Design of cold heat power supply scheme

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Abstract

The combination of cold and heat electricity, that is, CCHP, refers to the operation of gas-fired power generation equipment such as gas turbines, micro-combustion engines or internal combustion engine generators, which is driven by natural gas as the main fuel. The power generated by the power supply users after the system is generated is recovered by waste heat. Use equipment (waste heat boiler or waste heat direct combustion engine, etc.) to supply heat and cooling to users. In this way, the primary energy utilization rate of the entire system is greatly improved, and the cascade utilization of energy is realized. It is also possible to provide grid-connected power for energy complementation, and the economic benefits and efficiency of the entire system are correspondingly increased.

Keywords

Cold and hot electricity; scheme design.

1. Introduction

In order to promote the whole society to save energy and reduce resources and recover resources, respond to the requirements of environmental protection at home and abroad, scientifically carry out energy sustainable development strategies, and dig deep into the technology of waste heat recovery and utilization of flue gas. The waste heat resources are widely distributed, and only the waste heat carried by high-temperature flue gas accounts for 40% of the total waste heat resources [4]. The major energy consumption and pollution emissions led by the thermal power generation industry are the key areas for the country to implement energy conservation and emission reduction, but the proportion of waste heat recovery in other industrial-intensive sectors is also increasing year by year. For example, in the case of a thermal power generating unit, the utilization of flue gas waste heat is generally divided into two methods: external use and internal use.

The use of flue gas waste heat outside the thermal system does not alter the thermal efficiency of the plant, while internal use of the thermal system increases thermal efficiency. The external utilization methods of the system mainly include waste heat power generation, heating and cooling, seawater desalination and dry raw coal. The internal utilization of the system is subject to the constraints and limitations of the overall space requirements, the main purpose is to reduce the smoke loss to improve the cycle heat efficiency. In the case of normal operation of the combustion system, the amount of chilled air at the inlet of the coal mill is reduced in the milling system, which can effectively reduce the exhaust gas temperature. Steam or air purging of the heated surface during operation can effectively remove the ash adhering to the heated surface and reduce the heat transfer resistance of the flue gas side and the steam side. Soot blowing is a commonly used effective means. It can not only improve the heat exchange capacity of the boiler, but also reduce the exhaust gas temperature and improve the thermal efficiency of the trainer. Due to the change of the burning coal, the heating surface is unreasonably arranged in the original heating surface. On the basis of transformation, adding the heat absorption of the heated surface, or reducing the amount of air leakage, can effectively reduce the exhaust gas temperature. Add air preheater and economizer to the flue of the boiler tail. The direct use of boiler flue gas waste heat is the most The general method of increasing boiler efficiency by reducing the exhaust gas temperature is an effective way to save energy.

At present, the current design efficiency of power station boilers in China is about 90% to 95%. In actual power plant operation, the exhaust temperature of boilers is often higher than the designed value by about 5℃to 10℃, resulting in a reduction of boiler efficiency by 0.3% to 0.5℃. In terms of system integration optimization, Xi'an Jiaotong University and Shandong University carried out research on the installation of low-pressure economizers, and successfully applied them to Kaifeng Power Plant and Changchun No. 2 Thermal Power Plant class unit boilers, which reduced the exhaust gas temperature by 20℃ to 30℃. In the aspect of waste heat technology reform, it is generally through research on the enhanced heat transfer technology of air preheater and low temperature economizer, and the sealing reform technology of rotary air preheater is also a new field of research. Huang Xinyuan and others used the low-pressure economizer installed at the tail of the boiler to recover the flue gas waste heat resources to heat the turbine condensate, replacing some of the low-pressure heaters, and discharging the corresponding regenerative extraction steam to improve the thermal efficiency of the unit and reduce the heat. Consumption rate and coal consumption rate. Using the idea oflow-foot economizer, heater and air preheater combined operation, the optimization design of low-pressure economizer was deeply studied, and the thermal economy was optimized by establishing mathematical model.

The thermal power plant system has serious energy problems, and the use of low-temperature flue gas waste heat has been vigorously carried out, while the low-temperature flue gas waste heat resources in other industrial fields are more abundant. From the current status of China's industrial waste heat recovery technology, it can be seen that the medium and high temperature waste heat recovery technology is relatively mature, especially in steel, cement, metallurgy and other industries. According to statistics, low-grade waste heat energy accounts for about 50% of total industrial waste heat. The technology used abroad relies on the addition of a low-temperature organic Rankine cycle system to convert the heat recovered from low-temperature flue gas into high-grade mechanical energy or electrical energy.

China's low-temperature waste heat recovery technology is still not mature enough. The low-temperature waste heat utilization technology is still in an experimental stage. This part of the waste heat is not directly discharged into the environment through recycling, resulting in energy waste and environmental pollution. From this point of view, in-depth exploration of low-temperature waste heat recovery and utilization technology is of great significance for improving China's energy efficiency. Many European and American countries have built a number of low-temperature flue gas waste heat organic Rankine cycle power generation system heat source including gas turbine flue gas, waste incinerator flue gas and cement dense furnace flue gas. With the tight supply of energy, research on industrial waste heat recovery technology has become more and more extensive. Among them, Zhang, Yu; Gao, Jianmin; He, Mingyue and others studied the simulation optimization of a new amino carbon capture process and low temperature waste heat utilization. Chowdhury, Jahedul, Islam and others studied the research of supercritical waste heat recovery system for vehicle driving conditions. Thomas Arink and others studied the waste heat of waste gas for preheating of metal scrap.

In recent years, heat pipe technology has been widely used to develop heat pipe technology products such as heat pipe waste heat boilers, heat pipe steam generators, heat pipe hot air furnaces and heat pipe gas and gas heat exchangers. Heat pipe technology is used to heat air or gas in metallurgical heating furnace, petrochemical heat exchanger, industrial boiler economizer, etc. Energy recovery heat pump technology for waste heat resource is an efficient low temperature waste heat recovery technology, which is already heating, Widely used in air conditioning, drying and drying, it can not only recover waste heat from 120℃, but also recover low-grade heat in water, air and other low-temperature heat sources such as groundwater and solar energy. Low boiling point working fluid or mixed working medium power generation technology is also an important part of low temperature flue gas waste heat. Low temperature heat source organic Rankine cycle power generation. The system has been in solar thermal power generation, industrial waste heat power generation, biomass power generation, ammonia power generation, flammable for ten years. Ice power generation and geothermal power generation machinery and equipment have been applied. Compared with thermal power generation, waste heat power generation does not need to consume primary fossil energy fuel such as coal, and it does not produce environmental pollutants such as carbon dioxide and sparse. In summary, the development of low-temperature flue gas waste heat power generation technology is of great significance in terms of thermal efficiency, economic benefits and environmental benefits.

2. Design of cold heat power supply scheme

The initial stage of cogeneration of cold and heat electricity was developed on the basis of cogeneration. At the beginning of the 20th century, cogeneration of heat and power entered the practical application stage. At that time, the main power generation means in the world was coal-fired boiler-driven steam turbine power generation. In summer, the unit load is at a peak and the heat load is low, which makes the operation adjustment of the unit difficult, and the energy saving economy of the unit is also reduced a lot. In order to solve this problem, the combination of cogeneration and absorption or adsorption refrigeration technology is combined with cogeneration technology to enable thermal power plants to supply both thermal and cold energy while supplying electricity. After the introduction of the distributed energy system, the application field of the cogeneration system has gradually expanded to more fields.

Introduction of main components of the cogeneration system:

(1) Lithium bromide unit: In the lithium bromide absorption unit, water is used as a refrigerant and lithium bromide is used as an absorbent. Since the lithium bromide aqueous solution itself has a high boiling point and is extremely difficult to exert, it is considered that the vapor on the liquid surface of the lithium bromide saturated solution is pure water vapor. At a certain temperature, the saturated partial pressure of water vapor on the surface of the lithium bromide aqueous solution is smaller than the saturated partial pressure of pure water, and the higher the concentration, the smaller the partial pressure of water vapor saturation on the liquid surface. Therefore, under the same temperature conditions, the greater the concentration of lithium bromide aqueous solution, the stronger its ability to absorb water. This is why lithium bromide is usually used as an absorbent and water is used as a refrigerant.

The main equipment of the absorption type lithium bromide unit is a generator, a condenser, an evaporator, an absorber, a heat exchanger, a circulating water pump and the like.

(2) Biogas tank: The principle of biogas fermentation: Biogas is a kind of mixed combustible gas formed by the fermentation of specific microorganisms under anaerobic conditions, such as human and animal waste, crop rice straw, fruit and vegetable waste and kitchen waste. Its main components include 50% to 80% of methane, 20% to 40% of carbon dioxide and other small amounts of ammonia, nitrogen and sulfur. The fermentation process of biogas is a complex biochemical change. During the period, there are many microbes involved. The fermentation process of biogas is divided into two stages: first, a wide variety of microorganisms, proteins, sugars, and fats in complex organic substances. It is degraded and separated into simple small molecular substances such as carbon dioxide, alcohols, aldehydes, ammonia, lower fatty acids, oxygen and sulfurized oxygen. Secondly, under the action of methanogens, methane is mainly produced by biological reaction. To produce biogas normally, good conditions must be created for the microbe:

A. The biogas tank must be sealed, and the fungus can produce methane better under anaerobic conditions;

B. Maintain the constant temperature conditions of the biogas digesters. The existing biogas fermentation technology proposes the optimal fermentation temperature, which is 30 ℃ low temperature, 37 ℃ medium temperature and 52 ℃ high temperature. According to different fermentation raw materials, under these three temperature conditions, Methanogens have the strongest methanogenic capacity and produce the most biogas;

C. The pH of the biogas digester is generally controlled at 7~8.5. During the anaerobic fermentation of biomass, there are two peaks of biogas production with increasing temperature, one is near 52℃, and the other is around 37℃. The gas production at 52℃is about twice that at 37 ℃.

The manure of humans, livestock and poultry is one of the main sources of biogas fermentation raw materials in rural China. This raw material is relatively fine and contains many low molecular compounds. Therefore, no pretreatment is required during use, and the decomposition rate and gas production are required. The speed is also very fast, but the fermentation cycle of this raw material is short, and the total gas production per unit of fermentation raw material is small. Crop straw is also one of the main sources of biogas fermentation raw materials in rural China. It is characterized by slow decomposition rate, long gas production cycle, and high total gas production per unit of raw material, but must be pretreated before use.

(3) Stirling machine: Stirling Engine, also known as hot air machine, gas external combustion engine, is a closed-loop reciprocating piston type external combustion engine. Its ideal thermodynamic cycle is called Stirling. Loop, the generalized Carnot cycle. Therefore, its theoretical efficiency is the highest under the same temperature limit. The Stirling machine has the following features:

A. The diversity of fuel. The main advantage of the Stirling machine is the ability to use a variety of fuels, whether liquid, gaseous or solid;

B, higher heat conversion efficiency;

C, good environmental characteristics. Less exhaust pollution and low noise;

D, good running performance;

E, reliable work, low maintenance costs and long life;

The main problems and shortcomings of the Stirling machine are that the structure is more complicated, the manufacturing process is high, and the processing cost is high.

Biogas tank design: The constant temperature anaerobic fermentation technology using flue gas heating, the flue gas is heated by the spiral tube heat exchanger in the biogas tank, and maintained at a constant temperature of 52℃

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