

# Study on Energy Saving and Consumption Reducing Measures of Circulating Fluidized Bed Boiler

**Ding HAN**

Shanxi Chongguang Power Generation Co., Ltd, Jinzhong, Shanxi, China  
renj1985@126.com

**ABSTRACT.** As an efficient and energy saving product, circulating fluidized bed boiler is widely used in industrial production. Especially with the policy of sustainable economic development in China, circulating fluidized bed boiler brings great convenience to industrial production. This paper mainly analyses the optimization measures of circulating fluidized bed boiler in energy saving and consumption reduction, in order to further improve the energy saving and consumption reduction capacity of circulating fluidized bed boiler and promote the sustainable development of China's industrial production.

**KEYWORDS:** Circulating fluidized bed boiler, Energy saving and consumption reduction, Measures

## 1. Introduction

As an energy saving and environmental protection product, circulating fluidized bed boiler is widely used in various fields of industrial production in China. Under the policy of economic sustainable development, how to make good use of circulating fluidized bed boiler, give full play to the role of energy saving and consumption reduction of the equipment so as to achieve the goal of energy saving and emission reduction in our country is the issue of particular concern at present. Circulating fluidized bed boiler can obviously improve the operation efficiency of enterprise production, so it can also bring greater economic benefits to the enterprise. Therefore, it is necessary to strengthen the research on energy saving and consumption reduction of circulating fluidized bed boiler.

## 2. Characteristics of Circulating Fluidized Bed Boiler

### 2.1 Wide Range of Load Changes, Easy to Adjust

High temperature circulating ash is often used as raw material in circulating fluidized bed boiler, which produces more heat energy and has higher heat storage effect, so it can ensure the stability of steam parameters and combustion. The addition of high temperature circulating ash can ensure the normal operation of the boiler. In addition, the load generated by circulating fluidized bed boiler is relatively low. Generally, the load varies from 25% to 100%. Once the load changes, it only needs to adjust the fluidized speed and coal feeding amount<sup>[1]</sup>.

### 2.2 Strong Fuel Adaptability and High Combustion Efficiency

The circulating fluidized bed boiler contains a lot of ash particles, which can ensure the stability of the circulation. The newly added fuel only accounts for a small part of the circulating fluidized bed boiler. However, because of the special hydrodynamic characteristics of the circulating fluidized bed boiler, the heat and mass in the boiler can be effectively exchanged. This can provide good combustion conditions for the new fuel. In addition, the coal particles that are not fully burnt out will go through repeated circulation, so that the residence time in the boiler is significantly increased, and multiple heat and mass exchanges can be realized. In this way, the fuel in the circulating fluidized bed boiler can be fully burnt out and the combustion efficiency can be improved<sup>[2]</sup>.

## 3. Measures for Energy Saving and Consumption Reduction of Circulating Fluidized Bed Boiler

### 3.1 Adjusting Elements and Equipment

Firstly, regulate the air volume of circulating fluidized bed boiler. Circulating fluidized bed boiler has a high level special structure, which requires a high accuracy of air volume. Therefore, it is necessary for equipment maintenance personnel to calibrate the air volume measuring elements of circulating fluidized bed boiler every year. At present, the most common way to calibrate the air volume measuring elements of circulating fluidized bed boiler is the thermal mass flowmeter; secondly, adjust the coal crusher. The indispensable equipment in the fuel combustion of coal crusher is also the most critical joint in the combustion. The coal crusher can distribute coal particles and coal particle size more evenly. For example, when there is more fine powder in the fuel, combustibles may enter the return feeder, so that combustibles will burn in the return feeder, causing coking problem. Besides the return feeder, the combustibles will also enter the tail flue, increasing the exhaust temperature, which is easy to cause combustion failure of the tail flue. As long as the above problems are solved, the coal crusher can be effectively used to ensure that the circulating fluidized bed boiler can achieve a more stable combustion mode and reduce the impact of coal particle size and shape on combustion; Thirdly, reasonable use of slag cooler. The slag cooler can make the bottom slag discharge smoothly and improve the sulfurization quality and combustion efficiency obviously. It can be seen that the use of slag cooler plays an important role in ensuring the operation safety and reliability of circulating fluidized bed boiler. Based on the analysis of energy saving and consumption reduction, the use of cooling water in slag cooler can achieve the purpose of energy saving and consumption reduction; fourthly, strengthen the control of desuperheating water valve and drain valve. There are many problems involved in the thermal system of circulating fluidized bed, and the valve internal leakage is more common. Once the valve internal leakage occurs, it will bring great thermal loss. In view of the above problems, it is necessary to strengthen the control of desuperheating water valve and drain valve to prevent the internal leakage of desuperheating water valve; fifthly, effectively control the water replenishment rate. The thermal system with water make-up rate less than 5% is better. In order to ensure the energy saving and consumption reducing effect of circulating fluidized bed boiler, it is necessary to keep the continuous blowdown rate within 1%. Before testing the make-up rate of circulating fluidized bed boiler, it is necessary to increase the make-up flow of the system to ensure that the operating condition of the condenser is at high water level, and then close the make-up valve. At the same time, it is necessary to reasonably regulate the system drainage and observe the falling range of the water level of the condenser, so as to calculate the water make-up rate of the thermal system. The coal consumption of the thermal system will increase by 0.22% for each 1% increase of water supplement rate. Sixthly, control the air volume. Keeping enough air system in the circulating fluidized bed boiler hall can ensure the combustion stability of the circulating fluidized bed boiler and the best air coal ratio in the combustion process of the boiler. It is an important way to determine the excess air coefficient of furnace outlet by measuring the oxygen content at the outlet of tail flue. Therefore, it is necessary for equipment maintenance personnel to control the oxygen parameter to ensure the best air coal ratio in combustion<sup>[3]</sup>.

### ***3.2 Reduce Abnormal Shutdown***

One of the key measures to save energy and reduce consumption of circulating fluidized bed boiler is to reduce abnormal boiler shutdown. The restart of circulating fluidized bed boiler after each shutdown will directly increase the power consumption. According to the investigation and research of relevant data, each abnormal shutdown can produce a direct economic loss of more than 100,000 yuan. Therefore, the whole start-up process of circulating fluidized bed boiler needs to be controlled according to the temperature rise rate of air duct burner. Once the coal feeding conditions meet the requirements of the standard, coal feeding is required immediately. Once equipment maintenance personnel find any small fault, they need to deal with it in time to avoid the expansion of the accident. In addition, maintenance personnel need to strengthen the daily maintenance of circulating fluidized bed boiler, formulate preventive measures in advance, and reduce the occurrence of abnormal boiler shutdown<sup>[4]</sup>.

### ***3.3 Optimized Operation Mode***

The personnel need to carry out the optimization adjustment test in combination with the actual operation of the main and auxiliary equipment, combined with the data from the optimization test to carry out a comprehensive analysis and build a scientific and reasonable operation degree and optimization mode, so as to ensure that the unit can maintain the best operation parameters within various load ranges and ensure the stability of the operation process. One of the important parameters for energy saving and consumption reduction of circulating fluidized bed boiler is bed temperature. The adjustment of bed temperature needs to be determined in combination with the change of coal quality and the actual situation of load, so as to ensure the best coal quantity, scientific and reasonable material layer thickness and air coal ratio, and ensure the combustion efficiency of boiler on the basis of improving bed temperature. The control of temperature is directly related to the nature of fuel itself. Different power plants have different requirements on temperature. Some power plants require a temperature of at least 950°C and ensure that the bed does not coking. Therefore, the bed temperature of high sulfur fuel can be kept at 850°C, and the desulfurization effect is the best at this temperature. For better quality coal, the temperature can be raised appropriately, and the combustion efficiency of the main circulation circuit can be improved on this basis. The coal feeding quantity of the boiler shall be determined

according to the load generated by the operating boiler to ensure that the air pressure and bed temperature are within a reasonable range. In addition to effectively controlling the bed temperature, it is also necessary to reasonably determine the steam and water parameters. Therefore, the main steam temperature is directly proportional to the coal consumption. The main steam temperature is reduced by 10°C, and the coal consumption is increased by 0.03%. For steam with steam pressure of 10Mpa-25Mpa and temperature of 540°C, if the main steam temperature is reduced by 10°C, the cycle thermal efficiency will be reduced by 0.5%. The steam humidity at the outlet of the steam turbine will also increase significantly, which will corrode the turbine blades when the steam humidity increases. It can be seen that the main steam temperature will not only increase the coal consumption, but also erode the turbine blades. It is difficult to ensure the safety of turbine operation when the turbine blades are eroded. In order to solve this problem, we need to further improve the automatic input rate of thermal control, which can effectively solve the problem of internal leakage of desuperheating water regulating valve. In addition, the most critical parameter in the circulating fluidized bed boiler is the exhaust gas temperature. Another important process to optimize the circulating fluidized bed boiler is to control the exhaust gas temperature, ensure the cleanness of each heating surface, and ensure the heat exchange effect, so as to avoid unnecessary energy consumption in case of abnormal exhaust gas temperature <sup>[5-6]</sup>.

### **3.4 Reduce Limestone Consumption with Desulfurization System**

The desulfurization system can promote the further optimization of the operation mode of the circulating fluidized bed boiler. With the help of the desulfurization system, the consumption of limestone can be further reduced, and the consumption of desulfurizer can be reduced. The optimization measures mainly include adjusting the particle size of limestone, determining the best calcium-sulfur ratio, and adjusting the appropriate bed temperature. During the normal operation of the circulating fluidized bed boiler, the bed temperature needs to be set at about 870°C, and the maximum cannot exceed 900°C. The amount of oxygen needs to be set at about 2.5%, and the maximum cannot exceed 3%. At this time, the desulfurization effect is the best. The desulfurization efficiency is directly proportional to the calcium-sulfur ratio. The latter will increase on the basis of the increase of the former. The emission value of SO<sub>2</sub> needs to meet environmental protection requirements, and to ensure that on the basis of meeting environmental protection requirements, do not arbitrarily reduce SO<sub>2</sub> emissions. Because in the process of blindly reducing the SO<sub>2</sub> emission value, the limestone powder will increase exponentially. If the limestone used in the operation of the circulating fluidized bed boiler is special, the best limestone particle size curve needs to be selected at this time. Setting the limestone particle size curve within the range of 0.1-0.5mm can extend the residence time of limestone in the boiler. The desulfurization effect presented at this time is also the most obvious. Whether to carry out the limestone putting test needs to be determined according to the sulfur dioxide emission concentration and the sulfur content of the coal type. Set the SO<sub>2</sub> emission, coal consumption and limestone consumption within a certain range, and coordinate the three to promote the normal operation of the circulating fluidized bed boiler , To reduce the usage of limestone <sup>[7-8]</sup>.

### **3.5 Strengthen the Daily Maintenance of Operating Boilers**

The CFB air volume test system in the circulating fluidized bed boiler is very important for operation and debugging. Perform air volume calibration tests on the main air duct and branch air ducts of the fluidized air. Before starting the bed burner to ignite the boiler, it is necessary to check the atomization of the oil gun and implement the corresponding tests to ensure that the oil gun has a better atomization effect. The circulating fluidized bed boiler needs to go through the coal feed line inspection test before the official start-up and during the operation. The purpose of this test is to ensure that the coal line can work normally, so as to prevent the coal line from malfunctioning and causing coal breakage. After the circulating fluidized bed boiler is shut down, it is also necessary to adjust the gap of the rotary air preheater, and to eliminate the defects, remove the dust in the air preheater, and confirm that there is no dust accumulation and blockage. The air preheater leakage inspection can be carried out once a month. When the air preheater leakage inspection exceeds 8%, leakage and plugging measures are required. In addition, it is also necessary to strengthen the research on the wear laws of circulating vulcanization boilers. Equipment maintenance personnel can implement anti-wear measures from the following aspects. One is to strengthen the management of coal and effectively control the gangue content. Do a good job of testing the coal quality and control the coal screening force. The hammer head gap of the coal crusher can be adjusted according to the distribution of fuel particle size. The secondary crushing system is preferred to ensure the uniformity of coal particles and avoid the total amount of coal. The problem of the high proportion of large-particle coal; the second is to take effective measures to further optimize the operating conditions of the circulating fluidized bed boiler. On the premise of ensuring that the bed material is fully fluidized, the primary air volume can be reduced as much as possible. Under the premise of ensuring sufficient oxygen, the secondary air volume should be adjusted appropriately, and the upper and lower secondary air volumes should be reasonably configured to ensure that the excess air coefficient is in the appropriate range. In addition, the height of the dense phase zone can also be appropriately reduced, in order to extend the residence time of coal particles in the furnace as much as possible, so as to avoid high-strength scouring of the cold wall tube. The carbon content in fly ash also needs to be

effectively controlled to ensure effective grinding; third, the circulating fluidized bed boiler should be regularly overhauled and modified to avoid bulging on the surface of the water wall tube screen. After the water wall tube is overhauled, it is necessary Polish the edge of the welding joint smoothly, and pay attention to welding the fins of the water wall tube to ensure that there are no gaps and holes. Install the anti-wear protective plate on the water wall pipe, and pay attention to control the gap between the water wall pipe and the anti-wear protective plate, so as to avoid the formation of a boss due to the excessive gap. In the process of inspection and modification of circulating fluidized bed boilers, pipe letting technology can be used. Under this technology, high-quality wear-resistant castables need to be selected and implemented by a professional construction team. The formation of slope problems should be avoided when the castables softly land. Once there is a slope, it will increase the degree of wear of the water cooling pipe. The above measures can further optimize the construction process of the circulating fluidized bed boiler, ensure the normal operation of the unit, and ensure that the wear-resistant castable does not fall off<sup>[9-10]</sup>.

#### **4. Conclusion**

To sum up, the circulating fluidized bed boiler plays an important role in industrial production, and the equipment has a great effect of energy saving and consumption reduction. There are many components that make up a circulating fluidized bed boiler. Strengthening the transformation of related components can achieve significant energy saving and consumption reduction effects. The above is the analysis of energy-saving and consumption reduction measures of circulating fluidized bed boiler, hoping to further improve the energy saving and consumption reduction effect of circulating fluidized bed boiler and promote the sustainable development of social economy in China.

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