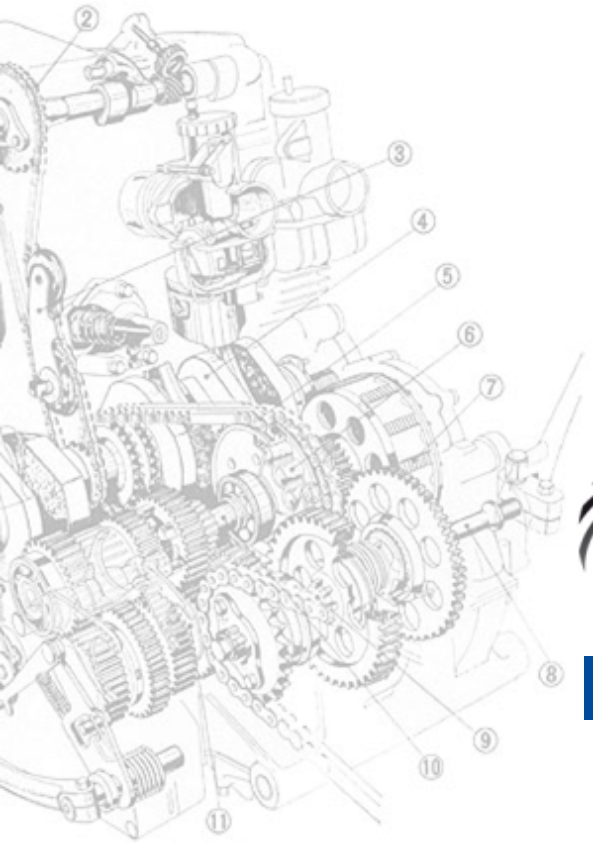


NanoLub®

SURFACE RECONDITIONING NANO-LUBRICANTS

NanoMaterials
Active Protection NANOmaterials APNANO

31/3/2015

Engine oil test for Lascor

Done by:
Larissa Drangai
Dr. Mark Lubarsky

NanoMaterials
Active Protection NANOmaterials APNANO

Engine oils

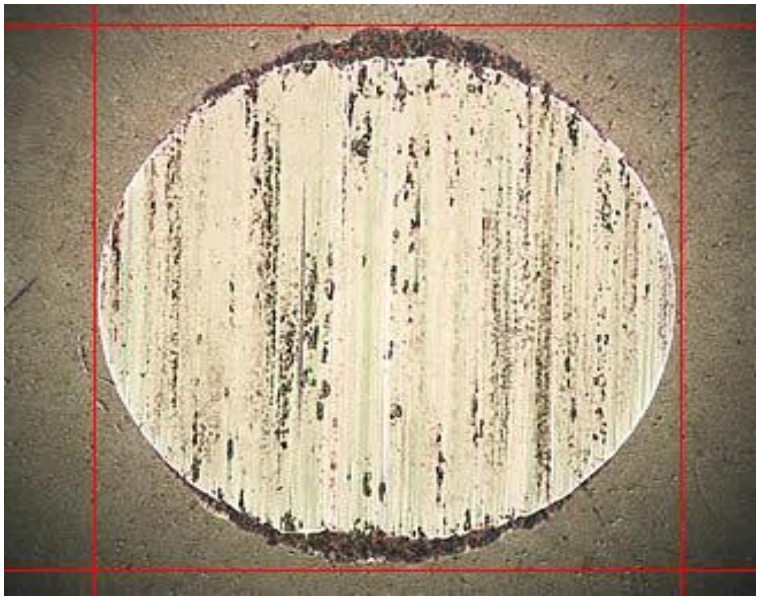
- In this document is consolidated 4-balls EP and AW performed on:

- Caltex Delo 400 Multi 15W40 engine oil

4-ball machine

Measuring:

- After testing, scar diameters are measured on each of the three clamped balls. Figure is 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.



4 Balls AW description:

- To compare the anti-wear performances of Caltex Delo 40015W40 oil as is vs. Caltex Delo 40015W40 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.

NanoLub®

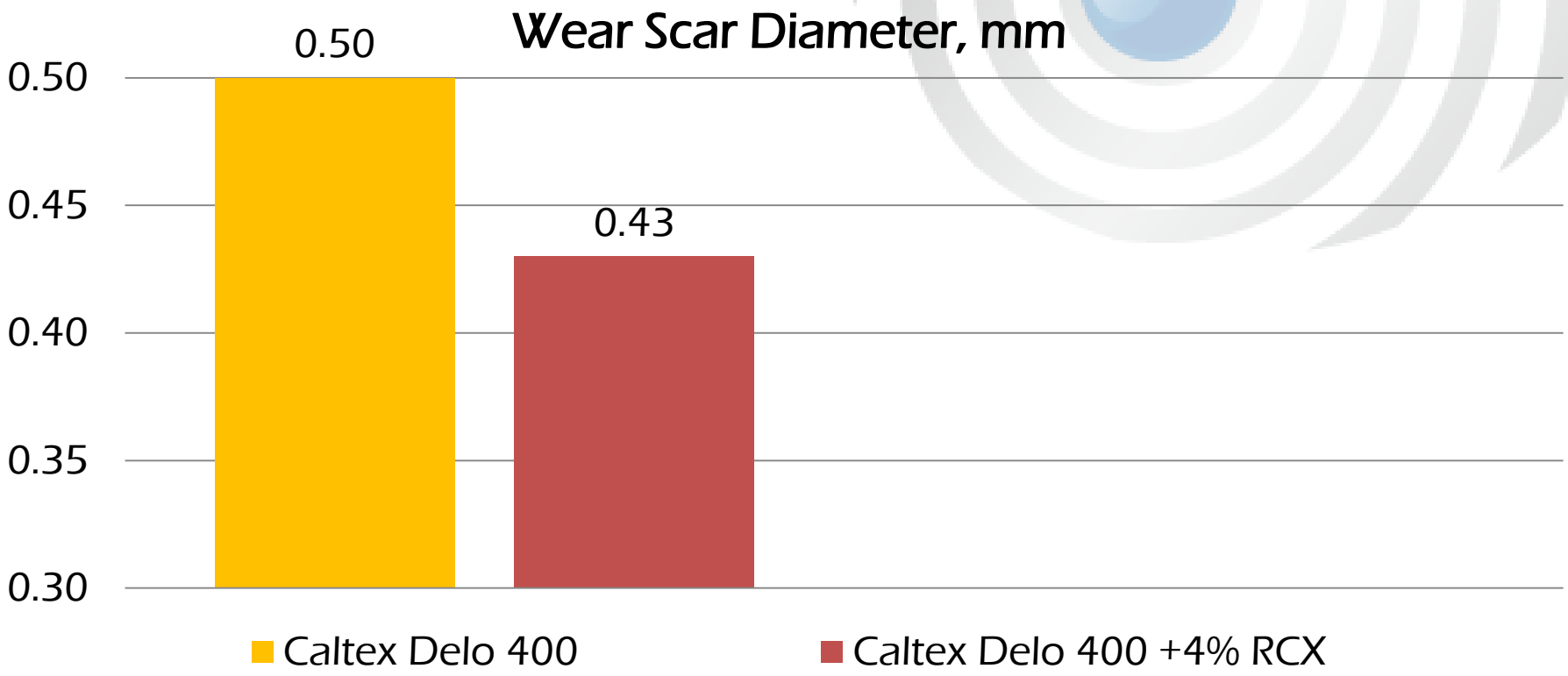
Wear Scar Diameter Test Results:

	Caltex Delo 40015W40 as is	Caltex Delo 400 15W40 +4%RCX
WSD, mm	0.50	0.43

NanoMaterials
Active Protection NANOmaterials APNANO

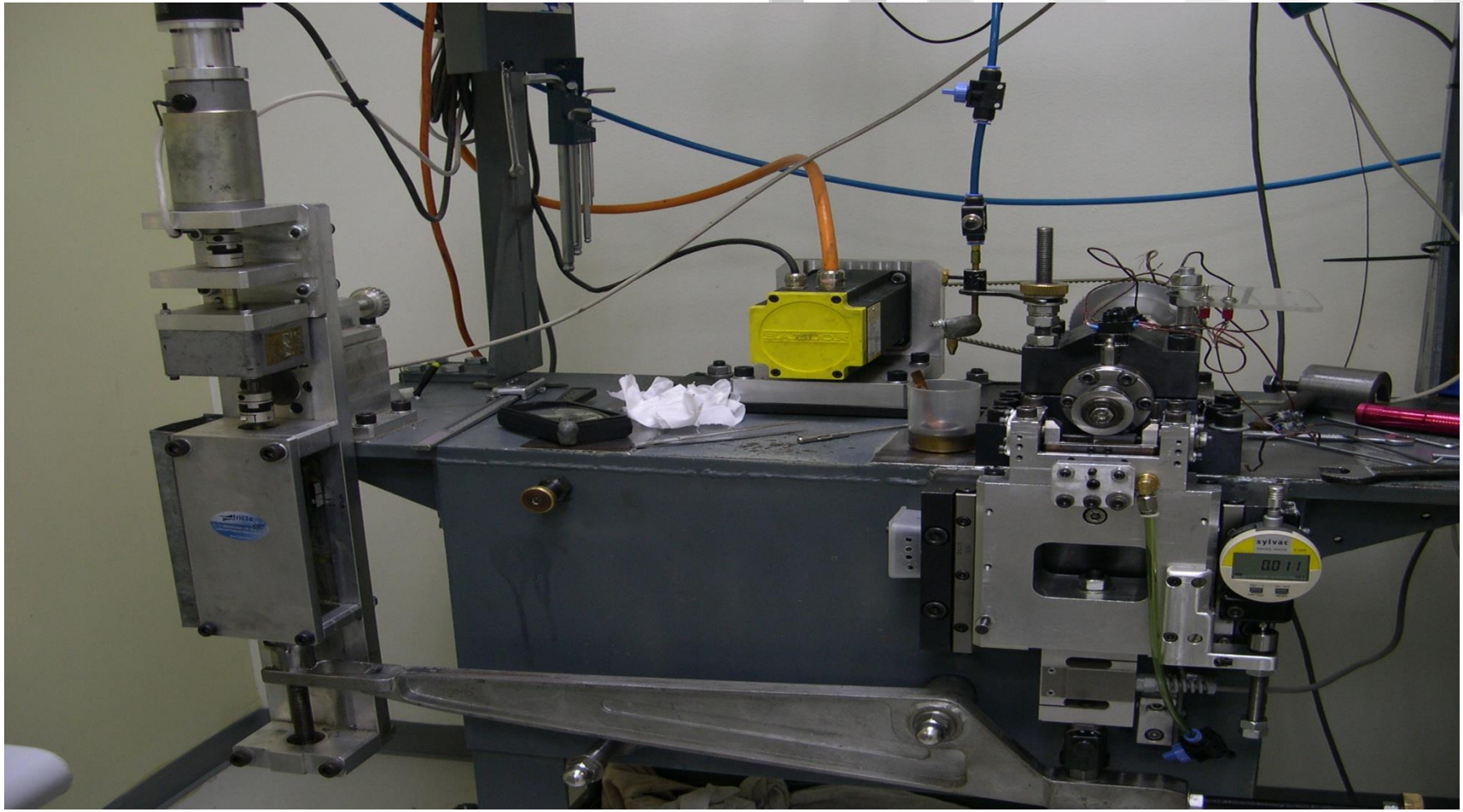
Wear Scar Diameter test results:

Caltex Delo 400 15W40 oil as is vs. Caltex Delo 40015W40 oil formulated with Nanolub products



NanoMaterials
Active Protection NANOmaterials APNANO

Roller-On-Block Tribotesting Machine



NanoMaterials
Active Protection NANOmaterials APNANO

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 300 N
- Speed 0.6 m/s
- Roller diameter 38 mm, width 10 mm
- Block width 10 mm
- Way 600 meters

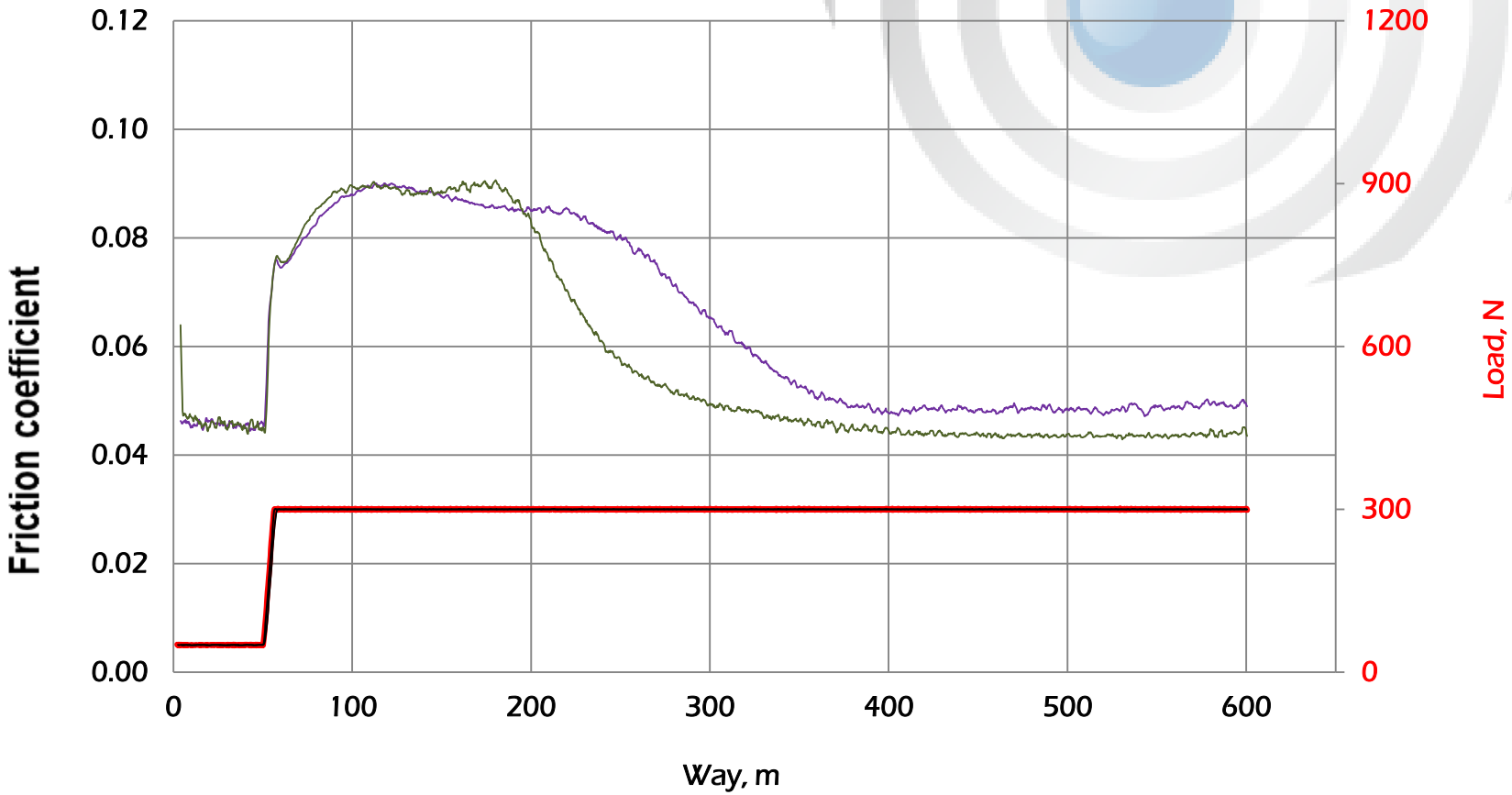
Test "Roller-on-Block"

Friction Coefficient

Caltex Delo 40015W40 vs. Caltex Delo 40015W40 +4% RCX

Way 600 meters

300 N, velocity 0.6 m/sec



NanoMaterials
Active Protection NANOmaterials APNANO

Conclusions:

- According to the study using 4-ball machine and further testing on Roller-on-block friction machine we got the following results:

  Caltex Delo 400 – According to the ASTM 4172 test results was found significant improvement of tribological properties of oil formulated with NanoLub additives of about 15% and CoF reduction of the oil treated with NanoLub additives ,according to the ASTM G-77.