7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Application of an Artificial Olfactory System for the Evaluation of Thermally Induced Lubricant Degradation

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This paper describes the application of a bespoke artificial olfactory system as a tool to identify the degradation of thermally stressed lubricants. The system shows promise as a flexible, convenient and effective means to conduct on-line lubricant degradation monitoring. Further work will involve the application of artificial olfactory systems to evaluate lubricant degradation in bench top mechanical test equipment and eventually, in full scale machines.

Keywords (from 3 to 5 max): Artificial Olfactory System, Lubricant degradation monitoring, gas sensing.

1. Introduction

Lubricants used in engines and industrial machinery are formulated from a range of base oils and additives to improve their lifetime and performance. Degradation occurs through chemical and physical processes including, base oil degradation, oil contamination and/or additive depletion. The dominant degradation mechanism is determined by factors, such as oil formulation, contact pressure, mechanical stress, operating temperature, maintenance strategies, etc. The wide range of oil formulations, and the parameters governing oil degradation, make the oil aging process complex and difficult to monitor on-line [1, 2]. However, aging stages can be characterised by the variety of volatile compounds emitted by the oil, and headspace gas analysis can, therefore, potentially be adopted for on-line degradation monitoring. This paper describes experiments using a bespoke artificial olfactory system, described in [3], for online monitoring of oil degradation.

2. Methods

The artificial olfactory system is based on an array of metal oxide gas sensors displaying differential sensitivities to the range of volatile compounds emitted by lubricants, allowing identification of different degradation stages. It includes a bespoke measurement chamber, containing the gas sensor array and a temperature sensor, as illustrated in Figure 1. This sensor chamber ensures a homogeneous flow over each sensor and avoids position dependent sensor response. The capability of the system to discriminate thermal degradation stages of a range of lubricants is now being investigated. Samples, at different degradation stages, are stored in vials for a period of time to form a stable headspace and headspace gas is delivered to the sensor chamber using the delivery system shown in Figure 2. Sensor resistances are collected and saved on a PC for analysis using Principal Component Analysis (PCA) and Partial Least Square-Discriminant Analysis (PLS-DA), allowing a sensor database to be built. Results from this work will be reported in the presentation.

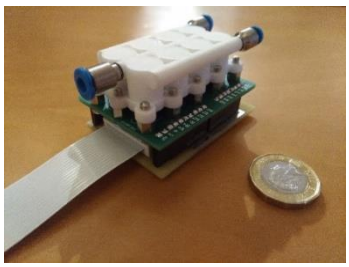

Figure 1: Sensor chamber and sensor array.

3. Future work

Future work will involve on-line monitoring of lubricants using a tribo-test machine to generate high levels of mechanical stress on a range of test lubricants. Degradation behavior will be compared to data from thermally stressed lubricants.

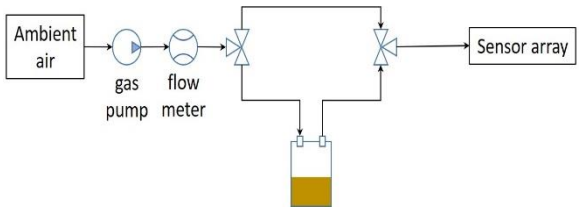

Figure 2: Delivery system used for lab experiments on thermally degraded lubricant oils.

4. References

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