The effect of temperature on the friction and wear behaviour of fuel oils under oxygen and nitrogen (inert) atmosphere.

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Fuel oils, which require good lubricating properties, are passed through pumps, filters, nozzles and other equipment before they reach the burner section of a steam boiler. Users of fuel oils are experiencing problems such as blockages in fuel oil filters and injector nozzles, increased wear and failures of pumps and, in some cases, decreased efficiency of combustion. In an attempt to understand the role of oxygen as a contributing cause of the problems experienced with fuel oils at different temperatures, lubricity tests were performed with a selection of fuel oil samples. Two atmospheres (i.e. oxygen-rich (atmospheric air) and inert (nitrogen) were used).

Keywords: friction, wear, oxygen, lubricity.

1. Introduction

Energy losses due to ignorance of the role of tribology amount to approximately one third of the world's industry energy resources. Friction reduction and wear control is thus of particular importance for economic reasons and long term reliability of equipment [1]. This investigation aims to determine the lubricating properties of fuel oils used in power generation via their friction and wear behaviour capabilities, whilst also taking into consideration the effect of oxidative wear by performing runs in an oxidising (air) atmosphere and comparing it with runs performed in an inert (nitrogen) atmosphere over a range of temperatures. The oxidation products form an oxide film on the contacting metal surfaces which tends to slow down or even arrest oxidation.

2. Methods

Lubricity tests were performed with a selection of three fuel oil samples on the HFRR lubricity test rig following method ISO 12156-1. The test conditions are summarised in Table 1. Three unique fuel oils were selected: a light cycle oil (LFO), a medium wax-blend oil (MFO) and a crude-derived heavy fuel oil (HFO).

Table 1: HFRR test conditions.

Parameter	Value
Stroke length [mm]	1
Frequency [Hz]	50
Humidity [% RH]	50(Air),15(N_2)
Fluid temperature [°C]	25, 60, 100, 115
Load [g]	200
Test duration [min]	75
Fluid volume [ml]	2
Reservoir surface area [mm²]	600

2.1. Elemental analysis
Elemental analysis of the fuel oils was done using an inductively coupled plasma optical emission spectrometer (ICP OES). The preparation method used for the ICP OES was the wet washing procedure [2].

2.2. Viscometer measurements
An Anton Paar SVM 3000 Stabinger viscometer was used to measure the dynamic viscosity of fuel oils at different temperatures.

2.3. Results
Two sets of results are used: coefficient of friction (COF) and wear scar diameter (WSD).

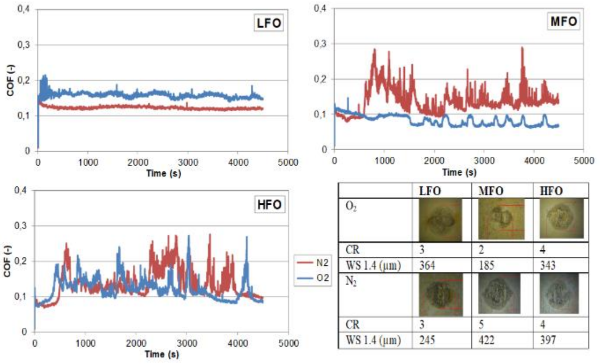

Figure 1: COF versus time graphs and ball wear scars for fuel oils at 100 °C in air and in nitrogen atmosphere.

3. Discussion

The three fuel oil samples show different trends at 100 °C. For LFO, the COF increases under oxygen-rich atmosphere, although for MFO the COF drastically decreases when compared to under nitrogen atmosphere. The change in atmosphere appears to not affect the COF of HFO. The WSD of the fuel oils follows the same trend as the COF results. For LFO and MFO, results show no abrasive wear under oxygen-rich atmosphere, however, under nitrogen atmosphere there is slight abrasion for LFO and severe abrasion for MFO. For HFO, both atmosphere results show severe abrasive wear. Results for the fuel oil samples showed that temperature and atmospheric conditions contributed to the friction and wear behaviour, but that composition of each of these fuel oils played a significant role.

4. References

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