Vibration Measurement	Abnormality of Piezoelectric Type Vibrometer	Rotating Machinery

Object Machine

Reduction gear for gas turbine generator (Fig.1)
(46Mw, rotating speed; pinion side = 60Hz, wheel side = 50Hz)

Observed Phenomena

When the load was increased during load operation, the output of a vibration monitoring vibrometer (piezoelectric type acceleration sensor) attached to four bearing parts suddenly increased and then the machine tripped. That is, immediately before tripping, the indication of vibrations started to fluctuate, and suddenly increased upon tripping (refer to Fig.2). The load condition in tripping had reproducibility in several times of operating speeds.

Cause Estimation

As the vibration generating conditions differed from one of normal vibrations and, in particular, temperatures of the bearing parts (bearing holding rings) do not suddenly change as same as vibration change, a question arose if the measured vibrations were correct or not.
As the vibrometer used was a piezoelectric type of acceleration sensor, there is a possibility that noises due to power source noises (50Hz) or low noise cable is vibrating.

Analysis and Data Processing

An acceleration sensor or dynamo-electric type velocity sensor (conventionally used and reliable sensor) is attached at the same position and perform comparative evaluation.
As a result, it was found that the outputs of these two types of sensors under low load operations were similar (Fig.3), but a remarkable difference was observed between them under a condition of tripping (Fig.4). Frequency components considered abnormal were integer times (power source noises) of the power source frequency (50Hz) and frequencies of integer times of 10Hz (60 - 50Hz?) appeared as teeth of comb. It was also confirmed that noises also increased when power source of auxiliaries of generator (for lubrication system) was switched to the source of in-house generator(Fig.5).
Thus, it was judged that the acceleration vibrometer was the source of trouble.
There is a high possibility that a saturation phenomenon (clip) in the charge amplifier generates as cause that the noise occurrence condition greatly changes depending on the loading condition,

Countermeasures and Results

Power source noises may be reduced by means of grounding (earthing) of the measurement system. Thus, as shown in Fig.6, the differential grounding was changed to the single end grounding (amplifier case earthing). As the results, the occurrence of power source noises decreased (not completely eliminated) and no abnormal output resulted in tripping.

Lesson

When using piezoelectric type acceleration vibrometers, we should pay attention to power source noises, vibration of cables, and saturation phenomenon of charge amplifiers. Attention must also be paid to commercially available sensors as they may have inferior performance.

References

Nothing in particular.

Keywords

Acceleration meter, piezoelectric type, seismic type vibration meter, power source noise, saturation phenomenon of charge amplifiers

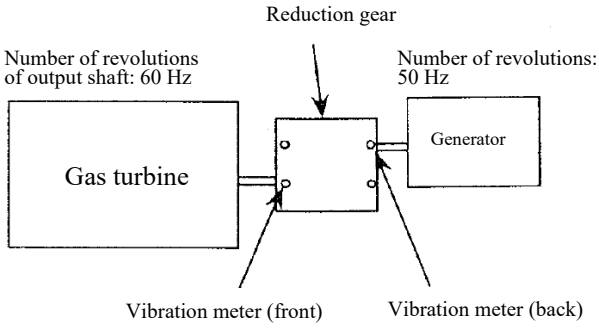


Fig.1 Gas turbine and vibration meter-attached position

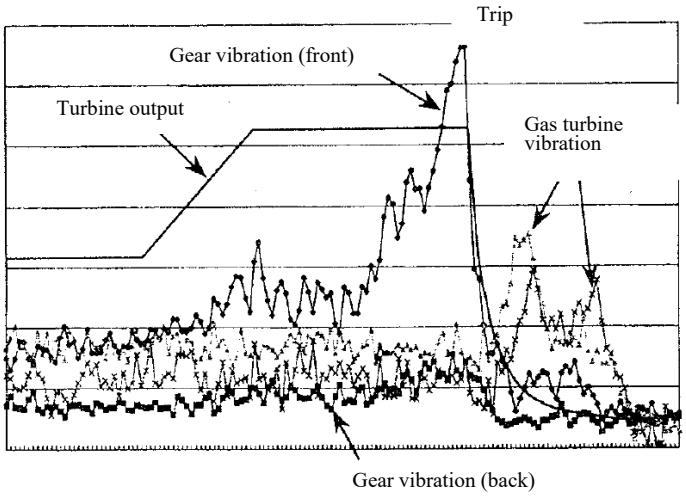


Fig.2 Record of vibrations upon tripping

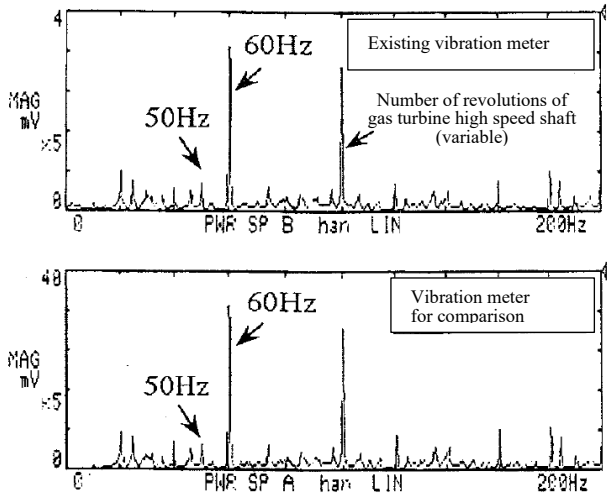


Fig.3 Output of gear vibration (front) under light load

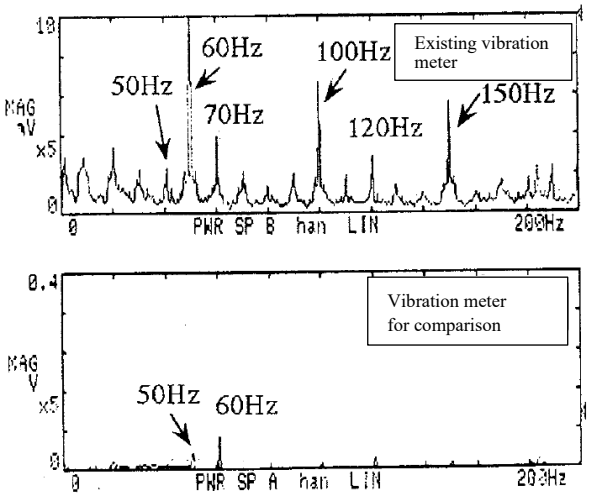
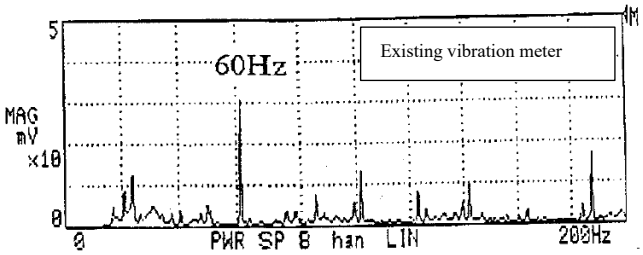
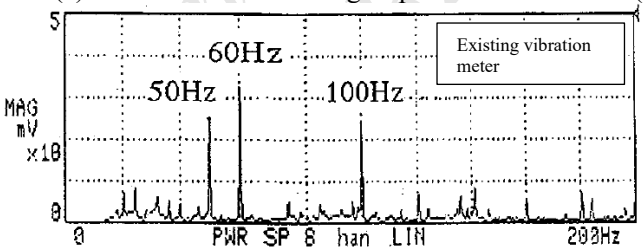


Fig.4 Output of gear vibration (front) under heavy load

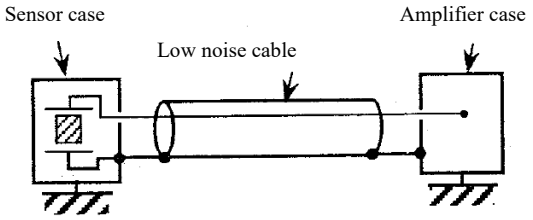


(a) In case of commercial grid power source

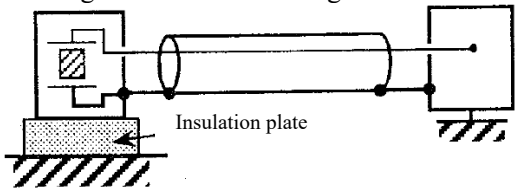


(b) In case of in-house diesel generator power source

Fig.5 Difference due to power source used for gas turbine auxiliaries



(a) Sensor grounding method before taking countermeasures



(b) Sensor grounding method after taking countermeasure

Fig.6 Noise countermeasures (changed to sensor grounding method)