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On-line Ferrous Wear Debris Sensor†

1. Introduction

Although the vibration method has long been used as a bearing diagnosis method[1)], in some cases effective diagnosis is difficult with extremely low speed rotating machinery. Ferrography, in which the wear condition of bearings is assessed based on the concentration of iron powder in grease, can be used to compensate for this shortcoming, but it is difficult to grasp the continuously changing condition of iron powder concentration with the conventional method, as that method relies on sample analysis. Moreover, the time and work required by analysis was also a problem. To improve these drawbacks, JFE Advantech developed and commercialized "On-line Ferrous Wear Debris Sensor, MK-90" as an on-line device which continuously measures the concentration of iron powder in grease.

This report introduces the composition and features of this device.

2. Outline and Features of On-line Ferrous Wear Debris Sensor

2.1 Measurement Principle

This device was developed by applying a differential transformer, which is one seed technology of JFE Advantech. The configuration of the sensor section is shown in **Fig. 1**.

The following explains the principle of measurement in this device, referring to Fig. 1. Coils A and C in Fig. 1 are respectively exciting circuits. The excitation force in the two coils is equalized in advance. Coils B and D are detecting circuits. These two coils are connected in opposite directions, with Coil D as the reference coil and Coil B as the detecting coil. When piping for grease which contains a metal such as iron powder passes through Coils A and B, the electromotive force at Coil B will show a different value from that at Coil D due to the difference in magnetic permeability. Therefore, the amount of iron powder can be obtained by measuring the difference in electromotive force between the two coils.

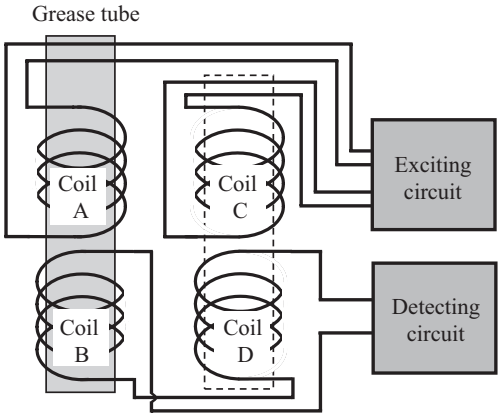

Fig. 1 Description of the measurement circuit

2.2 Features of Product

This device has the following features, while also realizing in an on-line device measurement accuracy equal to that of the portable-type iron powder meters

Table 1 Specifications

Detected particles	Ferrous wear debris
Measurement range (mass%)	0.000 to 2.000
Accuracy (%)	±1 F.S.（full scale）
Number of measurement point	1 to 5
Measurement interval	5 seconds/point（minimum）
Analogue output	DC 4 - 20 mA
Communication interface	RS-232C (Option)
Power supply	100 to 220 V AC
Ambient temperature	0 to 50ºC
Dimensions (mm)	312*W*×250*H*×102*D*

Photo 1 Appearance of MK-90

† Originally published in *JFE GIHO* No. 27 (Feb. 2011), p. 63−64

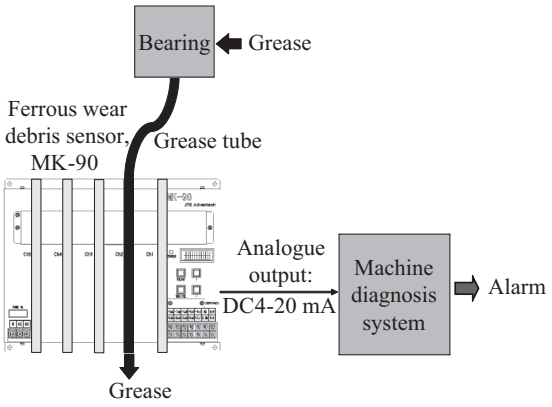

Fig. 2 Outline of on-line ferrous wear debris measurment system

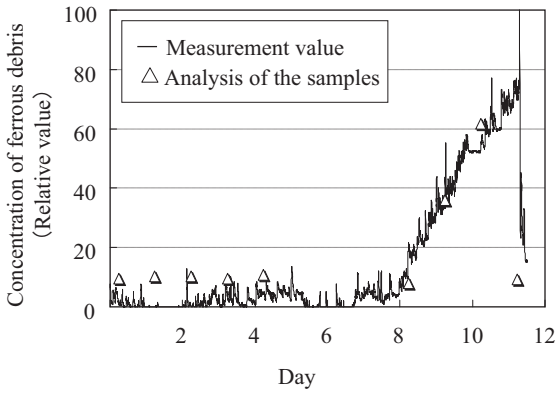

Fig. 3 Measurement example of ferrous

which have been used conventionally.

(1) Measurement is possible simply by passing the grease piping through the device.
(2) It is possible to measure a maximum of 5 points with one unit.
(3) The measurement time at one point is 5 seconds (minimum).

The specifications of the device are shown in **Table 1**.

The appearance of the device is shown in **Photo 1**.

2.3 Example of Composition of Measurement Device

An example of a measurement system using this device is shown in **Fig. 2**. The effect of external disturbances due to temperature fluctuations and external magnetic fields, etc. is reduced by incorporating the sensor section within the body of the device, as can be seen in Photo 1 and Fig. 2.

In addition, more detailed equipment monitoring and diagnosis is possible by combining this device with a machine diagnosis device in the CMS series manufactured by JFE Advantech.

3. Results of Measurement with On-line Sensor

An example of on-line measurement of the iron powder concentration value in the bearing grease of actual machinery using this device is shown **Fig. 3**.

As can be understood from this example, the measured values obtained with the device (solid line) not only show good agreement with the conventional manual analysis values (△), but sudden changes in the iron powder concentration can also be grasped accurately.

It may be noted that the iron powder concentration first rose and then decreased suddenly in this figure due to bearing maintenance.

4. Conclusion

Use of the on-line ferrous wear debris sensor to measure the iron powder concentration in grease continuously and as a total amount enables early detection of anomalous wear or damage of bearings and other parts. The following benefits can be expected.

(1) Prevention of Equipment Trouble.

Occurrence of serious trouble can be prevented by early detection of anomalous conditions.

In addition, accurate detection of sudden large occurrences of wear-related powder is possible based on total amount measurement.

(2) Labor Saving and Improved Safety

In cases where conventional manual analysis of lubricants had been used, automatic measurement with this device eliminates the need for lubricant analysis and related manual work.

Work safety can also be improved because lubricant sampling and analysis under poor environments can be discontinued.

Reference

1) Kira, K. “An application of machine diagnosis system to rotating machinery”. Plant Engineer. 2008-03, vol. 40, no. 3, p. 9–13.

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