Analysis of common problems of steam engine technical supervision in thermal power plant

Yongqiang Che [1], Yisen Chen [1] and Haizhen Lv [2]

[1] State Grid Shandong Electric Power Research Institute, Jinan 250003, China
[2] Shandong Zhongshiyitong Group Co., Ltd, Jinan 250003, China.

Abstract. Through the work of steam turbine technical supervision, the paper focuses on the construction of technical supervision system, daily management, equipment management, operation indicators, countermeasures management, hidden danger investigation, network-related safety and personnel training and other aspects, and finds out the existing common problems and analyzes them.

Keywords: Large vibration; overspeed hidden danger; high metal temperature; system leakage.

1. Introduction

Technical supervision is an important means to ensure the safe and stable operation of units. As one of the three major majors in thermal power plant, the safe and stable operation of steam engine equipment is very important for the whole thermal power plant[1]. Every summer, due to the high temperature of the weather and the high load of the power grid, the unit is required to operate at full load, which puts forward higher requirements for unit operation. Therefore, regular organization of technical supervision and inspection every summer has become a routine operation, known as the summer kurtosis supervision and inspection. Through summer supervision and inspection of kurtosis, hidden dangers and risks in unit operation can be found, and experience can be provided for other units.

2. Vibration of steam turbine

The vibration of most units is good, but the vibration of many units is too large or even exceeds the alarm value, and some of them have affected the normal load adjustment of units. During the peak summer, some power plants have taken some temporary measures to ensure the normal operation of the units in view of the large vibration problem. If the vibration of the unit is relatively stable and does not continue to increase, it is generally recommended to maintain the operation of the unit first, but monitoring should be strengthened to control the temperature of lubricating oil and the speed of load lifting of the unit[2]. Vibration professionals can be contacted for on-site monitoring and analysis, and preventive and treatment measures can be formulated in advance, which can be put into practice when there is an opportunity to stop maintenance. The vibration of the following units is too large, even exceeding the alarm value, which should be paid attention to:

The vibration of generator excitation end bearing of No. 2 machine in a factory gives an accidental alarm. The DCS screen and historical data show that the bearing vibration of generator excitation end (bearing #9) of unit #2 tends to increase with the increase of load. When the load reaches more than 90%, the bearing vibration value reaches about 80um, and the alarm value has exceeded 79um. The vibration is closely related to the excitation current and has time delay. It is suspected that the vibration is related to the thermal deformation of the generator. Power plants can strengthen the operation monitoring, use the downtime opportunity, eliminate the abnormal vibration of bearings, to ensure the safe operation of equipment.

The two units in the first phase of a factory have the problem of large 9Y vibration, and the vibration value is closely related to the load of the unit. When the load of the unit is close to full load, the vibration reaches the maximum, exceeding 140μm (operation regulation: normal operation is below 150μm, and tripping exceeds 250μm). # 2 unit vibration generator turn-to-turn short circuit, was the main cause of the processing of balancing have made three times in the same place, after each processing of balancing vibration situation has improved significantly, but after a period of time after operation and rev. Stop many times, the vibration value and slowly up to the state before the counterweight, analysis and unit start-stop often have a certain relationship, this problem has been included in the unit overhaul in September, Prepare to return the generator for disposal. Unit #1 also SUFFERED FROM LARGE 9Y vibration recently, and the on-line inspection device did not find the generator inter-turn short circuit problem in the unit, and the vibration cause needs to be further analyzed.

During the operation of the sequence valve of Unit #4 in a factory, the vibration value of bearing bush #1 and #2 in the adjustment of some load sections is fluctuated. The problem mainly occurs in the low load section, where the GV3 opening is 0-33%, and the vibration amplitude tends to increase to the maximum of 120um. Under different load segments and different opening states, the rotor of high regulating gate GV3 of unit #4 is destabilized by steam flow disturbance and the vibration increases when the sequence valve is running. It is suggested to strengthen the observation and trend of #1 and #2 bearing vibration of #4 unit, organize discussion and analysis in time, and formulate corresponding adjustment and emergency measures; When lifting load, closely monitor bearing vibration and shaft temperature, by timely adjusting the opening of the door, control the vibration of any bearing does not exceed the alarm value (127μm); Check and adjust the flow of high and high pressure cylinder.

When the load of unit #7 in a factory is 661MW, the shaft vibration of bearing #1 is 118μm; According to the historical curve, the vibration value of the bearing increases with the increase of load. When the load reaches 900MW, the shaft vibration is 150μm. It is understood that the #1 bearing vibration of this type of unit is relatively common, the main reason is that the #1 bearing is at the end of the shafting, the load is light, and the vibration is easy to occur. It is suggested to organize vibration professionals to carry out on-site monitoring and diagnosis, identify the cause of vibration, and put forward the treatment measures.

3. Steam turbine overspeed risk

Steam turbine valve jamming, tone wave (or off), valve rigor poor motivation (especially oil), oil leak, spring break or valve pin fracture problems still outstanding, which affect the normal regulating function of the steam turbine, load fluctuations or down load operation, serious and even lead to the unit not stop events[3].

In the movable test of the middle joint door of Machine #1 in a factory, the ICV2 valve was stuck around 96% and could not be closed. After replacing the adjusting servo valve, the remote test shows that the ICV2 of machine #1 is fully open and normal. When closing, the instruction is 87.9%, and the feedback is unchanged at 94.7%. It is still stuck and cannot be closed. The replacement of the adjustable servo valve has no effect, and the analysis is that there is a problem in the valve or oil circuit.

The switching valve of main oil cooler of Unit #6 in a factory is stuck. The switching valve of the main oil cooler almost does not switch during normal operation, and the switching valve action frequency is low. After a long period of operation of the unit, the switching valve may be stuck. It is recommended to maintain the current operating state and avoid valve switching operation. It is suggested that the disassembly and overhaul of the main oil cooler switching valve be included in the overhaul project of Unit #6, and the overhaul and maintenance work should be completed as soon as possible to ensure the safety of the system.

References are cited in the text just by square brackets [1]. (If square brackets are not available, slashes may be used instead, e.g. /2/.) Two or more references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under a heading References, see our example below.

4. Abnormal bearing metal temperature

The metal temperature of most of the steam turbine bearings is within the normal range, but there are still some units with high bearing temperature, large temperature deviation of each thrust tile, high bearing oil return temperature, especially the case that the temperature difference between each thrust tile exceeds 10℃ is relatively more. High bearing metal temperature is related to bearing load, bearing lubricating oil inlet and return[4], bearing installation quality and other factors. Power plants should closely monitor the changing trend of bearing temperature, conduct statistical analysis on relevant influencing factors, and formulate corresponding treatment measures and preventive measures.

The two temperature measurement points of the front upper part of the thrust bearing of unit #2 in a factory are 66℃ and 77℃ respectively, and the left and right temperature measurement points of the rear upper part are 73℃ and 65℃ respectively. The temperature difference between the two front and upper parts is 11℃, and the temperature level between the thrust tiles is not uniform. It is suggested that the power plant should take advantage of the maintenance opportunity to check the contact and self-positioning of each thrust tile, grind each tile to ensure that the load of each tile is uniform and has good self-positioning performance, and overhaul and assemble the thrust bearing in strict accordance with the requirements of maintenance technology and regulations.

When the load of unit #6 in a factory is 243.8MW, the #2 watt temperature is 92.0°C, the #3 watt temperature is 62.2°C, the #4 watt temperature is 94.6°C, and the #3 bearing bush temperature is much lower than that of #2 and #4 bearings. When the load of unit #7 is 232.7MW, the #2 w temperature is 87.0°C, the #3 W temperature is 59.0°C, the #4 W temperature is 96.1°C, and the #3 bearing bush temperature is much lower than that of #2 and #4 bearings. Shafting load is uneven, #2 and #4 bearing load is too large, #3 bearing load is too light, multiple units in the province due to #3 load is too light caused by oil film vibration caused by vibration. The power plant has the opportunity to take measures to redistribute the shafting load, and it is recommended to raise the #3 bearing to increase the bearing capacity.

The temperature of the #4 bearing of the #1 steam turbine in a factory is high. After referring to the operation history curve of the #1 machine, it is found that the oil pressure of the #4 bearing in the local jacking shaft of the #1 machine is zero in normal operation, and the temperature rises abnormally during the shutdown process. It is suspected that there are problems related to the oil pipeline of the #4 bearing jacking shaft. The pipe inside the jacking oil to the #4 bearing box is broken or slipknot is loosened, resulting in pressure relief. It is suggested to use the mediation opportunity to check the oil pipeline of #4 bearing jacking shaft, check the leakage point and deal with it, ensure the normal oil pressure of jacking shaft, and ensure the normal establishment of bearing oil film when the jacking shaft oil system is put into operation in the process of starting and stopping.

The load of unit #1 in a factory is 250MW, and the temperature level difference between thrust tiles on the working face is 16.4℃. The load of unit #2 is 227MW, and the temperature level difference between the thrust tiles on the working face is 18.4℃. It is recommended to analyze the equipment defects together with the design and assembly department of the manufacturer. Add assessment clause in maintenance outsourcing contract.

5. Heater Terminal Difference

In many units, the heater end difference, especially the hydrophobic end difference is large, which affects the unit economy[5]. For example: the difference between the upper and lower ends of Unit #4 #2 in a factory is 9.26℃. The high loading and hydrophobic temperature of unit #1 #3 in a factory is 173.72℃, and the lower end difference is 21℃. The difference between the lower end of the #3 high additive of unit #5 in a factory reaches 21℃, far exceeding the design value. The #3 high additive is operating under bad condition, with many leakage times and high pipe blocking rate. The unit has been running for many years, and the heat transfer performance has decreased. It is suggested to control the water level of #3 high water tank well in operation, and replace the high water tank when conditions permit.

It is suggested to strengthen the tracking and monitoring of the heater end difference and establish the heater ledger under typical working conditions. For the large difference of the hydrophobic end, the water level of the heater should be checked first, and the adjustment should be strengthened in operation to ensure enough hydrophobic water level. At the same time, the running exhaust system of the heater, especially the low - add, is checked to ensure the smooth exhaust. Strengthen the monitoring of the operation of the heater, find leakage in time, and deal with it in time. Replace the high pressure heater if possible.

6. System Leak

All power plants attach great importance to the control of valve leakage, but the valve leakage problem is still common, especially the high and low pressure bypass valves of units, water supply flow recirculation valves and other parts of the leakage phenomenon is serious, the details are as follows:

1) No. 2 machine of a factory is not strict to the secondary cooling auxiliary steam check door, some steam leakage phenomenon, directly affect the unit economy. It is suggested that the power plant take advantage of the maintenance opportunity to repair or replace the secondary cooling to auxiliary steam check door to improve the unit economy.

2) The drainage temperature from main steam to small engine main pipe of Unit #5 in a factory is 307℃, and there is valve internal leakage. Frequent start and stop of the unit, long-term maintenance of the valve, valve quality problems. Valve leakage will reduce the economic efficiency of the unit, and at the same time, there are huge safety risks, which need to be paid attention to. It is suggested that the power plant should try to choose valves with better quality level on the basis of full investigation to solve the problem of valve leakage.

3) The temperature measured after recirculating valve of steam pump A of Machine #6 in A factory is high (98℃), which indicates that there is slight internal leakage. The recirculation valve of steam pump of machine A operates under bad condition, resulting in scour of spool seat. It is suggested to use the mediation opportunity of Unit #6 to replace the valve core and seat of the steam pump recirculation valve of Unit #6 A or consider upgrading the recirculation door.

4) A factory #6 machine #2 bearing shaft seal leakage is large; The low pressure cylinder shaft end of unit #4 and #5 May have air intake. The low pressure shaft seal steam supply pressure of unit #5 reaches 71kPa, which exceeds the normal low pressure shaft seal steam supply pressure, but no steam leakage phenomenon is found at the shaft end. Turbine shaft end seal wear, sealing effect is poor. It is suggested to overhaul the shaft seal of low pressure cylinder of unit #4 and #5, and adopt the sealing form and material with better sealing effect.

5) A factory #8 machine B steam feed pump recirculating pneumatic door leakage, measuring point temperature 102℃. Valve leakage is mainly caused by the valve core, seat sealing line is not complete, the seal is not strict. It is suggested to take advantage of the overhaul opportunity of the unit to overhaul the hydrophobic pneumatic door of the main steam pipeline to eliminate the internal leakage problem. #8 Engine A steam pump recirculating electric regulating door for disassembly inspection, check the valve sealing line, thoroughly eliminate the problem of internal leakage.

6) Internal leakage of closed water cooler A of Unit #5 in A factory. The closed water cooler in power plant is a multi-layer dense plate heat exchanger with large sealed cooling area and many potential dew points. Leakage may occur after long-term operation. It is recommended to switch the closed water to B cooler for operation, and organize maintenance personnel to carefully check the dew point and repair and restore as soon as possible.

7) When the load of machine #1 in a factory is 344MW, the feed water flow at the inlet of steam pump is 1322T /h, the feed water flow at the inlet of economizer is 1036T /h, and the recirculation valve opening of feed water pump is 0. The internal leakage of this valve is serious. Internal leakage of recirculating valve of feed water pump is a common problem. The unit frequently participates in depth peak regulating, start and stop peak regulating, and the recirculating valve of feed water pump often operates, especially the scouring under small opening has the greatest influence on the tightness of the valve. Some power plants install pneumatic shut-off ball valve before the recirculation valve of the feed water pump to share the scouring under small opening. It is suggested that the

power plant should investigate the modification experience in this aspect.

8) There is leakage in the low-pressure cylinder water temperature reducing regulating valve of Machine #2 in a factory. When the bypass water temperature reducing regulating valve is closed to 0% in the process of cylinder cutting, there is still water spraying. It is judged that there is leakage in the valve, resulting in the waste of warm water and affecting the normal use and regulation. When the valve leaves the factory, the spool seat does not meet the standard, or the abnormal flushing in the process of operation leads to a large amount of internal leakage. It is suggested to repair or replace the water jet temperature reducing regulating valve of the low pressure cylinder of machine #2 combined with the shutdown opportunity to reduce the internal leakage and improve the reliability of the equipment.

The valve leakage in the thermal system directly loses the effective energy of the high quality working medium, which has an obvious influence on the coal consumption of the unit. Therefore, it is necessary to strengthen the control of valve leakage. At present, the power plant has been attached great importance to the problem, has taken many effective measures, such as strengthening the valve before and after the temperature monitoring, replace more safety and reliable long-life valve, improve the quality of valve repair, valve leakage problem has improved, but the valve type selection, operation adjustment habits, there are large difference between valve leakage management, governance effect is difference is bigger also.

Power plants should make use of the opportunities for major and minor repairs and downtime to strengthen the control of valve internal leakage, make good selection of new valves and quality control of acceptance, strengthen the supervision of process quality in the valve maintenance process, and ensure that the valve can meet the quality standards of flexible switch without sticking, tight closure and leakage after maintenance. It is suggested that each factory establish a special management ledger of valve leakage, timely grasp the valve leakage situation, planned and step management; At the same time, each factory should strengthen communication and exchange, especially in the valve selection, maintenance, operation and monitoring aspects of mutual learning and reference, common improvement.

7. Cooling Effect

The cooling tower with multiple units has the problem of uneven water pouring, which reduces the heat exchange performance of the cooling tower[7], affects the water temperature of the tower, and thus reduces the output of the unit. Such as:

1) There is water column in the #4 cooling tower of a factory, and the water is not even. The reason is that the packing or water distribution pipe in the cooling tower is damaged. It is recommended to use the overhaul opportunity to check the packing and water distribution pipe in the cooling tower, and # 4 cooling tower can also be retrofitted according to the retrofit experience of the other three cooling towers.

2) In the normal operation of the cooling tower of Unit #4 in a factory, there are many places where the circulating water column falls. The outlet water temperature in the tower is about 2℃ higher than that of other units, and the height of the cooling tower is 2-3℃ higher than that of unit #3, which affects the economy of unit #4. The cooling tower of unit #4 adopts ceramic packing, which is seriously weathered and collapsed and has the problem of uneven water shower. Dehydrator, water distribution pipe, nozzle and other equipment have different degrees of aging, damage, deformation problems, affect the efficiency of steam water removal, water film formation will cause poor evaporation efficiency. Treatment suggestions: combined with the comprehensive treatment and transformation of the cooling water tower of the technical reform project, upgrade and replace the packing (can be replaced with the same PVC material as the packing material of the #3 machine cooling water tower); Check the dehydrator, water distribution pipe, nozzle and other equipment, replace the damaged parts, replace the efficient nozzle.

3) There is a lot of silt in the bottom pool of cooling tower of Unit #3 in a factory, and the packing has scaling, sinking and aging phenomenon. Treatment suggestion: Take advantage of the unit maintenance opportunity to thoroughly inspect the cooling tower components of Unit 3, repair the damaged packing, splashing device, water remover, and remove the scale.

4) The cooling water tower of Unit #2 in a factory has the problem of large water column and nozzle falling off. Reason analysis: the unit runs all year round, and the poor quality of the circulating water causes the aging and falling off of the spraying equipment of the cooling tower. Rectification suggestions: check and replace the damaged parts according to the shutdown opportunity; Check other spraying devices and fillers of the cooling tower to eliminate hidden dangers.

5) The outlet water temperature of cooling tower of Unit #7 in a factory is 2℃ higher than that of unit #6, and the outlet water density of cooling tower of unit #7 is not uniform. Reason analysis: packing of cooling tower of #7 unit falls off, bamboo lattice rots and piles up, which affects the ventilation of water tower and reduces the heat exchange effect. Rectification suggestions: Include in the maintenance plan, and replace the core packing of the cooling tower.

8. Summary

Through inspection, it is found that all power plants attach great importance to the technical supervision of steam engines, with a sound supervision system, complete personnel configuration and clear division of responsibilities. It can actively carry out various supervision work according to the requirements of turbine technical supervision work regulations, and give full play to the role of advanced supervision, risk control and advanced technology promotion in the aspects of unit stability, economic operation and energy saving transformation. The power plants pay more attention to the formulation and implementation of anti-accident measures, but the daily management, equipment maintenance and operation still need to be strengthened and improved, and the technical supervision of each plant needs to be further strengthened.

References

1. Yu Yingli, Han Yi, Cai Bin, et al. Current situation and development of boiler technology supervision in electric power industry. Power & Energy. 2017,38(06), p. 809-811.
2. Guo Jia, He Xinrong, Tan Rui, et al. Analysis and Treatment of Abnormal Shaft Vibration in 600 MW Supercritical Steam Turbine Generator Unit. Northeast Electric Power Technology. 2022,43(06), p.40-43, 48.
3. Zhang Xing. Cause Analysis and Treatment on Control Instruction Fluctuation of Medium-pressure Regulating Valve. Zhejiang Electric Power. 2016,35(02), p. 45-47.
4. Wang Fei, Xie Weiyang. Abnormal Analysis and treatment of low-pressure bearing temperature of 1000MW steam turbine. Turbine Technology. 2021,63(06), p. 455-457.
5. Zhan Hailong. Cause Analysis on Big Difference of Heater Lower End of Regenerative System in 330 MW Unit of Thermal Power Plant. Internal Combustion Engine & Parts. 2016, (12), p. 62-63.
6. Zhang Heng. Causes and countermeasures of pipe valve leakage in thermal system of thermal power plant. Inner Mongolia Coal Economy. 2021, (18), p. 168-169.
7. Wang Yongquan, Cai Lanyan, Ye Xiaozhen. Cooling tower performance research and upgrading. Energy and Environment. 2021, (01), p. 45-46, 48.