The Economical Operation of Coal Chain Grate Boiler

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Abstract. This paper analyzes the factors that influence the economic operation of the chain grate boiler, and introduces the relationship between the air distribution method and economic operation.

1. Introduction
Chain boiler is the most widely used fire bed furnace in China. At present, 10t/h, 20t/h, 35t/h industrial boilers are used in chain boilers. Chain boiler in practical application process, thermal efficiency is low, a large part of the chain boiler combustion efficiency is only 60%, is common in the operation of low operation load, excess air coefficient, high exhaust temperature, slag carbon content is high. To solve these problems in the operation of coal-fired industrial boilers, boiler operators need to be skilled in operating procedures to understand the nature of coal, boiler structure and combustion characteristics. According to the specific situation, we should adjust the boiler condition reasonably, so as to avoid the long-term low load operation of the boiler.

2. Relationship between mix wind and combustion of chain grate

2.1. The characteristics of the chain grate mix wind and the section air supply
In the chain boiler, the coal is moved backward from the front of the grate, and the air from the bottom up to the furnace, and as the furnace is constantly moving backwards, the fire, combustion, burning and other stages occur in sequence. Due to the development of combustion process, the thickness of fire bed is gradually reduced along the furnace line, and the slag layer is formed at the rear of the furnace. With the decrease of the thickness of the fire bed, the ventilation resistance is gradually reduced, and the combustion of coal in the grate is divided and the partition is carried out, so the amount of air required to go along the length of the grate is different [1]. In the fuel preheating dry, can completely do not need air, in the volatile precipitation area, some combustible gas has already begun to fire, so you need to supply a part of the air, continuous precipitation can be burning zone is the main part of the combustion process, need to put into a large amount of air. Finally, the formation area of ash residue, the combustion process has been almost completed, so it is not necessary to have much air, mainly for the furnace cooling needs to be sent out.

The resistance of the fire bed to the fire bed is gradually reduced, and the air supply is increased to the rear end of the grate. Therefore, the air supply is too much, but the air is not enough in the middle. The result is that the loss of chemical incomplete combustion loss and mechanical incomplete combustion loss is increased, and a large part of the heat is carried away with the unutilized air, which increases the exhaust loss. It can be seen from the combustion process of the chain furnace that the air demand is low in the ignition area and the burning area, and the burning area needs to be large, and the
maximum demand is in the burning area [2]. The reasonable method is to adopt the stage to send the wind, divide the grate into a few areas, separate from each other, namely into the wind chamber, through each wind chamber into the furnace discharge volume can be adjusted independently.

As the air in the middle part is insufficient, the air supply is not completely burning, while the two ends are air surplus. This will lead to incomplete combustion heat loss of gas and solid incomplete combustion heat loss increase, and a large part of heat over not being taken away by using air, increase exhaust heat loss, the contradiction between supply and demand in order to improve the combustion air quantity, need to adopt zoning air supply way, under the fire grate along the length direction of the system of storehouse into several segments, and mutual assistance is separated into several small wind room, can independently control regulation. Theoretically points wind chamber can separate the more the more close to the combustion air demand curve, but too much air chamber structure is not an option, it makes the structure is extremely complex, also not convenient operation, general points wind room air distribution along the grate longitudinal wind chamber is divided into 4 ~ 6 points. The wind chamber is much, the air pressure wind quantity regulation fine, is advantageous to combustion, but the structure is complex, the cost is high; The wind room is small, the structure is simple, manufacturing is convenient, but the regulation is thick, use the 4 wind chamber when the high quality coal is used, the burning of inferior bituminous coal USES 5~6 wind room. When the boiler capacity is large, it is necessary to set up two sides of the wind for the horizontal and uniform distribution of the furnace.

2.2. Reasonable distribution of wind
It is a precondition for the flexible regulation and reasonable organization. Rational distribution of wind is the reliable guarantee for optimizing the combustion and combustion of coal seam in the chain furnace. In the actual operation, but also according to the gasification of coal properties and hearth furnace arch structure to adjust the air distribution, through combustion adjustment to determine the wind room air door or small throttle switch position and mixing proportion [3]. The delivery of each subregion is adjusted, can change the position of the fire grate on all areas, appropriate adjustment partition local air supply air to avoid too much, keep proper fire bed length, to ensure that the boiler efficiency, improve the efficiency of the boiler has great significance.

3. The three air distribution methods of the longitudinal section of the chain furnace
3.1. Early distribution of wind
This method is based on the fuel layer's ability to dissipation of air as early as possible. In the early stages of combustion, a large amount of volatiles are released, and a large amount of air is sent to the air, and as the fuel temperature increases and the combustion is intensified, the air will be sent as far as possible until the fire is burnt out. Five wind chamber, for example: the first wind chamber by volatile coal, the adequate supply, the more general to the second wind chamber into the wind (full open), the third the wind chamber, until the fourth wind chamber, the air supply is slightly reduced. The subsequent combustion of the fuel layer is carried out, the air consumption is further reduced, and the air supply is greatly reduced, so the fifth wind chamber is only slightly open or full.

This style of distribution has the following characteristics:
(1) As early as possible air distribution method is suitable for high volatile coal, the early stage of the coal absorbing heat release large amounts of volatile matter, to make the combustible gas (volatile) are fully burning, need to put into a large amount of air, to form the strong front combustion.
(2) Due to the strong burning of the front, the front arch area is prone to slagging, and even the coal gate is burned. Therefore, it is important to control the forward air supply. At the same time, due to the intense burning of the front, the flue gas volume expands rapidly, causing the flue gas in the back arch to flow out, forming the stuffy air in the outlet of the smoke in the rear arch.
(3) In the front of the burning high temperature zone, the weak burning area at the rear of the grate is larger, the temperature is lower and the coke burning is difficult to maintain, resulting in the increase of carbon content in the slag, which reduces the combustion efficiency of the boiler [4].

3.2. Delaying the distribution of air distribution
The delay of the distribution of the air distribution method is a significant feature of the resection of the strong combustion zone. For example: the first wind chamber is the ignition period, which is not dedicated to air supply. The second wind chamber has entered the burning period, but still sends small wind or stroke; High winds in the middle of combustion (third and fourth wind); The fifth wind chamber is in the end of the grate, with only a small amount of air, generally to ensure the reliable cooling of the grate is appropriate, so the wind door is fully closed, relying on the wind in the adjacent wind room for the wind [5].

The characteristics of the delayed distribution method are:
(1) The delay with the method of air distribution and air distribution method as soon as possible the main difference is that the second wind chamber with air volume, delayed air distribution method is deliberately reduce its supply air, and air distribution law is as early as possible according to the requirement for combustible gas into the air. Due to deliberately reduce the air volume, the front of a large number of release of flammable gas form an oxygen "hunger" space, urgently needs the excess air and at the back of the grate furnace combustion air leakage and oxygen supply, effectively reduce the total excess air coefficient. The air volume distribution is shown in figure 1 a).

(2) A high temperature zone must be formed in the rear arch exit or in the center of the furnace, because the coal layer enters the rear arch and delivers the strong wind. The high temperature of the high forward romantic to arch before ignition role, for backward by radiation heating to keep the high temperature of the burning area, promote the coke burning, formed a "burning in the middle, two head" way of combustion. The air volume distribution is shown in figure 1 b).

(3) To delay the use of air distribution method is conditional, that is the requirement of furnace arch of mixing performance is good, in order to make sure the back of the oxygen enriched flue gas of the gas and the front more gas in the mix, achieve the goal of combustible gas burnt out. The air volume distribution is shown in figure 1 c).

3.3. Strong wind blowing method
This is an extreme delay in special air distribution. A long grate from the new coal to the furnace was not sent to the wind, until the last, two wind Chambers were delivered to the wind. At this time, because of the high coal temperature, see the wind immediately catch fire and strong combustion. After the wind blows, a large amount of hot and fine coal is blown from the coal seam in the rear combustion zone [6]. As the flue gas goes forward, it falls on the new coal at the front and forms a hot coal pellet. This blanket will continue to heat the new coal until it is ignited in a second wind chamber.

The main features of wind blowing after strong wind:
(1) The extreme postponement of the air supply and the later wind gusts created a hot coal pellet to promote the ignition of the fuel, which is called "burning the back and pushing ahead".

(2) The main advantages of blowing method after strong wind can burn low volatile coal. Its main disadvantage is that because of air supply is too concentrated, combustion strength greatly increased, easy to cause the serious slagging, fire bed damage at the back of the combustion area of coal seam, leading to excessive intake, affect the normal combustion. In addition, because the overburden of the new coal is too thick, the new fuel absorbs the heat of radiation and causes the fire to deteriorate.
4. Horizontal uniform air supply method of chain grate

In order to achieve reasonable air supply, it is necessary to solve the problem of uneven air supply and uneven air distribution in the direction of the furnace line. Segmented supply basically solved the combustion problem in the oven, according to the principle of combustion process with the wind, can according to the characteristic and the chamber of a stove or furnace fuel used in the furnace arch structure characteristics to determine the recent throttle position and air distribution proportion of air distribution, but can not be fully realized along grate width of uniform air supply.

Generally in the chain furnace below 10t/h, the small wind chamber with the air supply is the one-side inlet wind structure. When the air enters the small wind chamber, the pressure decreases with the sudden expansion of the circulation section in the inlet. Along the flow direction (the width of the furnace), the flow rate decreases, the flow rate decreases, and the static pressure rises as the air keeps flowing into the furnace, and the pressure differential along the width of the furnace line increases gradually.

The main measures of horizontal uniform air supply in chain grate:

(1) Improving the inlet of the wind chamber and connecting with the horn at the inlet to eliminate eddy current phenomenon.

(2) Install all flow baffles or replace the pressure wind positions on the air duct along the width of the furnace, so that the static pressure distribution is even, and the horizontal distribution is even. As is shown in figure 2 b), c), d), e).

For the larger chain furnace, double-sided inlet air is adopted to reduce the imported horizontal speed, so that the width of the furnace line is uniform. For chain grate, attention should be paid to the leakage of the side of the road. If the air leakage should be improved. The small wind room and adjust the wind door is tight, like the wind room is not strict, each other wind is not able to make the furnace row to match the wind even, should repair or improve. As is shown in figure 2 f).
5. The relationship between the combustion adjustment of chain grate and economic operation

The adjustment of the combustion condition of the chain furnace mainly refers to the combination of air supply and coal burning. Measure of the stand or fall of boiler combustion condition the key is to see whether fire bed ignition time, ignition is stable, the combustion is even, whether the cannon fire, fire bed all burning zone length are appropriate, burning line is obvious. The combustion of chain furnace is very important to the technical quality of operators. Adjustable parameters of the combustion process, such as the thickness of coal seam, the grate speed, the piecewise supply air throttle opening and fan and induced draft fan throttle opening and so on, the operator should be based on fire in running and coal bed combustion condition adjustment in a timely manner [7].

(1) The determination of the furnace speed is not only to adapt to the boiler load, but also to adjust the ignition characteristics of the coal. The low volatile coal is not easy to catch fire, and the grate speed should be slower to ensure the fire. It is easy to break the fire if the grate is too fast. The high speed of the volatile coal furnace should be faster, and the slow speed of the grate will cause the ignition point to be too high, so that the coal gate will be burnt.

(2) The determination of coal seam thickness should be adjusted to the boiler load, according to the coal and coal characteristics. Ash, water, ash melting point and large coal are generally used in thick coal seam. However, the coal with low particle size and low melting point is generally used in thin coal seam because of the difficulty of ventilation. This is not only good for ventilation, but also the
coal seam is not easy to get slag. The thickness of coal seam is not adjusted when the load is adjusted, only when the coal is changed.

(3) The wind pressure of the boiler is related to the thickness of the coal seam. The coal seam thickness is easy to use high wind pressure, otherwise the combustion is not strong, the boiler is small. Low wind pressure is generally used when the coal seam thickness is thin, otherwise it is easy to blow up fine coal and create a crater. There is a lot of air in the caldera, burning strongly and the other parts are not fully burnt due to insufficient air, so that the whole fire bed burns unevenly and the heat loss increases, and the boiler output decreases.

(4) The opening degree and wind pressure of the wind are determined by the structure of coal, grate and furnace arch. In order to ensure the reasonable combustion of the chain furnace, the air distribution should be small in front of the grate and in the middle. For the high volatile coal, the air should be supplied after the fire. The air supply should be concentrated in the front of the grate, and the door of the section should be kept fully open. For the less volatile coal, it is difficult to catch fire. When coke burns, it requires a large amount of air, and the opening of the air door is gradually opened up from the rear. Section to send the actual opening of throttle, along with the grate speed, the change of coal particle size, moisture and adjust the bed of the burning fire, but adjust the magnitude of the should not be too big, is mainly to maintain fire bed length, to adapt to changes in the boiler load.

(5) Adjustment of excessive air coefficient in the furnace. As far as possible to satisfy volatile and coke combustion, reduce the boiler air coefficient. Depends, to a large extent because of a stove or furnace excess air coefficient of boiler combustion efficiency, excess air coefficient will increase the smoke heat loss, and starts to increase the mechanical damage and chemical incomplete combustion heat loss, general chain furnace hearth best economic data export excess air coefficient is 1.4 ~ 1.5.

(6) Chain furnace operators should always watch the fire when they are on duty, and make the combustion adjustment in a timely manner. If the fire should be noticed, it should pay attention to the suitability of the air volume, whether the fire bed is flat, the fire line and the burning line are appropriate.

The renovation of inefficient coal-fired boiler is the key to energy conservation and emissions reduction work in China, this paper discusses the problems of the chain boiler, analyzes the influencing factors and several technical retrofit scheme is given, and hope to provide some references for the optimization and upgrading of chain boiler.

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