Case History	Rubbing Vibration of Steam Turbine Generator	Rotating machinery (turbine & generator)
Self-excited Vibration		

Object Machine

Steam turbine generator (Fig.1)

Observed Phenomena

During stretch-out operation at a newly installed power generation plant, shaft vibration of the front and rear low of pressure turbine gradually increased, thus unable to increase the speed.

Cause Presumed

In consideration of changes in amplitude and phase over time, and turbine operating conditions (no load, constant rotational speed), as well as from the vibration characteristics, rubbing vibration was judged to be the cause. In order to assess the contact position, examination was made on positions that would be likely to come into contact.

Analysis and Data Processing

(1) Positions having large vibration changes are only the front and the rear of low pressure turbine.
Low pressure turbine front: 39→77 μm p-p (overall)
Low pressure turbine rear: 38→68 μm p-p (overall)
(2) Phase changes: slightly lagging direction
(3) Vibration frequencies: rotational speed component
(4) Changes in vibration have repeatability.

Judging from the above characteristics, rubbing was considered to be the cause of vibration. Thus, in order to determine the positions, a listening bar was used to check around the low pressure turbine bearing stands. As a result, in the vicinity of oil deflectors on both sides of the front bearing stand, some abnormal noise like contact sound was identified. For shaft vibrations at the front and rear of low pressure turbine having especially large vibration changes among the data obtained during stretch-out operation, Fig.2 shows changes in rotational speed-amplitude and Fig.3 indicates changes in vibration vectors. In addition, Fig. 4 shows changes in each shaft vibration.

Countermeasures and Results

Before removing the bearing top cover of the low pressure turbine front, but after turbine stop, a gap check between the rotor shaft and the oil deflector fins was performed. As a result, measured gap values on the intermediate pressure side were found smaller than the set values.
Thus, after removing the bearing top cover and checking the rubbing position, the gaps of the oil deflector fins were readjusted at the set value. Then, it was possible to raise its rotational speed up to the rated value, and no vibration problem has occurred thereafter.
Fig.5 shows the rubbing positions at the bearing of the low pressure turbine front.

Lesson Learned

Even a slight setting error in assembling a turbine will disturb the plant operation. It is vital to pay careful attention to gap control and offset, among other things.

References

Vibration & Noise of Rotating Machinery: Their Causes and Countermeasures, Analysis, Investigation & Diagnosis. Publishing Department of Management Development Center (Keiei Kaihatsu Center), 1978

Keyword

Turbine, generator, self-excited vibration, rubbing vibration, bearing stand oil deflector

★ It is also reported that AE sensors may be used to detect the positions where rubbing has occurred.

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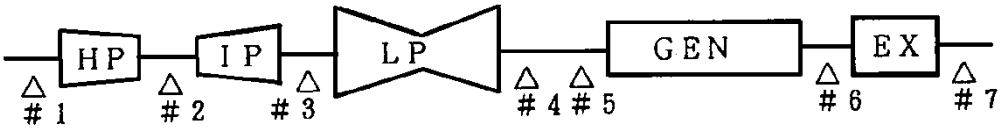


Fig.1: Steam turbine generator

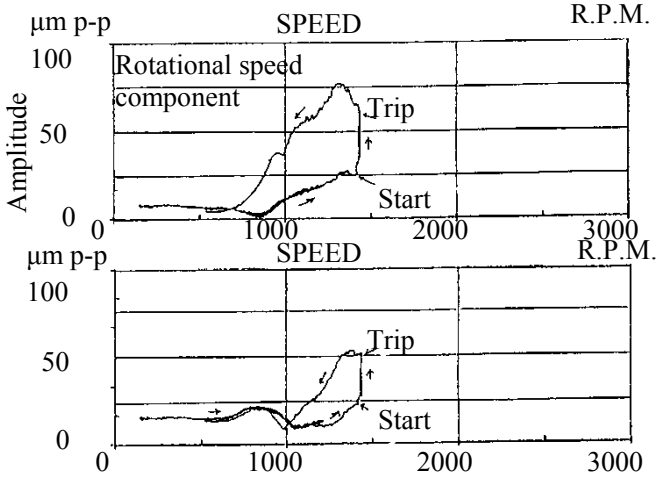


Fig.2: Changes in rotational speed-amplitude (during stretch-out operation)

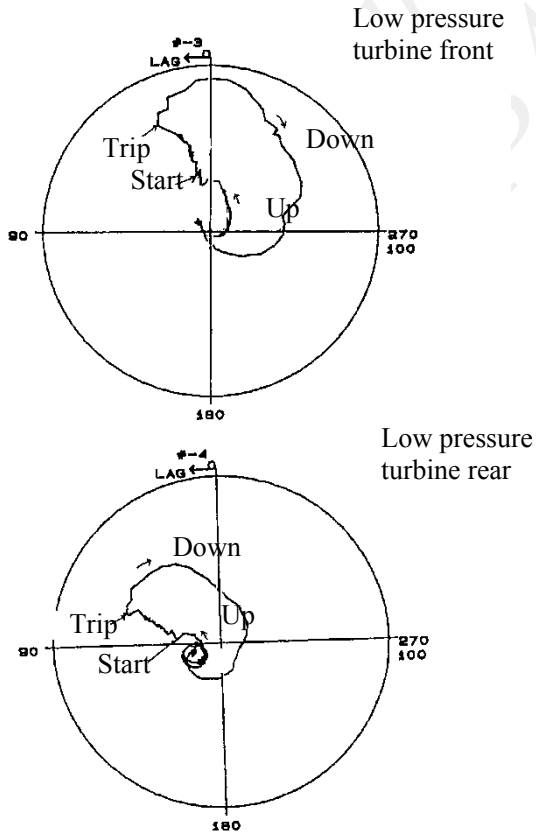


Fig.3: Changes in vibration vectors (during stretch-out operation)

★ In this case, changes in phase are small, but in some cases, phase varies in the opposite direction.

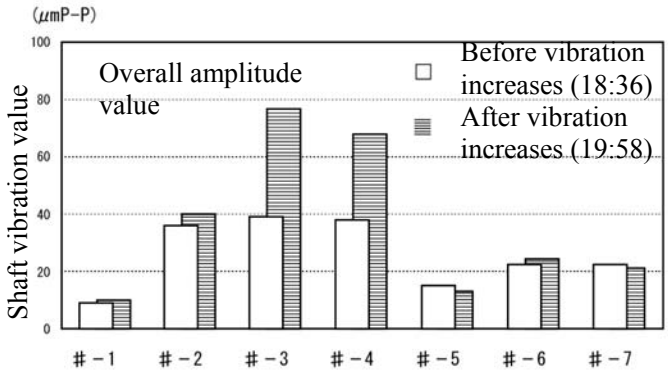
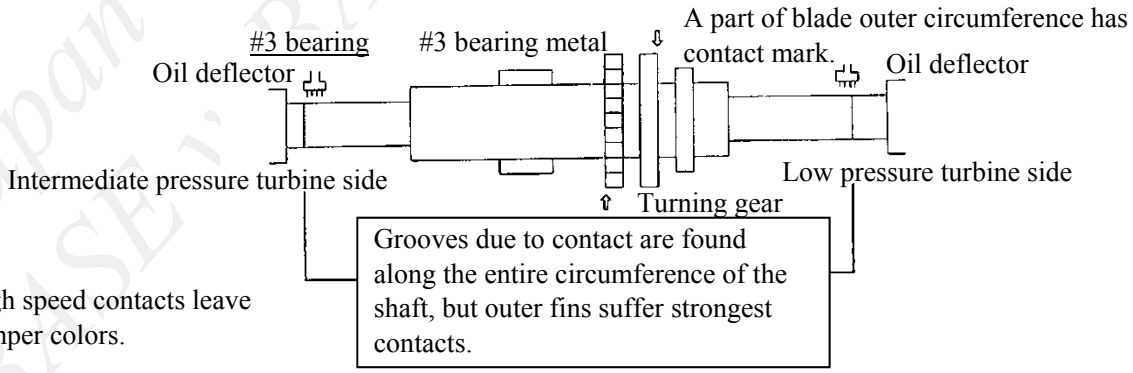


Fig.4: Amount of changes in each shaft vibration (during stretch-out operation)



★ High speed contacts leave temper colors.

Fig.5: Rubbing positions (bearing at low pressure turbine front)