GETRIEBE Renovator NanoVit

EFFICIENCY TECHNOLOGIES

# Analysis and simulation of friction and wear processes using sliding stress – Universal tribometer

## TÜV Thuringia examination extracts

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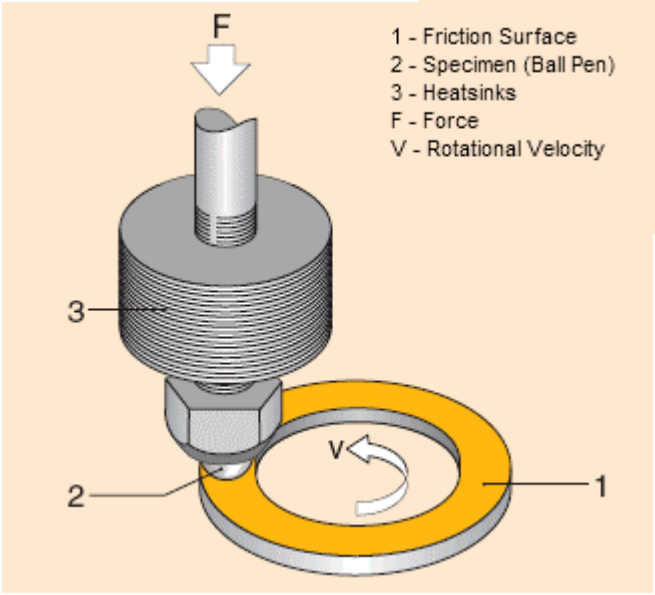
The **Universal tribometer type TRM 1000** used to study and simulate friction and wear processes with sliding stress.

During friction value measurement a stationary sample test specimen (pin of 100Cr6 steel) is pushed by a defined force against the front surface of a rotating disk (100Cr6 steel). Both parts are vertically arranged.



**Tests will be made with NanoVit additive 85W90 GL-4 gear oil and compared to non-additive gear oil of the same 85W90 GL-4 type.**

**1. Test - determine the friction coefficient**

- 0.5% working concentration (5 ml NanoVit ASC181-/ 1 L Neutral) – “A” test oil
- 2.0% working concentration (5 ml NanoVit ASC181-/ 1 L Neutral) – “B” test oil

**2. Test - Determination of wear**

- 0.5% working concentration (5 ml NanoVit ASC181-/ 1 L Neutral) – “A” test oil
- 2.0% working concentration (5 ml NanoVit ASC181-/ 1 L Neutral) – “B” test oil

**3. Test - surface structure of the specimen**

-Wear Image Analysis

**Test on Universal Tribometer**

Pretreatment: Storage of specimens in the NanoVit-GR - Test Oil
- Time: 120 minutes
- Temperature: 50 ° C

| | |
|---|---|
| Test load: | 300 N to 1,000 N / load level View |
| Lubricants: | Additional continuous lubrication |
| Emergency shut-down: | If you have high wear |

**The problem**

A modern transmission should synchronize easily on the one hand, on the other hand it should be resistant to high surface pressures and surface stresses to prevent wear and pitting.

The general requirements for a transmission system are simply determined by the requirements for operation.

On the touching friction surfaces of gears there are corresponding high pressures. As a consequence of friction thermal influences develop.

Thus, a transmission lubricant system needs to ensure the following functions:

- Lubrication
- Shear stability of the lubricant
- Reliable wear protection for transmission components and seals
- Anti-foaming
- Temperature control
- Corrosion
- Load-carrying capacity
- Prevention of pitting
- Dispersing
- Insensitivity to metal
- Mixing with other lubricant

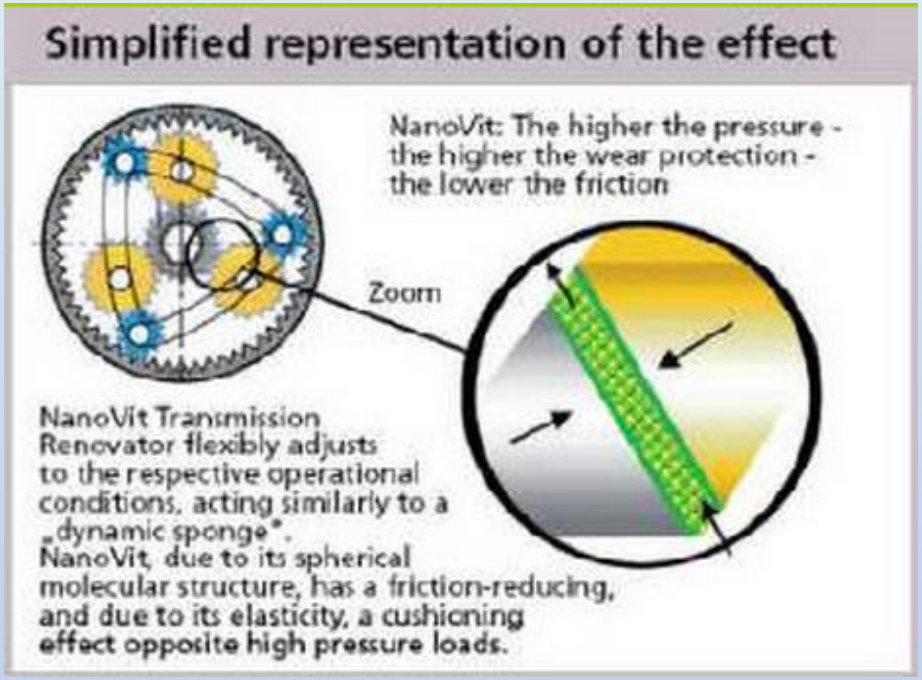
**NanoVit Gear Renovator**

The NanoVit-gear Renovator guarantees a long-term wear protection for all types of gears.

The specially designed active components ensure that the surfaces of the transmission's moving parts are coated with a firmly adherent and elastic anti-friction surface with a long-lasting, structural effect.

The friction loaded metal surfaces in the transmission now form a metal-organic connection, thus wear and friction are reduced and the lifetime of the Transmission is significantly extended.

NanoVit has no influence on the formulations and formulations of lubricants, and forms no rigid film layers. NanoVit is effective beyond oil changes.

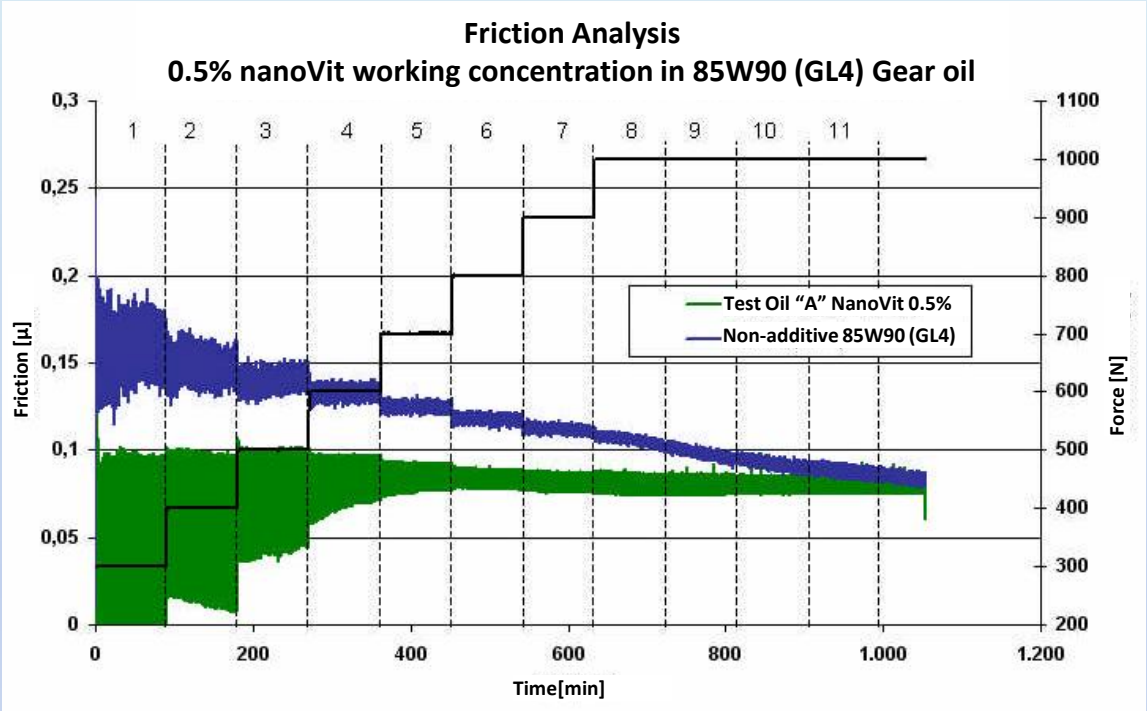



NanoVit Gear Renovator for manual transmissions consists of 99.9% 85W90 GL-4 and <0.1% NanoVit

NanoVit Gear Renovator for automatic transmissions consists of 99.9% ATF 75W and <0.1% NanoVit

# Test results - Friction analysis with 0.5% NanoVit

RESULT: The NanoVit Gear Renovator is consistently below the friction coefficients of non-additive transmission oil. The smallest friction coefficient of NanoVit Gear Renovator is 0.0001 µ, for non-additive oil the lowest value is 0.08 µ. The largest value for NanoVit Gear-Renovator is 0.075 µ, for non-additive oil it is 0.2 µ.




Lower friction means lower operating temperature. In consequence there is less oil wear and less material wear.

# Test results - Friction analysis with 0.5% NanoVit

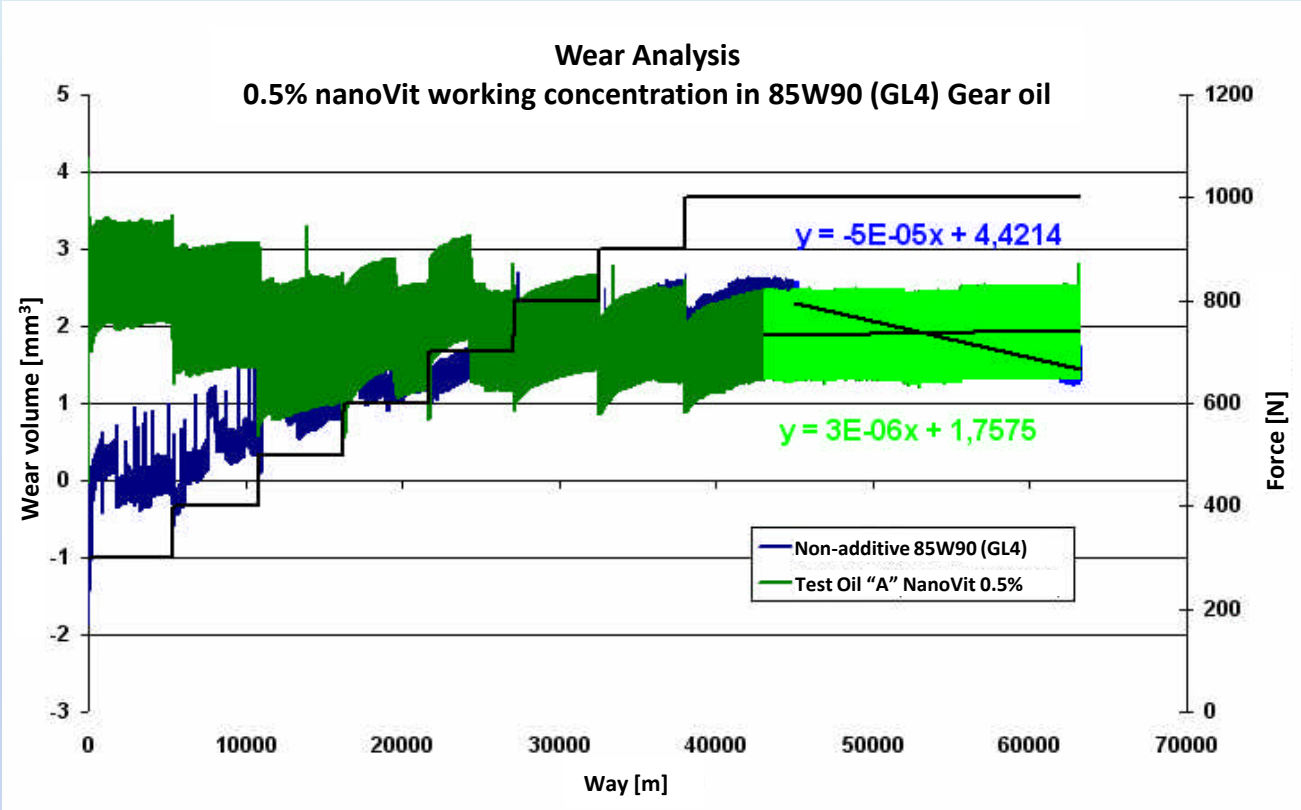
For the test a force profile of 300 N - 1,000 N was used. The graph shows a clear difference between the frictional resistance of the non-additive oil and the NanoVit Gear Renovator test oil; NanoVit oil has lower frictional resistance in all the test loads.

If we compare the friction curves with one another it is noticeable that the friction coefficient for NanoVit oscillates over a wider range than the non-additive gear oil. (Oscillation is typical for this test)

The maximum reached is 0.1 µ, the smallest friction coefficient 0.0001 µ. This is caused by the deposited NanoVit components on the surfaces. These work against the externally influencing pressure and thus protect the friction surface from wear.

It is interesting that the friction value oscillation decreases with increasing test loads. That Friction value oscillation becomes constant starting from 700 N with 0,075 m and remains constant regardless of test load upto the test maximium at 1000 N. This result is remarkable, since friction means heat is produced, which negatively affects the viscosity of the oil.

With rising temperature the viscosity, and thus the friction resistance, decreases (see friction value curve of the non-additive transmission oil). The danger of a lubricating film break is therefore higher as temperature is raised. The transmission oil treated with NanoVit does not exhibit this effect. The NanoVit components counter the temperature induced viscosity decrease in the oil, effectively preventing a lubricating film break.




CONCLUSION: This result for non-additive 85W-90 GL-4 shows a specific wear rate of 5 * 10-5 mm ³ / Nm and for the NanoVit Gear oil, a value of 3 * 10-6 mm ³ / Nm.

## Test results – Wear analysis with 0.5% NanoVit

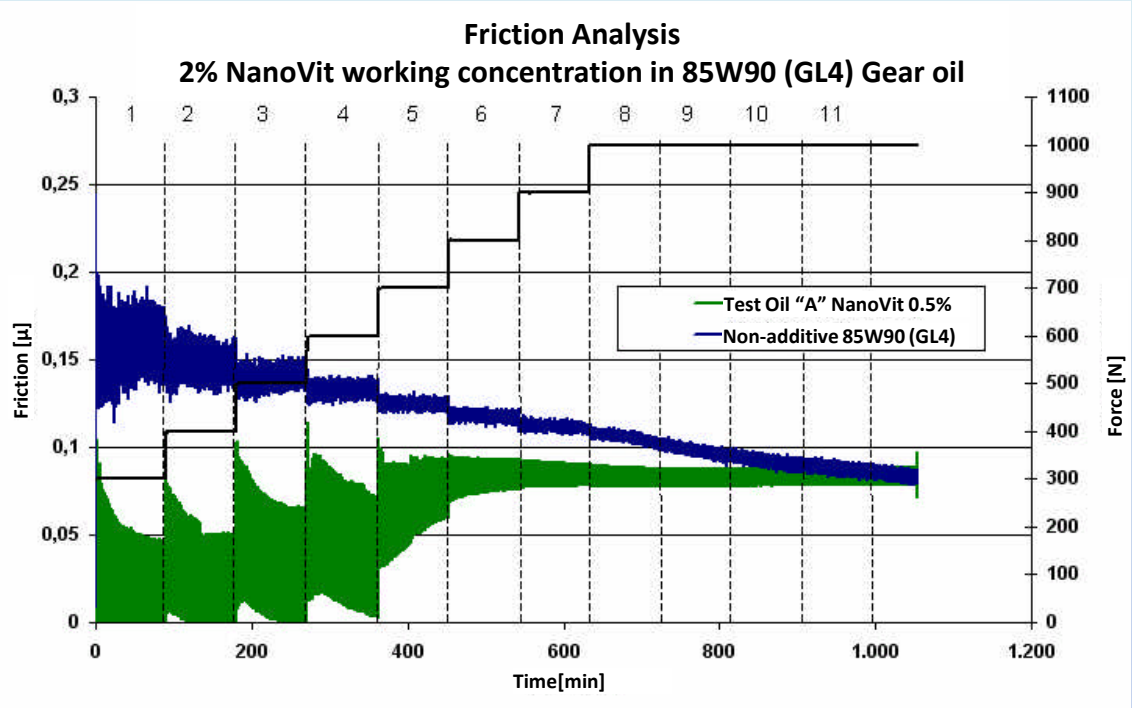
With this test set-up the determined wear values depend strongly on the dominant process temperature. If the temperature rises, then the inspection piece expands. The wear characteristic values also rise. Once the temperature is stabilized, the test equipment sensors can measure the direct material removal or wear. In this case the wear curve drops.

In the non-additive oil it is evident that the frictional energy generated causes the specimen and the transmission oil to heat up. The curve trend of 300 N - 900 N is rising. Because the target area of the wear analysis is 1000 N, the testing time at this level was extended 6-fold. The temperature stabilizes at this load. The curve trend is clearly decreasing.

The curve trend of the NanoVit test oil is significantly different. The curve trend is nearly a straight line, which is equated with very little wear. Particularly striking is the trend of the curve at 1,000 N. Only very low wear is detectable.

In the final analysis, the 0.5% NanoVit working concentration oil showed that the wear resistance of the 85W-90 GL-4 was improved by 94% (an improvement of 94% to 6% over the non-additive oil)

In this analysis, the transmission oil was prepared with 2% NanoVit Gear Renovator added. The aim of the study is to examine higher concentrations to determine their possibly different effects on the wear protection.




As in Test 1, the friction values are well below the non-additive gear oil.

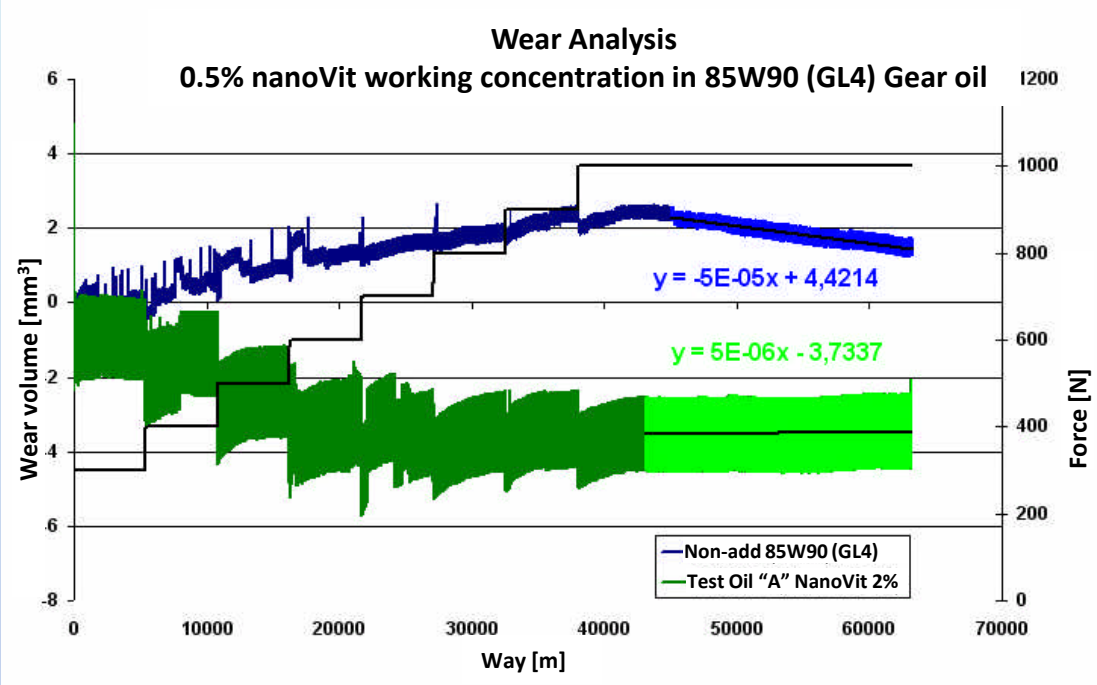
The experiments have shown the over-concentration has no adverse effect on the wear protective effect of NanoVit Gear Renovator.

The result the wear analysis showed it could be determined that the use of 2% NanoVit Gear Renovator also equips the transmission with a wear protection around 90% better than if a commercial transmission oil were used (i.e. an improvement around 90% to 10% opposite the non-additive oil).

Looking at the curves from the non-additive gear oil, it is evident that the heat generated by friction causes the test apparatus to heat up (as in the first test). The cooling effect of the oil in this phase is non-existent.

The temperature only stabilizes during the prolonged period at 1,000 N. The wear on the sample piece can then be determined.

The wear curve of NanoVit GR shows a downward slope trend in all phases. The generated friction heat is intercepted by the gear oil.




The target area of the wear test is at 1000 N. Here the NanoVit-GR curve has an almost linear trend. This shows the concentration provides an effective protection against wear. The curve trend of the NanoVit gear oil is not falling away. The wear protection is clearly visible.

The 85W-90 GL-4 non-additive oil has a specific wear rate of 5 * 10-5 mm ³ / Nm, and for the NanoVit-GR test oil has a value of 5 * 10-6 mm ³ / Nm. In the final analysis, the 2.0% NanoVit concentration shows the wear protection of 85W-90 GL-4 was improved by 90%.

## Test results - Wear pattern analysis

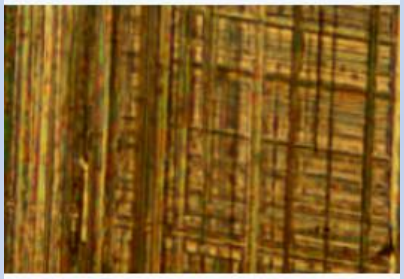
To determine the wear protection abilities of a product or additives, it is necessary (in addition to the recording of technical test data) to carry out an optical analysis of the worn surface.

Wear pattern on the test disc
- 100 x magnification

85W-90 GL-4
Test load
1,000 N
Mileage 63,000 m

In the test image it is evident how the 85W90 transmission oil thermally decomposed due to the development of high temperature . The residues are deposited as an oil-plaque (black) on the friction surfaces, producing wear.

NanoVit GR test oil 0.5%
Test load
1,000 N
Mileage 63,000 m



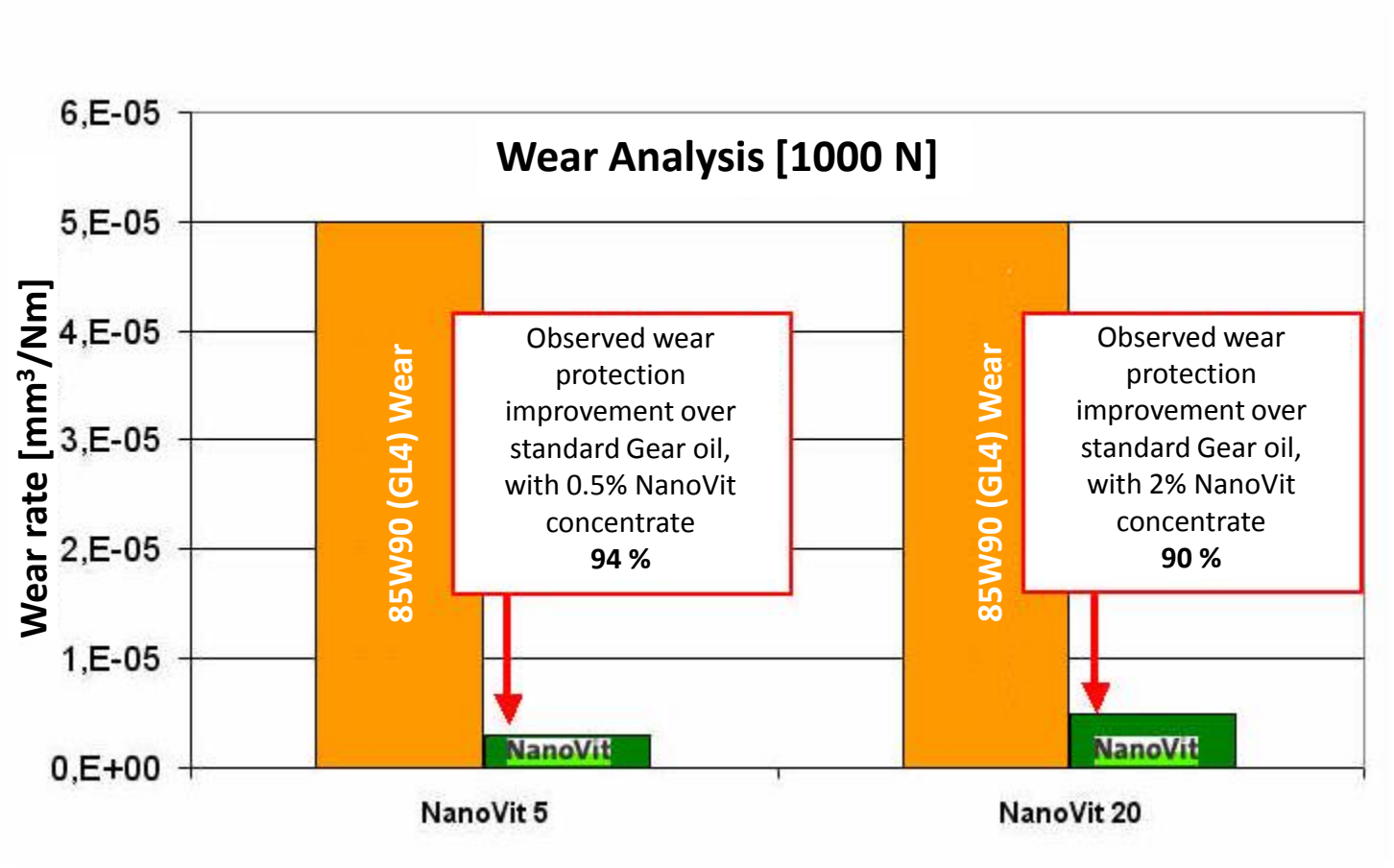
Looking at the wear surfaces of the specimens from NanoVit-GR as compared to the non-additive specimens shows significantly reduced transmission oil plaque. Annealing discolourations are evident in the typical friction areas.

NanoVit GR test oil 2%
Test load
1,000 N
Mileage 63,000 m

In this application, it shows the lowest accumulation of oil plaque. The friction surface is protected. The typical discolourations do not occur very often, indicating a near perfectly adjusted friction process.

**Conclusion**: Optical analysis confirms positive results for the wear protection analysis for NanoVit. With the application of NanoVit the standard transmission oil wear protection deficits have been successfully prevented.

## Summary / Interpretation



## Summary / Interpretation

The results of this test have shown that by using NanoVit Gear Renovator the frictional resistance could be significantly reduced and the wear protection significantly improved against standard 85W90 gear oil.

A direct consequence of the shear zones are therefore lower loads, which has less wear. At the same means to reduce the frictional resistance of the lower thermal stress Transmission oil, which counteracts the wear and the drop in viscosity of the oil.

The non-additive gear oil optical examination shows significant carbon deposits, in the form of an oil plaque on the friction surfaces which generates additional wear. NanoVit Gear Renovator effectively prevented this.

The wear analysis showed that in the tested concentrations, a very good wear protection could be built on the friction surfaces.

The NanoVit Gear Renovator ensures

- Long-term wear protection
- High compressive strength
- Reduced friction
- Viscosity improvement in the oil

**NanoVit Gear Renovator is awarded “Certified proof of efficacy”**