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NEW MANAGEMENT APPROACH FOR TURBINE OILS

TRACK OR CATEGORY

Power Generation

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INTRODUCTION

As a result of these efforts, turbine oils are increasingly subjected to harsh usage conditions due to the increased gas temperatures at the inlet of the turbine. Further, for large power plants generating megawatts of electricity, long-term stable operation is required, which means management of turbine oils is important. It is therefore the mission of oil manufacturers to develop management technologies that enable prompt assessments of the status of turbine oils.

In this article, we describe new management methods for turbine oils using a Fourier transform infrared spectrometer (FT-IR) and a colorimeter that allow easy and prompt measurements.

ADD MAIN BODY HERE

Several types of turbine oils that provide long service life are available in the market. Most of the turbine oils have a high initial RPVOT number or have the property of retaining high RPVOT number. However, some of these products cause sludge and varnish problems, even though the RPVOT number remains high. We established a new technology that can support high RPVOT number and low sludge/varnish formation at the same time. To establish this technology, we focused on achieving a balance between anti-oxidation and solubility improvement by using some synthetic base oil. Figures 1 and 2 show two types of turbine oils. Turbine oil A is an easy-management type oil (EMTO), and Turbine oil B is an oil with a high RPVOT value. Turbine oil B will appear to be better if only RPVOT number is considered, but rapid formation of sludge was observed with Turbine oil B, regardless of the RPVOT number. On the other hand, Turbine oil A formed little sludge by maintaining the RPVOT number high. Therefore, Turbine oil A is easy to manage.

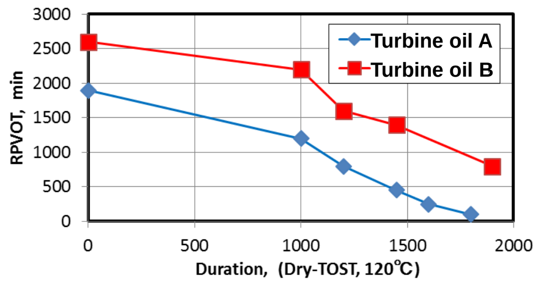


Figure 1. Relationship between the duration and the RPVOT value

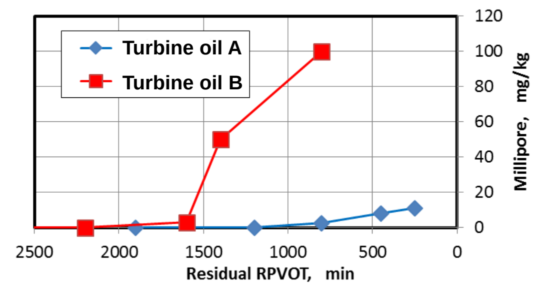


Figure 2. Relationship between the RPVOT value and the sludge formation

The degree of deterioration of an EMTO can be controlled with only the RPVOT number. However, it takes a lot of time to get the test result with RPVOT. We investigated a method for determining the degree of deterioration based on the relationship between the amount of antioxidant, measured with a simple FT-IR instrument, and the RPVOT value. First, EMTO samples were deteriorated under several conditions in accordance with the Dry-TOST method as per ASTM D7873 or the high pressure circulating oxidation stability test (accelerated deterioration under adiabatic compression using a high pressure pump) as per JCMAS P045, and the relationship with the ratio of the level of antioxidant and the RPVOT value was investigated. As shown in Fig. 3, the relationship is linear, with a high correlation coefficient of 0.969. We then investigated the same relationship using EMTO samples used for the main shaft and control of an actually-operated GTCC turbine that had been in use for approximately seven years. As shown in Fig. 4, this is a long-life oil, and even after approximately seven years of use, its RPVOT value was maintained at more than 50% of the value for a new oil. Although the ratio of the amount of antioxidant at the threshold of the RPVOT value was unknown, the relationship was derived by conveniently by applying the quadratic expression, which resulted in a high correlation, with a correlation coefficient of 0.945.

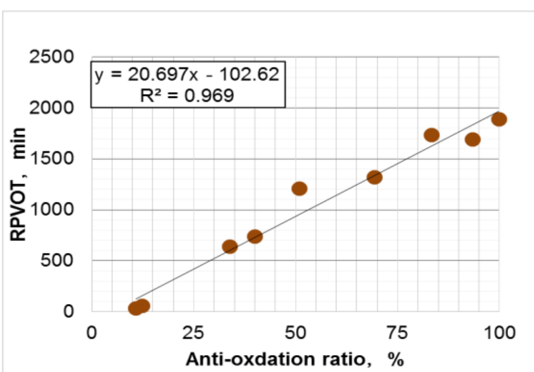


Figure 3. Relationship between the antioxidant ratio and the RPVOT value as measured in experimentally-deteriorated EMTO

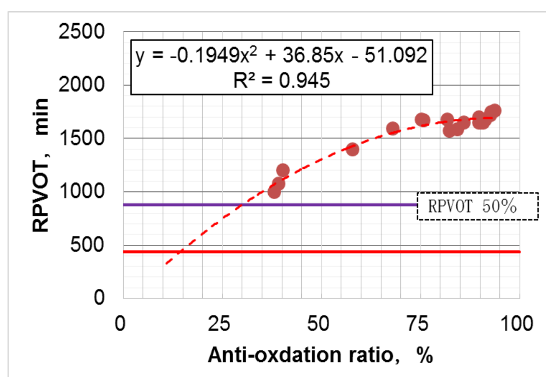


Figure 4. Relationship between the antioxidant ratio and the RPVOT value as measured in actually-used EMTO

We investigated a method for determining the degree of deterioration based on the relationship between the color difference (ΔE) of the material captured on a filter, as measured with a simple colorimeter, and the RPVOT value, as well as the amount of sludge (Millipore value) and the acid value.

Determination methods using color differences include ASTM D7843 and another method under study at Fukui University.[1)] The method for determining the deterioration of oils involves filtering the used oil with a filter such as filter paper, illuminating the surface or inside of the filter and detecting the reflected or transmitted light, and then deriving the color difference (ΔE) based on the light's three primary colors.

In this article, we describe the results of tests conducted using EMTO samples deteriorated using the Dry-TOST method. As shown in Table 1,[2)] the RPVOT retention decreased and ΔE increased with deterioration. Table 2 shows an example of the criteria for the determination of ΔE.[3)] According to the criteria, the supply point should be at the point where RPVOT retention is 50%. Figure 5 shows the relationship between RPVOT retention and ΔE, as well as the ratio of the amount of antioxidant. It can be seen that the RPVOT retention correlates with both ΔE and the ratio, and that the amount of antioxidant and ΔE can be used for controlling the degree of deterioration.[2)]

Table1. Example of ΔE determination on EMTO

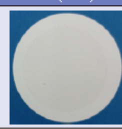
Dry-TOST test (120°C, hrs)	0 (new)	240	480	720	1000
Millipore filter color (MPC) (Picture of 0.45 μm membrane filter) Method of ASTM D7843-12					
ΔE	1.0	6.1	7.3	11.7	13.6
Vanish potential (Determination of degree of deterioration)	Normal				
RPVOT retention (%)	100	83.4	72.5	63.4	55.4
Millipore 1.0 μm membrane filter (mg/100 ml)	0.0	0.0	0.3	0.4	0.9
Acid value (mg KOH/g)	0.09	0.06	0.06	0.07	0.08

Table2. Example of determination criteria for ΔE

ΔE value	Below 15	15-30	30-40	Above 40
Determination	Normal	Observation necessary	Abnormal	Danger

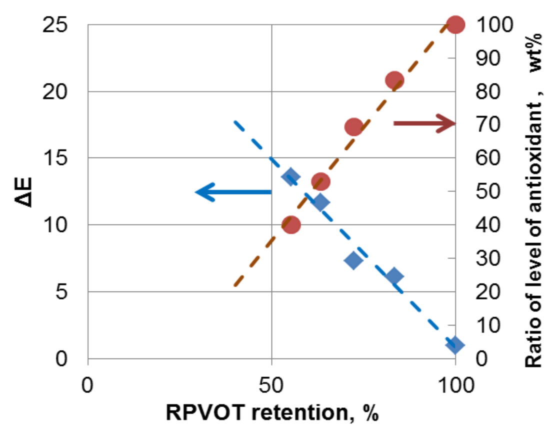


Figure 5. Relationship between RPVOT retention and ΔE, and antioxidant ratio as measured in deteriorated EMTO

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KEYWORDS

Lubricants:Gas Turbine Oils, Additives:Antioxidants, Maintenance:Oil Condition Monitoring.