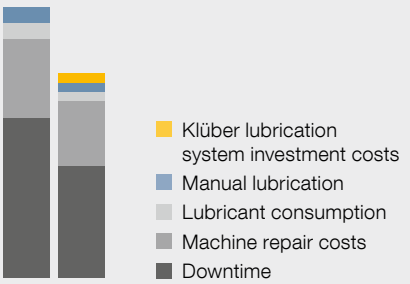
Premature wear leads to unwanted downtime. The service life of grease-lubricated bearings can be significantly increased with a carefully planned lubrication strategy.

With lubrication by means of Klübermatic systems, up to 75 % of all bearing failures can be prevented.
– Reliable supply of friction points with fresh lubricant
– High equipment availability due to permanent relubrication
– Reduction of maintenance costs and unplanned equipment downtime

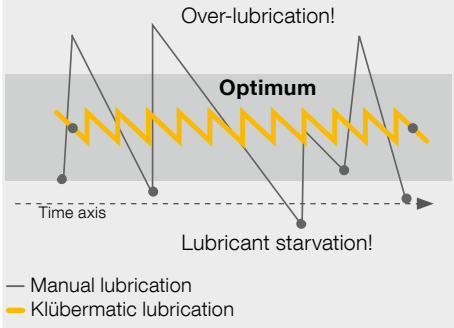
Profitability: Klübermatic reduces cost by more than 25 %

Klübermatic lubricating systems contribute effectively to cost reduction. With constant, automatic lubrication, premature wear and hence downtime are minimised. Expensive repairs and maintenance are prevented.
– High equipment availability due to automated production
– Plannable maintenance intervals during standstills
– Reduction of repair and maintenance costs

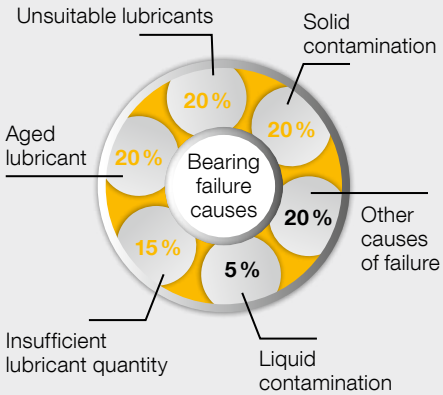
Benefits of Klübermatic dispensers



- **High equipment availability** through automation
- **Maintenance intervals can be scheduled** during downtimes
- **Reduction in repair and maintenance costs**



- Discharge periods from **1 day to 36 months**
- Lubricant volumes from **30 cm³ to 7,000 cm³**
- Operating temperatures from **–40 °C to +60 °C**
- Lubrication systems with high-performance **lubricants up to NLGI2**



- **High equipment availability** through automation
- **Maintenance intervals can be scheduled** during downtimes
- **Reduction in repair and maintenance costs**

Environmental Acceptable Lubricants (EAL)

What are EALs?

To limit the harmful leakage of lubricants and other media in the Marine Industry, the USA issued the Vessel General Permit (VGP), which came into force in 2013. Standard lubricants based on mineral oil are only permitted in exceptional cases for the lubrication of propellers, thrusters and other equipment with water-lubricant interfaces to avoid harmful emissions into the sea. The only permitted lubricants are those placed on the market as Environmental Acceptable Lubricants (EALs).

They must have the following characteristics:
Non-bioaccumulative: The chemicals must not accumulate in the tissue of an organism and enter the food chain

Biodegradable: The constituent substances of a lubricant must naturally break down by least 60% within 28 days

Non-toxic to aquatic life: The lubricant must not hinder the growth or well-being of aquatic life

This shows the criteria determining what makes an EAL relate to the consequences of lubricant leakage on the water and its microorganisms. Bioaccumulation describes the degree to which a chemical can build up in a living organism; biodegradability is the timespan during which a lubricant will decompose into harmless components.

Why use EALs in the chemical industry?

The strict regulations of the marine industry also benefit users in the chemical industry. By using EAL, you can take a big step towards achieving your sustainability goals. Not least your customers or residents in the vicinity of the production site might demand this. In this way, you will not only comply with legal requirements, but also strengthen the reputation of your company.

Most large chemical parks or chemical production facilities have equipment that is located outdoors and often near bodies of water. Tracks and switches, water treatment plants, loading arms, conveyor belts or open gears are applications that can pose a risk to the environment.

EAL from Klüber Lubrication have a reduced environmental impact in the event of spills as they are ultimately biodegradable and non-toxic. They also reduce the impact to the environment due to their synthetic base oil and the expected longer relubrication intervals and component lifetime.
Of course, they are also available in the Klübermatic lubricant dispenser with all the advantages of an automatic lubrication system:
– Klüberbio BM 32-142 in Klübermatic NOVA 125 ml
– Klüberbio AG 29-602 in Klübermatic STAR 250 ml

The solution for extreme requirements: PFPE lubricants from Klüber Lubrication

Reliable production under extreme conditions …
Global competition puts pressure on production capacities, plant availability and reduction of maintenance and repair costs in the chemical industry.
… presents challenges for you …
The service life of heavily loaded components such as bearings as well as the operational reliability and cost situation of the unit can be positively influenced by selecting PFPE products matching the specific environmental factors.
… which we help to solve.
BARRIERTA greases, tried and tested over decades, are typically used in rolling and plain bearings, valves, O-rings and other types of seals.

Why are PFPE lubricants so useful?

PFPE (perfluorinated polyether) is a long-chain polymer which consists of carbon, oxygen and fluorine atoms. The molecular structure can be branched, linear, or a combination of both, depending on the desired properties. The fluorine and oxygen atoms are strongly bonded to the carbon atoms. PFPE is extremely inert, as no element of the molecule is available for a reaction to take place. This inertness provides excellent **high-temperature performance** and makes **PFPE extremely useful** in the presence of highly reactive chemicals such as corrosives, acids and liquid oxygen.

Influence of media and sensitive materials

The strengths of PFPE oxygen sliding agents made by Klüber Lubrication become particularly apparent when used in valves, fittings and installations carrying oxygen under extreme pressure. Klüberalfa YV 93-1202, for instance, shows an extraordinarily high resistance to oxygen surges and very good resistance to various chemicals. To ensure continuous adherence to this high quality standard, Klüberalfa YV 93-1202 is produced in small batches applying very strict manufacturing criteria, and each batch is tested for resistance to gaseous and liquid oxygen.

Klüber Tyreno Fluid 6-14 V is a filling fluid for vacuum pumps offering high operational reliability in installations and components where it comes into contact with gaseous oxygen.

Klüber Tyreno Fluid 3-6 V is used, for example, as a barrier fluid for mechanical seals in the chemical industry, as its chemical stability is very high and the product is resistant to aggressive media, hydrocarbons, solvents, acidic and alkaline solutions. PFPE greases from Klüber Lubrication make an important contribution towards ensuring the functionalities of components even under the influence of chemicals, UV radiation or X-rays.

If direct contact between the lubricant and aggressive media cannot be avoided, lubricants have to offer particularly high resistance. This kind of chemical stability is found in the PFPE-based lubricants from Klüber Lubrication because of their specific structure and purity.

Klüberalfa PI 83-271 is also a good choice for lifting and metering equipment operating under the influence of media in laboratory automation, pneumatic cylinders and valves as well as in dynamically loaded seals and plastic guideways.

Application notes
Initial greasing and cleaning

PFPE lubricants offer best adhesion on bright surfaces that are absolutely free of grease. Thorough cleaning prior to greasing is a prerequisite for optimum results to be attained with your lubricants.

The cleaning fluid Klüberalfa XZ 3-1 removes any hydrocarbon solvent residues and evaporates quickly and completely. Klüberalfa XZ 3-1 is a dispersant, solvent and cleaning agent for use in combination with PFPE lubricants. Its boiling point is at about 55 °C. The chemical composition of Klüberalfa XZ 3-1 is very similar to that of perfluorinated polyether (PFPE). For this reason, lubricants based on PFPE are dissolved or dispersed in Klüberalfa XZ 3-1. Klüberalfa XZ 3-1 is not a chlorinated fluorocarbon (CFC) and is therefore not subject to the CFC/halon prohibition ordinance.

Klüberalfa XZ 3-1 is registered as NSF H1 and complies with FDA 21 CFR § 178.3570. It was developed for incidental contact with products and packaging materials in the food-processing, cosmetics, pharmaceutical or animal feed industries.

Miscibility with other lubricants

PFPE-based greases are miscible with one another. Other types of lubricant cannot be mixed with PFPE greases, irrespective of the mixing ratio. For this reason, the friction points should be thoroughly cleaned prior to a lubricant changeover, as described above, in order to attain maximum lubricity.

Cleaning in 4 steps

1. **Cleaning** using hydrocarbon-solving cleaning agents (white spirit)
2. **Drying** using paper or oil-free compressed air

Higher density

When determining the grease quantity and selecting the viscosity for a specific application, the fact that the density of PFPE lubricants is almost twice as high should be taken into account.

3. **Cleaning** using a cleaning fluid that is compatible with PFPE (Klüberalfa XZ3-1)
4. **Drying** using oil-free compressed air

Our contribution to the green fuel hydrogen: the right lubricants for hydrogen applications

Production of green hydrogen

The term green hydrogen refers to hydrogen produced by means of an electrolyzer, in which the energy required for electrolysis is provided by renewable resources such as the wind energy or the sun. It is considered the only environmentally friendly, climate-neutral option for hydrogen production.

Product overview of Klüber Lubrication

Gas compressors	Valves, fittings, screws and bolts
Reciprocating: – Klüber Summit DSL XM – Klüber Summit LCG – Klüber Summit NGL – Klüber Summit GRC	Based on PFPE and solids: – Klübertemp YV 93-92 – Klübertemp YV 93-302 – Klüberalfa YV 93 -1202
Rotary-screw: – Klüber Summit NGSH – Klüber Summit LCG	Based on silicone oil and solids – Klüberbeta VR 87-883
	Based on SHC oil and calcium complex soap – Klübersynth V 94-751

The data in this document is based on our general experience and knowledge at the time of publication and is intended to give information of possible applications to a reader with technical experience. It constitutes neither an assurance of product properties nor does it release the user from the obligation of performing preliminary field tests with the product selected for a specific application. All data are guide values which depend on the lubricant's composition, the intended use and the application method. The technical values of lubricants change depending on the mechanical, dynamical, chemical and thermal loads, time and pressure. These changes may affect the function of a component. We recommend contacting us to discuss your specific application. If possible we will be pleased to provide a sample for testing on request. Products from Klüber Lubrication are continually improved. Therefore, Klüber Lubrication reserves the right to change all the technical data in this document at any time without notice.

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Klüber Lubrication – your global specialist

Innovative tribological solutions are our passion. Through personal contact and consultation, we help our customers to be successful worldwide, in all industries and markets. With our pioneering technical concepts and experienced, competent staff we have been fulfilling increasingly demanding requirements by manufacturing efficient high-performance lubricants for more than 90 years.

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