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Analysis on Combustion System of Circulating Fluidized Bed Boiler

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ABSTRACT. With the rapid development of social economy in China, more and more attention has been paid to the protection of ecological environment. The combustion technology required by traditional factories is mostly composed of combustion technology with low efficiency and high pollution. Therefore, in the process of production, more pollution is often caused, which seriously affects the construction of ecological civilization in China. As a new type, high efficiency and low pollution combustion system, circulating fluidized bed boiler is slowly changing the combustion composition system of the boiler [1]. This paper mainly starts from the advantages of circulating fluidized bed boiler combustion system, explores the advantages of circulating fluidized bed boiler compared with traditional boiler, and on this premise analyses the model and gain calculation of circulating fluidized bed boiler system in detail, hoping to provide certain reference for future related research work.

KEYWORDS: Circulating fluidized bed boiler, Combustion system, Structure analysis

1. Introduction

Circulating fluidized bed boiler has many advantages including complete combustion efficiency, adjustable load according to demand and low pollution emission. Because the combustion system can directly achieve desulfurization in the process of fuel combustion, it can not only reduce the cost of fuel, but also greatly reduce the impact of boiler combustion on ecological environment, so it has greater advantages compared with traditional boiler combustion system. However, the realization process of high efficiency combustion and low pollutant emission of circulating fluidized bed boiler combustion system is relatively complex, which needs complex internal operation process. Therefore, only when the composition of internal combustion system of circulating fluidized bed boiler is clear, further research and improvement can be carried out, so as to promote the progress and development of high efficiency boilers in China.

2. Advantages of Circulating Fluidized Bed Boiler Combustion System

Table 1 Comparison of Combustion Efficiency and Environmental Protection Capacity of Different Types of Boilers

	Grate Boiler	Bubbling Boiler	Pulverized Coal Boiler	Circulating Fluidized Bed Boiler
Interface Wind Speed	1.3	1.5-2.4	4-6	4-8
Coal Particle Size	6-33	<6	<0.1	<5
Load Regulation Ratio	4:1	3:1	--	4:1
Combustion Efficiency	86-89	90-95	98	95-100
NOx Emission	400-600	300-400	400-600	50-200
Desulfurization Efficiency in Furnace	--	80-90	low	85-96

From Table 1 above, it can be found that compared with other types of boilers, circulating fluidized bed boilers have better performance in both combustion and environmental protection capabilities. In detail, the advantages of circulating fluidized bed boilers are mainly concentrated in the following Several aspects.

2.1 Strong Combustion Adaptability

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The circulating fluidized bed boiler has a wider range of fuel adaptability. Whether it is coal or bark waste, whether it is high-quality coal or low-quality coal, it can be completely burned and fully generate heat, which is not possible with traditional boilers. In addition, the circulating fluidized bed boiler is not only able to adapt to common combustion materials, but also has a relatively simple feeding system. Compared with traditional boilers, it is more capable of exerting its own characteristics and burning fuels individually or mixedly according to actual needs. It not only greatly increases the convenience of operation, but also effectively improves the combustion quality and saves the combustion cost to a certain extent.

2.2 High Combustion Efficiency

The circulating fluidized bed boiler can fully integrate the fuel and air in the furnace, which greatly improves the combustion efficiency of the boiler. Compared with the traditional boiler, in order to achieve the same heat, the boiler needs less fuel. This reduces the waste of resources and greatly saves operating costs. According to investigations, the boiler's combustion efficiency can reach 99%, which means that during combustion, the fuel can be fully mixed with air, and unburned fuel particles are separated and returned to the furnace for a second time. Combustion increases combustion intensity, greatly improves combustion efficiency and speed, and truly realizes boiler technology, convenience, and efficiency.

2.3 Low Pollutant Emissions

The circulating fluidized bed boiler can achieve desulfurization and denitrification in the combustion process, greatly reducing the emission of boiler pollutants, while protecting the environment, avoiding the formation of other pollutants in the furnace, and greatly reducing the secondary pollution to the atmosphere Possible. This is because during the operation of the boiler, the temperature in the boiler has been maintained between 800 degrees Celsius and 900 degrees Celsius, which intensifies the desulfurization reaction and creates a good reaction environment for it. At the same time, because the boiler uses low-temperature power combustion, it can effectively inhibit and control the generation of sulfur dioxide and nitrogen oxides, so that the emissions of harmful gases and pollutants are far below the national emission standards, resulting in high efficiency, energy saving, and environmental protection. Boiler system.

2.4 Faster Load Regulation

At the same time, the circulating fluidized bed boiler also has the characteristics of faster load regulation. The boiler's adjustment speed can reach 6% to 10% per minute, and the adjustment range is wide, which can effectively maintain the stability of combustion, and to a certain extent ensure the combustion rate and overall combustion efficiency. In addition, under low load, the boiler has more advantages than traditional boilers, can not be interfered by other factors, can still maintain the stability of combustion, and even can be used as a backup under special circumstances. In real applications, this feature has great advantages for the operation of the national grid, so it is also widely used in the peak-shaving unit in the construction of the power grid, and has a very broad development prospect in the future.

2.5 Strong Chemical Activity of Ash

This advantage can further reflect that the circulating fluidized bed boiler can not only meet the needs of industrial combustion, but also can be effectively used in a comprehensive manner to give full play to its great role. This is because the boiler can perform multiple low-temperature combustions during combustion, and the ash and slag discharged from the fuel produced in the process have strong chemical activity and high utilization value. It is usually used in the mixed raw materials of cement and other common building materials, etc., to a certain extent, promote the recycling of resources, which is not only conducive to sustainable development, but also can save costs and obtain greater economic benefits.

3. Combustion System of Circulating Fluidized Bed Boiler

3.1 Combustion Efficiency Affected by Many Factors

Circulating fluidized bed boiler is mainly composed of two parts: material circulation loop and tail heating surface. Among them, the material circulation loop is the composed of a material return device, gas and solid separator, a heat exchanger and a furnace, and the tail heating surface is mainly composed of four parts: a coal economizer, an air

preheater, a reheater and a superheater [2]. The whole operation process of the boiler is controlled by the low temperature power system. It can realize the high speed and high flux liquid circulation and the rapid exchange and operation of its heat and quality, so the operation of the circulating fluidized bed boiler can be achieved.

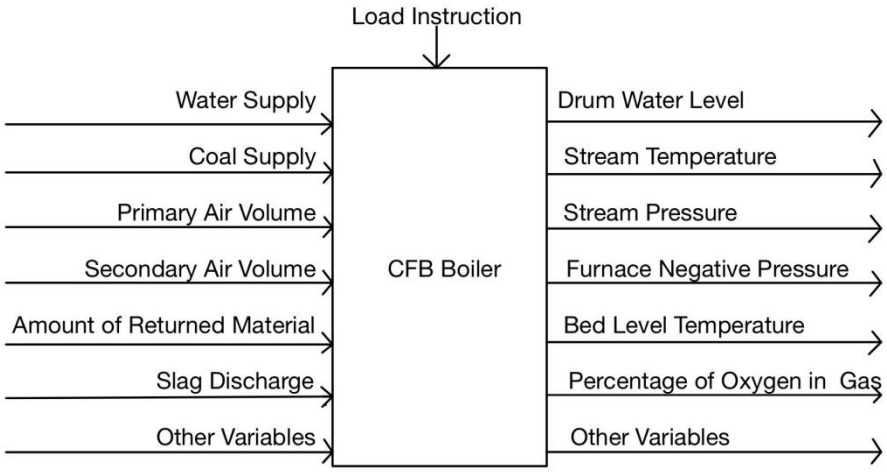

Fig.1 Analysis Chart of Variables Affecting the Operation Efficiency of Circulating Fluidized Bed Boiler

From the above figure, it can be found that the main factors affecting the operation efficiency of circulating fluidized bed boiler are water supply, coal supply, air volume, amount of returned material and slag discharge. Among them, drum water level, steam temperature and pressure, furnace negative pressure and bed level temperature will also directly affect the operation of circulating fluidized bed boiler operation efficiency. According to this data, China has established a sound circulating fluidized bed boiler operation control system, and established a perfect dynamic mathematical model by adjusting the air supply, coal supply and slag discharge. Based on this model, the change of material concentration and distribution position in the furnace chamber of the circulating fluidized bed boiler under different external environment was analyzed [3]. When the circulating fluidized bed boiler is in combustion state, the bed level temperature and main steam pressure will be affected by air volume and coal supply, so the internal combustion can be changed by adjusting variables. Therefore, according to the relevant data and principles, a transfer function matrix is formed. The furnace is divided into different parts according to the combustion capacity, contact air volume, coal supply and other variables. After experimental study, it can be found that there is a certain gap in the combustion capacity of different positions in the furnace. From the view of internal furnace structure, the contact area of internal furnace with oxygen and fuel is different in different positions, and there is a certain gap in the combustion capacity of different positions. Under the influence of the above factors, a relatively perfect closed combustion zone is formed in the circulating fluidized bed boiler, and the internal combustion state can be adjusted according to different requirements.

3.2 Relationship between Radial Particle Concentration and Combustion Efficiency

From the relevant research, it can be found that there is not only a temperature difference in the furnace of a circulating fluidized bed boiler, but also a small difference in the radial particle concentration on the basis of the same wind speed and material circulation rate, and the concentration near the wall will be higher, and the middle part of the furnace will be relatively low, and the gap between the two parts is relatively large. This is mainly due to the influence of wind speed, when the circulation capacity of materials becomes stronger, more particles will stay in the furnace, so the concentration at the same height in the furnace will also increase [4].

3.3 Relationship between Oxygen Concentration and Combustion Efficiency

Because oxygen is the premise and foundation to ensure the full combustion of fuel in the furnace, this study also analyses the circulating fluidized bed boiler system from the perspective of oxygen and carbon dioxide. Through relevant research, it can be found that the oxygen content in the core area of the circulating fluidized bed boiler furnace is much higher than that of the furnace wall position. Therefore, the rapid flow in the furnace promotes the circulation and increase of oxygen in the furnace, providing sufficient oxygen for the combustion of fuel. The carbon dioxide in the furnace can also volatilize in this process, the concentration of carbon dioxide is reduced, and the oxygen content is

greatly increased, so the combustion efficiency of the boiler is greatly improved, which is the main reason why the circulating fluidized bed boiler has higher efficiency than the traditional boiler [5].

3.4 The Relationship between Combustion Process and Combustion Efficiency

In the combustion process, air provides the oxygen required for material combustion, and the fuel is efficiently combusted under the action of high temperature and secondary air. At the same time, under the influence of secondary air and oxygen, the large particles of coal further volatilize part of the coke, and the fuel and oxygen are mixed and concentrated before further combustion, and heat exchange is carried out in the furnace. On the contrary, when the boiler load is reduced, in order to ensure that the fuel can be fluidized under the primary air, the ratio of the coal supply to the secondary air will be reduced to reduce the fuel combustion in the dilution zone, and even the secondary air supply will be under pressure. Stop at any time to meet the needs of load changes in real situations.

The higher the bed temperature of the boiler chamber, the greater the combustion portion under the bed. Since the oxygen provided by the secondary air volume accounts for about 60% of the air volume required for complete combustion of the fuel, the fuel in the dense phase zone is not completely combusted. of. Under the action of primary wind and fluid mechanics, when the fuel moves up from the dense phase to the dilute phase, it also moves down along the section close to the furnace wall, then rotates and circulates in the furnace chamber, and extends the fuel through material circulation The combustion time inside the boiler further promotes the improvement of combustion efficiency.

3.5 The Relationship between Separation and Balance of Circulating Fluidized Bed Boiler

Another major reason why the circulating fluidized bed boiler can achieve high-efficiency combustion and heat output is the separation and balance work inside the circulating fluidized bed boiler. Separation work mainly refers to the presence of a separator in the furnace, which can classify the degree of fuel particles. For fuels with smaller particles, it can directly achieve full combustion. For fuels with large particles and not easy to burn completely, the oxygen supply will be increased. , The method of reducing the concentration of carbon dioxide in the furnace promotes its combustion, ensuring that it can fully burn the fuel, and on this premise, reduces the output of pollutants caused by insufficient fuel combustion, so as to ensure the balance of fuel combustion in the furnace Sex [6].

Of course, in the process of actual work and operation, the combustion situation in the furnace of the circulating fluidized bed boiler and the particle situation of the fuel must be far from theoretical calculations. Generally speaking, the separation efficiency in the combustion process is often greater than Theoretical calculation data. Therefore, in the actual operation process, it is necessary to appropriately adjust the combustion method according to the actual combustion situation and the operation of the boiler, and promote the combustion of fuel through a reasonable external circulation, so as to achieve the flue gas balance in the boiler, and avoid the oxygen in the furnace. Insufficiency leads to insufficient fuel combustion, which results in waste of resources, increases costs, and is not conducive to sustainable development. In actual combustion, in addition to the outer circulation combustion that conforms to the actual situation, there is also inner circulation combustion. In order to better promote the fuel balance inside the boiler, the relevant technical operators must reasonably use technical means and strictly follow the relevant standards to make the boiler burn While the system runs smoothly, it can also improve the combustion efficiency and the utilization rate of combustion materials Conclusion.

4. Conclusion

Compared with traditional boilers, circulating fluidized bed boilers have greater advantages in combustion efficiency and environmental protection. Circulating fluidized bed boiler mainly depends on the optimization of air supply, coal supply and slag discharge to improve the combustion efficiency. With the rapid development of China's social economy, the technology of circulating fluidized bed boiler has been greatly improved than before. The development direction of China's boiler mainly lies in high efficiency, full combustion and minimization of pollution emission. While ensuring the improvement of combustion efficiency, it greatly reduces the negative impact of boiler combustion on the environment, so as to promote the continuous progress and development of China's social ecology.

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