

# An Advanced Device for Testing the Lubricity of Diesel Fuels -- Application of High Frequency Reciprocating Rig

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## Introduction

The tolerance of the component within a fuel-injection system are quite fine, some of which are measured in ten-thousandths of an inch. Because of this the lubricity of fuel becomes quite important. If the fuel's lubricity is too low, improper lubrication will shorten the service life of fuel injectors and high-pressure pumps. What's worse, this kind of damage always takes place without outward symptoms. The users will suddenly find their devices unable to run as the relevant components are totally ruined due to low lubricity. To avoid these problems, it's important to choose a right diesel to use, test the lubricity of diesel fuels before using them is significant and necessary. Koehler's product, the K93405 High-Frequency Reciprocating Rig, is an innovative device will test diesel's lubricity effectively.

## Test Method

Koehler's K93405 tests diesel's lubricity by High-Frequency Reciprocating Rig (HFRR) technology. HFRR is a reciprocating friction and wear test system which is going under microprocessor control. It provides a fast and repeatable assessment of the performance of fuels and has become an industry-standard test for diesel fuel lubricity. The test method of HFRR is based on ASTM D-6079 Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High Frequency Reciprocating Rig (HFRR).

ASTM D-6079, HFRR can help us confirm fuel's lubricity by micro perspective. The test features a metal ball being ran in a back-and-forth motion on sample fuels in a high frequency and for a long time, this will make tiny wear scars (in  $\mu\text{m}$ ) in the test plate. By measuring the wear scars' length in both major axis and minor axis, the wear scar diameter (WSD) can be calculated. The WSD is a intuitive data can reflect fuel lubricity. In the US, ASTM D-975 provides clear WSD requirement for qualified diesel.

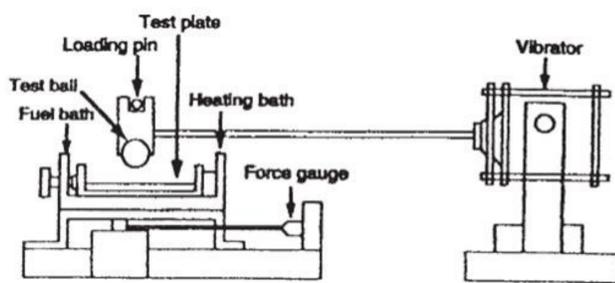


Figure 1. Schematic of HFRR instrument setup

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## Operation Procedure

- 2-mL of test specimen, diesel fuel, need to be placed in a test reservoir. The maintained temperature will stay at 25 or 60 °C as per ASTM D6079.
- When the temperature has stabilized, a vibrator arm holding a non-rotating steel ball and loaded with a 200-g mass is lowered until it contacts the test disk completely submerged in the fuel.
- The ball is caused to rub against the disk with a 1-mm stroke at a frequency of 50 Hz for 75 min.
- The dimensions of the major and minor axes of the wear scar will be measured under digital microscope and recorded by software
- Software in the instrument will use these data to calculate the wear scar diameter (WSD).

## ! Diesel Comparison

Different with gas engine, all diesel injection equipment has some reliance on diesel as a lubricant, especially for rotary and distributor type dual injection pumps as found in today's modern common rail injection systems. Because of this, the difference between using low lubricity fuel or good lubricity fuel will be significant.

- The biggest advantage of using good lubricity fuel can protect the diesel system well. It can extend machines' lifetime and lower the maintenance cost.
- Using high lubricity diesel can help users save fuel. It will lower the power loss during combustion and transmission, improve the energy conversion efficiency.

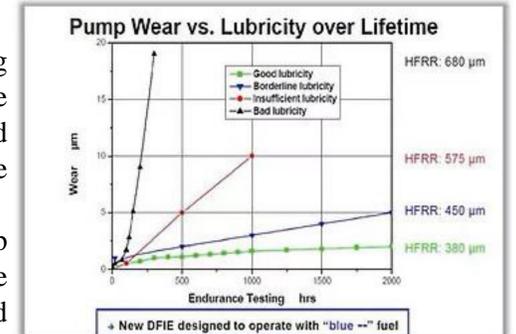


Figure 2. Different diesel samples undergo an endurance test for pump wear

## Product Advantages

- The test result is reliable. It conforms to ASTM D6079 and related specifications. ASTM test methods are petroleum industry standards, accepted worldwide for quality and reliability.
- Convenience to use. It has programmed test sequence for automated testing.
- High quality. It has a rigidly built dedicated tabletop rig.
- Easy to collect and save result. It has PC-based digital and data acquisition
- This product is highly integrated and do not need various accessories.

## Conclusion

Lubricity is one of the most important properties of fuels, especially for diesel. Kohler's K93405 is a highly integrated and automatic device capable of finding the lubricity of diesels by HFRR technology. It gives users reliable results and help them collect and save them wisely. By using this advance device, users can avoid various problems that are caused by using diesel with lack of lubricity.

## References

1. ASTM D6079 – 04 "Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR) ASTM International
2. ASTM D975 - 18 Standard Specification for Diesel Fuel Oils" www.astm.org. Retrieved 2018-08-08.
3. K93405, K93405 'High Frequency Reciprocating Rig(HFRR)' Koehler Instrument Company, Inc
4. LUBRICITY IMPROVERS, <https://www.cestoil.com/solutions/fuel-additives/lubricity-improvers/>