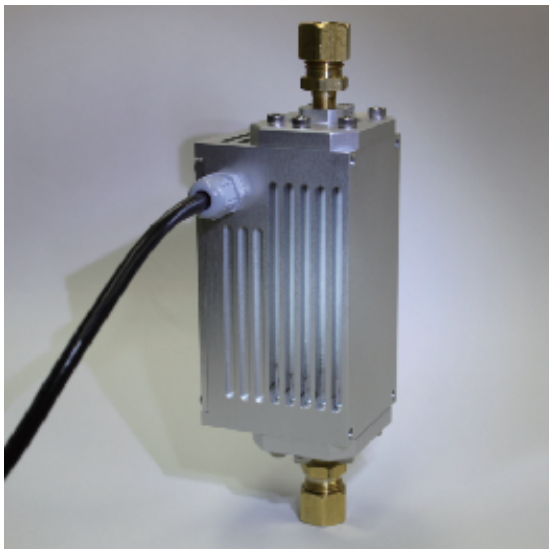
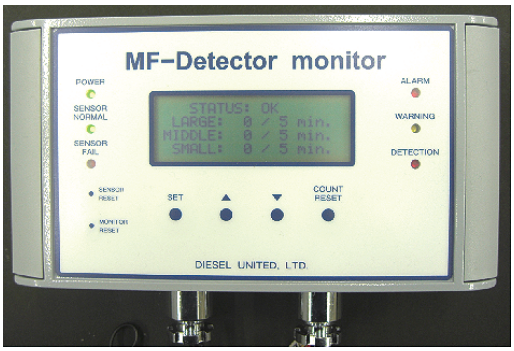
Lubricant Health Monitoring Sensor for Slidable Mechanical Equipment

Metal Fragment (MF) Detector could find and notice the lubricant degradation (conductive metal density) to avoid serious damage of mechanical equipment.

At the hearts of wind power generators, engines, pumps, and other such machines are sliding and rotating components. Whether these "hearts" are in good condition or not can be diagnosed by electrically detecting the metal powder that is mixed into the lubrication oil that serves as the blood of the machine.



Sensor part of MF-Detector



Monitor of MF-Detector (standard specification)

At the hearts of wind power generators, engines, pumps, and other such machines are sliding and rotating components. It is crucial for safety purposes to constantly monitor the operating condition of these hearts and stably operate the equipment. This is also essential in view of energy-saving, labor-saving, and extension of maintenance intervals, and so on.

Various methods have been proposed for monitoring the condition of such devices including temperature monitoring, pressure monitoring, lubrication oil analysis, vibration monitoring, and monitoring for foreign matter. A combination of appropriate monitoring methods is applied according to the properties of the device to be monitored. For instance, temperature monitoring is performed with slide bearings, and grease analysis is performed with parts lubricated by grease.

DIESEL UNITED, LTD. jointly developed the TF-Detector, a high-performance concentration sensor for magnetic abrasion powder, with Meiyo Electric Co., Ltd. The TF-Detector that they sell features extremely high resolution for measuring the ppm (weight) of steel and cast iron magnetic abrasion powder that is 1-3 μm in size. The problem is that the detected objects are limited to magnetic powders so the device does not detect materials such as aluminum, tin, and copper, which are commonly used in slide bearings and other components.

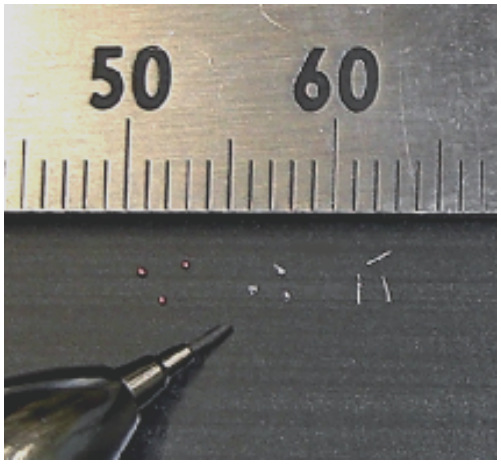
The MF-Detector was developed in order to compensate for this weakness by enabling constant monitoring of minute non-magnetic particles while the equipment is operating, as long as the particles are conductive. This sensor makes constant inline monitoring of only metal fragments in lubrication oil possible and thus enables the

detection of abnormalities in devices at an early stage.

In general, it is technically difficult to accurately detect a signal from minute metal powder under an environment with great electromagnetic noise, vibration, and temperature change, and others. The MF-Detector detects the change in frequency when minute metal fragments pass through the high-frequency magnetic field generated by two high-frequency oscillation circuits aligned in series in the detector. In order to eliminate the impact of disturbance and to enhance sensitivity at the same time, the two oscillation circuits are adjusted to oscillate in slightly different frequencies so that the frequency of the beat generated by the two superimposed waves can be monitored. The frequency of the beat is the difference between the frequencies of the two high-frequency oscillations. Monitoring the beat signal is tantamount to elimination of the impact of disturbance, which affects the two high-frequency circuits almost equally. At the same time, the frequency of the beat is much smaller than the original high frequency of the oscillation circuits, which makes the ratio of the frequency change associated with passing minute metal powder particles greater, giving the same effect as amplifying the signal. Moreover, the high-frequency oscillation circuits are devised to sensitively react to the energy loss. When minute metal powder particles pass through the high-frequency magnetic field, an eddy current emerges inside the minute metal powders, which causes a change in the magnetic field. The energy is consumed when the eddy current is converted into heat by the electric resistance of the metal powders. Detecting both change of the magnetic field and the energy loss improves the sensitivity of the detector.

Unlike commonly used optical foreign matter detectors that are designed only for transparent fluids, this device is able to accurately detect minute metal powders even when the target fluid is not transparent or when air bubbles or non-metal foreign matter gets mixed into the fluid.

The MF-Detector is designed to demonstrate a higher detection capacity regarding materials with lower electric resistance such as copper and aluminum. It is possible to detect copper and aluminum particles with sizes around 0.4 mm and steel particles with sizes around 1.0 mm.



Sample of detectable foreign matters

The designated monitor of the MF-Detector is equipped with a function to count the number of minute metal particles as well as to output warning and alarm signals based on the counted number. This monitor counts the number of detected minute metal particles according to three different categories of sizes and issues two-tiered signals, warning and alarm, when the count in a set period of time exceeds a predefined number for each type of signal. The warning and alarm levels are different from one monitored device to another. On the monitor screen, it is therefore possible for the user to set the counted numbers for which the signals are issued. A monitor with function for keeping a log of the detected minute metal particles along with the detection date and time is also being developed.

There is a wide range of potential applications for the MF-Detector. The detector can be used with almost all devices with sliding parts such as gears and bearings that are composed of metals and is expected to contribute to stable operation of the devices.

The TF-Detector (high-resolution magnetic powder concentration measuring device) can be effective in reduction or speed-up gears that have slide bearings to monitor their conditions. But a greater synergy effect can be achieved when used in tandem with the MF-Detector as together they make advanced monitoring of the condition of all the gears possible.

[Devices for which the MF-Detector can be effective (example)]

- Reciprocating devices
- Lubrication oil pumps
- Speed-up and reduction gears
- Other rotating equipment

The MF-Detector has generated widespread anticipation even from the prototype phase and is expected to be used with many devices to contribute to their stable operation. We are striving to develop a device that can not only detect finer metal particles for early identification of abnormalities, but also monitor changes in condition as compared to normal abrasion.

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