

→ **ADDINOL Eco Gear**
The innovative solution for industrial gear sets



Welcome to the World of ADDINOL





→ *ADDINOL – The Art of Oil since 1936*

ADDINOL – Additive in Oil – was one of the most famous brand names of the former GDR. After the German Unification the company changed its name to ADDINOL. In Leuna ADDINOL develops and manufactures high-performance lubricants of the new generation. The company is represented in more than 60 countries worldwide. With a product

range of more than 600 different lubricants ADDINOL offers the perfect product for each application. Customers all over the world benefit from the high and constant quality of the high-performance lubricants, the know-how and the individual customer consultancy service of the competent experts at ADDINOL.

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A ADDINOL Eco Gear and your gear – Never change a winning team

Gears transmit and transfer energy, movements and forces; they are essential in all industries and all over the world. They work under various, often extreme conditions.

The lubricant is essential for the operation. It is a construction element and has an influence on the efficiency and safety of the connected aggregates.

The careful choice of the gear oil is crucial. A reliable partner with experience and knowledge on the application of its products as well as innovative lubricants is indispensable.

For more than 70 years ADDINOL has been specializing in the development and production of high-performance lubricants. The lubrication of industrial gears is our expertise.

ADDINOL Eco Gear, with the innovative Surftec® formula against wear, is designed as high-performance industrial gear oil for modern gear efficiency. ADDINOL Eco Gear has been achieving spectacular successes for years. Cement, paper or sugar industry, gear units of ships or wind power plants – ADDINOL Eco Gear impresses with outstanding results everywhere.

The successes of ADDINOL Eco Gear are unmatched and supported by well-known independent institutions, such as the FZG*.

A ADDINOL Eco Gear to minimize and prevent wear

ADDINOL Eco Gear is unlike any other conventional industrial gear oil. Eco Gear M is based on mineral oils and Eco Gear S on synthetic oils. Both versions contain Surftec® as substance combination. It adapts to the changing loads in gear teeth and bonds to the gear.

ADDINOL Eco Gear M and S prevent the formation of both pitting and micro pitting as well as abrasive wear. The high-performance gear oils safely protect against material removal and deterioration. The damaged surfaces which carry the loads are smoother and in better condition. This exceptional lubricant behaviour reduces the friction coefficient.

A ADDINOL Eco Gear saves energy

In comparison to conventional industrial gear oils ADDINOL Eco Gear M and S reduce the friction coefficient significantly. Lower oil sump temperatures prove the significant improvements in efficiency and the large energy saving potential created by ADDINOL Eco Gear M and S.

With ADDINOL Eco Gear you permanently cut your costs, while improving efficiency and maximizing production safety.

ADDINOL Eco Gear – patent pending.

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* FZG – Research Centre for Gears and Gear Unit Design, Technical University of Munich



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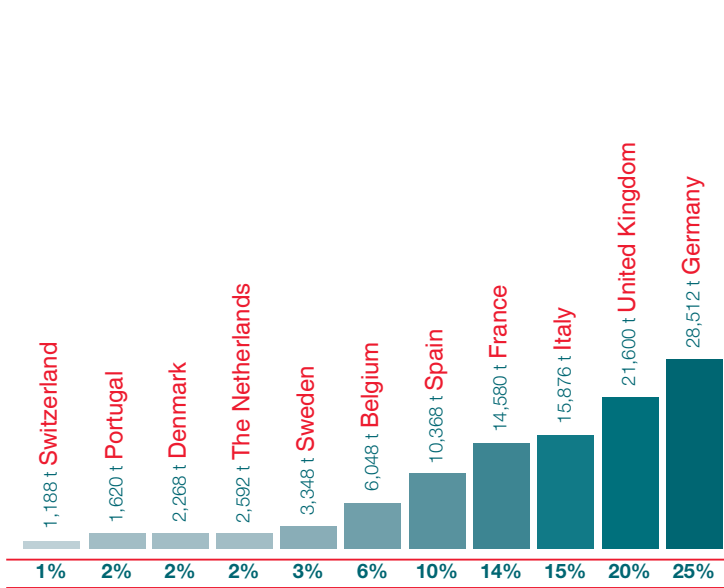
Industrial gears – application, requirements and specifications

Gears are used in all industrial areas. Different types of gears, i.e. spur gears, planetary gears, bevel gears or worm

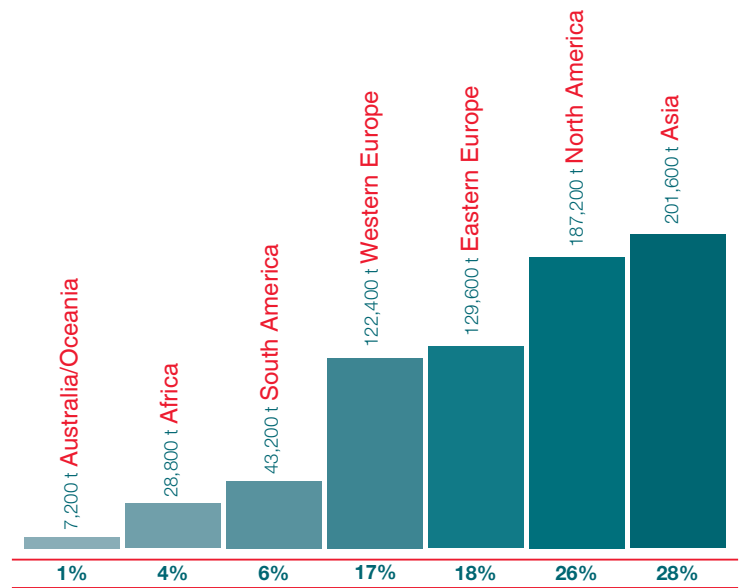
gears, are used depending on the task. They can be open or enclosed and are lubricated by bath or by circulation.

The requirements for industrial gear oils are extreme:

Annual consumption of selected European countries – 108,000 t/year



Worldwide consumption – 720,000 t/year



Modern gears have higher requirements on their lubricants:

Development of industrial gears

Higher performance

More compact gears with smaller oil volumes

Oxidation resistance
Higher thermal stability
Resistance to pitting and grey flecking
Longer service life
Protection against bearing wear and corrosion
Continuous performance
Improved water separation ability
Safe filterability



Higher loads on tooth flanks
Higher oil temperatures
New construction materials
New surface treatment

Industrial gear oils can be based on mineral oils, polyglycols, polyalphaolefins or synthetic esters.

Specifications for their application in industrial gears:

- ➔ AGMA 9005-D94 and in draft AGMA 6006
- ➔ ISO 12925-1 (demands on lubricants for enclosed systems – class C)
- ➔ DIN 51517 – part 3 (conventional gear oils)
- ➔ specifications and approvals of gear and bearing manufacturers (e.g. Friedrich A. Flender AG, Jahnelt-Kestermann, Rexroth, Eickhoff, FAG)

A ADDINOL Surftec® – the effective formula against wear

The ADDINOL Eco Gear operates differently than all conventional industrial gear oils. Since ADDINOL Eco Gear contains Surftec®, a combination of substances that adapts to the changing loads conditions in gear flanks and bonds with the surfaces, it is incomparable to other industrial gear oils.

ADDINOL Eco Gear transforms progressive metal abrasions into regressive ones!

Some typical examples from the practice:

After some operating time, micro pitting – an unmistakable sign of wear – occurred on tooth flanks of a wind power gear unit. The operator changed the plant from conventional gear oil to ADDINOL Eco Gear. After that, he meticulously documented the changes of his gear unit. Imprints of the tooth flanks were taken and analysed under a grid electron microscope.

Picture 01: Before

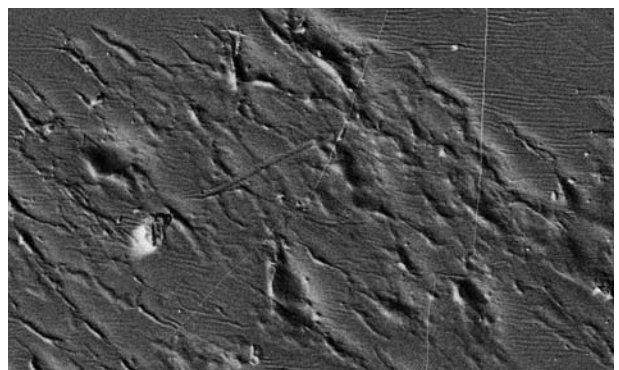
Gear before changing to ADDINOL Eco Gear. Micro pitting is still clearly visible.



Picture 01: Strong micro-pitting and pitting on tooth flanks

Picture 02: Three months after changing

Roughness and pitting are still clearly visible on the tooth flank imprint under the grid electron microscope.

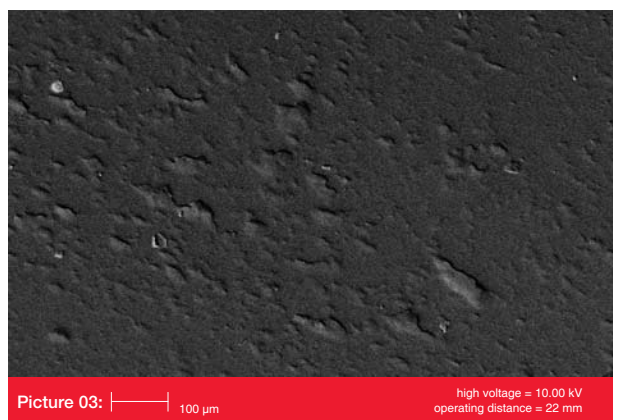


Picture 02: | 100 µm

high voltage = 10.00 kV
operating distance = 19 mm

Picture 03: Imprint of tooth flank after 25 months

The condition of the surface has improved significantly. Former pittings are smoother. Sharp edges and roughness have already disappeared.

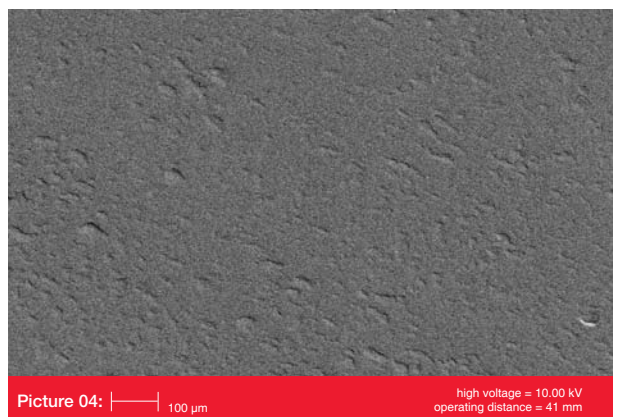


Picture 03: | 100 µm

high voltage = 10.00 kV
operating distance = 22 mm

Picture 04: Further improvements after 36 months

Under the grid electron microscope we see an almost perfectly smoothed surface. New damages did not occur.



Picture 04: | 100 µm

high voltage = 10.00 kV
operating distance = 41 mm

A Best results for ADDINOL Eco Gear in international standard testing

The performance of industrial gear oils is judged with international standard tests. Here ADDINOL Eco Gear achieved outstanding results.

Load carrying capacity class I in the Flender micro pitting test
Flender – one of the worldwide leading suppliers of power drive engineering – evaluates gear oils according to the Flender micro pitting test among others.

In the short-term test over 100 h and in the long-term test over 400 h ADDINOL Eco Gear competed against conventional and other gear oils under the respective loads.

Here the high-performance gear oil of ADDINOL achieved load carrying capacity class I and was judged by Flender accordingly: “Micro pitting can be ruled out almost entirely for the oil under investigation [ADDINOL Eco Gear].“

Best results in the FE-8 roller bearing test

The FE-8 test determines characteristic lines on a test bearing which give information on the wear of roller bearings and bearing cage according to DIN 51 819-3. Here ADDINOL Eco Gear achieved best results as well (see picture 07).

Highest load stage in the FZG scuffing load test

The scuffing load test of the FZG corresponds to DIN 51 354-2. Here the load carrying capacity of gear oils is determined on the FZG spur gear rig. ADDINOL achieved the highest load stages in the FZG scuffing test.

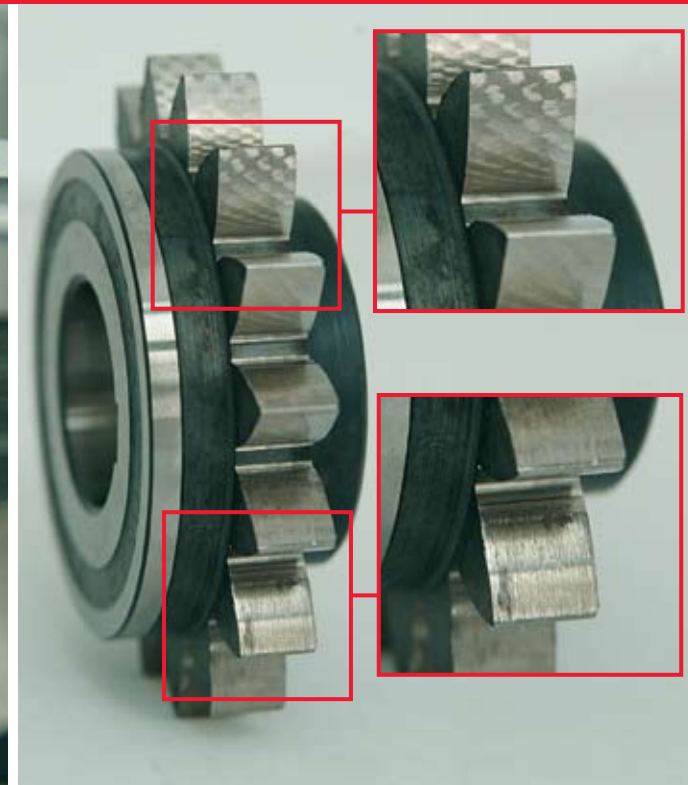
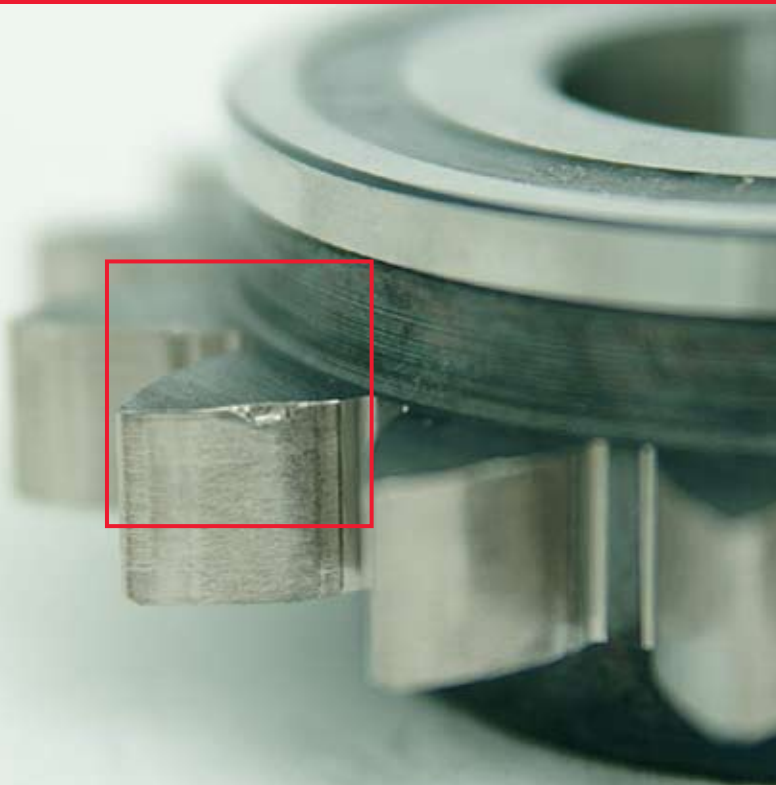
The FZG scuffing load test in comparison

One side of the gear wheel was tested with conventional gear oil (see picture 05). Strong scuffing with scratches is clearly visible. The other side of the gear wheel was tested with the same method and ADDINOL Eco Gear. The tooth flank does not show any damages (see picture 06). With ADDINOL Eco Gear the gear ran almost free of any wear.

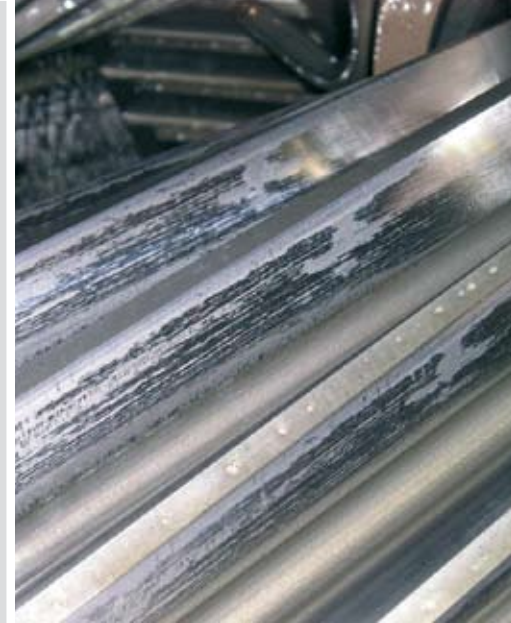
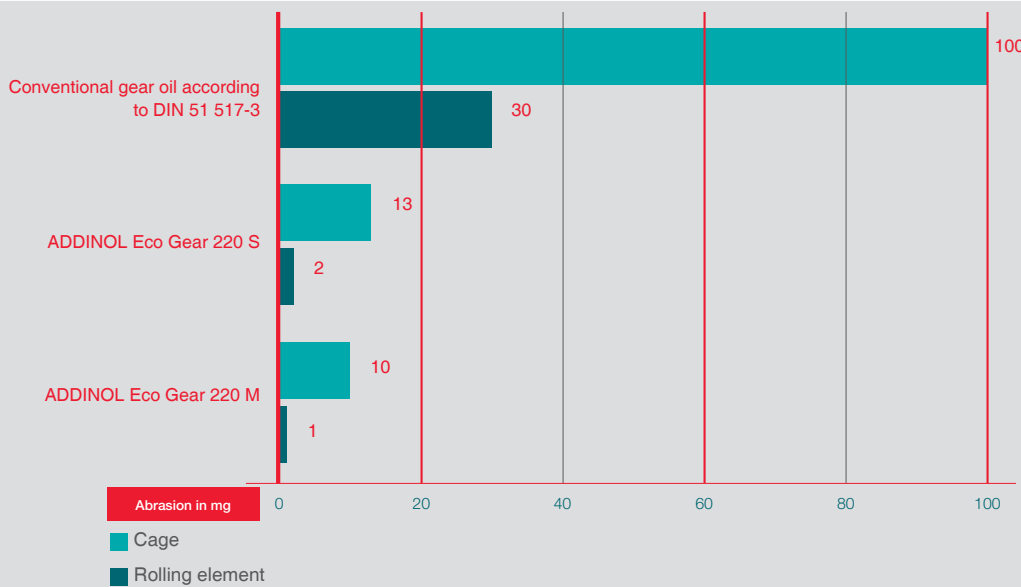
Method	Load Stage
A/10/16.6/120	>12
A/10/16.6/R/90	11

Picture 05: FZG Scuffing load test – conventional industrial gear oil

Picture 06: FZG Scuffing load test – ADDINOL Eco Gear



Excellent protection against wear: ADDINOL Eco Gear 220 S



Picture 07: FE-8 roller bearing test: 4 bearings/80 °C/80h/7.5 [1/min]

Picture 08: Micro pitting on the tooth flanks

A Micro pitting – an unmistakable sign of wear

Micro pitting occurs with mixed and boundary friction on gear wheels and in roller bearings. Characteristic for micro pitting are small surface cracks of a size of about 10 µm. The affected areas are grey and dull (see picture 08).

on tooth flanks. The wear process is influenced by the physical and chemical characteristics of the lubricant, type of gear, surface roughness and operating conditions.

Micro pitting might already develop in the early stage of operation because of high loads. In the course of time it becomes accelerated wear and causes massive damages

Influential factors in the development of micro pitting

Material	Lubricant	Operating Conditions
<p>Metallurgy Case hardened gear wheels tend to develop micro pitting</p> <p>Surface Roughness Smoother surfaces reduce the risk of micro pitting</p> <p>Hardness of surface Effects can be influenced by load and material</p>	<p>Viscosity As viscosity increases the risk is reduced</p> <p>Chemical components Synthetic products have advantages in comparison to mineral oil; Additives reduce micro pitting due to an improved wear protection</p> <p>Oil volume Larger oil amount reduces temperature and so the risk of micro pitting</p>	<p>Loads High loads mean high risk</p> <p>Speed Higher speed increases lubricant film thickness</p> <p>Temperature Because of higher temperatures lubricating film thickness decreases and thus the risk of micro pitting increases</p>

ADDINOL Eco Gear – Friction coefficient and energy saving

ADDINOL Eco Gear with Surftec® minimizes wear; this in turn influences the friction coefficient. The friction coefficient indicates the friction forces between two solid bodies or between solid body and lubricant. The friction coefficient of a lubricant is determined with the SRV standard test method (for oscillation friction and wear, according to DIN 51 834) at the respective loads and on the friction test rig.

ADDINOL Eco Gear performs much better than all conventional and so-called high-performance gear oils. The friction coefficient of ADDINOL Eco Gear is much lower than the one of conventional gear oils. This improves the efficiency of the gear unit, especially in conditions of mixed and boundary friction.

ADDINOL Eco Gear minimizes the friction coefficients; it has a positive and prophylactic effect against wear. According to the FZG Institute report, the application of ADDINOL Eco Gear enables “efficiencies which are usually only achieved with EHD* lubrication.”

This means ADDINOL Eco Gear almost reaches the ideal condition for lubrication.

* Elasto hydrodynamic

The gears run easier and smoother. This in turn drastically reduces friction losses and saves energy.

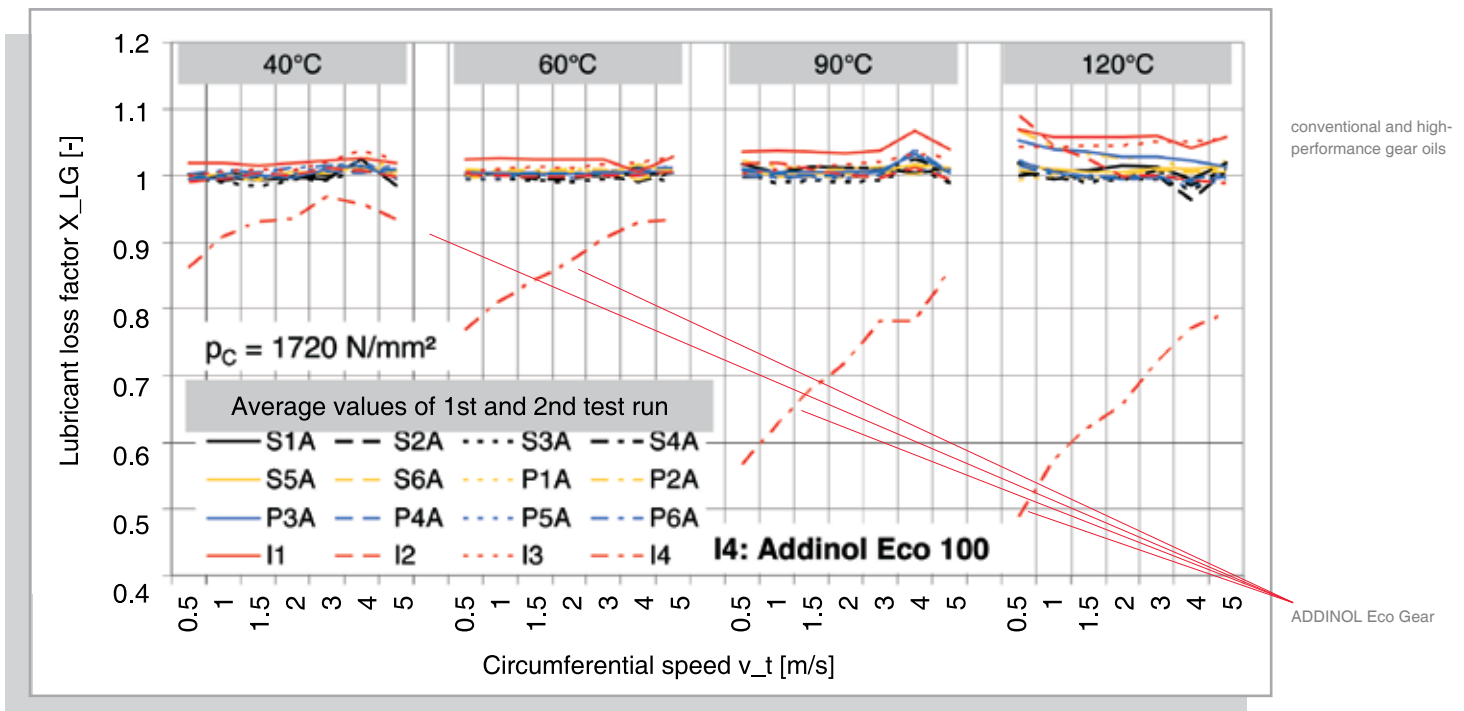
In the report of the FZG “Influence of the lubricant on energy loss and efficiency of tooth gears” ADDINOL achieved outstanding results (see picture 09).

The energy lost in gears is influenced by inefficiencies in tooth flanks and bearings as well as further losses caused by sealing, coupling, synchronizations, pumps etc. They are divided into general losses and load related losses (see picture 10).

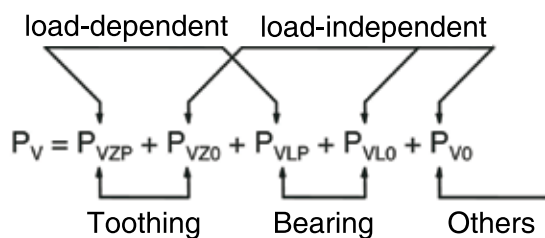
Viscosity influences the general energy losses and film thickness at the contact surfaces. The base oil determines the load related losses in elasto hydrodynamic lubrication. The additive mainly influences the load related losses for mixed and boundary friction.

Comparative testing with different types of additives in a mixed and boundary lubrication condition shows the Surftec® technology achieving half the friction coefficient versus conventional additive systems at a very thin lubricating film.

Picture 09: Friction related losses in gears for mixed and boundary friction

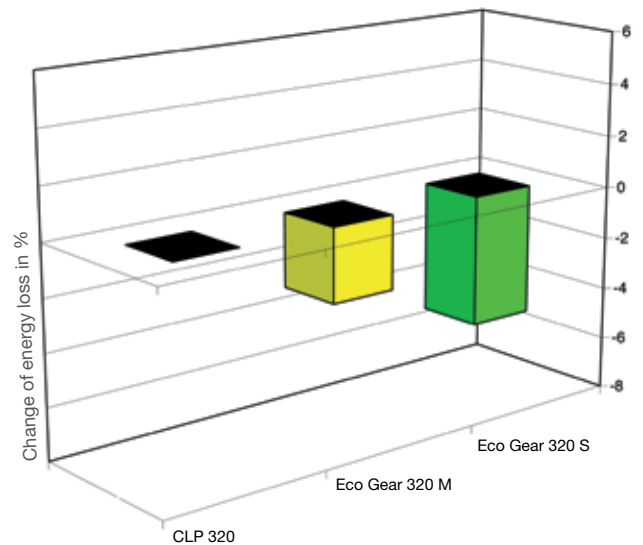


Due to the varying loads in practical applications, the advantage in performance for ADDINOL Eco Gear has different aspects. For example in a wind mill gear of 1.5 megawatt with a planetary drive and two additional spur wheel reduction stages: with ADDINOL Eco Gear 320 M power loss is reduced by 3 % at nominal load, with ADDINOL Eco Gear 320 S by about 5 % versus conventional mineral oil based gear oil 320 (see picture 11). While the general friction losses of ADDINOL Eco Gear 320 S do not differ significantly compared to conventional oils, the load related losses can be reduced by up to 41 %.



Source: Pictures 09-11 taken from the FZG report "Influence of the lubricant on energy loss and efficiency of tooth gears"

All in all, ADDINOL Eco Gear shows higher efficiency than conventional gear oils. It is also possible to achieve significantly lower friction and less energy loss in boundary friction conditions with different temperatures.



Picture 10: Calculation for friction losses in gears

Picture 11: Less energy lost for a wind power plant

ADDINOL Eco Gear – Characteristics

One expects, of course, gears to provide top performances and absolute reliability; even though they often work under extreme conditions.

Their operation can be challenged by:

- water and/or moisture
- high humidity
- extreme temperatures
- caustic cleaning agents
- acids and alkalis
- dirt and dust

With ADDINOL Eco Gear your gears work reliably and with maximum performance.

Characteristics of ADDINOL Eco Gear are optimized to give its unique performance:

- maximum wear protection for gears and bearings
- optimum micro pitting resistance
- higher energy saving
- extremely long oil drain intervals
- outstanding corrosion protection for steel and copper alloys
- excellent demulsibility
- safe anti-foam behaviour
- solid-free, no limitations on uses in filters and centrifuges
- compatible with all types of seals and paint
- significant reduction of disposal costs
- no hazardous waste, eco-friendly
- water risk class 1 means not endangering, therefore easy storage

A ADDINOL Eco Gear – Long term warranty

For ADDINOL Eco Gear M and ADDINOL Eco Gear S, ADDINOL guarantees a service life of 4 years in industrial gears where oil changes will not be needed.

A lifetime of 4 years corresponds to 10,000 operating hours for one shift operation, respectively 30,000 operating hours for three shift operation.

The use of ADDINOL Eco Gear for long-term operation will be accompanied by a service of oil analysis at specified intervals.

If problems should occur which are demonstrably caused by the oil, ADDINOL will supply replacement free of charge for the filling quantity in the gear. The rules for the oil analysis are clear and can be met without much effort.

The advantages of the long-term warranty speak for themselves:

- safety of operation in the long run
- additional safety because of lubricant analyses free for over 500 litres ADDINOL Eco Gear
- cost savings due to long oil drain intervals
- cost reduction due to reduced oil waste



A ADDINOL Eco Gear – In practice:

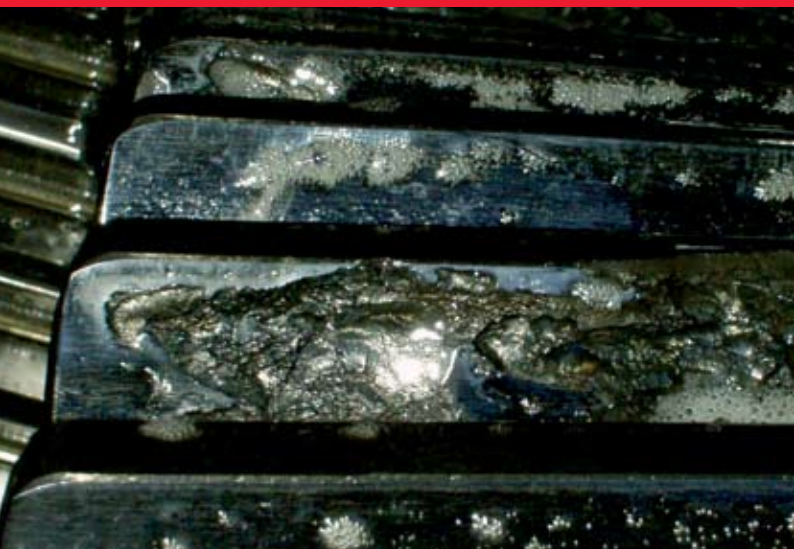
Usually industrial oils are applied according to DIN 51 517 – part 3 (conventional gear oils). However, they are not always prepared for extreme requirements, as the study of a wind power plant operator shows:

Picture 12: Since the start in October 1999 conventional gear oil 320 has been used in this wind mill gear. Pitting developed on the tooth flanks during operation in comparable plants to the point of needing to replace the gears set.

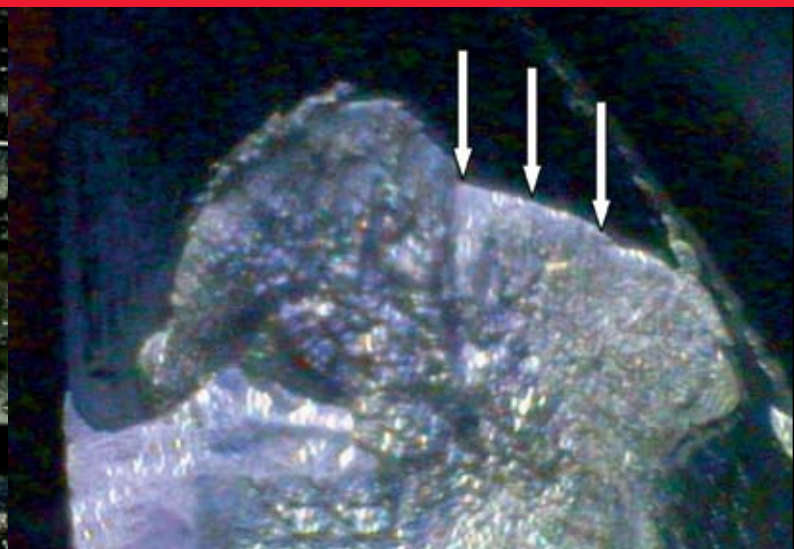
Picture 13: The gear oil ADDINOL Eco Gear 320 S has been used now for 20,515 hours in the same gearbox of the wind mill. Surface and edges of pitting have been smoothed, further breakouts could be prevented, and there are no bearing damages in this gear unit.

As the use of ADDINOL Eco Gear 320 S was so successful the operator changed other wind mills to Eco Gear S and always achieved positive results.

Picture 12: Strong pitting



Picture 13: Smoothened



A ADDINOL Eco Gear – types, specifications and typical values

ADDINOL Eco Gear is available in three product lines:

ADDINOL Eco Gear M

Silicone free, mineral oil based, high-performance gear oils with Surftec®
ISO VG 100, 150, 220, 320, 460, 680
Temperature range: -10 °C up to +100 °C



ADDINOL Eco Gear S

Silicone free, synthetic high-performance gear oils with Surftec®
For thermally heavy loaded gears
ISO VG 100, 150, 220, 320, 460, 680
Temperature range: -30 °C up to +120 °C



ADDINOL Eco Gear 68 S-T

Silicone free, synthetic high-performance gear oil with Surftec®
Outstanding flow behaviour at low temperatures, pour point below -50 °C
ISO VG 68
Temperature range: -50 °C up to +120 °C



ADDINOL Eco Gear outperforms:

- ➔ DIN 51517-3 (Conventional gear oil)
- ➔ ISO 12925-1 as well as all requirements that matter technically

QUALITÄTSMANAGEMENTSYSTEM



DQS-zertifiziert nach
DIN EN ISO 9001:2000
Reg.-Nr. DE-000979QM

ADDINOL Eco Gear is compatible with:

- ➔ All commercial elastomeric sealing materials
- ➔ All conventional fluid sealing
- ➔ All regular internal coatings for gear units



ADDINOL Eco Gear is classified according to:

Water risk class 1 – no risk to underground water,
in Germany there are no special requirements for storage

ADDINOL Eco Gear is approved by leading gear manufacturers.

Please ask for the current overview of all approvals.

Picture 14: ADDINOL Eco Gear – the innovative solution for your industrial gear

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