



## LUBRICANTS OF THE FUTURE (7)

The effect of GERnano® under difficult operating conditions and use of different fuels, especially biofuels.

The extension of oil service intervals by the use of GERnano, is one of many, important and unexpected effects.

During the use of GERnano in lubricants it was found that oil service intervals could be extended by a factor 3 to 10. All of the substantial parameter for a proper functioning were respected. In "LUBRICANTS OF THE FUTURE" 1 – 6 the effects of GERnano are explained in detail already.

The most important effects from GERnano are the formation macro-molecular structures, which improves the local viscosity at the frictional areas, increases the heat capacity of the lubricant and initiates the surface cleaning process. This leads to a reduction of the friction and wear, whereby the life span of the aggregates is being extended.

The thermodynamic conditions were mainly defined by the quality of the fuel used.

The increasing use of „local fuels“ like natural gas (Fracking), Biogas and biodiesel fuel with a high sulfur content leads to shorter oil change intervals, as these fuels contain many contaminations which have a negative effect on the lubricants. Very quickly, the formation of residues and crack-reactions can be observed.

The use of GERnano counteracts this process. This happens through the cleaning capabilities of GERnano and the lasting regeneration of the frictional surfaces in the engine.

CHP's are often operated with bio-fuels (Biogas, Bio-Diesel) with an increased sulphur contents. In these cases, the oil change intervals are carried out after 300 – 400 operating hours. This means that at continues operation, every 15 – 20 days (around 20 times p/a) an operation interruption is due to an oil change interval.

By the use of GERnano the oil change intervals are extended, even under difficult conditions, and resources are spared and economics increased.

The experiences of GERnano using customers who carry out oil analysis on regular bases, show that the characteristics established by the laboratory not always comply with the recommendations of the oil manufacturer. This applies in particular the alkaline number TBN (mg KOH/g) as well as the wear of metals. The viscosity values remain constant.

This concerns mainly the following values:

- Viscosity: The viscosity is the most important value and indicator for an oil change. If the value reaches the allowed limit (especially the upper limit), an oil change is necessary. However, with the use of GERnano the oil change becomes necessary after some of the recommended oil changes. If the viscosity remains constant after some suspended oil changes, an oil change becomes needful after 5 – 10 suspended oil change intervals. This is required because the smallest residue particles accumulate and cannot be filtered out of the oil circulation system.



- TBN-Values: Basic oils consist mainly of hydrogen molecules which have a natural reaction with oxygen. The TBN values are registered as the sum of the additives which neutralises the acidity in lubricants and thus prevent the formation of hard deposits. This value shows the neutralisation capacity of the lubricants.

The process of acid formation starts at the frictional surfaces of the engine which heat up by the hot exhaust gasses. This leads to the formation of deposits of tar and carbides on the pistons, piston rings, valve and cylinders. These residues form varnishes which influence the viscosity of the lubricant. At the same time, aggressive, organic acids are formed. These acids react with non-ferrous metals and their alloying components and leads to corrosion, especially at the sliding surfaces of the conrod bushings. Also, combustion residues of the fuel will get into the oil system and enhance this process.

The alkaline additives should slow down the acid formation process. According to current knowledge there is no traceable link between the neutralization number and its lubrication and corrosion protection properties. To this extent, from today's point of view this is hardly significant for the lubrication capacity of the oil.

Through the use of GERnano and the use of normal fuels, the TBN value remains constant within the allowed limits for the entire service life of the oil.

When using fuels with high sulphur content, the TBN values may be below the recommended values. This can be ignored when GERnano is applied, since the frictional surfaces are permanently protected against contamination by GERnano.

**Wear of metals:** During the initial application of GERnano, all deposits are released from the frictional surfaces as a result of the cleaning process, the number of metal particles as well as the contamination in the oil will increase.

The oil and filter changes reduce the number of metal particles to a minimum. The cleaning and wear-protection effect of GERnano® is now permanently applied.

The extended use of the lubricant leads to considerable economic savings. Also the environmental benefits are obvious.

Remark:

The question often arises how a small amount of our technology (20 mg powder per 1l oil volume) can generate such an effect. The 20 mg appear initially as not worth mentioning, however at a closer look, it's not that small.

The average primary particle size of GERnano® powder without graphite is approx. 7 nm. If we would align the particles of 1 g of powder in a chain, this would create a chain with a length which corresponds to 17 times the distance from the earth to the moon.

The BET surface area of GERnano® including graphite is 155 m<sup>2</sup> / g.