



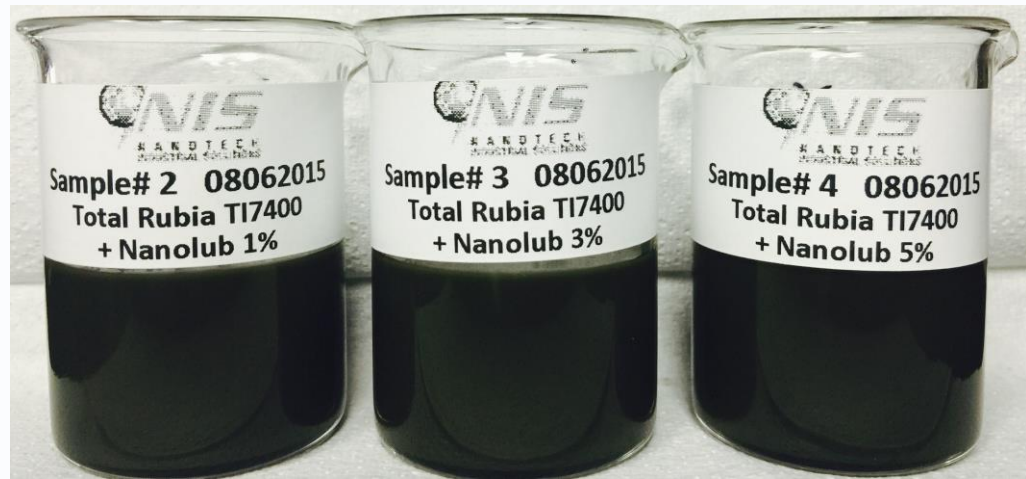
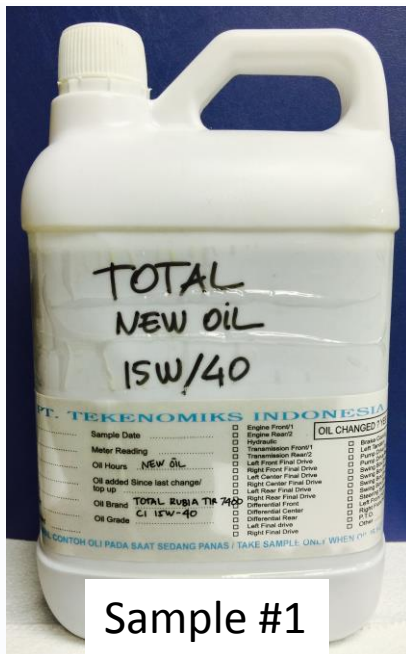
# Total Rubia TIR7400 15W40 with Nanolub<sup>®</sup>

**Test report**  
**08/06/2015**

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George Diloyan

# Samples Description

| # of Sample | Total Rubia TIR7400<br>15W40, wt% | Nanolub <sup>®</sup> , wt% |
|-------------|-----------------------------------|----------------------------|
| Sample #1   | 100                               | 0                          |
| Sample #2   | 99                                | 1                          |
| Sample #3   | 97                                | 3                          |
| Sample #4   | 95                                | 5                          |



**Sample #2**

**Sample #3**

**Sample #4**

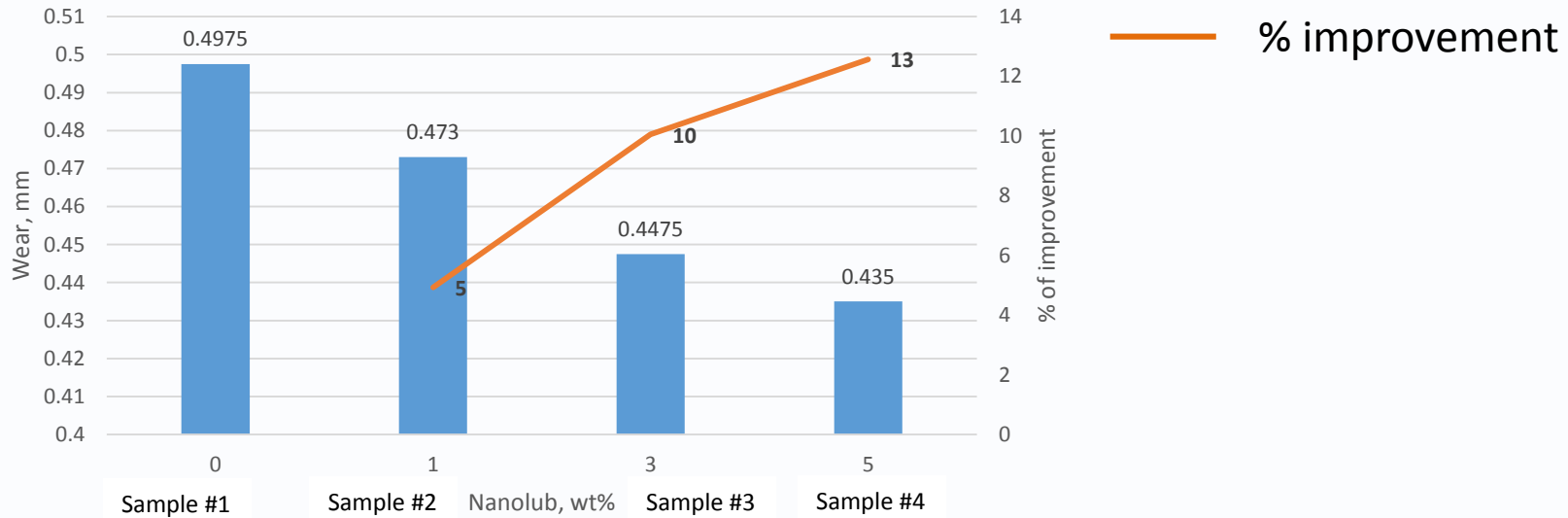
# ASTM D4172

## 4 Ball wear test

- To compare the anti-wear performances of Total Rubia TIR7400 15W40 vs. Total Rubia TIR7400 15W40 with NanoLub additives. The 4 Balls ASTM ASTM D4172 is used at 75°C.
- This test method covers the determination of the wear preventive characteristics of oil and greases in sliding steel-on-steel applications. 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.

## ASTM D4172 4 ball wear (1h length)

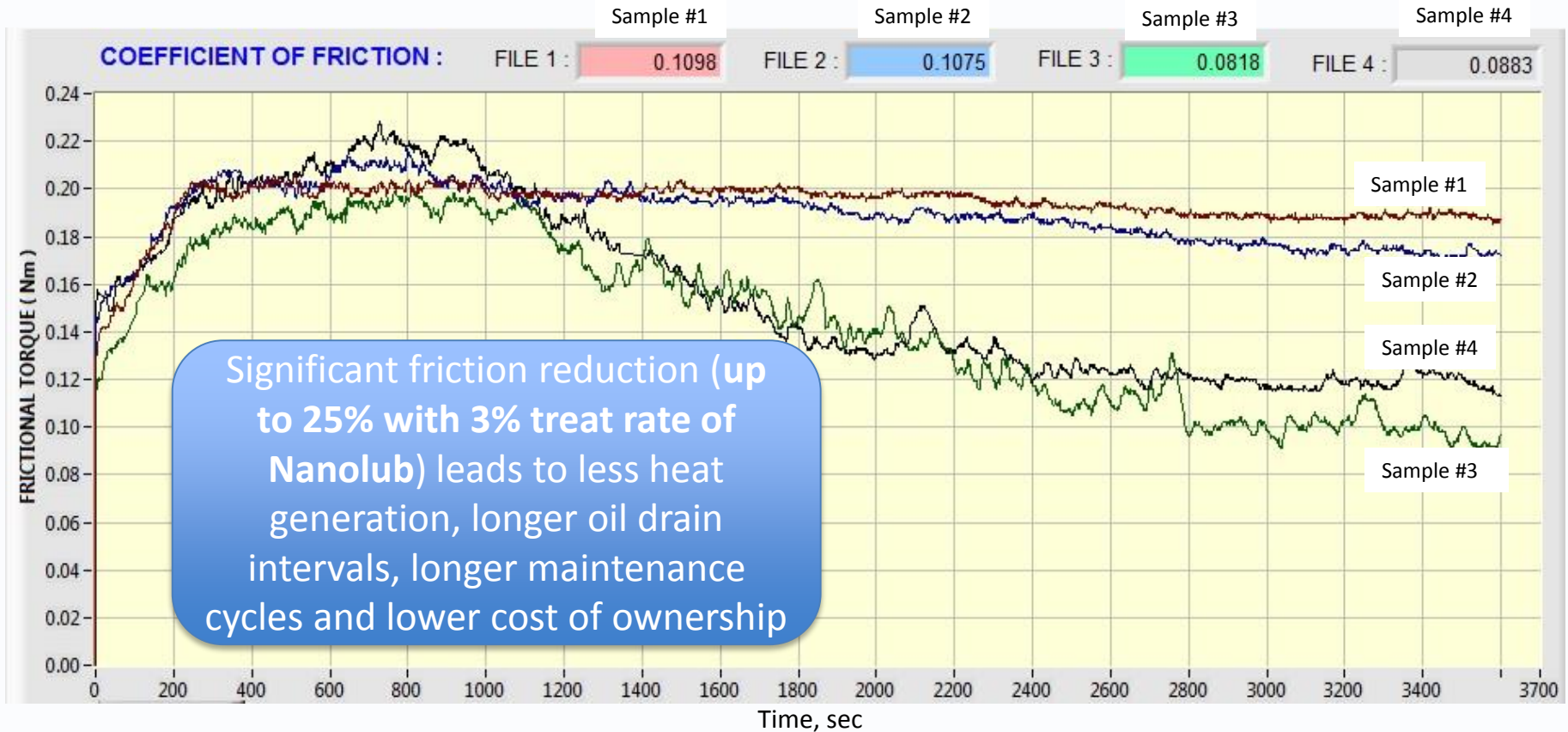
ASTM D2266 1h length Total Rubia TIR7400 15W40 with Nanolub®



Significant wear reduction (up to 13% with 5% treat rate of Nanolub) leads to longer life of equipment longer maintenance cycles and lower cost of ownership.

# Coefficient of Friction

## ASTM D4172 4 ball wear (1h length)



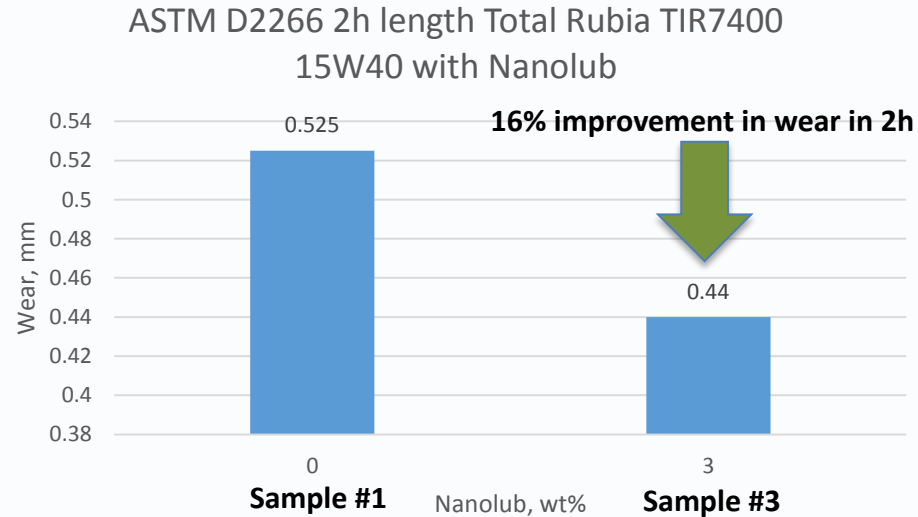
**For extended wear test (shown on next page 7) 3% Nanolub<sup>®</sup> treat rate have been chosen as optimal treat rate, based on cost/performance ratio.**

**5% Nanolub treat rate gives highest wear reduction with additional cost. It is up to customer to select treat level of Nanolub for their application.**



# Results

## Extended 4 ball wear test (2h length)

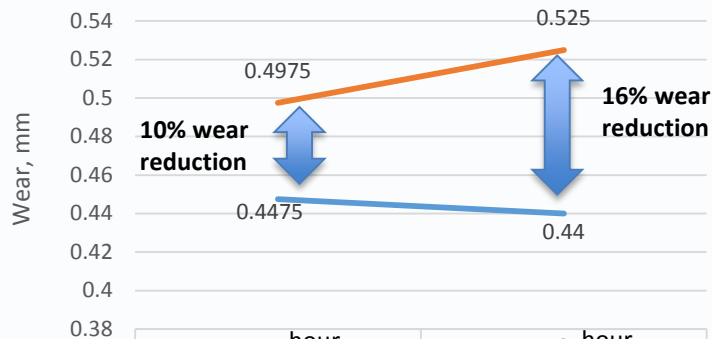


Extended 2 hour wear test showed further improvement in wear reduction (16% reduction in wear with 3% of Nanolub).

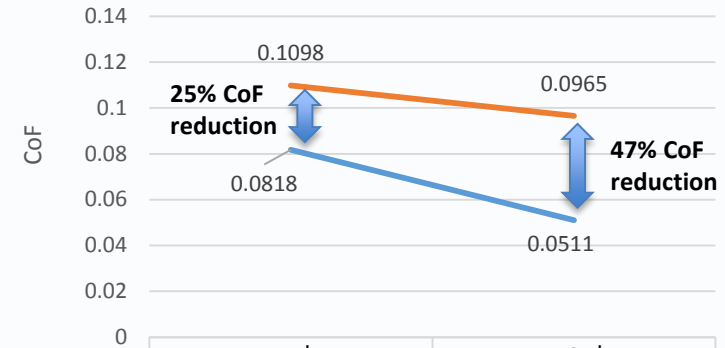
# Effect of test length on wear

## 1h VS 2h

Effect of test length on wear



Effect of test length on CoF



| Sample                                       | 1 hour | 2 hour |
|--|--------|--------|
| Total Rubia TIR7400 + 3% Nanolub (Sample #3) | 0.0818 | 0.0511 |
| Total Rubia TIR 7400 (Sample #1)             | 0.1098 | 0.0965 |

The longer machine is being operated with Nanolub the better effect on wear reduction. This happens due to bigger amount of nanoparticles being exfoliated and attached to surfaces of the metal protecting it from wear.



# Coefficient of Friction


## Extended 4 ball wear test (2h length)



# Summary

| # of Sample | Total Rubia TIR7400 15W40, wt% | Nanolub <sup>®</sup> , wt% | ASTM D4172 wear, mm | ASTM D4172, CoF | 4 ball 2h wear, mm | 4 ball 2h, CoF |
|-------------|--------------------------------|----------------------------|---------------------|-----------------|--------------------|----------------|
| Sample #1   | 100                            | 0                          | 0.4975              | 0.1098          | 0.525              | 0.0965         |
| Sample #2   | 99                             | 1                          | 0.473               | 0.1075          |                    |                |
| Sample #3   | 97                             | 3                          | 0.4475              | 0.0818          | 0.44               | 0.0511         |
| Sample #4   | 95                             | 5                          | 0.435               | 0.0883          |                    |                |

In order to lower maintenance, cost of ownership and significantly reduce friction and wear it is **recommended** to use 3% treat rate of Nanolub<sup>®</sup> with Total Rubia TIR7400 15W40 oil. The treat rates are recommendatory only, actual treat rates in final application should be decided by customer.

A large, faint, blue-tinted world map is centered in the background of the slide. The map shows the outlines of continents and major landmasses. In the bottom corners, there are faint, dark blue molecular or nanotechnology structures, possibly representing carbon nanotubes or similar nanoscale materials.

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