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To cite this article: Wanjun Li *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **252** 032021

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Fault Diagnosis and treatment of Abnormal vibration of vertical condenser pump motor towards Ultra-supercritical 660MW turbo-generator set

Wanjun Li ^{1,*}, Xiaoxia Li ², Tianqi Huang ¹, Qingliang Niu ¹, Deke Zhang ¹ and Yang Dong ¹

¹ Huadian Electric Power Research Institute in Shandong branch, Jinan250014, China

² CRRC Wind Power (ShanDong) CO., LTD, Jinan250022, China

*Corresponding author e-mail: 418907504@qq.com

Abstract. The motor driving end vibrates when there is no-load test run after overhaul of condensate pump of power plant unit; Through fault diagnosis and analysis, reasons for vibration were checked and solution found. The main reason is that the condensate pump motor magnetic force center line is not centered. The condensate pump motor is disassembled, then the reason of magnetic force center line is not centered was found and solution. Potential equipment safety hazard was eliminated successfully.

Keywords. Vertical condenser pump motor; Abnormal vibration; Fault diagnosis; Fault treatment

1. Overview of equipment

A power plant ultra-supercritical 660MW steam turbine generator set is equipped with two condensate pumps, one for operation and one for standby. The condensate pump adopts vertical layout. The condensate pump motor is a vertical three-phase asynchronous motor with variable frequency speed regulation produced by xiangtan electric machinery factory, and the model is yspkk1560-4.

Main design parameters of condensate pump motor are shown in table 1.

Table1. Main design parameters of condensate pump motor.

project	Design value
Rated power	1600kW
Rated voltage	6kV
Synchronous speed	1489r/min
Rated frequency	50Hz
Constant torque frequency range	25~50Hz
Rated current	181.3A
power factor	0.89
Insulation class	F
Connection type	2Y
Cooling method	IC611
Space heater power	1.2kW(Use during power failure)
Space heater voltage	220V
efficiency	95.4%



2. Description of fault phenomenon

On March 29, 2018, the motor driving end vibrates when there is no-load test run after overhaul of condensate pump.

After vibration testing, it can be found that the value of axial vibration of driving end is 0.9 mm/s, radial vibration is 2 mm/s, tangential vibration is 6.78 mm/s, more than alarm value (alarm value of 4.5 mm/s, the critical value of 7.1 mm/s).

3. Analysis of Fault cause

3.1. Analysis on the major causes of vibration of condensate pump motor in no-load test run

Before the overhaul of the unit, the operation parameters of condensate pump motor are normal without disassembly maintenance. After the overhaul of the unit, condensate pump motor is reinstalled, and no-load test run is carried out after it is in place. When the rated speed is reached, it is found that the driving end vibrates. Vibration monitoring of condensate pump motor is carried out, and the vibration spectrum is shown in Fig.1.

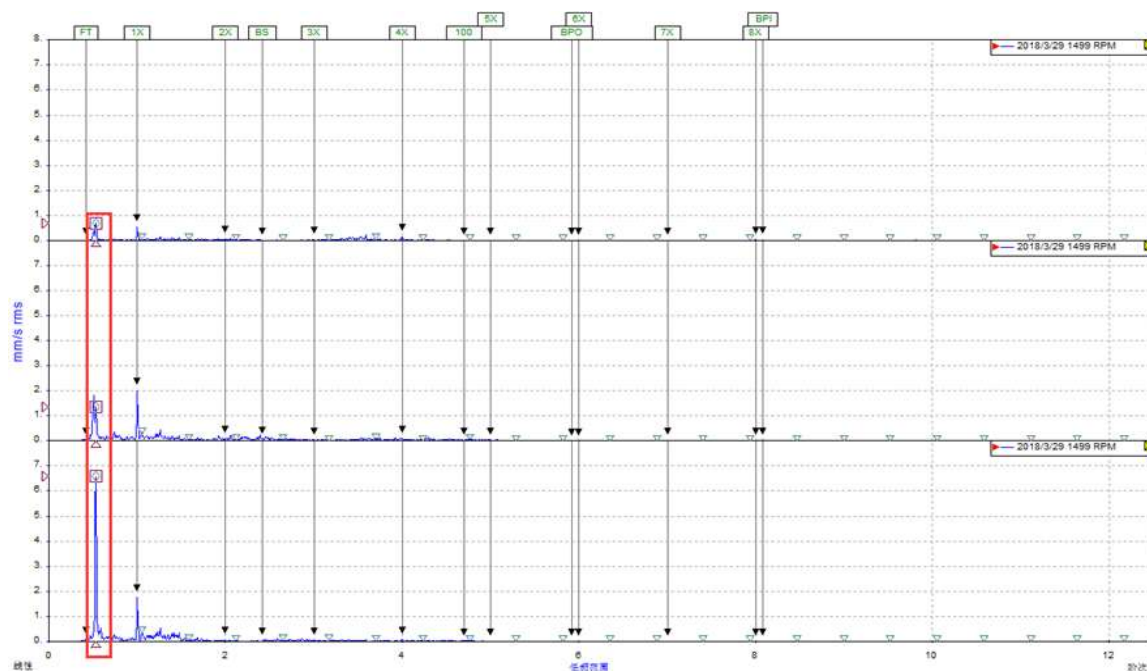


Figure 1 .Spectrum diagram of vibration at the driving end of condensate pump motor running without load.

We can see from Fig.1 that the vibration speed is mainly half frequency, also has a certain frequency component, the may reason is caused by bearing failure or the motor magnetic force center line is not centered, there is a certain eccentric electromagnetic force.

If the center line of the magnetic force of the motor is not centered, the vibration of the condensate pump motor will be large, and the vibration value of the condensate pump motor will decrease after the operation with load. Therefore, the vibration was measured after the condensate pump motor with load. The value of axial vibration of driving end is 1.41 mm/s, radial vibration is 2.18 mm/s, tangential vibration is 1.89 mm/s, and the vibration spectrum is shown in Fig.2.

Compared with no-load test run, there is a decline, which is mainly due to the condensate pump motor movement is limited in a certain range when running with load, under the action of the condensate pump thrust bearing, the motor rotor stability is improved, so that the motor overall vibration value is

reduced. Therefore, it can be judged that the misalignment of the magnetic center line of the motor is the main reason for the vibration of the condensate pump motor.

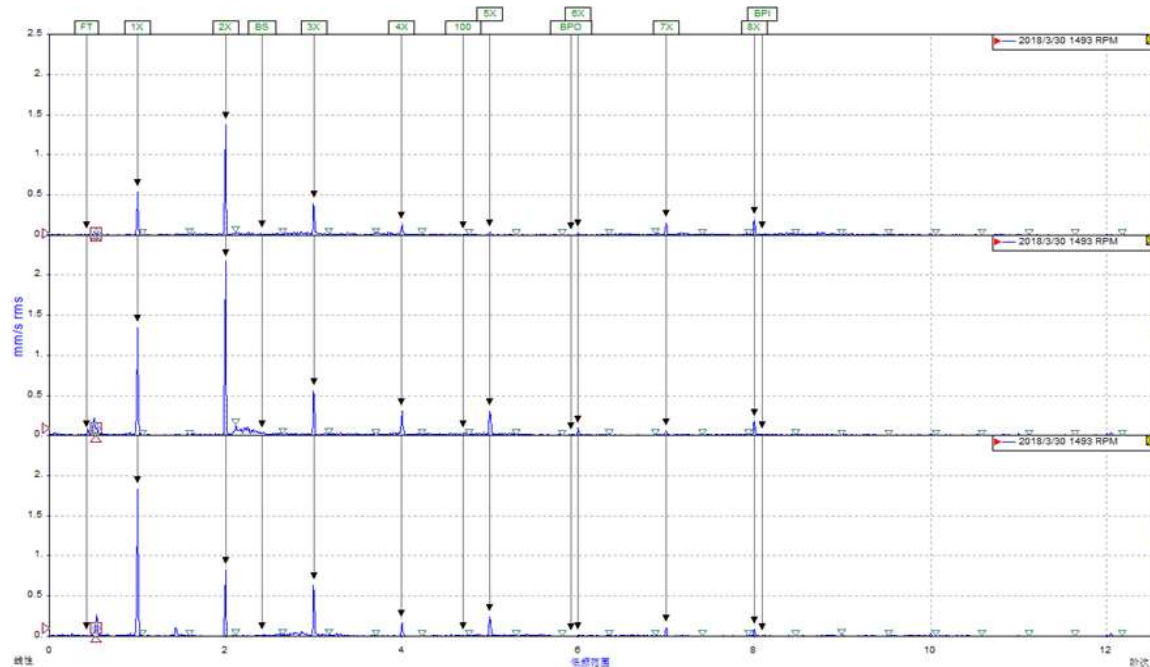


Figure 2. Spectrum diagram of vibration at the driving end of condensate pump motor running with load.

According to the demodulation waveform of the driving end of the condensate pump (as shown in Fig.3), it can be seen that the axial impact value of the pump bearing is large, reaching 68.7g, and a high peak value occurs every one second or so, and the radial and tangential impact value is relatively small.

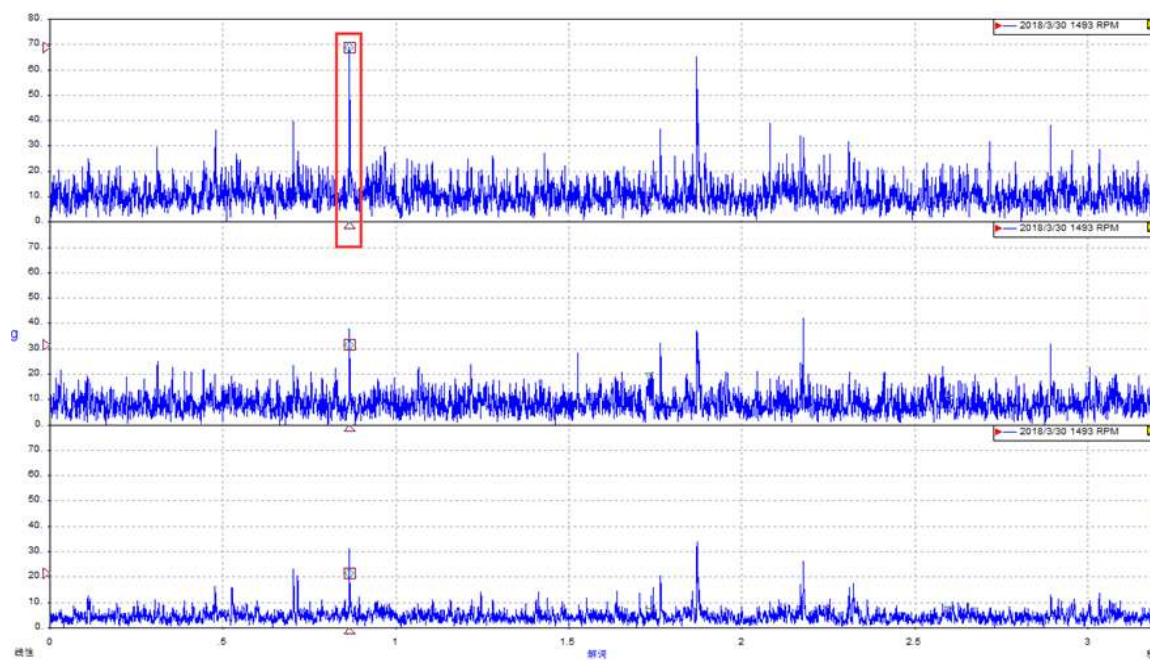


Figure 3. Demodulation waveform of driving end of condensate pump

3.2. Analysis of the center line of magnetic force is not centered

According to the vibration change law with load and no-load and the condensate pump impact value is too large and other phenomena, there are two major reasons of the condensate pump motor magnetic force center line is not centered :first,the center of gravity of the motor stator deviates from the vertical direction;second,motor rotor positioning is not correct.

If the center line of the magnetic force of the condensate pump motor is not centered when it is installed, the magnetic force gap between the rotor and the stator may deviate to different degrees, causing the rotor to deviate from the center position of the magnetic field. In the process of motor operation, the rotor moves from the bottom to the center of the magnetic field under the action of the magnetic field, and bounces back when it hits the root of the rotor, forming reciprocating movement. As the non-driving end bearing of the condensate pump motor (7330-b-np) is angular contact ball bearing, its ball groove is close to the cone type, the upper width and the lower width, because the rotor is channeling, the rotor and stator seat of the bearing is not on a plane, the ball will deviate from the original orbit, the rotating radius of the moving seat will become larger, thus causing the motor to shake, vibration is large.

3.3. Analysis after the condensate pump motor is disassembled

According to the above analysis, we decided to disassemble the condensate pump motor for inspection, it can be found that driving end bearing sleeve has been worn (the maximum wear depth is 0.65mm), as shown in Fig. 4,and color of bearing oil has changed as shown in Fig. 5.



Figure 4. Wear of driving end bearing sleeve

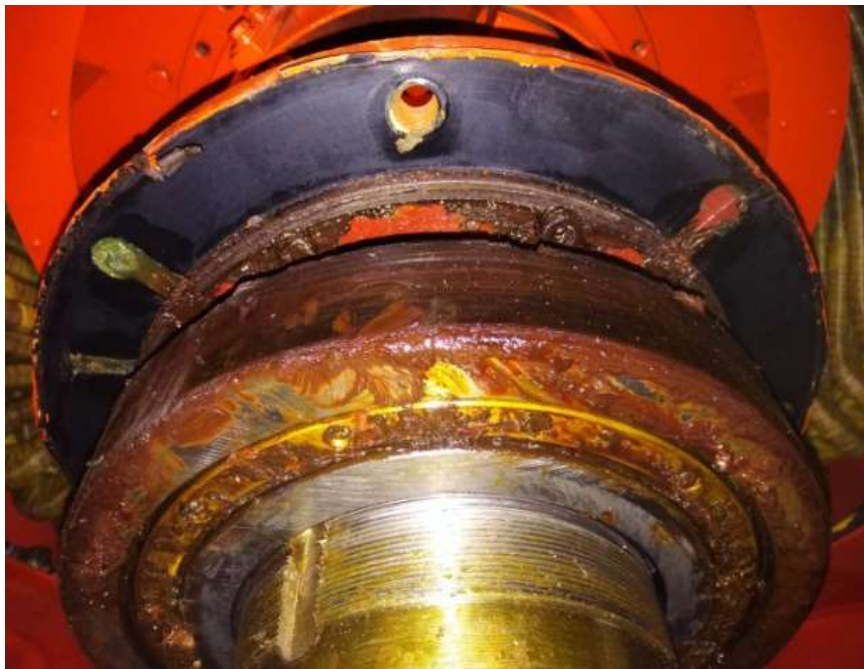


Figure 5. Color of bearing oil

After the disassembly of the condensate pump motor, the stator and rotor of the motor were tested and checked, and the cooperation of various parts and related accessories of the condensate pump motor was measured. No abnormal phenomena were found. Condensate pump motor base bedplate levelness has been measured, the result shown that the bedplate levelness is 0.27 mm/m, more than design value of 0.05 mm/m requirement, which cause condensate pump motor stator weight deviation from the vertical direction and the center line of rotor magnetic force is not centered. The vibration of motor increases during no-load test run due to the action of a partial magnetic force. The larger vibration will cause load impact on the driving end bearing, which will lead to wear of shaft sleeve gradually.

Other reasons that may lead to wear of shaft sleeve shall be investigated one by one:

1) Bearing abnormal

The driving end bearing has been checked after the disassembly of the motor. The bearing rotates flexibly, but the deterioration and discoloration of lubricating grease do not affect the normal operation of the motor, and no other abnormal problems were found.

2) Overhaul disassembly process is not standard

The motor has never been disassembled for maintenance since it was put into operation in 2016., instead, lubricating oil was added regularly. So the factor of non-standard technology in the maintenance process can be ruled out.

3) Thermal expansion leads to excessive fit clearance

Motor installed in a condensate pump pit, running records show that bearing temperature round within 38 °C all the year, temperature difference and temperature are in the reasonable scope, therefore, temperature difference will not lead to steel and cast iron produced by different expansion coefficient larger expansion amount. So the factor of thermal expansion leads to excessive fit clearance can be ruled out.

4) Abnormal shaft current is too large

The excessive shaft current is mainly caused by the different shaft voltages generated by the two ends of the rotor to the ground when rotating. The excessive shaft voltage will form the shaft current through the lubricating oil film, resulting in oil film damage, bearing and axle diameter damage. However, no abnormalities are found in the inspection.

Towards above analysis, driving end bearing sleeve has been weared mainly due to the vibration of the driving end of the motor suddenly increases. There are two major reasons of the condensate pump motor magnetic force center line is not centered: first, the center of gravity of the motor stator deviates from the vertical direction; second, motor rotor positioning is not correct.

4. Treatment measures and effects

1) The upper surface of the base plate of condensate pump motor is scraped and repaired, and the levelness of the upper surface of the base plate is ensured by means of adjusting gaskets to meet the design requirements. These measures can ensure that the stator center of gravity of the condensate pump motor is in the vertical center line, the rotor positioning is accurate, and the magnetic center line is aligned.

2) Replace the worn shaft sleeve at the driving end, adjust the interference amount of shaft sleeve and bearing to 0.02mm, and re-check the center.

3) Replace the lubrication grease of the driving end and non-driving end bearings of condensate pump motor to ensure the lubrication effect of oil film.

After the repair and treatment of condensate pump motor, it is reinstalled and tested at no load. All vibration values and watt-temperature indexes of condensate pump motor are normal.

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