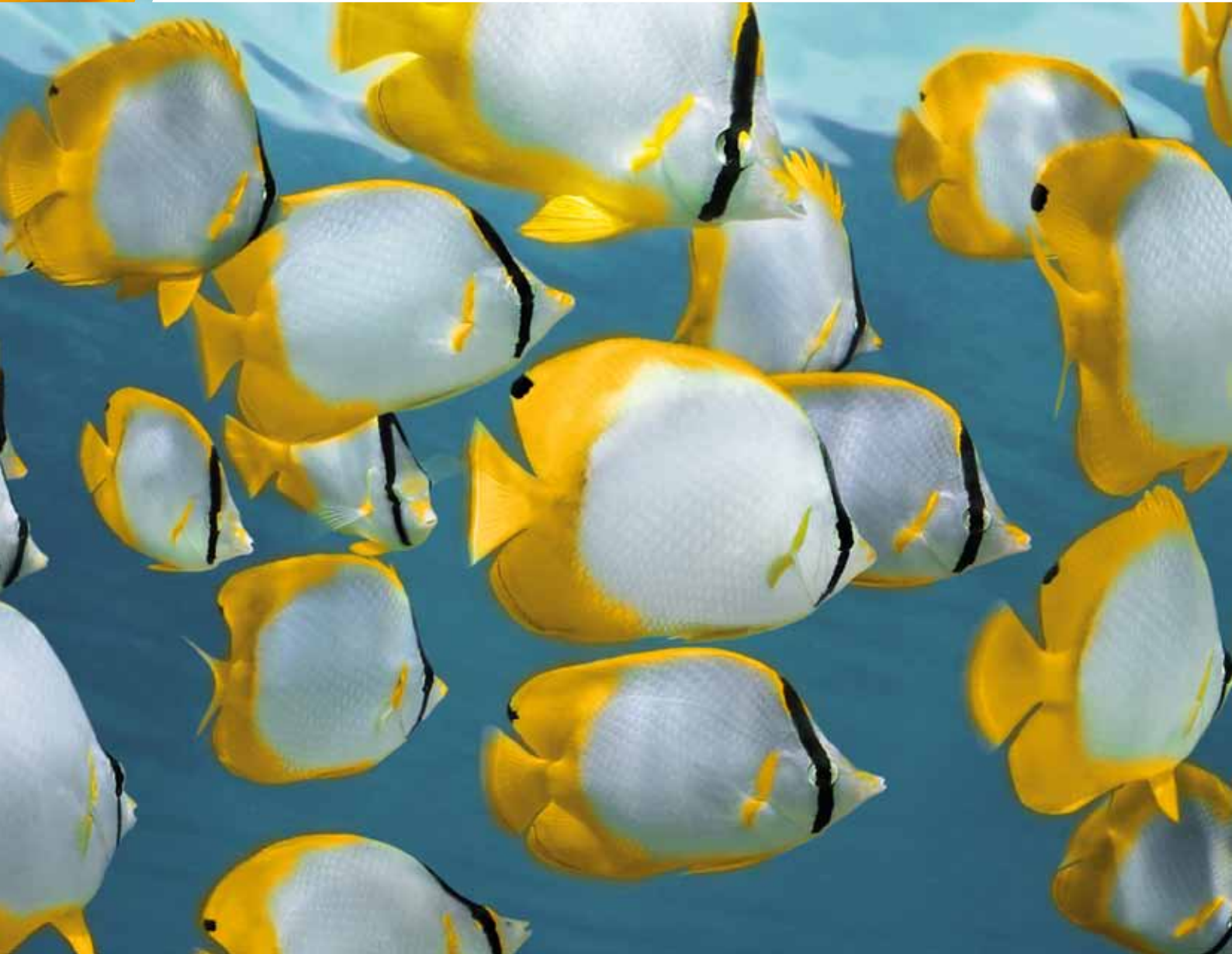


your global specialist

Detailed information

Powerful, naturally.

Environmentally acceptable and biodegradable
lubricants for the marine industry



Combine environmental and economic benefits with speciality lubricants from Klüber Lubrication



Attain both environmental and economic advantages – Powerful, naturally!

Reducing impacts from shipping operations on the environment is important to the shipping industry. As a shipping operator, you are aware of the expanding body of environmental regulations affecting your business. Additionally, a growing interest in ecological issues is driving your customers to ask you for environmentally sound operating practices.

At the same time, you also need to have a lock on your costs. You invest in ships for the transportation of goods and people or for offshore services and you seek a profitable return on your investments.

The lubricant – a small investment that can make a big difference

Selecting the right lubricant is critical to maximising the output of your marine equipment while minimising operational costs. In today's environment, a lubricant that combines ecological and economic advantages is vital to the success of your operation. Klüber Lubrication environmentally acceptable lubricants are the perfect choice. We work closely with manufacturers of marine components to extend service intervals, lengthen component lifetime and increase operational reliability while meeting regulatory and market demands for environmentally sustainable practices. With speciality lubricants from Klüber, you save on total operating costs while you help save the environment.

Ecological challenges

Reducing the stream of mineral oil-based lubricants entering oceans, bays, harbours and inland waters from standard operational practices is a major challenge for marine operators. According to the US Environmental Protection Agency, several million litres of lubricants are discharged into commercial harbours each year through stern tube leakages alone. Additionally, millions of litres more are estimated to be discharged through other on-deck and thru hull machine elements such as cranes, winches, stabilisers, and bow thrusters. Oils and greases are needed to operate your vessel and yet the next wave can sweep them away into the sea.

Legislation, Regulation and Compliance

The use of environmentally acceptable lubricants (EALs) receives more and more attention from legislators and regulators around the globe. In the USA, the use of EALs has become mandatory as defined in the US Environmental Protection Agency's Vessel General Permit. Lubricants used for mechanical equipment subject to immersion and in oil to water interfaces (stern tubes, thruster shafts, fin stabilisers) must be biodegradable, non-toxic, and non-bioaccumulating as long as an approved EAL is available.

To be "Environmentally Acceptable", a lubricant has to be:

- Non-bioaccumulative: the chemicals may not accumulate in the tissue of an organism and enter the food chain. Test Methods: OECD 117 and 107.
- Biodegradable: the constituent substances of a lubricant must break down naturally according to the required test standards. In general, at least 60 % of the formulation has to biodegrade within 28 days under the test conditions. Acceptable test methods include: OECD Test Guidelines 301 A-F, 306, and 310, and International Organization for Standardization 14593:1999.
- Non-toxic: the formulation must pass either OECD 201, 202, and 203 for acute toxicity testing, or OECD 210 and 211 for chronic toxicity testing.

Performance remains the key to lubricant selection

High performance synthetic lubricants, including the synthetic ester oils from which Klüber Lubrication's biodegradable lubricants are designed, reduce friction and reduce operating temperatures thereby reducing energy consumption. As an example, in land based systems, a 1 % to 2 % reduction in energy usage has been documented by switching to a better lubricant in gear box systems. Klüber believes the same efficiencies gained in on-land applications can be achieved onboard vessels. Even a 1 % energy reduction would directly relate to fuel cost savings. Switching to high-efficiency gear lubricants could be a component of a Ship Energy Efficiency Management Plan.



Just the best for you: tested quality

Klüber does not launch a new lubricant unless it has been put through extensive testing. To achieve this, we have developed a test bay that is un-paralleled in the industry. We simulate the exact loads lubricants are subject to in your applications: fluctuating temperatures, high surface pressure, micro movements, and/or salt air and salt water.

We work together in close collaboration with leading OEMs to design lubricants that maximise the performance of their products. You can achieve best operational practices through selecting Klüber lubricants.

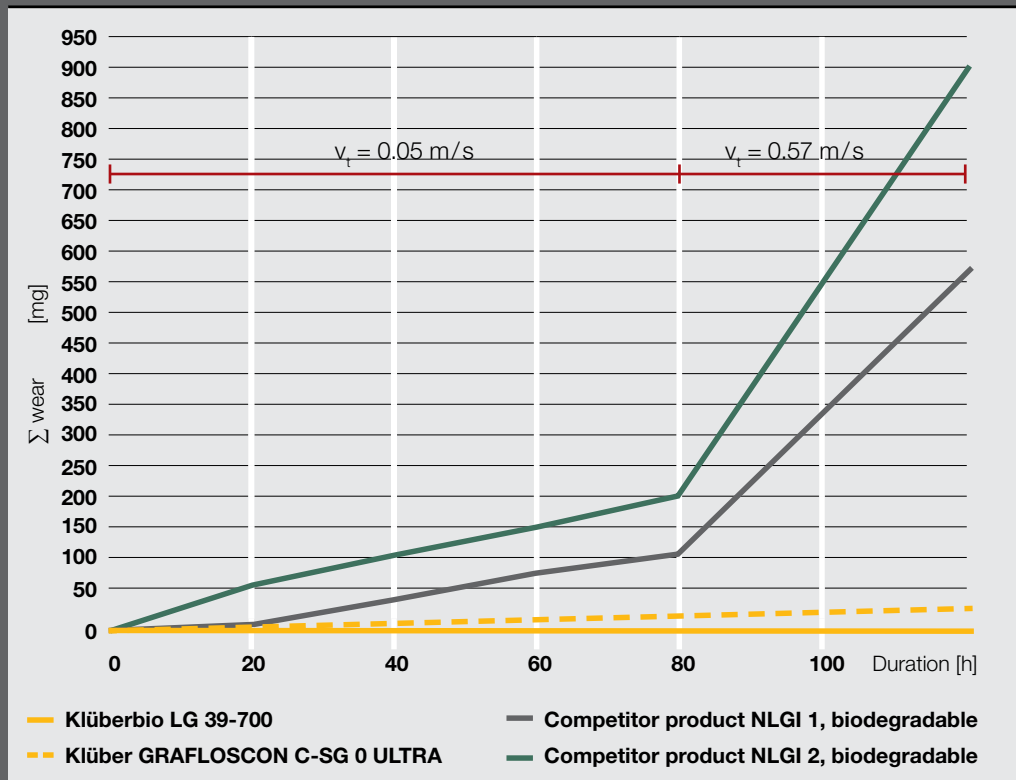
If you have any questions regarding our products or if you wish to discuss a particular application, please contact us. Our specialists are nearby and happy to help.

An example: Klüberbio LG 39-700

Klüberbio LG 39-700, Klüber Lubrication's new open gear grease, provides the combination of biodegradability and performance. The finished lubricant is formulated with more than 90 % renewable materials. The base oil of the grease was developed with new technology that yields a higher viscosity and considerably improved low-temperature behaviour compared

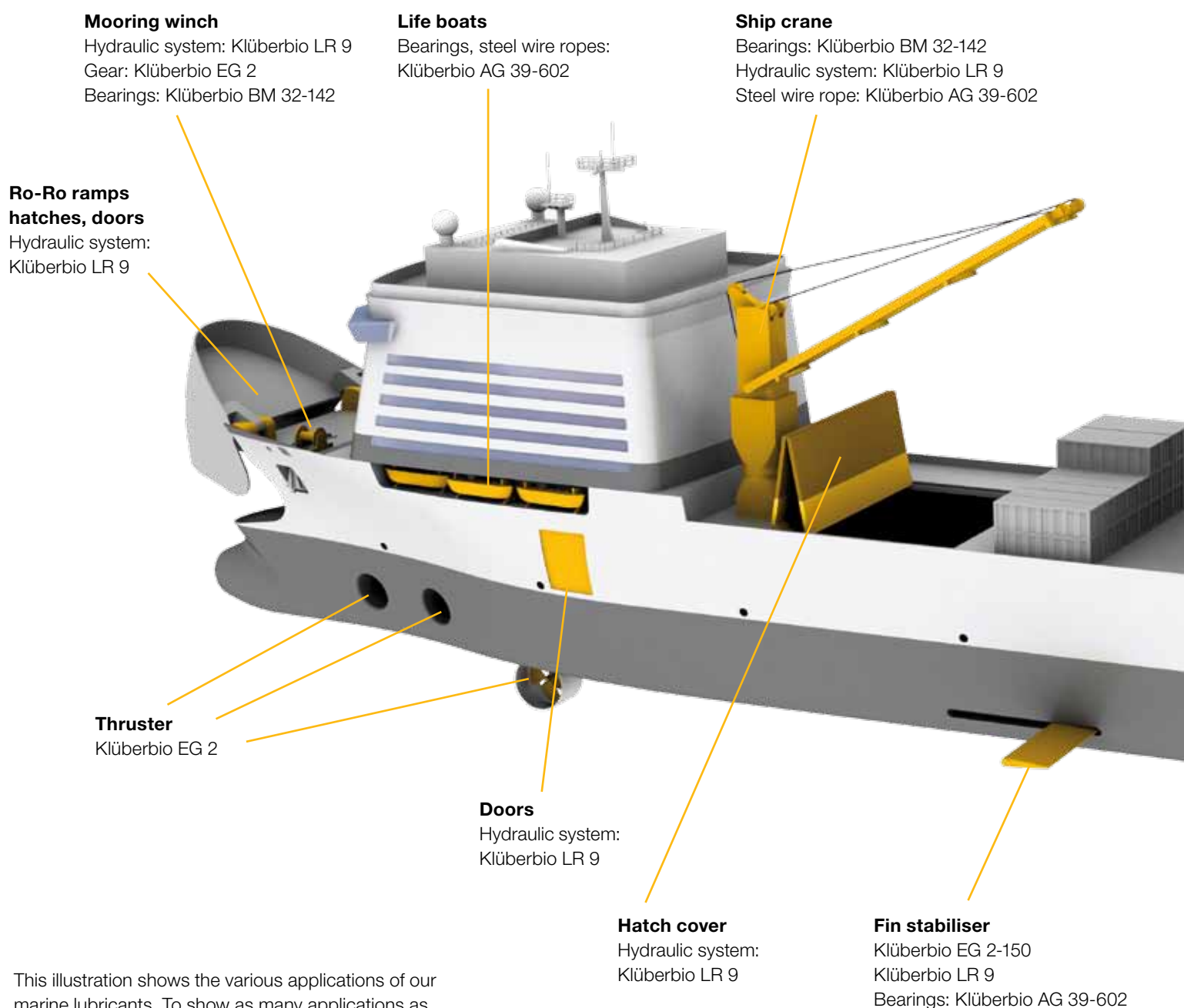
to other ester type oils. Furthermore, Klüberbio LG 39-700 outperforms the wear protection of other lubricants for this application. By extending the service life of pinions, large gears and tooth racks, this product contributes to energy savings and operational cost savings over the entire lifespan of the ship.

Modified FZG slow speed wear test acc. to DGMK 377-01



Klüberbio LG 39-700 shows lower wear rates than other open gear lubricants.

Speciality lubricants on board



This illustration shows the various applications of our marine lubricants. To show as many applications as possible in one illustration, we included components of the following ship types in this synthetic ship: Ferry, cruise ship, cargo ship, wind turbine installation vessel, anchor handling tug supply vessel.



Jacking system

Tooth rack & pinion: Klüberbio LG 39-700 , Klüberbio AG 39-602
Planetary gearbox: Klübersynth GEM 2-320

Anchor handling winch

Open gear: Klüberbio AG 39-602
Enclosed gear: Klübersynth GEM 2-320
Hydraulic motor: Klüberbio LR 9
Steel wire rope: Klüberbio AG 39-602

Offshore crane

Hydraulic system: Klüberbio LR 9
Bearings: Klüberbio BM 32-142
Steel wire rope: Klüberbio AG 39-602

Fairleads

Bearings: Klüberbio BM 32-142

Stern roller

Bearings:
Klüberbio LG 39-700

Towing pins

Klüberbio AG 39-602

Rudder

Bearings and seals:
Klüberbio AG 39-602

Thruster / rudder propeller

Steering shaft seal: Klüberbio AG 39-602
Gear: Klüberbio EG 2

Azipod

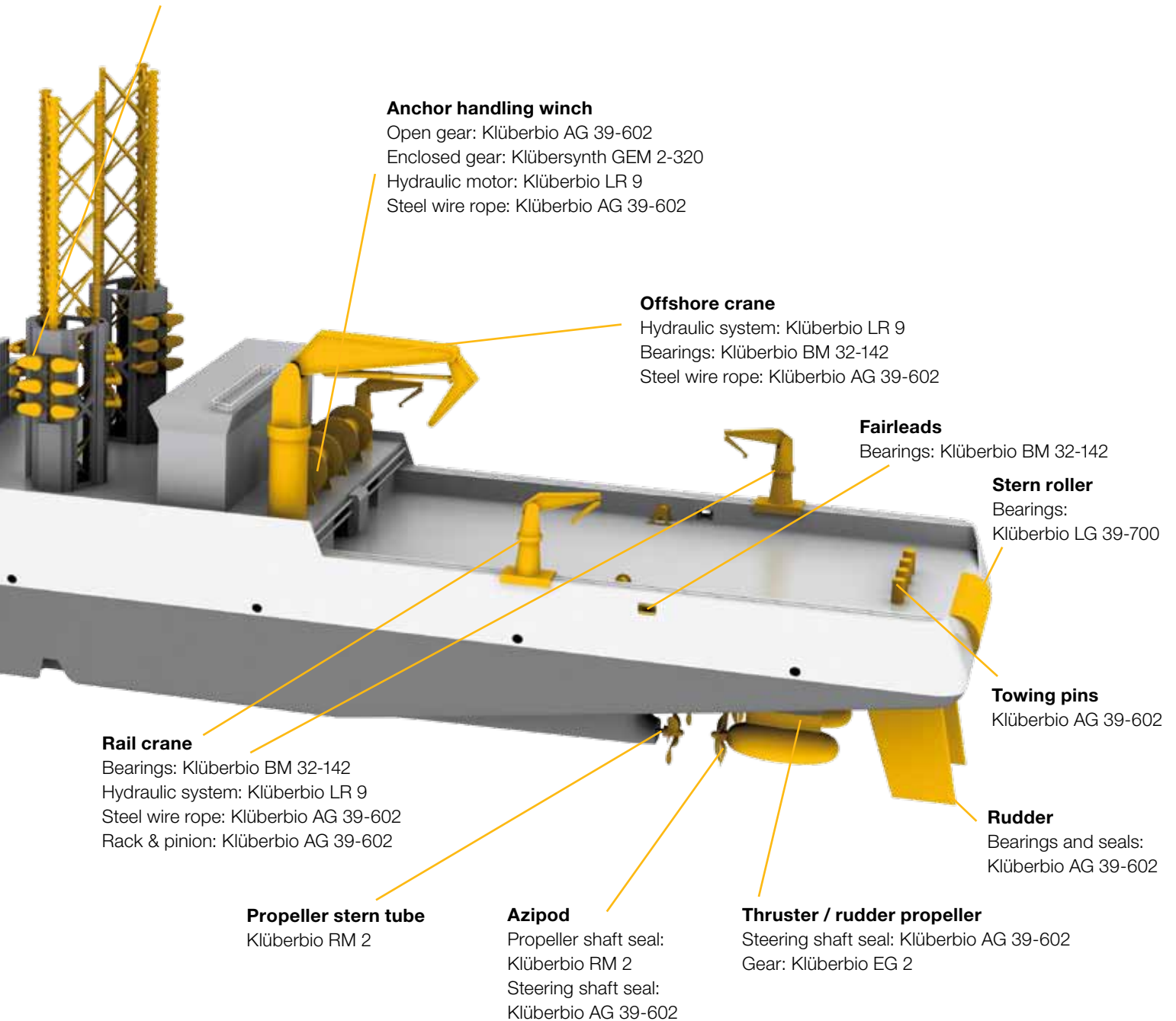
Propeller shaft seal:
Klüberbio RM 2
Steering shaft seal:
Klüberbio AG 39-602

Propeller stern tube

Klüberbio RM 2

Rail crane

Bearings: Klüberbio BM 32-142
Hydraulic system: Klüberbio LR 9
Steel wire rope: Klüberbio AG 39-602
Rack & pinion: Klüberbio AG 39-602



Environmentally acceptable and biodegradable lubricants for the marine industry

| Product description | Klüber specialty lubricant | Characteristics and environmentally relevant information | Module | Component |
|------------------------------------|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Stern tube oil | Klüberbio RM 2-100 ¹⁾ Klüberbio RM 2-150 ¹⁾ | ISO VG 100 / 150 Biodegradability > 60 % European Ecolabel | Controllable pitch propeller Fixed pitch propeller | Stern tube bearing Propeller shaft seal |
| Gear oil | Klüberbio EG 2-68 ¹⁾ Klüberbio EG 2-100 ¹⁾ Klüberbio EG 2-150 ¹⁾ | ISO VG 68 / 100 / 150 Meet CLP requirements according to ISO 51517-3 Biodegradability > 60 % European Ecolabel | Thruster | Gear set, bearings and seal |
| Gear oil | Klübersynth GEM 2-320 | ISO VG 320 Meet CLP requirements according to ISO 51517-3 Biodegradability > 60 % | Anchor handling /mooring winch | Enclosed gearbox |
| Hydraulic oil | Klüberbio LR 9-32 ¹⁾ Klüberbio LR 9-46 ¹⁾ Klüberbio LR 9-68 ¹⁾ | ISO VG 32 / 46 / 68 Meet HEES requirements according to DIN ISO 15380 Biodegradability > 60 % European Ecolabel Swedish Standard SS 15 54 34 | Anchor handling /mooring winch Ship crane Offshore crane Controllable pitch propeller | Hydraulic motor Hydraulic components Servo piston inside the hub |
| Chain oil | Klüberbio C 2-46 | ISO VG 46 Biodegradability > 60 % | Derrick | Chain |
| Open gear grease | Klüberbio LG 39-700 | NLGI 0 Biodegradability according to CEC-TDLL-103 test after 21 days >70 %, biodegradability of base oil >60 % | Jacking system Anchor handling winch | Rack & pinion gear Open gear |
| Open gear & steel wire rope grease | Klüberbio AG 39-602 ¹⁾ | NLGI 1-2 Biodegradability > 60 % | Crane Jacking System Anchor handling winch | Steel wire rope Rack & pinion gear Open gear Bearings |
| Multi-purpose EP 2 grease | Klüberbio BM 32-142 ¹⁾²⁾ | NLGI 2 Biodegradability > 60 % European Ecolabel | Deck machinery | Bearings |
| Multi-purpose EP 2 grease | Klüberbio M 72-82 | NLGI 2 Biodegradability > 60 % | Deck machinery | Bearings Steel wire ropes |
| Rust removing agent | Klüberbio Z 2-5 | ISO VG 5 Biodegradability > 60 % | Miscellaneous | |

ISO viscosity class according to DIN ISO 3448, consistency grade according to DIN 51818, biodegradability according to OECD 301 F/B test after 28 days

¹⁾ Complies with requirements for Environmentally Acceptable Lubricants as defined in Appendix A of the 2013 Vessel General Permit.

²⁾ Available from 2nd half of 2014



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Klüber Lubrication München SE & Co. KG
Geisenhausenerstraße 7
81379 München
Germany

Local first-instance court Munich, Germany
Certificate of registration 46624

www.klueber.com

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 ambitious technical concepts and experienced, competent staff we have been fulfilling increasingly demanding requirements by manufacturing efficient high-performance lubricants for more than 80 years.



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