Vibration	Abnormal Noise due to Electrolytic Corrosion of Reducer Roller Bearing	Rotating Machinery
Forced vibration		

Object Machine

VVVF motor-driven reducer

Observed Phenomena

About half a year after delivery of the equipment, sounds around the reducer began increasing.

Cause Estimation

In consideration of noises around the reducer, the following two points were suspected: (1) noises due to meshing of gears, (2) noises due to bearing abnormality.

Analysis and Data Processing

In order to identify the cause, measurements were made of noises and vibrations during reducer operation, and the results of narrow band frequency analysis of measured noises are shown in Fig. 2, which indicates that the main component has a frequency of 3,400Hz. On the other hand, consistency of the gear meshing frequency (Table 1) was checked, but no component corresponding to 3,400Hz was found. After reviewing Fig.2~~)~~, a feature was found that, in addition to 3,400Hz noise~~s~~, there are sideband waves at an interval of about 140Hz. Then, time waveforms of casing vibrations (Fig.3) were checked to find that shock vibrations occurred at an interval of about 7.1ms = about 141Hz.
As the gear has no frequency component that corresponds to 140Hz, characteristic frequency of each rolling bearing was checked (Table 2). The result proved that the above frequency is nearly equal to the frequency generated by the bearing ② that has damage on the outer race, and thus bearing disassembling inspection was conducted.

Countermeasures and Results

Disassembling inspection of the bearings revealed that the outer race of the bearing ② has damage (Fig.4), which was assumed to be undoubtedly due to electrolytic corrosion. Electrolytic corrosion refers to a phenomenon that, if current flows at the contact parts of a rotating race and a rolling elements of bearings under rotation, sparks occur through a thin lubrication oil film, leading to local melting of the surface to cause asperities. Then, voltage measurement was made to confirm a potential difference between the motor and the reducer. As this reducer uses an inverter, a leakage current peculiar to high-frequency switching operation of the inverter passes to the ground though a floating capacity inside the motor. In this arrangement, the motor and the extruder (containing the reducer) have an individual base, thus causing a potential difference between them due to leakage current. It was estimated that this current flows from the motor earthing brush -> motor shaft -> reducer shaft -> reducer bearing, to cause electrolytic corrosion. Thus, as a countermeasure, each base was connected by flat braided wires. As a result, the potential difference was reduced to 1/10, and as a matter of course, the abnormal bearing was replaced.

Lesson

Frequency analysis of vibration and noise offers a variety of information, but time waveforms shall also be examined without fail. Also, in case of inverter-motor driven rotating machineries, pay attention to potential difference between the motor and the equipment.

References

Nothing in particular

Keywords

Rolling bearing, electrolytic corrosion, reducer, inverter motor

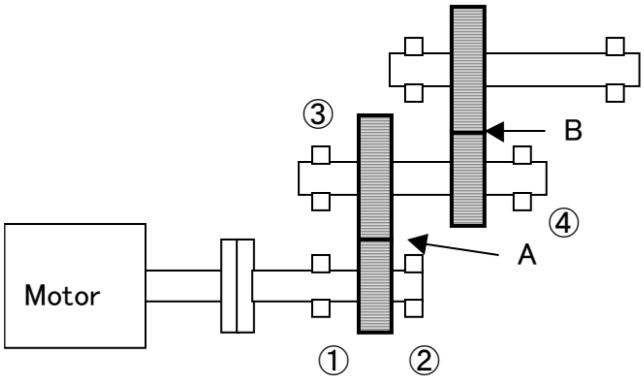

Fig.1 General arrangement of reducer

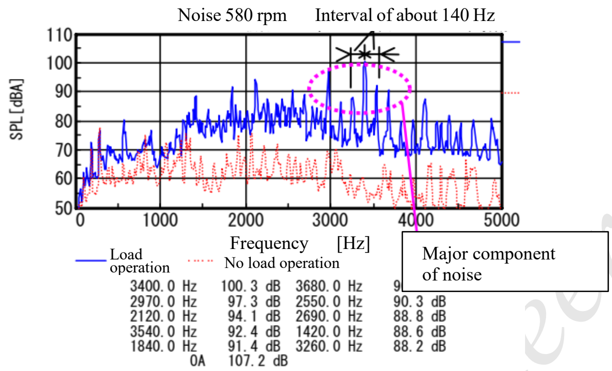

Fig.2 Narrow band frequency analysis result of noise measurements

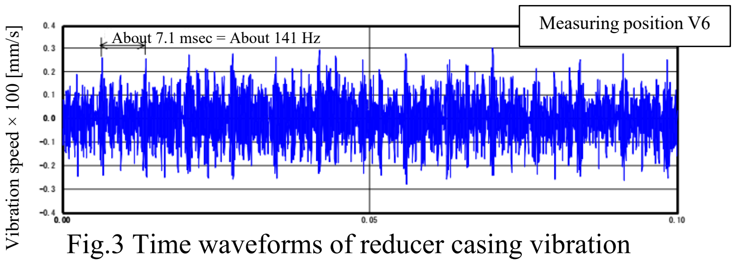

Fig.3 Time waveforms of reducer casing vibration

Table 1 Gear meshing frequency

Position	Meshing frequency (Hz) = rotating frequency × number of teeth
Meshing part A	570
Meshing part B	177

Table 2 Frequency that occurred on roller bearing

Z: Number of Rollers, fr: Shaft rotational speed [Hz]

ITEM	Z	fr [Hz]	fi [Hz]	fo [Hz]	fb [Hz]	fin [Hz]	fout [Hz]	fbo [Hz]
①	16	24.8	14.5	10.3	69.9	232.3	164.2	139.9
②	14	24.8	14.7	10.1	65.5	205.2	141.7	130.9
③	25	9.8	5.4	4.4	47.9	135.3	110.4	95.8
④	30	9.8	5.2	4.6	72.1	157.4	137.4	144.3

Characteristic frequency of inner ring having a flaw (* fr = rotational speed)

$fi = fr \times (1 + d \times \cos\alpha / D) / 2$

Characteristic frequency of outer ring having a flaw

$fo = fr \times (1 - d \times \cos\alpha / D) / 2$

Characteristic frequency of rotating body having a flaw

$fb = fr \times (1 - (d \times \cos\alpha / D)^2) / (2 \times d)$

Each generated frequency is as follows

$fin = fi \times Z$ $fout = fo \times Z$ $fbo = fb \times 2$ (Z = number of rollers)

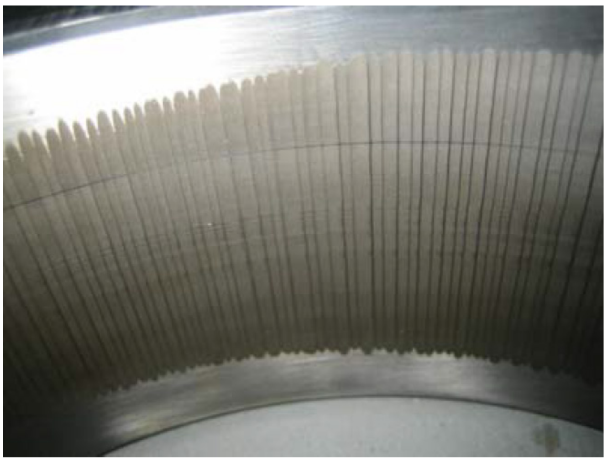

Fig.4 Photo of electrolytic corrosion of bearing outer race