Design of flue gas waste heat supply scheme

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Abstract

Energy problem is one of the basic problems in the healthy development of China's economy and society. It is an important indicator of the comprehensive national strength and the degree of civilization development. At present, China's energy conservation work has made great progress, but in terms of energy use and the rest of the world compared to other developed countries there is still a big gap in the energy efficiency aspects of the task is still arduous. Waste heat utilization technology can effectively save energy. This paper designs the design of flue gas waste heat utilization scheme, using waste heat for heating. And analyzed the thermal economy of the program.

Keywords

Flue gas waste heat utilization; scheme design; thermal economy.

1. Introduction

At present, China's energy conservation work has made great progress, but there is still a big gap in energy utilization levels compared with other developed countries in the world. The task of energy conservation and efficiency improvement is still arduous. At present, the level of energy utilization efficiency in developed countries is at least 10% ahead of that in China. China's energy consumption is more than twice the world's average level, while in terms of per capita energy consumption, it is only about half of the average level. China has become the country with the highest energy consumption in the world. China's energy utilization rate in the industrial sector is more than 40% higher than the world's advanced level. Therefore, adhering to the path of lowering energy consumption and high efficiency of energy conservation and emission reduction has become the main way to solve China's energy problems.

Among them, waste heat recovery is an energy conservation and environmental protection project encouraged and promoted by the state. During the “Eleventh Five-Year Plan” period, the state's special support policies for the waste heat recycling industry have effectively promoted the progress of China's waste heat recovery technology and industrial development. During the "Twelfth Five-Year Plan" period, the country's support for the waste heat reuse industry will increase its market prospects.

The general principle of the utilization of flue gas waste heat should be based on the thermodynamics point of view, according to the "quality use energy, cascade utilization", for the waste gas recovery and utilization of flue gas with different temperatures and different tastes. For high-temperature residual heat and medium-temperature residual heat, the energy level is higher, and it is generally converted into high-grade electric energy by a turbine generator. At present, the commonly used methods include waste heat boiler to recover high temperature flue gas waste heat, gas turbine for power recovery or high temperature air combustion technology to directly recover medium and high temperature waste heat. Although the energy quality of low-temperature waste heat is low, with the serious energy problem, the research on the utilization of low-temperature waste heat is more and more extensive. The main low-temperature flue gas waste heat is heated by air preheater, economizer, and water, or used to preheat and dry raw materials or working fluids. At this stage, China's medium and high temperature waste heat utilization technology has reached the international advanced level, and the research on waste heat utilization technology of low temperature flue gas is still not mature, and it is still a hot research field at home and abroad.

2. Determination of Flue Gas Waste Heat Utilization System Scheme

The use of flue gas waste heat is the most traditional flue gas waste heat utilization method. In this subject, the temperature of the flue gas is relatively high, and the flue gas can be first exchanged through the heat exchanger to reduce the temperature of the flue gas to 100 ° C first. The heat obtained is used for district heating (the return water temperature is 85 ° C and 60 ° C respectively); the heat of the remaining flue gas is recovered by a heat exchanger, and the temperature of the flue gas is lowered to 60 ° C, and the heat obtained is used for heat of living. Water (hot water for domestic use is 35 ° C).

The flue gas waste heat heating system is mainly divided into three parts, namely heat exchange equipment, hot water pipeline and heat dissipating equipment. In the system, the flue gas first exchanges heat with the heat exchanger to obtain hot water, and the hot water passes the heat to the user through the circulation pipe network, and then the flue gas exchanges heat with the heat exchanger to generate domestic hot water and then supplies the user.

The main problem in this system is the efficiency of heat exchange equipment. Although the heat exchanger has many styles, the plate heat exchanger technology is the most mature and the heat loss is low. Therefore, the plate heat exchanger is selected in the system.

Although plate heat exchangers come in many forms, they work in much the same way. The plate heat exchanger mainly assembles the heat exchange plates by external force, and the medium flows through the through holes on the heat exchanger plates on the surface of the plates, and the turbulent flow is formed under the action of the plate ripples, and the cold and heat medium are respectively The two sides of the heat exchange plate flow, and a large number of heat exchange surfaces formed by the crucible are in contact with the plate, and sufficient heat transfer is performed through the plate to achieve the final heat exchange effect. The isolation of the cold and heat medium is mainly ensured by the division of the gasket or by a large number of welds, and the hot and cold medium is not confused in the case where the hot plate is not cracked and perforated.

The heat transfer mechanism of the plate heat exchanger is based on the heat transfer mechanism according to the law of thermodynamics: heat is always spontaneously transmitted from a high temperature object to a low temperature object. If there is a temperature difference between the two fluids, heat is inevitably transmitted. In the forced convection heat transfer process of the two fluids with temperature difference, the heat exchange rate is 92% because the surface of the heat transfer plate is optimized by corrugated wave structure. Even if the fluid flow rate is below the Reynolds value, the fluid is in the plate. The movement between the three movements also promotes the formation of severe turbulence in the fluid, reducing the thermal resistance of the boundary layer and enhancing the heat transfer efficiency.

In the design calculation of heat exchangers, the main design methods are logarithmic mean temperature difference method and efficiency-heat transfer unit number (ε-NTU) method [9], which method is adopted according to specific known conditions. Deciding to find the right method is not only simple calculation process but also accurate results, so we must learn to analyze the known conditions to find a suitable design calculation method.

The average temperature difference between the single-flow and counter-current heat exchangers is calculated by the logarithmic mean temperature difference method, and the logarithmic mean temperature difference can be calculated according to the formula.

$$\Delta t_{\mathrm{m}} = \frac{\Delta t_{\max} - \Delta t_{\min}}{\ln \frac{\Delta t_{\max}}{\Delta t_{\min}}}$$

The calculation of the average temperature difference is calculated according to formula.

$$\theta_{\mathrm{mco}} = \frac{(t_1' - t_2'') - (t_1'' - t_2')}{\ln \frac{t_1' - t_2''}{t_1'' - t_2'}}$$

The main components in the district heating system using flue gas waste heat are heat exchangers, hot water pipes, and radiators. So the biggest advantage of this system solution is that its mode is simple and easy to build and run. But he also has outstanding shortcomings:

(1) The system runs only for heating in winter, and the system stops running in summer and excessive seasons, wasting a lot of time;

(2) The waste heat of the flue gas is only used for heating, which seriously wastes such high-grade heat (the flue gas temperature is 450 °C);

(3) The traditional flue gas waste heat utilization system has poor economy and low profit.

It can be concluded that the traditional flue gas waste heat supply scheme is not reasonable enough, so how to construct a reasonable and efficient flue gas waste heat utilization scheme becomes more important.

3. Conclusion

The analysis method based on the first law of thermodynamics mainly uses the principle of heat balance and the thermal efficiency as the basic criterion to analyze and evaluate the energy efficient utilization of energy utilization equipment and systems. In terms of quantity, it reflects the conservation of energy, such as primary energy utilization rate, primary energy saving rate and so on.

The heat method measures the thermal performance of the system by the magnitude of thermal efficiency or heat loss rate. Among them, the thermal efficiency reaction thermal equipment converts energy into or outputs effective energy.

For system-thermal efficiency $\eta_1 = \frac{8551.22}{9805.72} \times 100 = 87.2\%$

The efficiency of reflects the degree of utilization of the system, not only the quantity of energy, but also the value of energy. Efficiency considers the inequality of taste of different energies, revealing the thermodynamic nature of the energy use process. So in general, efficiency is an important criterion for evaluating various practical thermodynamics.

Depreciation of heat load $E_h = (1 - \frac{T_0}{T_h})Q_h$, the system's efficiency is 37.6%.

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