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Gas Boiler Development Research

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Abstract: With the socio-economic development, large-scale use of fossil fuels caused by energy problems and environmental problems become increasingly serious. Gas boilers will gradually replace coal-fired boilers and will have good development prospects in the future. This paper introduces the development background and significance of gas boilers, and introduces different types of gas boilers. Heat exchanger is an important part of gas boiler. This paper introduces the classification of gas boiler heat exchanger from various aspects.
Keywords: Natural gas, Gas boiler, Heat exchanger

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1. RESEARCH BACKGROUND AND SIGNIFICANCE

Energy is the material basis for human survival. It is closely related to the development of social economy and people's lives, and has become the focus of political, economic, military and diplomatic concerns of all countries [1]. In recent years, China's urbanization process has been advancing rapidly, and the people's demands for their own quality of life have been continuously improved, and the pressure on energy supply is increasing. China has now become the world's largest energy producer, and the total energy production has been on the rise. According to the statistics of the National Bureau of Statistics, the total energy consumption of China in 2016 was 4.36 billion tons of standard coal, which has nearly doubled the growth rate since 2000.

Although raw coal is in an absolute position in energy consumption, its proportion is decreasing year by year. Although the proportion of natural gas consumption is the lowest among several energy sources, its proportion has increased year by year, reaching 6.4% in 2016. In December 2016, the National Development and Reform Commission and the Energy Bureau issued the "13th Five-Year Plan for Energy Development", stating that by 2020, natural gas consumption will reach 10% than gravity, and the proportion of coal consumption will fall below 58%. In June 2017, the National Development and Reform Commission and various ministries and commissions issued the "Opinions on Accelerating the Use of Natural Gas", pointing out that gradually cultivating natural gas as one of the main energy sources of China's modern clean energy system, and proposing that natural gas will be used once in 2020 and 2030. The share of the energy consumption structure is expected to reach the target of 10% and 15% [2].

With the country's efforts to increase energy conservation and emission reduction in the heating industry, the era of natural gas is coming. As a representative of clean energy, the unit calorific value of natural gas is as high as 38.97 MJ/kg, which is 1.3 times and 1.9 times of the calorific value of raw coal and standard coal, respectively. Compared with coal, the calorific value is obvious, as shown in Figure 1.2a. From the efficiency point of view, the thermal efficiency of natural gas on power generation and industrial fuel is about 10% higher than that of coal. The heat supply efficiency of natural gas cold and heat electricity is nearly double that of coal-fired power generation. From the perspective of fuel combustion products, as an environmentally friendly fuel, the emission of air pollutants in natural gas combustion products is lower than that of coal and petroleum; in addition, the greenhouse gas emissions of natural gas (CO2) are lower than other fuels.

Gas boilers will gradually replace coal-fired boilers and will have good development prospects in the future. The condensing gas boiler is equipped with a condensing heat exchanger based on a conventional boiler, which can reduce the exhaust gas temperature below the dew point temperature compared with the conventional ordinary gas boiler. The exhaust temperature of the condensing boiler is lower than the dew point temperature, and the heat released during the condensation process can be greatly improved, and the condensing boiler dissolves some harmful substances such as carbon dioxide and nitrogen oxides after the water vapor is condensed. It reduces the damage to the environment and has obvious environmental benefits [3, 4].

2. OVERVIEW OF GAS BOILERS

As we all know, the boiler is composed of two parts, “pot” and “furnace”, but it does not constitute the whole of the boiler. It should also include valve instrumentation and automatic control. For gas boilers, “furnace” refers to a gas burner, and “pot” refers to a heat exchange container. At present, boilers are mainly divided into shell-and-tube boilers, water tube boilers, and submerged boilers.

2.1 Shell gas boiler

The shell-and-boiler boiler has a traditional structure, and the heat-receiving surface is subject to large restrictions, large water and steam capacity, good adaptability to load changes, and lower water quality requirements than water-tube boilers. Whether it is a shell boiler or a water tube boiler, there are vertical and horizontal points, but there is no strict dividing line. Among them, the vertical boiler capacity is generally small, while the horizontal boiler capacity is relatively large. The capacity of the general vertical water tube boiler is less than 4t/h(2.8MW). The structure is compact and the steam production is fast. However, the water pipe structure has higher requirements on water quality and is more difficult to overhaul. Due to the special structure, the temperature of the boiler tube of the shell-and-boiler boiler is relatively high, especially in the welding of the front tube sheet of the smoke tube and the back-combustion chamber, which is prone to cracks in the tube sheet and become a natural defect. There must

be greater innovation in the innovation of the structure, process, materials and water cycle of the pipe.

2.2 Water pipe gas boiler

The water-tube boiler has flexible heating surface layout and good heat transfer performance. It can be used in large capacity and high-parameter conditions in the structure, but it has high requirements on water quality and operation. The 1970s was the development period of China's first gas boiler. During this period, some companies chose the US convection tube bundle route to develop D-type, A-type and O-type water pipe gas boilers, as shown in Fig. 1.The common feature of D-type, A-type and O-type gas boilers is the horizontal arrangement of the double-drum horizontally, the horizontal installation of the burner in front of the furnace, convenient operation and maintenance, small length, width, high size, large length and flexibility, suitable for Serialized production, more importantly, meets the needs of traditional crafts at the time.

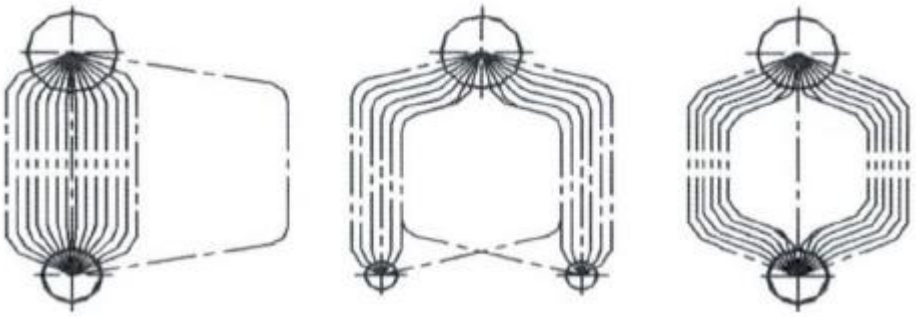

Fig.1 D type, A type and O type gas boiler heat exchanger

However, for gas-fired hot water boilers, most boiler plants still use D, A and O steam boilers, which is a helpless choice. Compared with steam boilers, the capacity of hot water boilers is large. In bulk production, the manufacturing process of double drum and convection tube bundle is not easy to implement on site. Therefore, it is imperative to carry out structural reorganization of gas-fired hot water boilers on the market.

3. HEAT EXCHANGER ENHANCED HEAT TRANSFER TECHNOLOGY

The "pot" of a gas boiler is a heat exchange container that exchanges heat. Gas boilers can be divided into shell boilers (also known as fire tube boilers) and water tube boilers in terms of their body structure, as shown in Fig. 2 and Fig. 3. The shell-and-tube boiler is named after the high-temperature flue gas after the fuel burns flows in the boiler (furnace) and the pipe of the boiler. Corresponding to the shell-and-shell (fire tube) boiler, when the water, steam or steam-water mixture flows in the tube, and the flame or flue gas is burned and flowed outside the tube, the boiler is collectively called a water tube boiler.

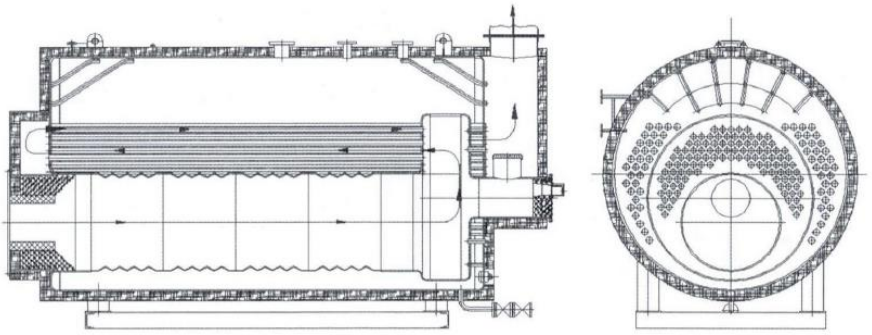

Fig.2 Shell boiler body heat exchanger structure

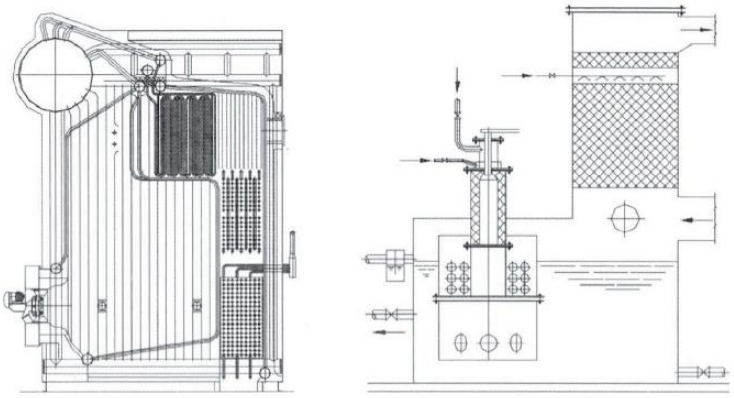

Fig.3 Water pipe and submerged boiler body heat exchanger structurev

3.1 Shell boiler heat exchanger

There are two main types of heat exchange containers used in boiler-shell gas boilers, one is a radiant heat exchanger and the other is a convection heat exchanger. For a radiant heat exchanger, the radiant heating surface in the boiler furnace is generally an evaporation heating surface, that is, a heating surface in which the working medium absorbs heat and vaporizes. This article mainly introduces the convection heat exchanger.

For convection heat exchangers, the smoke pipe is the main convection heating surface of the boiler-shell boiler, which is divided into a light pipe and an enhanced heat transfer tube heating surface. For example, the single-head threaded pipe in China has almost become the standard configuration of the Chinese fuel gas boiler. In order to achieve a lower exhaust gas temperature, it is often necessary to set up 3 to 4 return pipes. However, in recent years, with the continuous need to strengthen heat transfer technology and the need for backhaul, the return of the pipe has been reduced to 2 or even 1 return, and the other return is replaced by the heated surface of the pipe strengthened by the outer wing.

The enhanced heat transfer technology of the pipe is generally divided into two categories: active strengthening technology and passive strengthening technology. Since the active enhancement technology requires additional energy and is limited by development, the passive enhancement technology mainly divides the two types of tubes and tube inserts. The special-shaped tubes currently used for gas-fired boiler pipes include spiral grooved pipes, threaded pipes, horizontally-drawn pipes and dimple pipes [5-7].

Pipe inserts are one of the effective ways to enhance the heat transfer of single-phase fluids (especially gases) in pipes. The method is simple and convenient, low in cost and convenient in disassembly and assembly. In gas-fired boilers, there are mainly three types of in-line inserts that are used, namely twisted belts, spirals, and large voids around the filaments [6, 7]. Under the action of fluid flow, automatic rotation can be generated, and the flow tendency of the fluid is changed, and a swirling flow is formed, which causes the displacement of the central fluid and the wall fluid, and destroys the development of the boundary layer. Experiments have shown that these tube inserts have the same level of heat transfer enhancement as threaded tubes, but the resistance of the tube inserts is significantly higher than that of threaded tubes. This does not meet the ultimate goal of enhanced heat transfer. The goal of enhanced heat transfer is to To achieve efficient heat transfer under low-resistance conditions, therefore, although there are many academic studies on pipe inserts in China, the use of engineering is greatly limited [5].

3.2 Convection boiler heat exchanger

The heat exchange container used in the convection gas boiler has the same main form as the shell boiler, one is a radiant heat exchanger, and the other is a convection heat exchanger.

The radiant heat exchange container of the water tube boiler is mainly water-cooled wall, and the innovation space in this area is small. Commonly used water-cooled walls mainly include light pipes and membrane water walls. Membrane water wall is a set of tube screens welded by fins or flat steel between the tubes. The light pipe type water wall is simple to manufacture and install, but the protection effect on the furnace wall is small, and the heavy furnace wall is needed to easily leak air. The membrane water wall is mostly a water wall formed by welding flat steel between the light pipes, which can realize large-scale realization. For welding production, the membrane type water wall has the best protection for the furnace. Only the tube wall is required, and the furnace can be burned with micro-positive pressure.

Large-capacity gas-fired boilers Conventional convection heat exchangers generally use a serpentine tube-row structure, which is continuously bent from a seamless steel tube, and generally adopts a laterally flushed in-line and staggered tube bundle. The continuous bending of the serpentine tube row requires a large serpentine tube production line, which is a huge challenge for the industrial boiler plant; secondly, the inlet and outlet of the serpentine tube bundle generally needs to pass through the wall, and the problem of sealing the tube bundle and the furnace wall through the wall; Third, the tube bundle can be used for any superheater or reheater at the flue gas temperature, but when the low smoke temperature or temperature difference is small, it is necessary to carry out enhanced heat transfer on the extended heating surface to save metal material and keep the convection structure compact. Sex. In order to solve the problem of wall penetration, European countries invented the flag heating surface and applied it to the angle tube boiler [5].

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