

nanol

Summary

## Features

Nanol<sup>®</sup> is a unique, innovative and patented lubricant additive that reduces friction and wear. It increases efficiency, reduces fuel consumption, extends equipment lifetimes, reduces emissions and mitigates hydrogen embrittlement. These performance benefits have been proven and demonstrated in extensive field tests. Additionally, a wide range of third-party laboratory, rig and engine test have been carried out with Nanol<sup>®</sup> to support the performance claims.













The company has successfully carried out extensive field tests in many different applications, especially focused on the shipping sector. Currently Nanol has been used for more than 300.000 hours in 15 different 4-stroke engine types. Nanol<sup>®</sup> has delivered 2-6% reduction in fuel consumption that provides significant savings in operating costs.

The Nanol<sup>®</sup> additive can deliver many important performance benefits:

- Reduces friction, which increases energy efficiency
- Reduces wear and tear, which leads to longer lifetime of components, increased service and maintenance cycles and, eventually, to lower maintenance costs
- Lowers equipment downtime with longer service intervals
- More environmentally friendly with lower emissions and reduced waste

## Applications

The technology can be used in a wide range of different applications within transport, energy production and industrial applications.

Transport	Marine <span style="float: right;">①</span> 	Heavy vehicles <span style="float: right;">②</span> 	General automotive <span style="float: right;">③</span> 	Other (e.g. trains, agriculture) 
Energy production	Power plants (e.g. diesel generators) <span style="float: right;">①</span> 	Wind turbines <span style="float: right;">③</span> 	Other turbines 	Other (e.g. oil & gas) 
Industrial applications	Bearings <span style="float: right;">③</span> 	Mining <span style="float: right;">①</span> 	Industrial machines <span style="float: right;">③</span> 	Other (e.g. metal) 

- ① Nanol in commercial use
- ② Nanol being evaluated by customers
- ③ Nanol tested by leading research

## Technology

Nanol is a high performance unique additive for lubricant oils and greases. The additive technology is based on the selective transfer concept. Nanol<sup>®</sup> contains copper nanoparticles inside reverse micelles within a stable colloid that ensures the additive is completely soluble in oil. This prevents agglomeration and sedimentation that is a frequent problem with other nanotechnology based additives. The Nanol<sup>®</sup> micelles transport the

copper nanoparticles to the metal surface where, under boundary lubrication conditions, a thin copper tribofilm is formed. This tribofilm has low tangential strength and reduces the coefficient of friction.

Also unlike conventional lubricant additives, the NanoI<sup>®</sup> copper particles are continuously deposited to self-heal the tribofilm and ensure sustained and robust performance. This NanoI<sup>®</sup> copper tribofilm also has considerable compressive strength to protect against wear. It has been shown that the copper diffuses into the near surface of friction surfaces to further boost wear protection. NanoI<sup>®</sup> is also different to because the copper tribofilm is only formed on the friction surfaces where it is activated. As a result, the NanoI<sup>®</sup> additive is very selective and does not interfere with the function of other lubricant additives.

Extensive research carried out at Fraunhofer Institute in Germany has demonstrated that NanoI<sup>®</sup> also prevents hydrogen embrittlement by important interactions with reinforced multilayer tribofilms. These reinforced multilayer tribofilms are also critical constituents of the third body that influences running-in kinetics. Thus, NanoI<sup>®</sup> must be considered a multifunctional package including viscosity index improvement, friction modification, anti-wear properties and protection against hydrogen embrittlement (White Etch Cracking, WEC).

NanoI<sup>®</sup> is not considered to be “nanomaterials” in accordance with the Commission Recommendation of 18 October 2011 on the definition of a nanomaterial (2011/696/EU) (i).

## Chemistry

NanoI<sup>®</sup> is kept dispersed in the lubricant oil due to a unique reversed micelle structure in a stable colloid.

**NanoI is based on reversed micelle structure:**

- Produced by proprietary chemical process
- Cu<sup>0</sup> is the central atom surrounded by Cu<sup>2+</sup>
- Head group of copper oleate is attached to copper shell while non-polar tail spreads out to the surrounding oil.

⇒ **NanoI additive remains dispersed in oil**

<p><b>PHASE I: Adsorption of polar head groups to the friction surface</b> ⇒ Instant friction reduction</p>	
<p><b>PHASE II: Shear-induced disruption of micelles</b> ⇒ Formation of additional free polar head groups and copper nanoparticles ⇒ Redox reaction: Cu<sup>2+</sup> interacts with the iron of the surface and forms Cu<sup>0</sup> ⇒ Reinforced multi-layer tribofilm</p>	
<p><b>PHASE III: Diffusion to metal (intermixing)</b> ⇒ Due to intermixing sub-surface regions acts as self-regulating solid lubricant</p>	



### Contact

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