Optimization of Low Pressure Steam Heating Technology of Thermoelectric Joint Production

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Abstract

In order to reduce the loss of heat saving in the thermal engine, improve energy utilization efficiency. This paper uses EBSILON simulation software to establish models and perform changes to the working condition, and the comparison of design values on the thermal balance graph. The results show that this method is applicable to the calculation of the thermoelectric gauge. At different heat supply and exhaust flow and the ambient temperature, the heat transfer characteristics of the unit is constantly changed. When the ambient temperature is less than 15°C, the combined circulation thermal consumption rate is negative and the ambient temperature is negative, and the ambient temperature is higher than 15°C time is positively correlated. When the heating capacity is greater than 300 gj/h, the combined cycle efficiency of the unit at the same heating rate is higher than the 100% load rate. Conclusion: the EBSILON simulation software is reliable.

Keywords: Electric cogeneration, steam, heating characteristics, optimization.

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1 Introduction

China is the world's first energy producer and consumer country, accounting for 23.2% of global energy consumption. In recent years, with the acceleration of urbanization process in my country, urban centralized heating demand has grown index. According to the national sustainable development strategy, the "Twelfth Five-Year" energy conservation and emission reduction planning and energy saving and reduction planning, more and more large-capacity, high-parameters of the thermoelectric gauges put into operation. Utilizing the heat of heat during the power generation process, the energy utilization efficiency of the pure condensed thermal power plant can be increased by about 45% of the original to 80%, thereby reducing the loss of cold source, and achieving energy level utilization. Central heating is related to national energy security and the people's livelihood, and is an important part of the energy production and consumption revolution and the people's lifestyle revolution. Energy conservation emission reduction in the thermoelectric field has always been a key task of national and local planning. At present, the proportion of clean heating in northern my country is low, especially in some areas, a large number of scattered coals in winter, and the air pollutant emissions are large, and the need to advance clean heating is an important part of energy production and consumption revolution, rural lifestyle revolution. In recent years, governments at all levels have developed a series of administrative regulations and development planning, and continuously promote the development of thermal industry. In June 2014, the general office of the state council issued the energy development strategy action plan (2014–2020), and the efforts to develop coal clean development and utilization technology, continuously improve the level of coal clean efficient development and utilization. With the focus of economy and developed areas and large and medium cities, the advancement of the coal-to-gas project is promoted in an orderly, strengthen the waste heat, the waste use, accelerate the phase-out dispersion coal-fired boiler, and formulate and implement coal clean efficient use planning, and actively promoting coal grading gemliner utilization.

In March 2016, the national development and reform commission, the ministry of energy, the ministry of finance, the ministry of housing and urban-rural development, pointed out that in order to promote the prevention and control of air pollution, improve energy utilization efficiency, future thermoelectric joint development will follow unified planning, the principle of thermal power supply, foothold, structure optimization, improve energy efficiency, environmental protection priority, strive to achieve more than 60% of the centralized heating rate of the northern large and medium-sized cities, 200,000 population all coverage, formation planning science, reasonable layout, use efficient, heat-saving, thermal development, health development pattern [1].

Although the heat source form of the heating system of the thermoelectric joint production area is more diverse, because my country's energy structure is more special, the coal still dominsizes in the future for a long time. Therefore, for the heat source of the high thermoelectric network, the coal-fired thermoelectric unit and the coal-fired peak boiler are still the protagonist, coal-fired thermoelectric unit and the optimal configuration and the context of the coal-fired peak boiler. Research is very important.

There are two main problems from the perspective of energy saving. First, in most evaluation and optimization research, its object is only targeted by thermoelectric cohesion, but not considering thermal energy distribution. Although the thermoelectric branch is a world-recognized effective energy-saving measure, the power supply can have an energy saving effect than the thermoelectric distribution, in addition to the characteristics of the unit, and also related to the characteristics of the distribution unit. Only by first determined that the thermoelectric cogeneration is more thermoelectric distribution energy saving, the next optimization is meaningful. The second is: in the study of the energy consumption index of the day, the energy consumption associated with the coal capacity, although considering the characteristics of the generated system, the power generation coal consumption and heating coal consumption rate of the thermoelectric gauge is determined in accordance with some kind of person as specified. Due to the unique, different provisions, different regulations may result in different results.

Optimizing the heat source of the thermoelectric network from the economic perspective, although the economic heat coefficients used by different scholars are different, the optimization algorithms are different, but they are inseparable from the CHP-DH system. Calculation of thermal costs. The reasonable allocation of heat and electricity cost is still an urgent problem to be solved in the thermoence production. The thermoelectric combination method proposed by Zhao, X., can make the results change between the benefits of heat and the benefits [2]. If you can determine this ratio, you can give a relatively reasonable amount of heat transfer. However, it is not enough, and there is no way to determine this unavailable proportion in the thermoelectric combination method. Lineykin, S. et al., through the full-working conditions of the entire thermoelectric construction system, the combined performance curve of the thermoelectric network is obtained, and the optimal hot meter selection method is summarized [3]. CHEN, LG, etc. introduce the concept of energy taste into thermoelectric construction system, and compare the problems and operational methods in China's 300 MW plows [4]. Kang, Y., wait for the hot network side as a whole, calculate the heat load and circulating water parameters required for the entire heating period, and calculate the parameters required for the vehicle side of the heater on the steam side of the heater on the heat transfer unit according to the heat transfer theory and the actual power of the heating unit. Running guidance [5].

Gholami, Z., etc. combined with a typical working condition, analyzing the trend and cause of various evaluation index after heating unit heating and renovation, determining the actual operating energy efficiency of the unit throughout the year [6]. Due to the geographical location, energy structure, economic level, foreign research direction of thermoelectric joint is mainly small distributed thermoelectric cogeneration, fuel cell coeration, and utilization using biomass energy, industrial waste and other low-level energy . In terms of fuel cell, energy storage and biomass, ISMAILA, K. G. Use genetic algorithm to study the optimization configuration of the actual microgban system containing renewable energy, fuel cell, energy storage, and thermoelectric unit [7]. Lineykin, S. et al. Takes a 1 kW miniature low-temperature proton exchange membrane (ProtonExchangemetermembrane) fuel cell as the core, designed the size of the thermoelectric construction system, and evaluates from energy utilization efficiency and technical economic perspective [8]. Nazem, M. A. the large biomass thermal cogeneration system in London heathrow airport is used as an example, and the entire life cycle is evaluated from fuel acquisition to grazing processing and analyzes its superiority [9].

2 Gas-Steam Combined Circulating Thermoelectric Unit Model

2.1 Model Establishment

A thermal model is built with a 460 MW gas-steam combined circulating thermoelectric agency unit. The unit gas turbine portion configures TCA/FGH (turbine rotor cooling air/fuel performance heater) system, TCA cooling water is supplied from high pressure water water, and the medium pressure feed water is heated after heating of the provincial coal (FGH);

natural gas is fuel, the low level of fuel is 47 369 kJ/kg; the waste heat boiler is used to heat, no retraction, natural circulation; steam turbine is a set of steam, high pressure cylinder exports to heat, medium pressure cylinder the intermediate stage extracts two heating steam. After the water supply and steam is reduced pressure, the required parameters are achieved, and the three heating fluid parameters are 2 MPa/330°C, 1.3 MPa/250°C, 0.58 MPa/165°C, respectively. The topology of the model is drawn according to the arrangement of the gas circulation, steam circulation, and the various components of the remaining heat boiler in the thermal balance drawing.

This article is based on performance guarantee conditions (ambient temperature 27.85°C, relative air humidity of 82.0%, atmospheric pressure 100.41 kPa), gas turbine 100% load rate pure condensation work condition is designed, according to parameter settings on the unit heat balance map, complete design conditions thermal calculation; switch the calculation mode to the variable working condition mode, change the load rate and the amount of pumping, adjust other parameters, to complete different load rates (75%, 50%) and different type heat calculations for different pumping combinations.

Ebsilon software is calculated in the simulation calculation process, which is calculated according to the conservation of three parameters of pressure, flow and enthalpy, and then calculates other thermal parameters such as temperature, power and other thermodynamic formulas according to the water vapor properties and other thermodynamics. In the design conditions mode, the quality flow, temperature, pressure, etc. Required for thermal balance (mainly gas turbine side fuel mass flow, compressor pressure ratio, flue gas flow, heat boiler) are calculated according to data input in the thermal balance map. End paragraph, steam turbine side main steam temperature and flow, input and exit pressure, condenser back pressure, etc.), complete thermal cycle calculation; after switching to variable working mode, control gas flow through the controller to make gas turbine load decrease, software is calculated from the flue gas parameters of the current working condition based on flow changes and built-in efficiency with flow change characteristic curve iteration.

2.2 Model Verification

In order to verify the reliability and accuracy of the model, the simulation calculation results are compared to the thermal balance graph. Verification Status list is shown in Table 1. Verify model calculation conditions include

Table 1 Is the list of verification conditions

Group Number	Environment Temperature/°C	Working Condition	Load Rate
1	27.85	ChunNing	100%, 75%, 50%
2	27.85	Rated heating and maximum heating	100%
3	14.2	Pure condensation, rated heating	100%
4	38.2	Pure condensation, rated heating	100%
5	15	Pure condensation, rated heating	100%
6	−0.5	Pure condensation, maximum heat supply	100%

Table 2 Simulation results of 100% load under the calculation mode under the design condition

Project	Design Value	Simulation Value	Relative Error/%
Gas turbine exhaust steam temperature/°C	606.60	606.68	0.013
Waste heat boiler exhaust temperature/°C	87.8	86.55	−1.42
Main steam flow (kg·h^{-1})	307400	307400	0
Reheat steam flow (kg·h^{-1})	347500	347500	0
Low pressure steam flow/kw	53600	53600	0
Combustion turbine power generation/kw	294530	294553	0.0078
Turbine power generation	144550	144945	0.27
Exhaust steam flow/(kg·h^{-1})	416200	416200	0
Exhaust steam enthalpy/(kJ·kg^{-1})	2413.6	2413.59	−0.00033

pure coagulation conditions and rated heating conditions, from 50% to 100% a total of 3 load rates, environmental conditions include 5 environments from −0.5°C to 38.2°C summer temperature 5 environments temperature, a total of 14 working conditions. The design value comparison between the simulation results and the thermal balance map is shown in Tables 2 and 3.

From Tables 2 and 3, Table 3 shows that the results of pure coagulation conditions and heating conditions are compared to design values; each parameter relative error is within 5%, and the engineering can be accepted. Therefore, simulation calculation data can be used in the various characteristics of the joint cycle unit, and there is actual engineering value [10].

Table 3 Simulation results of G100-H55M50L35 working conditions under variable working condition calculation mode

Project	Design Value	Simulation Value	Relative Error/%
Gas turbine exhaust steam temperature/°C	606.60	607.01	0.068
Waste heat boiler exhaust temperature/°C	82.3	81.25	−1.27
Main steam flow (kg·h^{-1})	305200	308379.7	1.04
Reheat steam flow (kg·h^{-1})	302600	298909.7	−1.2
Low pressure steam flow/kw	46200	46714.87	1.11
Combustion turbine power generation/kw	294530	294529	−0.0003
Turbine power generation	109520	113110	3.27
Exhaust steam flow/(kg·h^{-1})	434600	433524.3	−0.25
Exhaust steam enthalpy/(kJ·kg^{-1})	2429.4	2433	0.15

3 Analysis of Heating Characteristics of Combined Circulating Heat Cogeneration

During the production of the thermoelectric gauge, there are two energy products that are different from electric and hot. Heating not only affects the entire combination of influent efficiency, thermal consumption and other indicators, but also has a big impact on power generation. Analysis of the coupling relationship between the thermoelectricity of the thermoelectricity by comparing the pure coagulation conditions and heating conditions, different heating parameters, different heating parameters and different environmental parameters heating conditions, analyzed the coupling relationship of the thermoelectricity, and can be productive pricing and unit optimization operations provide theoretical guidance.

3.1 Heat Summing Characteristics of Different Parameter Steam

Due to the existence of three different parameters, different quality steps are different, so the impact on the unit is not the same. When studying the influence of the unit, the amount of heat exhaust fluid flow is maintained unchanged, and only a variable flow rate change is treated. Table 4 is a simulation calculation result of changing the high pressure heating pumping drum (medium pressure pumping and low pressure pins) at a 100% load rate (50, 35 T/h), respectively.

Table 4 Calculation results of changing high pressure extraction flow under 100% load rate (gas turbine power 294530 KW)

Serial Number	Working Condition	Turbine Power/ kw	Heating Load/ (GJ·h^{-1})	Waste Heat Boiler Efficiency/%	Combined Cycle Efficiency/%	Heat Loss Rate/(HJ·(KW·h)$^{-1}$)
1	H0M0L0(ChunNing)	144945	0	87.27	58.18	6187.99
2	H0M50L35	129348	228.36	87.22	64.51	5876.91
3	H30M50L35	121353	316.09	87.27	66.68	5778.96
4	H55M50L35	113110	389.41	87.30	68.28	5715.95
5	H70M50L35	110143	433.35	87.47	69.51	5649.28
6	H85M50L35	106720	477.49	87.37	70.68	5587.48
7	H100M50L35	101025	521.69	87.26	71.55	5556.17
8	H120M50L35	95279	580.58	86.88	72.95	5486.97

As can be seen from Table 4: the efficiency of the remaining hot boiler is not large, all of which are about 87.2%, and the increase in steam turbine is reduced as high pressure pumping flows, and the combined cycle efficiency is significantly increased. Under more than 70% of the working conditions of the pumping flow, the combined cycle efficiency of pure coagulation conditions is increased by 14%; the heat consumption ratio of pure coagulating conditions is higher than 6 100 kJ/(kW·h), and the amount of draw turning flow is increased to the maximum heating. The heat consumption can be reduced to 5,500 kJ/(kW·h) below.

3.2 Ambient Temperature Characteristics

The effect of temperature on the gas-steam combined cycle is mainly reflected in the effect of temperature on gas turbine. When the temperature is high in summer, the gas turbine is low; when the temperature is low in winter, the gas turbine has a high power: resulting in a change in the actual operating parameters of the remaining heat boiler and steam turbines in the rear of the gas turbine. Simulation calculation of the characteristics of the combined circulatory heating unit at different temperatures can intuitively understand the thermal economy of each season unit.

4 Conclusion

As the basic heat source of the heating system as the heat transfer system, this paper is based on the heating system of the thermoelectric network, and the optimization problem of heat source configuration is studied by energy saving and economics. Ebsilon software establishes the reliability of the combined cycle model.

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Biographies

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