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Study on Influencing Factors and Improved Measures of Turbine Heat

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Abstract. By the study on the commissioning and performance testing of 600 MW steam turbine unit, this paper gives a detailed analysis of the unreasonable problems of modern large turbine operation mode prevalent in the actual operation and other issues, as well as the impact on the economy of the unit, and some suggestions for improving power plant running.

Introduction

The turbine is an important equipment to convert heat into electrical energy, usually heat rate as an important indicator to measure power plant heat economy. The assessment and analysis of the heat rate indicators have been the universal importance of the power plant, to become one of the important means of monitoring the performance of the turbine. Reduce the unit's heat rate in the establishment of power plant safety, economic, stable, reliable operating system as well as an important guiding role in the electricity market, bidding costing system. The heat rate calculation is more cumbersome, complex factors, and is closely related to the specific design and operating parameters of the unit. A dozen units in accordance with the actual needs of the power plant, the author has in recent years a number of large-scale thermal power plants of 100 ~ 300 MW steam turbine unit developed for the heat rate calculation program, greatly improving the calculation speed and accuracy of the on-site technical personnel, as well as find and solve the problem of certain algorithms. This article discusses the counterbalance method to calculate the heat rate step analysis of the factors affecting the unit heat rate. Take 300 MW units as the example, and it gives a quantitative analysis of the main factors and parameters that affect the heat rate calculation accuracy.

The Main Factor of the Unit Heat Rate

The Turbine Flow Efficiency Is Low

The Turbine Flow efficiency depends on the steam turbine, the efficiency of the low-pressure cylinder and high pressure with steam institutions throttling losses. Overhaul before the performance test show that the # 12 crew efficiency of the high-pressure cylinder 80. # 11 crew efficiency of the high-pressure cylinder 80, 3672 (141 MW), low compared to the design value of 84.2057% 3.8385%. The Main factors are:

(1) The design of the models for the design of the unit the first single-cylinder, single-axis 150MW units to improve the unit to adapt to a fast start peaking capacity and to ensure the safe operation of the unit labyrinth clearance of more than 1mm;

(2) High pressure within the cylinder interlayer cooling the excessive steam holes and pore size is too large (8mm × Φ8mm);

(3) High-pressure cylinder with steam institutions throttling losses;

(4) Tip the steam seal structure still in the laying comb structure, the loss of steam leakage.

Feed Water Temperature Is Less than the Design Value

Feed water temperature of less than the design values make Water Heat cycle thermal efficiency is reduced, thereby increasing the heat consumption;, the feed water temperature increased, reducing the water supply and boiler tube metal temperature difference to reduce the thermal shock and improve the safety of the equipment . For the feed water temperature is raised, in addition to the guarantee of 100% of the heater input rate should be lower end of the heater, in order to improve

the efficiency of the heat recovery. Sichuan Huadian Panzhihua 3D Power Generation Company Limited # 11, # 12 unit # 2 high-pressure heater there is an insufficient temperature rise, resulting in low feed water temperature. Factors affecting the water supply temperature as follows:

(1) Lower annual unit average load, # 11, # 12 unit average load of 2006 was 123, 175, 113 and 73MW respectively.

(2) The high pressure heater is the impact the feed water temperature unit operation is an important indicator of the economy. # 11 crew 90MW operating point, for example, the high-pressure heater stopped running heart rate of 9440 499kJ / (kW · h), compared with when put into operation 9 392 57 KJ / (kW · h) 47. 929kJ / (kW · h).

(3) Heater temperature rise. Lack of temperature rise will make on a heater heat load increases, affecting Water Heat System enthalpy raise distribution, eventually leading to the water supply temperature decreases. 2006 # 11 unit # 1, # 2 high pressure heater temperature rise of 27.6, 27 ° C, # 12 Unit # 1, # 2 high pressure heater temperature rise of 16, 36 ° C, and the design temperature rise of 19, 44 ° C.

(4) High-pressure heater bypass damps the rigor bad. Due to the high-pressure heater rigor poor, causing part of the water supply is not bypassed through the heater, so that the feed water temperature decreases.

(5) High-pressure heaters serious leak, plugging high rate. As of August 2007, # 11, # 12 unit # 2 high-pressure heater leak plugging rate reached 8%, 9%.

(6) # 1, # 2 high-pressure heaters hydrophobic high temperature, close to the heater into the saturation temperature of the vapor pressure. As designed, high-pressure heaters should hydrophobic cooling section, doubt whether the heater selection matches with the host design.

The Condenser Vacuum Is Below the Design Value

Low condenser vacuum, resulting in loss of Turbine cold source increases, reduce cycle thermal efficiency, heat rate rise. Factors affecting the condenser vacuum:

(1) The circulating cooling water inlet temperature by the influence of the outside temperature. Power Generation Co. Ltd. of Sichuan Huadian Panzhihua three-dimensional circulating water inlet temperature annual average / maximum (large) / minimum (small) is 16. 3/24. 6/8. 0 ℃.

(2) Circulating cooling water temperature liters of cooling water has a lot to circulating water temperature rose more than 15 ℃, you can consider it soared to open a circulating pump, increase the cooling magnification. Cooling water shortage reasons: circulating water pump the insufficient output or increased water resistance, and water resistance to increase steel pipe blockage, export or condenser circulating pump into the valve opening degree.

(3) Condenser end. The condenser end difference increases, the same cause elevated exhaust temperature vacuum reduces. And the difference between the inlet temperature of the cooling water, the cooling area, the cleanliness of the steel surface (scaling) and condenser accumulate the amount of air and other factors related to the size of the show that the condenser thermal efficiency level of end difference. Lower end difference, can greatly reduce coal consumption.

(4) Vacuum tightness. One of the main factors of condenser vacuum tightness of the characterization of the main indicators of the operating characteristics of the Condenser influence Turbine economic operation. Due to the leakage of steam decomposition and system Condenser always have a certain number of non-condensable gases. The test proved that even contain only 2% of the non-condensing gas, water vapor will be reduced by 5% or more of the amount of water vapor condensation. Vapor - liquid at the interface of the non-condensing gas when water vapor contained in the non-condensable gases, water vapor and non-condensable gases in the condensation process in the interface aggregation concentration increases, the concentration of the non-condensable gases is formed outwardly from the interface. The concentration of the maximum is different. In the steady state, the non-condensable gases to rely on the difference in concentration from the interface to outward diffusion, the diffusion rate and water vapor at the same rate of arriving at the interface. Since the total pressure is certain, so the large interfacial concentration at the partial pressure of the non-condensable gases is also large, the partial pressure of water vapor inevitably reduced. The steam saturation temperature corresponding to the partial pressure

condensation, so the liquid membrane outer surface of the temperature below the mainstream at the saturation temperature, is adding the equivalent of a thermal resistance, will inevitably affect Condenser terminal temperature difference.

Solutions and Effect

Solutions

First of all, should be avoided and timely elimination of the sealing surface leakage of the column port; Secondly, change the material of the lens pad to be provided with the headliner layer of the same material, the same as the electrode potential so that the two, so as not to generate electrochemical corrosion conditions. To this end, the tower mouth lining at the sealing surface corrosion to take a knife to repair, manufacturing lenses pad to switch the domestic 00Cr25Ni22Mo2N material (leaning tower).

Effects

After September 2002 to repair and put to good effect, not only to solve the tower mouth sealing surface corrosion problems, as well as the sealing accessories (lens pad), localization, and considerable foreign exchange savings for the company. Meet the heating needs, but also increase the generating capacity, thereby enhancing economic efficiency. To save money, QF-6-2 generators and ancillary equipment dynamic principle; according to the production needs of the fertilizer system, the exhaust steam pressure increased to 1.1 MPa 1.0 MPa. To optimize the design of the turbine flow passage of thermodynamic accounting, to take measures to reduce the acting blade height, reducing the flow area, and improve the work efficiency of the turbine, so more power to achieve the purpose of the existing steam load.

Transformation of Content

Steam Institutions

Accounting to determine the transformation with steam institutions to adjust the steam valve, 6 and change the valve diameter to match the nozzle. Second valve the spherical valve into plow-valve, in order to improve the stability when the unit variable parameter operation. It Should as far as possible to reduce to the superheated less water flow, take advantage of the overhaul the opportunity to eliminate high plus Bypass Water leakage current. Overheating by warm water (or high plus Bypass Water leakage current) for each additional 1 t / h, heat consumption increase of 0.65 kJ / kW · h.

Nozzle and Turn the Wizard Leaves the Ring

To improve the thermal characteristics of the unit, re-designed nozzle group and transfer wizard leaves the pitch diameter of ring by Φ1 050 mm instead Φ1 040 mm.

Partitions

Enthalpy drop in the after transformation Turbine levels allocated more reasonable, a new design, the two partitions, both to improve the efficiency of each level, but also to ensure the exhaust steam pressure and the steam turbine output power requirements. Improve condenser vacuum. All factors that affect the unit heat condenser vacuum (the unit back pressure) on heat consumption, according to the manufacturer of vacuum curve, vacuum unit for every 1 kPa, heat rate can be reduced by 0.5% (40 kJ / kW · h), contribute to an increase of approximately 0.5% (1 500 kW), efficiency is very obvious

The Spindle Assembly and Complex Speed Level, Pressure Stage Impeller Blades

Replace the impeller blades of the complex speed stage impeller blades and the first and second pressure level; replace the high-pressure section of the steam seal steam seal sleeve, its diameter by the Φ234 mm instead Φ240 mm to reduce the steam turbine axial thrust guarantee steamship safety operation of the generator set.

Front Bearing

The tachometer was changed from mechanical to electronic analog distance transmission speed by the speed sensor signal, remote display and control. The speed sensor bracket is fixed to the front bearing flange cover, after the demolition of the original tachometer and transmission mechanism, stuffy blocked, to prevent oil leakage before bearing.

Regulators

Due to the rated power of the machine, the exhaust steam pressure have a greater change, the appropriate transformation of the regulator, the replacement of a pressure transducer sleeve, wrong throttle sleeve adjuster sleeve, wrong throttle spring regulator the spring throttle ring and adjusting pads and other components, and static test.

Transformation Operation

After the transformation, the turbine on October 31, 2003, the official car and a success so far is operating normally.

(1) Adjust the performance is good, did not find the swing area to solve the problem of the regulatory system in the transformation of the former 1 000 ~ 1 500 kW load swing to meet the need for low-load operation in the summer, to achieve the annual power generation.

(2) The steam load of 40 t / h, the hours of power generation 2 000 kW · h; steam load of 60 t / h hour power generation 3 300 kW · h up to 000 kW · h to achieve the designed output, and may overload operation.

(3) The turbine exhaust steam temperature dropped to 310 ° C reduced about 50 ℃ than the transformation of the former, the heat energy to be fully utilized to effectively prevent the rear cylinder overheating deformation.

(4) Design back pressure is 0.9 ~ 1.4 MPa, and the rated back pressure of 1.1 MPa (representing change before an increase of 0.1 MPa), there is a large adjustment amount, solved the high load on urea system. When back depressed, provide a strong guarantee for stable and high yield of the urea plant.

On the 1st June 2004, generated a total of 10 108 240 kW · h, an increase of 102.6% over the same period last year, the expected annual power generation of 18 × 106kW · h.

Conclusion

Main factors affect the steam turbine unit heat rate indicator's crew performance, operation mode, operating parameters and measurement data uncertainty, therefore, requires not only the adoption of new technologies, new equipment, but also to strengthen the scientific management of the plant operation. Main steam flow and reheat steam flow calculation, Steam Turbine Exhaust Enthalpy and less water flow is a key issue that must be resolved in the heat rate calculation. The purpose of the Thermal Performance Test is the design, manufacturing quality testing unit, the unit heat rate calculated by the software's purpose is the unit's operation and management more scientific guidance. It calculates the thermal performance of the calculation results with turbine manufacturers to provide 300 MW Turbine instance data in the book comparison, heat rate to calculate the relative error were maintained at 0.5%, a good degree of agreement can be provided for field staff the value of offline and online calculation tool.

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