

NanoLub[®]

SURFACE RECONDITIONING NANO-LUBRICANTS



NanoMaterials
Active Protection NANOMaterials APNANO



CALTEX



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Compressor EP VDL mineral oil

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NanoLub[®] Compressor EP VDL mineral oil

- In this document is consolidated 4-balls EP and AW performed on following samples :
- Compressor EP VDL oil
- Compressor EP VDL oil formulated with NanoLub additives.

4-ball machine

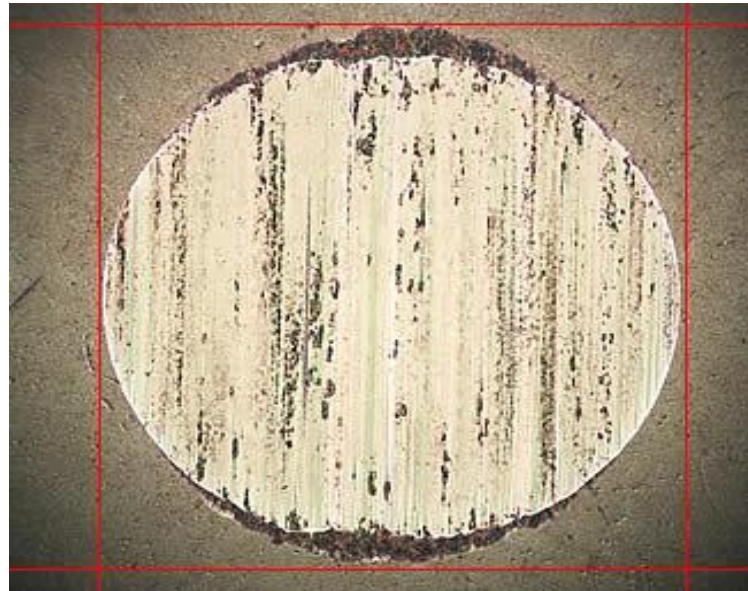


4 Balls AW description:

- To compare the anti-wear performances of Compressor EP VDL oil as is vs. Compressor EP VDL oil formulated with NanoLub additives. The 4 Balls ASTM D-ASTM 4172 is used at 75°C.
- This test method covers the determination of the wear preventive characteristics of oil in sliding steel-on-steel applications with total immersion of tested balls into the oil. It is not intended to predict wear characteristics with metal combinations other than steel-on-steel or to evaluate the extreme pressure characteristics of the lubricants.
- Three 1/2 inch (12.7 mm) diameter AISI 52100 steel balls are clamped together and covered with the lubricant to be evaluated. A fourth 1/2 inch diameter steel ball, referred to as the top ball, is pressed with a force of 40 kg (392 N) into the cavity formed by the three clamped balls for three-point contact. The top ball is rotated at 1200 rpm for 60 min. Lubricants are compared by using the average size of the scar diameters worn on the three lower clamped balls.

Measuring:

- After testing, scar diameters are measured on each of the three clamped balls. Figure illustrates a typical wear scar on a ball. The measurements are made thanks to a binocular microscope associated with a numerical video camera that allows precise measurements through adequate software and calibration.
- The mean value of the three scar diameters is reported and gives the anti-wear characteristic of the tested fluid as described in ASTM D 4172. Because of repeatability questions, each lubricant is tested three times following the same procedure.

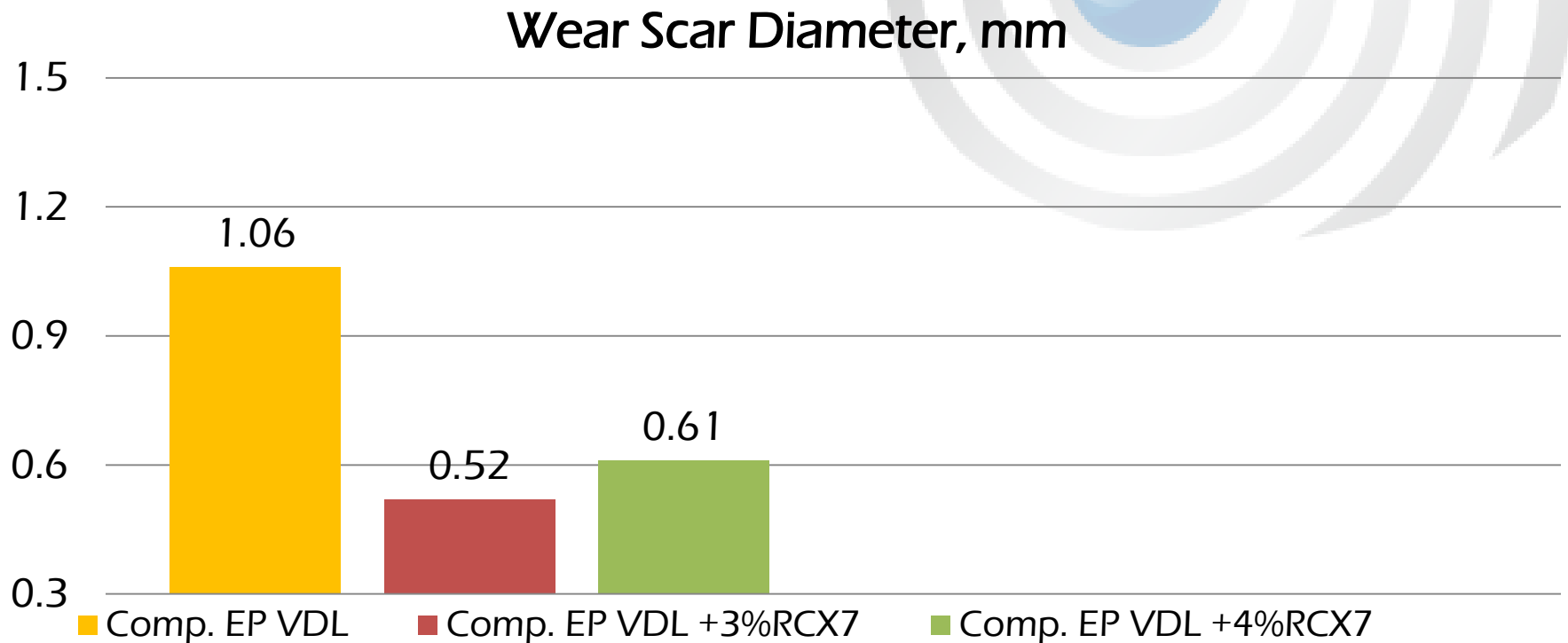


Wear Scar Diameter Test Results:

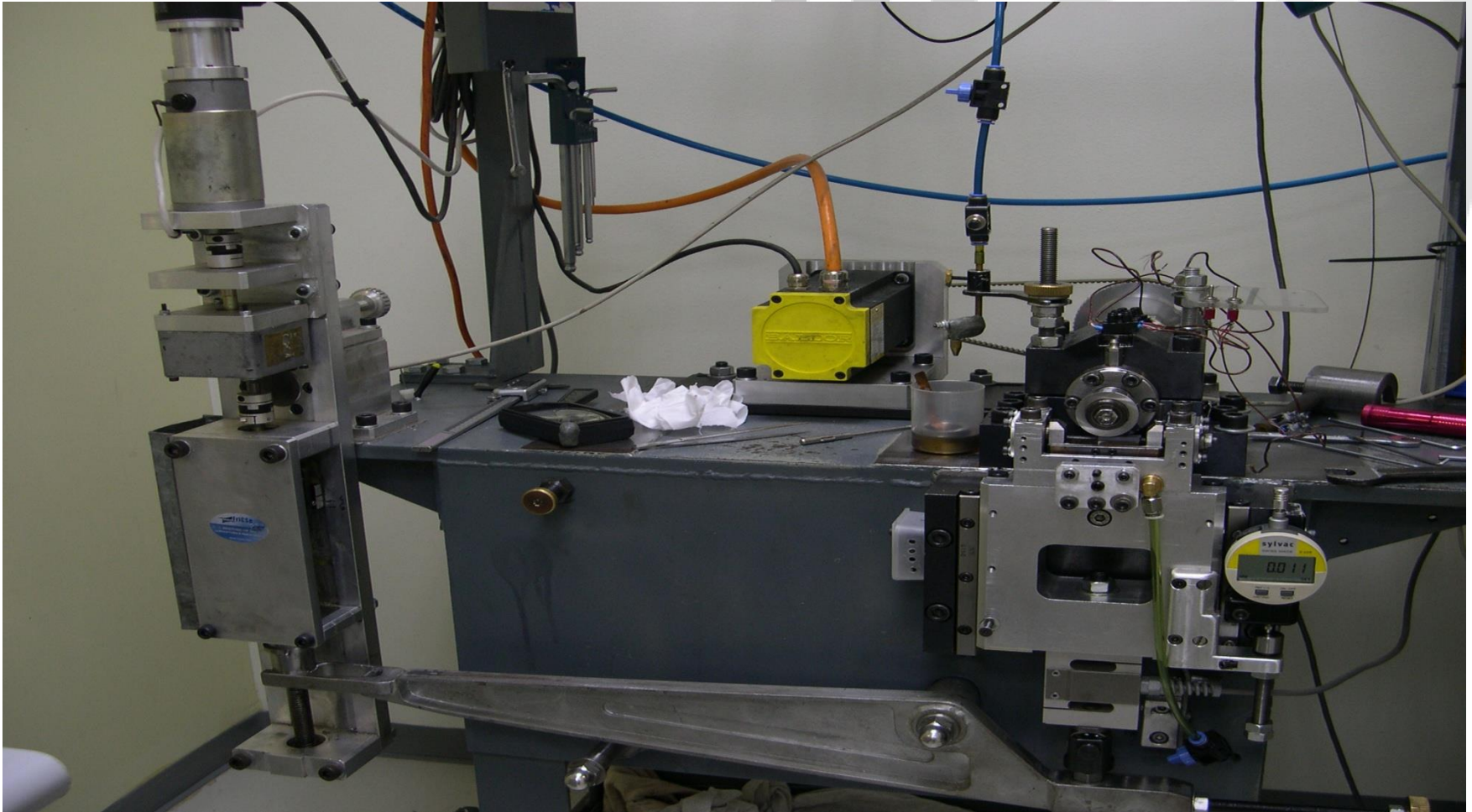
	Compressor EP VDL oil as is	Compressor EP VDL +3%RCX7	Compressor EP VDL +4%RCX7
WSD, mm	1.06	0.52	0.61

Wear Scar Diameter test results:

Compressor EP VDL oil as is vs. Compressor EP VDL formulated with Nanolub products



Roller-On-Block Tribotesting Machine



Roller-on-Block Tribotesting Machine

- Roller-on-Block
- Coefficient of friction and wear rate (WR) measures were performed using a roller -on- block test machine, approaching guidelines to the international standard ASTM G-77.
- Vertical load on the steel block (SAE 4340) ,roller is rubs on the surface of the block with the constant speed .
- The tests was done under boundary lubrication conditions.
- The measurements were performed according to the parameters given below:
- Load 500 N
- Speed 0.6 m/s
- Roller diameter 38 mm, width 10 mm
- Block width 10 mm
- Way 1000 meters

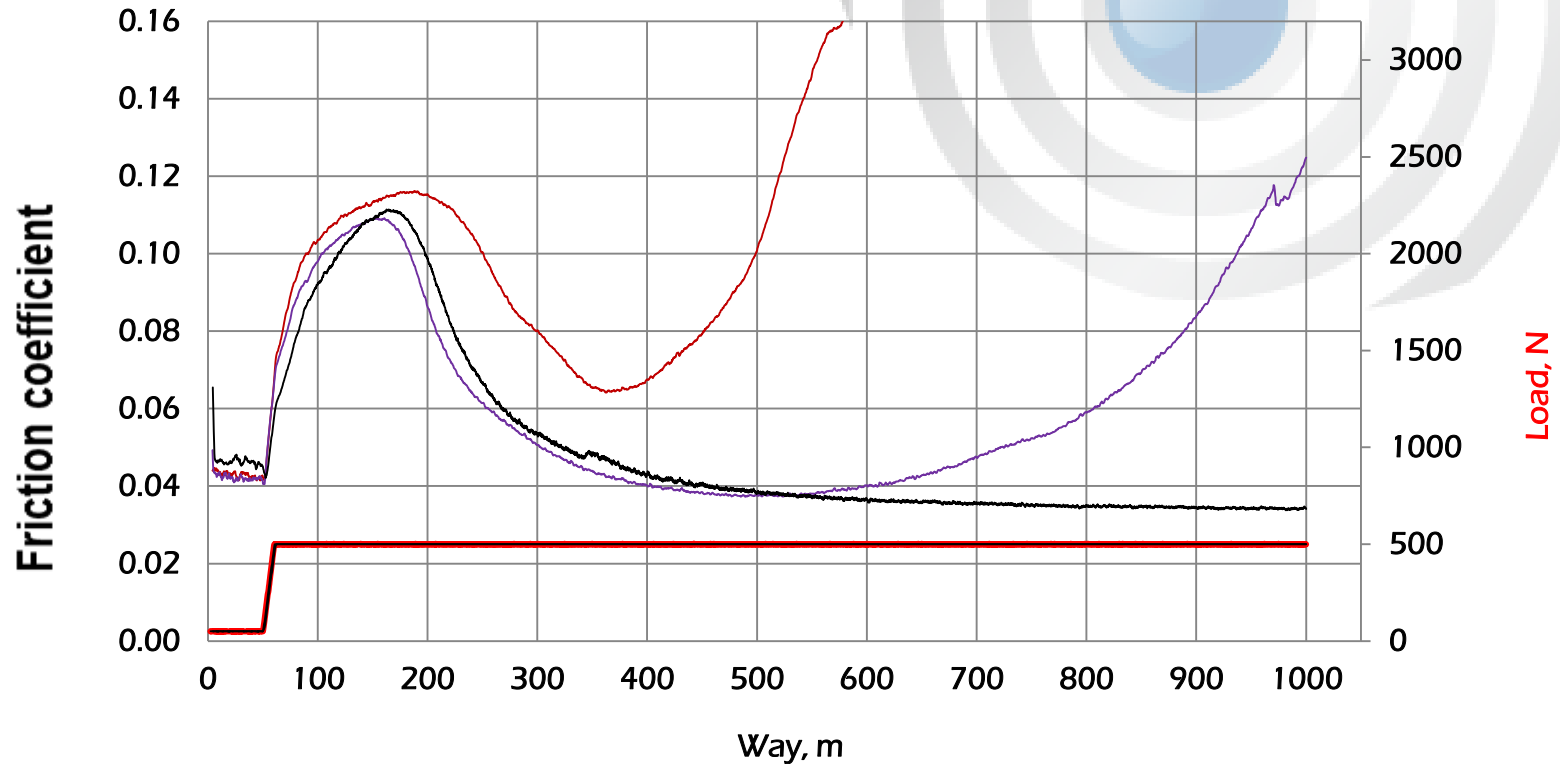
Test "Roller-on-Block"

Friction Coefficient

Compressor EP VDL vs. Compressor EP VDL +3% RCX7

Way 1000 meters

500 N, velocity 0.6 m/sec



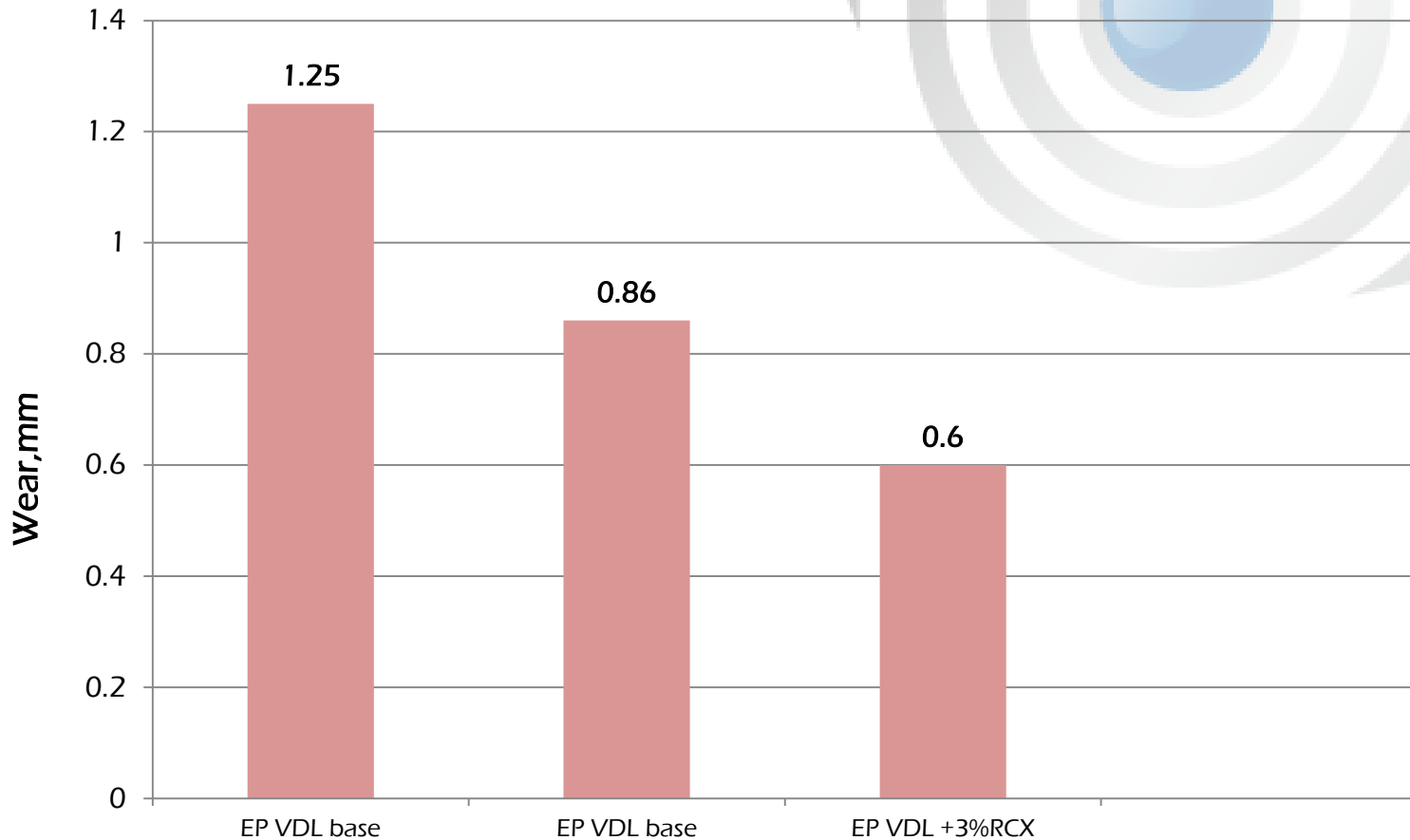
EP VDL-100 base

EP VDL-100 base

EP VDL-100+3%RCX7

Roller-on-Block test results: Wear Data

Compressor EP VDL vs. Compressor EP VDL formulated with 3% RCX



Conclusions:

- The laboratory study using 4-ball machine and further testing on Roller-on-block friction machine, clearly demonstrates the positive impact of NanoLub RCX7 on lubricants used for compressor applications.
- Based on the test results of ASTM G-77, on the graph clearly seen a sharp deterioration of the lubricating properties of the base oil due to the hard abrasive wear and as a result high CoF value, while formulated with NanoLub oil was stable throughout the test.
- According to the all test results we can conclude that the NanoLub RCX7 reduces wear of about 50%.
- Recommended treat rate is 3% of RCX.