Coal-fired Power Plant Boiler "Four Tubes" Wear Explosion-proof Effective Prevention and Control of Process Instance

Zhifeng Chen
*Inner Mongolia Jinglong Power Company*

**ABSTRACT**: Wear, explosion-proof work on prevention to eliminate boiler heating surface may wear and cracking happened or what will happen. In this paper, combined with years of experience in inspection and defect treatment, the Beijing power company in Inner Mongolia as an example, burn coal boiler unit tangential wear explosion-proof examine the common problems and treatment methods are expounded. In view of the various parts of the boiler heating surface, according to the boiler combustion mode, one by one, the analysis of the wear and corrosion mechanism, and implementation of effective countermeasures.

1 GENERAL INSTRUCTIONS

1.1 **Boiler combustion**

The coal ash content into the furnace is a major factor of boiler heating surface wear, if the ash content is small, it will suffer less wear and tear, relatively longer life of the heating surface. On the contrary, ash content increases will accelerate wear and tear, and speed up the heating surface wear; when protection measures may not be implemented, it may leak at any time. In the current form of economic, wok coal ash is far greater than the design coal, so protective measures of heating surface must be done very carefully; inscribed circle is the key to reducing the leakage of furnace water wall, the center of the flame is less to offset if inscribed circle better, it will not lead to high temperatures in the furnace water wall, outside corrosion, thinning, reducing wall coking. So, dynamic field tests should be organized after a large area burner replacement or adjustment to ensure inscribed circle within the design range. The correct operation of the combustion mode can effectively reduce the reheating system of short-term and long-term over-temperature burst pipe leakage rate. My company's boiler will serve as an example in the following paper, specifically addressed the main problems and the treatments of boiler heating surface of the components wear-proof inspection encountered.

1.2 **Boiler**

Boiler is not only the most important thermal power generation equipment, but also the worst operating conditions of equipment. According to statistics, especially the national power generation companies' generators unplanned outage rate recognized data in the past 50 years, shows that utility boiler accident rate of the accident rate units is equal to or more than 60%, while the boiler heating surface leakage accident rate of the boiler explosion accident rate is equal to or greater than 60%, of accident rates exceeded 36% as well. Therefore grasping the operating conditions of the boiler heating surface, clearing defect which may occur and implement reliable measures to prevent the heating surface burst leakage is crucial.

2 WEAR AND TREATMENT MEASURES OF SUPERHEATER SYSTEM

2.1 **Separator screen superheater located directly above the furnace, resulting the lower elbow suffered higher temperature and larger shaking in operation, so there will be a high temperature creeping inflation, high temperature corrosion, pipe screens scattered, mechanical abrasion and other defects.**

Each screen of separator screen superheater is divided into six small screens in the structure, tube screen is affected by the impact of the combustion gas stream in the long run, butterfly card will be disengaged, causing scattered tube screen. It will be mutual rubbing between the tubes, because of the long screen tube, the small tube spacing, the numerous weld joints between the pipes, and the shaking tube screen in the run. As the weld is more than high, it will cause wear and tear between adjacent tubes. The company has repeatedly found similar defects. Butterfly card does not apply to the connection between the tube partitioning screen, should be re-selection in the repair of replacement.
Anti-wear card blocks positioned on separator screen superheater tubes may rearward offset due to expansion in the process of running, would not achieve to prevent the wear with the partition screen tube and two positioned tubes. For this reason, we should lengthen wear block, install wear block on the partition screen may occur wear and rear screen superheater tubes.

2.2 Rear screen superheater located off flame corners, its position in the high temperature in the furnace area, prone to high temperature corrosion, so we can use maintenance lifting platform for the lower portion of the rear screen superheater elbow checked, split the severe high-temperature corrosion tubes, and do metallographic analysis, then replace the tubes according to test results. The rear screen through the lower and outlet pipe of the first three steel pipes used in higher material TP347H or T91 steel, but for more of the inner tube is 12Cr1MoV steel pipe.

Due to the high temperatures here, once over-temperature phenomenon in the operation, it is beyond the lower pipe material can withstand temperature extremes, and the occurrence of creeping inflation eventually happen squib. Since rear screen superheater suffered high temperature, so its positioning butterfly card will burn in the long run, lead to the occurrence of staggered tube bank, and here there are three pairs arranged Steam Blower discharge pipe and the distance less than one meter, making the discharge tube column damage caused by blowing steam (Figure 1).

2.3 High-temperature superheater rearward position in the furnace, located at the front of the low temperature superheater, flue gas temperature decreased, but the fly ash particles are converted from molten to solid state, high-temperature superheater presence of ash wear during operation, additionally arranged here two pairs of steam soot blowers, and less than a meter away from the tube's screen, blowing steam soot blowing tube screen is also a great loss. In the soot blower at the silver surface and the installation of anti-wear protection tiles it is very necessary.

High-temperature superheater tube card designed only take into account the ease of installation, such sparse shaped buckle after the installation there will be some gaps, due to the operation of the flue gas disturbance, the tube and pipe discharge occurs card collide mechanical wear, eventually cause leakage (there have been many precedents). So it should overhaul the sparsely-shaped buckle into a highly reliable hold cards, this clip will have some trouble during the installation, but you can eliminate the mechanical impact hazards, to prevent the occurrence of burst pipes.

2.4 Positioning cooling tube main role is to fix the distance between the heating surface tubes screen, make the same pitch to eliminate the occurrence of flue gas corridor to prevent wear.

But in the long run, the positioning tube pipe card slot on the screen will be disengaged (Figure 2), soot blower blowing cooling tube positioning damage is quite serious, so we must first restore the detachable clip in the inspection process, and then adding to the cooling tube wear tile positioning using wraparound installation.
2.5 Wall enclosure superheater mainly on the front wall carried wear protection.

Front wall enclosure superheater located behind the high-temperature superheater, the shaking is smaller in the process of running, and a single layout ensure the space relatively fixed, so that no mechanical collision occurred. However, in the arrangement of the top row of closely spaced from the side wall of the superheater, smoke corridor formed on the pipe caused by wear and tear, so the two sides of the wall superheater three bodies wrapped from top to bottom can wear protection tiles, while the side wall superheater phase location should also wear installed watt. When designing wall superheater outlet headers, half in the boiler, and the other half outside the boiler, there is a certain amount of wear between its internal header with header (Figure 3), pipe explosion occurred in many domestic header tube power plants here too. During the time of treatment, response header at the exit of the gray-faced welcome the installation of anti-wear protection tiles, for the installation of the furnace half header ramming mix.

![Figure 3. Post mount and header at the outlet of the wall superheater.](image)

2.6 Low temperature superheater horizontal arrangement, after the shaft is generally divided into three layers, during operation there will be wear and tear of fly ash

Soot blower steam purge wear, mechanical wear crash. Since fly ash in here to change the direction and flow area, the temperature is reduced accordingly, fly ash increased hardness, pipe wear also increased. Mainly in front of the low temperature superheater, rear elbow portion; the low temperature superheater inlet, at the outlet and a tube row. For before and after the installation of flue gas elbow portion spoiler, change the direction of flue gas to protect the elbow is not blowing smoke damage, and baffles should be based on the width of the scene, if it is too wide will cause blowing airflow scattering damage other parts, if it is too narrow will cause the bottom of the bend 2 and 3 are not protected. For the entrance of the first tube bank protective wear root installation of tile, pipe exhaust soot blower also installed at the wear tiles to enhance the protection. Due to the low temperature superheater is suspended in the economizer tubes dangling, such a structure, coupled with the steam soot blowing direction, will hang between the ear and the vortex tube exhaust pipe blow caused damage, the deal is here for the installation of wear tiles beneath lugs to strengthen protection. Side exhaust pipe at the flue gas velocity greater wear rate quickly, in 2014. A repair, we had found an elbow wall thickness of only 2.7mm (design wall thickness 7.0mm), should be taken to fill three rows on the side plus anti wear protection tile manner, focusing on the inside of the elbow, to ensure long-term security and stable operation of low temperature superheater.

3. WATER COOLING WALL

Water cooling wall located in the furnace around, it suffers a high temperature corrosion, low temperature corrosion, soot blower blowing steam loss, loss of blowing burner in the course of running. For the furnace temperature corrosion, low temperature corrosion, soot blowing steam blowing loss, according to the conventional method, only able to use the metal spraying to control, but for water cooling wall on both sides of the burner, because of its limited space, the presence of the metal spray impact, affect the quality of spraying, and the secondary air leak is large, sprayed layer can not adhere to a maintenance cycle, it is not recommended use. Here on a professional high-temperature processing ramming material, the effect is very good.

Water cooling wall sealing sheet short lance hole due to frequent thermal expansion and contraction and cracking, with the expansion of such cracks will gradually expand to the adjacent water wall tube (Figure 4), the company found that eight such defects in this year's A repair. This defect is fatal and must be replaced as soon as possible. Therefore, in a run overhaul cycle, double-check after each repair should be the site of brightly polished.

![Figure 4. Water cooling wall studs sootblowers holes to extend the sealing sheet crack pipe.](image)
4. ECONOMIZER

Economizer located in the lower rear flue, the flue gas outlet, suffering from fly ash wear, design unreasonable wear, mechanical wear, abrasion steam soot blowing in operation. Watt's wear manufacturers on economizer equipped with an angle of 120. In the operation of the flue gas flow vertically downwards, reflecting the fly ash can just make the second row of tubes subjected to erosion; therefore, these tiles wear should be gradually replaced by an angle of 180. Moreover, with the same low temperature superheater, economizer discharge side wear is relatively serious, so the edge of the three rows should all install wear tile; Economizer tubes suspended in the elevator and pipe welds to carefully check for cracking. Pipe soot blower at the need to install all wear watts.

5. REHEATING SYSTEM

The reheating system of our company includes: wall (radiation) reheating, screen reheating, high temperature reheating system.

a) Platen reheaters are arranged in the rear superheater, there is mainly mechanical wear, soot blowing loss in operation.

In each of the anti abrasion proof checker in my company, because of the blowing of the soot blower, the screen type reheating device always change the tube. Because of the reheater tubes are too thin, it is necessary to install an anti-wear-resistant tube for these easily blown tubes. (Figure 5). Positioning and cooling pipe disengaging phenomenon will happen in operation, once it disengaged, it will wear with the platen reheater tube mechanical, so this easily collision part need to install the anti-wear in operation.

b) Wall type reheating furnace is arranged in the wall of the left, right and front wall of the furnace

The main defect it may occur is the furnace wall leakage, it will caused the pipe blowing loss, the treatment here is to use the material to block at the entrance of the pipe wall, it can eliminate the blow by the leakage of the pipe. In order to reduce the separation of superheated sloshing in operation, taking into account it will occur the mechanical wear when we design, so the tube wall install the outer jacket (made of 304 stainless steel) to prevent leakage caused by mechanical wear.

However, manufacturers only concerned about the firmness of welding, and have not considered expansion in operation. In the long run the connection fillet is tearing because of the difference between tube wall and the sleeve coefficients of expansion, and then it will extend to the tube wall and then it may leakage (Figure 6,7). If not timely or measures are incorrect, the consequences will be unimaginable (there are lots of manufacturers occurred the leak at here). The lower fillet should be promptly removed, in order to the wall pipe can be free expansion in operation. Eliminate the hidden tear trouble of wall and tube due to the installation of the outer sheath.

Figure 5. Screen sweep type heater blowing soot blowing damage pipe

Figure 6. Torn reheated tube.

Figure 7. Screen pipe on the wall.
c) High temperature reheater are arranged in the front of high temperature superheater, there will be mechanical wear and soot blower in operation.

Due to the design of the fixed clamp for manufacturers in the factory is not reasonable, it can cause the pipe and pipe mechanical wear. This wear may be found in the inspection of the first 2 pipe wear, it is not possible to find about the wear in the middle of the tube screen. Removing the clamp, it can be found that the tube wear in the tube screen are deeper, so this must be replaced to the card clamp as soon as possible. When this kind of pipe is replaced by our company, we found that there are lots of wear and tear; there is more than 2mm depth, and the tube wall thickness of the high temperature heater is only 4mm. Three pairs of long rod soot blower are arranged at the front part of the high temperature heater, it can easily cause blow damage to the high temperature heater, so the soot blower cover must be equipped with anti-abrasion.

6. THE INSTALLATION AND USE OF ANTI ABRASION TILE

In addition to the furnace, the metal thermal spraying is not recommended. In the initial overhaul of our company, the over spraying are used in the horizontal flue and tail shaft, but most of it can not support over 1 overhaul period. The protective effect of the installation of the anti abrasion tile is better, and it has lower comprehensive cost. It can not be generalized, it should according to the location of the installation to choose installing. As a result of higher operating temperature, for the screen type superheater, after superheater, platen type reheater, high temperature reheater, front bag wall superheater, a water cooling wall hanging tube, have loose bowls of anti abrasive tile. It should select the 5mm’s 1Cr14Ni20Si2 stainless steel anti abrasive tile. For the high temperature superheater, front wall heater, we can use 3mm anti wear tile using 1Cr14Ni20Si2. Anti abrasive tile can use the stainless steel manufacture and low temperature superheater, economizer, wall superheater of 3mm 1Cr18Ni9Ti (or 1Cr14Ni20Si2).

7. CONCLUSION

Due to the impact of the cost of coal-fired power plants, the vast majority of power plants will be mixed with poor quality coal to reduce costs, which will inevitably lead to the boiler "Four Tubes" wear and tear. Although the local wear of each boiler is not the same, according to the author inspected dozens of units, most of the wear parts are the same. Our company has shipped from 2008 168 hours, never caused the boiler "Four Tubes" leakage due to abrasion proof work omissions. It can be seen that as long as we stick to the principle of every stop will check and make the right preventive measures, boiler "four tubes" leakage can be controlled, but the premise is it must have the correct operation mode (including soot blower) and reliable over temperature super pressure control.

REFERENCES