Sensitivity of Standard Fuel Tribological Methods to Environmental Oxygen

CATEGORY OR KEYWORDS
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INTRODUCTION

Standard tests for measuring the lubricating ability of fuels are typically conducted in air [1,2], although the fuel systems for which they measure this ability are typically devoid of large concentrations of atmospheric oxygen or water through filtering and absence of air cavities. Illustratively, the material damage leading to failure in the pump pistons of certain high-pressure fuel pumps lacked signs of oxidative processes. Different fuel lubricity standards are known to manifest different wear mechanisms with some standards demonstrating less oxidative wear and a wider range of wear mechanisms than others [3]. These less oxidative standards, however, do not necessarily produce the type of damage observed in high-pressure fuel pumps.

ABSTRACT

The point of failure in a high-pressure fuel pump that led to inadequate fuel flow with a low viscosity jet fuel will be shown to have originated from scuffing that lacked signs of oxidative processes. The non-oxidative scuffing will be compared to the extent of steel oxidation in the High Frequency Reciprocating Rig (HFRR) diesel fuel lubricity standard. The HFRR wear for several different fuels showed evidence of significant steel oxidation (see Figure 1), in contrast to the scuffing observed in the pump. The standard tribological methods of HFRR and Ball on Three Disks (BOTD) conducted in air will then be compared to both methods conducted in an oxygen-starved nitrogen gas environment to demonstrate the effect of the presence/absence of oxygen on fuel lubricity measurements for several different fuels.

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REFERENCES

[1] ASTM International, 2016, “Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)”, Designation D6079-11.
[2] Voitik, R. and Ren, N., 1995, "Diesel Fuel Lubricity by Standard Four Ball Apparatus Utilizing Ball on Three Disks, BOTD," SAE Technical Paper 950247.
[3] Hsieh, P. Y. and T. J. Bruno, 2015, "A perspective on the origin of lubricity in petroleum distillate motor fuels." *Fuel Processing Technology* **129**, pp. 52-60.

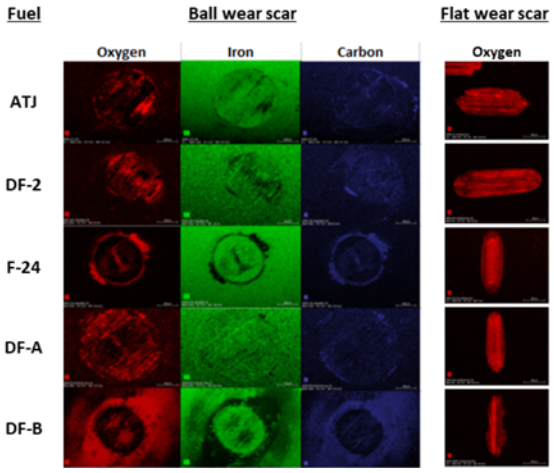

Figure 1. EDS of HFRR wear scars conducted in air