New Products & Technologies

Diagnosis Device for Low Speed Rotational Bearing, "MK-550"*

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1 Introduction

It has been considered difficult to perform an abnormality diagnosis of bearings, that rotate at low speeds of below 100 rpm, by the vibration method. However, it was demonstrated that this can be realized with the aid of cubic treatment of vibration signal.

Kawasaki Steel established a diagnosis algorithm using this theory and developed a portable diagnosis device, MK-550 for bearings rotating at low speeds.

2 Background of Product Development

Using the vibration method, it has up to now been considered difficult to judge whether abnormalities exist in rotary machines operating at under a rotation speed of 100 rpm because of too small energy of collision of the rolling elements of bearings against damaged portions. Although other diagnosis methods are available for low-speed rotational bearings, for examples, the AE analysis and ferrography analysis, they are more expensive and more complex diagnosis device.

At Mizushima Works of Kawasaki Steel, experiments on the vibration method have long been conducted and based on the experimental results, a new diagnosis method for low-speed rotational bearings was developed. Also, a portable diagnosis device that permits less expensive and simple diagnoses through the use of above-mentioned method was developed and brought to the commercial stage.

3 New Diagnosis Method (Cubic Treatment)

The reason why the diagnosis of low-speed rotational bearings has been considered difficult is that the energy of collision of the rolling element of a bearing against a damaged portion is small, with the result of high ratio of noise to an abnormality signal due to collision energy, in other words, the low *S/N* ratio.

In order to overcome this difficulty, the following technique was developed. First, filtering measured data through a band pass filter (BPF) allows to eliminate unnecessary data. Unnecessary data refers to noise and vibration signals at frequency band that show no difference between a normal condition and an abnormal condition. Thus treated signals are subjected to cubic treatment, thereby raising a *S/N* ratio hypothetically to permit abnormality judgment.

Wave forms are shown in **Figs. 1~4**. It is difficult to distinguish an original vibration waveform of an abnormal bearing (Fig. 2) from that of a normal bearing (Fig. 1). In contrast to the original signals, the difference in waveforms is clear when signals are subjected to cubic treatment (Figs. 3 and 4).

Kawasaki Steel and Kawatetsu Advantech Co., Ltd. have successfully developed a new methodology for a diagnosis of low-speed rotational bearing, and are jointly filing a patent application for this technique.[1,2]

4 Method of Judgment

Although an abnormality judgment is possible by visual comparison of two wave forms shown in Figs. 3 and 4, the following judgment method is incorporated in the software of MK-550 so that a more quantitative treatment can be formed.

Furthermore, MK-550 has the function of wave form display so as to observe wave forms. This function enables a visual judgment on wave forms to be made.

(1) To measure a vibration value of a bearing in a normal condition.

(2) To determine a decision value from the measured vibration value.

$$\text{Decision value} = (\text{Measured value} \times 3)^3$$

(3) To measure a vibration data for a bearing to be diagnosed.

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Fig. 1 Original wave form of the normal bearing

Fig. 2 Original wave form of the abnormal bearing

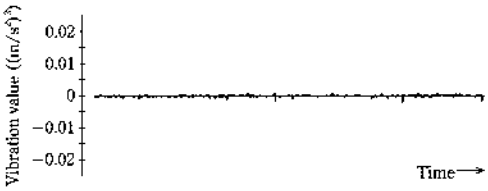

Fig. 3 Treatment wave form of the normal bearing

Fig. 4 Treatment wave form of the abnormal bearing

(4) To count occurrence times for which cubed vibration values exceed the decision value (count value). In a case shown in **Fig. 5**, the count value is equal to 6.
(5) To diagnose by comparing a measured count value with a set count value. From the decision chart shown in **Fig. 6**, the set count value means a count value corresponding to the number of revolutions of the object to be measured. For example, when the rotational frequency is 30 rpm in the decision chart, a normal level is 950 counts and that for an abnormal level is 9 500 counts.

5 Outline and Features of the Product

This is a battery-driven, compact and portable device to diagnose bearings with a rotational frequency of under 100 rpm. Since an amplifier is installed inside the present diagnosis device and software is preinstalled to proceed data treatment, automatically-calculated information is obtained for judging an abnormality of a rotary machine. It can be handily used as a measuring instrument for a machine diagnosis at a plant site.

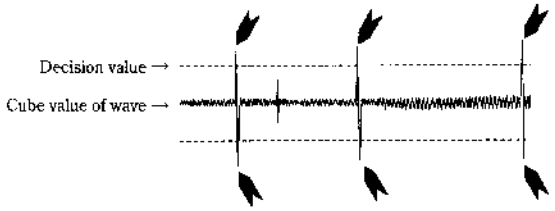

Fig. 5 Count value

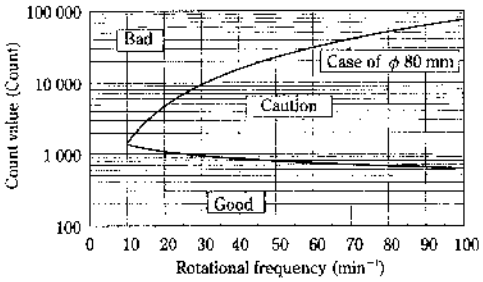

Fig. 6 Decision table

The appearance of the diagnosis device is shown in **Photo 1**. Main features are as follows:
(1) This diagnosis device makes it possible to diagnose bearings with a rotational frequency of under 100 rpm, for which the vibration method has so far been difficult to be applied.
(2) Because the present device is designed to be compact and lightweight and is battery driven, it is best suited to uses at the plant site where no electrical outlets are available.
(3) An amplifier is installed inside the device and its combination with a pickup permits easy measurement at the plant site.
(4) An LCD (liquid crystal display) permits interactive

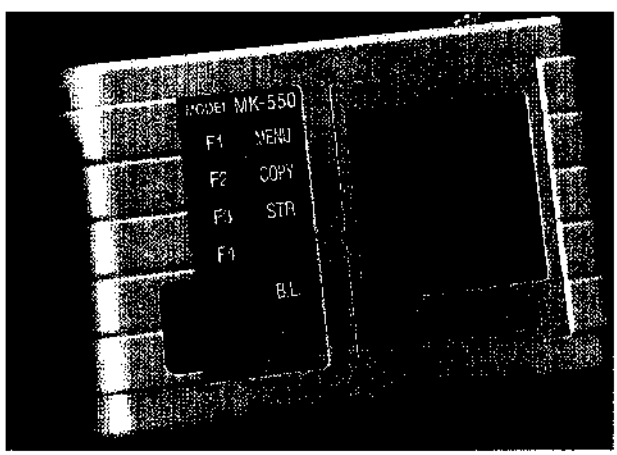

Photo 1 Appearance of MK-550

operation, leading to easy handling.

(5) Because of a memory function, data taken at the plant site can be stored.

6 Specifications

(1) Input Level
Pickup output: 5.1 and 10.2 mV/(m/s^2)

(2) Measuring Mode
Acceleration and velocity

(3) Measuring Range
0.5, 5, and 50 m/s^2 mm/s, automatic range

(4) Data Storage
(a) Information on measurement conditions: 100 entries maximum
(b) Measurement data: 100 entries maximum

(5) Power Supply
Six AA alkali dry-cell batteries
When an AC adapter is used:
Input electricity 100 V AC ±10%, 50/60 Hz

(6) Power Demand
About 2 W

(7) Continuous Operation Hours
3 h (when the back light is off)

(8) Working Temperature Range
0–40°C (85% RH or less, without dew condensation)

(9) Outside Dimensions and Weight
180 (W) × 46 (D) × 125 (H) mm, about 700 g (including batteries)

References

1) Kawasaki Steel Corp. and Kawatetsu Advantech Corp.: Jpn. Kokai 10-160638
2) Kawasaki Steel Corp. and Kawatetsu Advantech Corp.: Jpn. Kokai 11-337450

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