> High Frequency Reciprocating Test to Analyze Fuel Lubricity

Introduction:

Fuel lubricity is a critical parameter for engine manufacturers as several parts of diesel engine depend solely on fuel for lubrication.

Depending on the source of crude oil, refining methods, sulfur content and additives the lubricity of diesel can vary significantly.

High Frequency Reciprocating test HFRR (ASTM D6079, ASTM D7688, ISO 12156-1, CEC F-06-A-96, BS EN 590, JPI-5S-50-98 and IP 450/2000) is a standard method widely accepted by engine manufacturers, refiners, additive suppliers and consumer groups to evaluate the lubricity of diesel fuels, additives and blends.

Test Setup and Procedure

In a typical HFRR test a sample of fuel is placed in a temperature-controlled cup. The temperature is set to 60°C and the humidity is noted.

The upper and lower samples are 10 mm alloy steel disc (Ra ≤ 0.2µm) and 6 mm alloy steel ball.

The samples are cleaned with heptane to remove all residual materials before starting the test.

The ball is loaded with a load of 200 g (1.96N) and moved in a reciprocating motion against the lower sample with a stroke of 1mm at 50 Hz for 75 minutes.

At the end of the test the ball is cleaned and the wear scar diameter on the ball is measured in both parallel and perpendicular direction to the sliding.

The mean diameter is recorded and used to compare the lubricity of different fuel samples.

Rtec-Instruments HFRR:

Figure 1: Rtec-Instruments standalone FFT-M with HFRR setup

Rtec-Instruments HFRR provides easy, automated platform to perform high frequency reciprocating test with a high degree of reliability and repeatability.

The tester is completely automated and easy to use with real time force control.

When mounted on our MFT-5000 platform, it comes with an optional 2D microscope or 3D profilometer to test and measure directly the wear scar diameter.

The heavy-duty, flexure-based design uses electromagnetic voice coils to precisely control the stroke length and avoid vibrations from bearings.

Friction is measured real time using high frequency piezo sensors.

The temperature is controlled within ±0.5°C and humidity can be monitored or controlled real time.

The test rig can be used to apply a much wider range of force, stroke lengths, and frequencies to cover multiple standard tests and various customized tests making it an ideal choice in any research or quality control lab.

Results:

Two standard Fuel Samples, High Lubricity (Fluid A LOT 18) and Low Lubricity (Fluid B LOT 2018) from ASTM Test Monitoring Center were tested with the Rtec-Instruments HFRR according to ASTM D6079.

The 10mm standard discs and 6mm balls were cleaned using heptane following the method described in ASTM D6079.

The discs were submerged in 2ml of the fuel sample and heated to 60°C before starting the test. 1mm reciprocating test was carried at 50Hz frequency for 75 minutes.

After the test the wear scar diameters of the upper balls were noted. Each sample was repeated 5 times and the results are reported in Table 1.

The results were compared to the standard results obtained for the standard oils shown in Fig 3. Fig. 4 and Fig 5. show the sample wear scars on upper sample after the test.

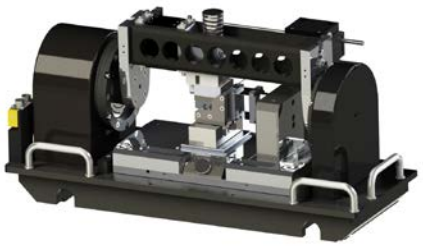


Figure 2: FFT-M for standalone (fig 1) or MFT-5000 setup

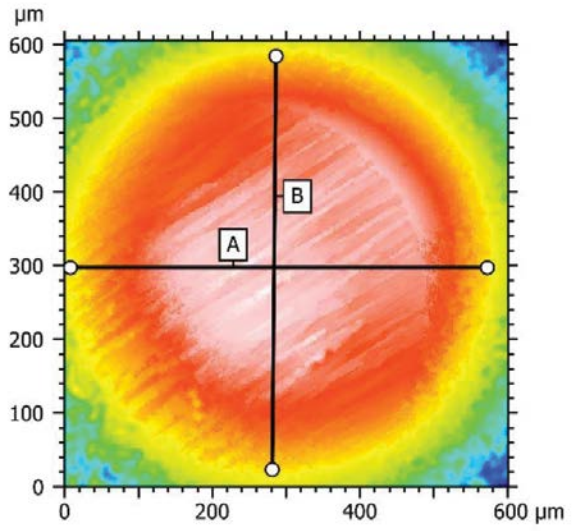
Diesel Fuel Lubricity
Reference Targets ASTM D6079
High Frequency Reciprocating Rig (HFRR) 60°C

Fluid Name	Reference Period	Target	Lower Acceptance	Higher Acceptance
Low (Fluid B Lot 18-1)	03/07/2018 - 03/06/2019	578	541	615
High (Fluid A Lot 18-1)		369	262	476

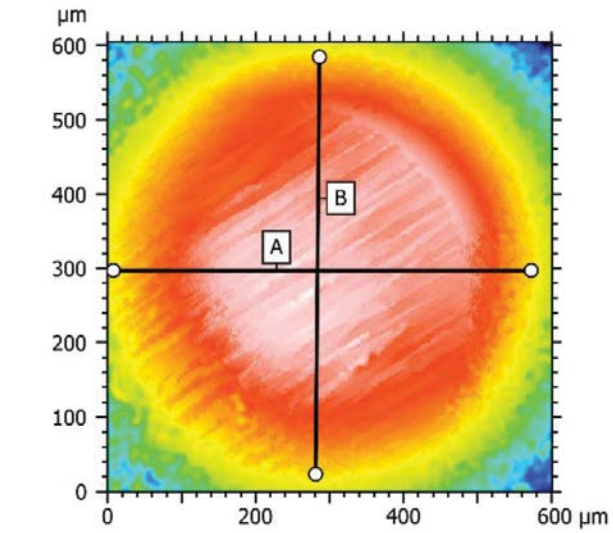
Figure 2: Standard HFFR Results from Oil A and OIL B as obtained from Test Monitoring Center

Test Fuel	Diameter Perpendicular to Motion (µm)	Diameter Parallel to Motion (µm)	Mean Wear Scar Diameter (µm)
Test Fuel A	564.7	560.9	562.8
	580.2	550.6	565.4
	590.7	572.2	581.5
	538.4	580.6	582.5
	590.6	554.4	572.5
Test Fuel B	345.9	347.9	346.9
	362.8	375.5	369.2
	358.4	402.4	380.4
	340.6	360.4	350.5
	398.2	386.4	392.3

Table 1: Results obtained using Rtec-Instruments HFRR with test conditions conforming to ASTM D6079.
All results comply with the standard results as provided with the reference fluids.



Distances	Unit	A	B
HDist	µm	564.6875	560.9531



Distances	Unit	A	B
HDist	µm	564.6875	560.9531

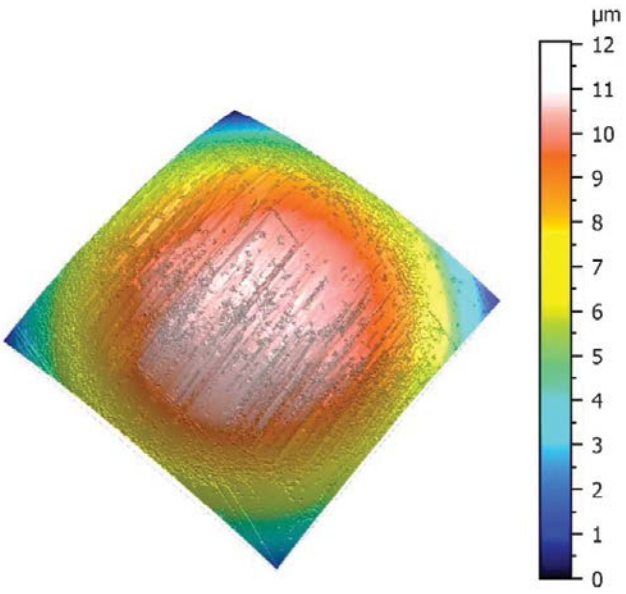


Figure 3: 2D and 3D images of the Wear Scar Diameter of Ball after Test 1 with Fuel A

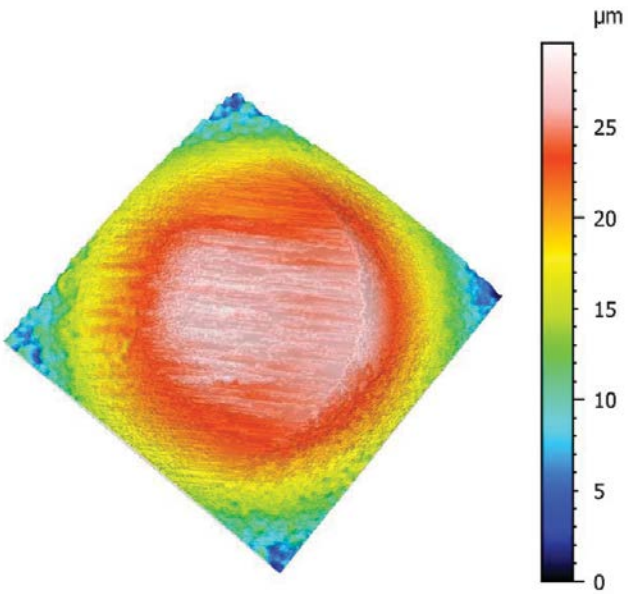


Figure 4: 2D and 3D images of the Wear Scar Diameter of Ball after Test 1 with Fuel B

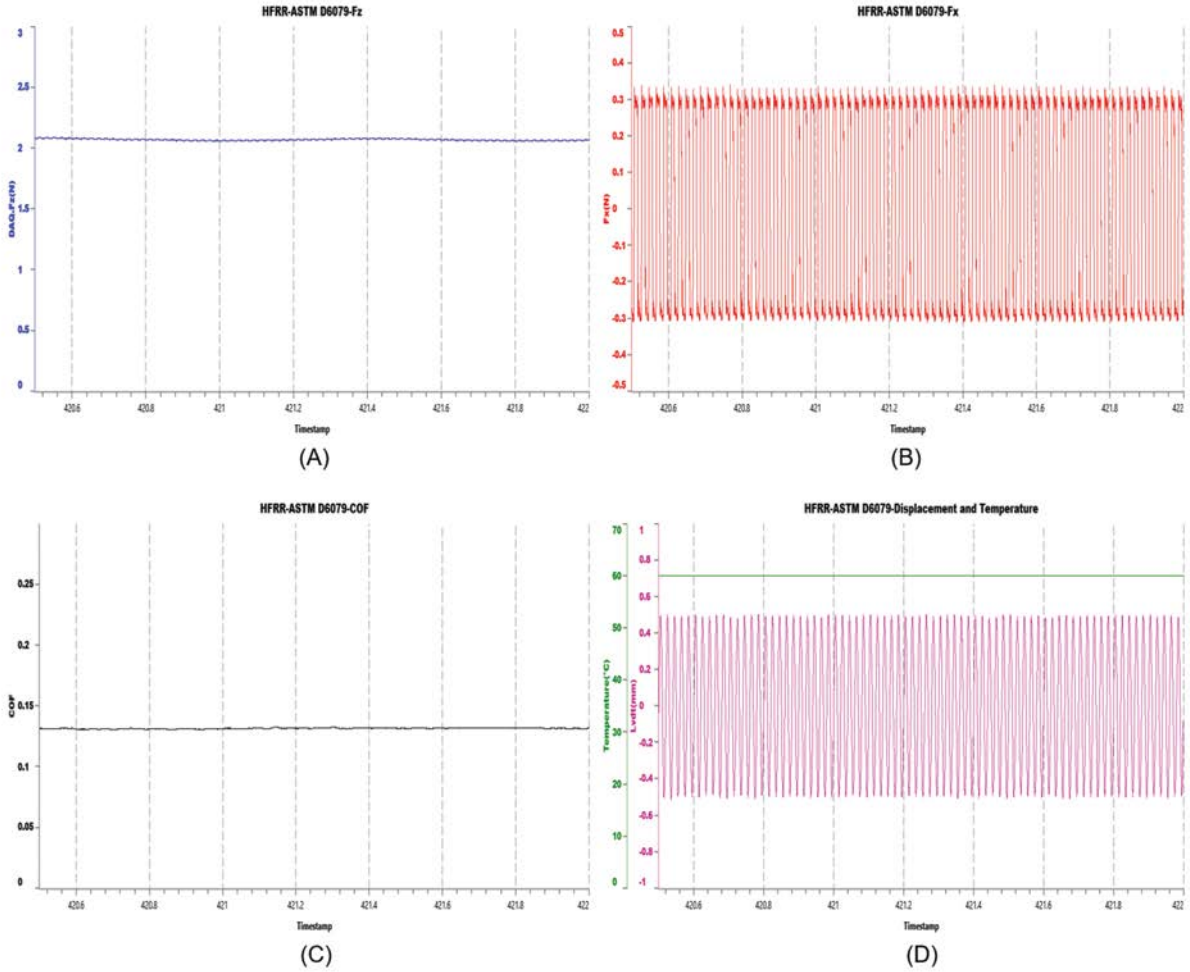


Figure 2: Real time Data- downforce (A), friction force (B), coefficient of friction (C), displacement and temperature (D)

Conclusions:

The wear scar diameters from Rtec-Instruments HFRR conforms with the standard results demonstrating the repeatability and reliability of the test rig.

The advanced piezo sensors, automated real time load control and precise oscillations using the electro-magnetic voice coils makes it the most advanced tester for high frequency tests.

The ease of use and versatility of the tester makes it an ideal choice for high frequency tests to accurately and reliably differentiate the lubricity of various fuels and additives.

High performance fretting for HFRR and SRV testing:

Fretting testers with three models cover a wide test load range.

A technology break through in voice coil control, high frequency signal processing algorithms allows to run fretting wear test from 5 micron stroke.

The tester allows to comprehensively characterize fretting wear from micron to macro scale. Ultra sensitive piezo based load cells , combined with rigid design, high stiffness holders, low floor noise and robust design provides quantitative fretting wear characterization of materials, interfaces, thin films, components etc.

To simulate real life scenarios the tests can be done in room or controlled environmental conditions.

Easy to use and interpret the data makes this tester an ideal tool in hands of researcher or quality control engineers.

Fretting Tester FFT-1 or FFT-2

Fretting on Multi Function Tribometer FFT-M2

Should you require further information, please contact

Rtec-Instruments
info@rtec-instruments.com
www.rtec-instruments.com

Rtec instruments