Shenwu Integration Technology for Energy Conservation and Emissions Reduction

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Abstract

Beijing Shenwu Group Corporation uses self-developed ceramic honeycomb as heat exchange cells instead of metal, with the advantages such as anti-corrosion, anti-erosion and anti-clogging, it can be used for air preheater and gas heater (GGH) in thermal power boiler island, to solving the problem of corrosion and plugging. Meanwhile, setting SCR catalyst in proper temperature region of ceramic honeycomb regenerator can save energy and reduce NOx. This air preheater can further reduce exhaust gas temperature, so as to improving boiler efficiency more than 3%, and achieving the goal of integration of energy conservation and emissions reduction ultimately.

1. Current Status of Energy-saving and DeNOx

Electric coal power industry is the foundation of the energy industry at present., it is expected that coal power industry will still be the main source of power in the development of the global economy after the year of 2050. The resource characteristics ‘rich coal, less gas and oil shortage’ determines the coal burning units is priority to others in China, the proportion is more than 77%. As the appearance of new material, new technology and the increasing proportion of primary energy into electrical energy, improving energy efficiency, environmental protection, development and utilization of new technology and equipment, will be a new important developing direction of electric power technology in China.

2. Solution Provided by Shenwu

Beijing Shenwu Group Corporation is the leader in research and industrial application of high temperature air combustion technology (HTAC), in China and even the world, Dr Wu Daohong, the chairman of Beijing Shenwu Group Corporation, is the pioneer of combustor in high temperature air combustion technology in china, have completed more than 800 industrial furnaces/heater both at home and abroad, with profound theoretical basis and practical experience in the flow and heat transfer of ceramic honeycomb regenerator.
Beijing Shenwu Group Corporation uses self-developed ceramic honeycomb as heat exchange components instead of metal, with light weight, low cost, no corrosion, scour resistance and anti clogging, it can be used for air preheating and GGH in conventional thermal power boiler island. By the comparison of ceramic honeycomb and metal, ceramic honeycomb has evident advantage in price, weight, etc, weight reduced more than 50%, life extension more than double, low cost of more than 10%, in the same heat as a benchmark. Meanwhile, decorating SCR catalyst in proper temperature region of ceramic honeycomb regenerator can save energy and reduce NOx. By using this new type of air preheater, can further reduces exhaust smoke temperature below 70 °C, increases boiler thermal efficiency by 3%, absorbs the latent heat of vaporization efficiency 1% ~ 5%, the total efficiency increased by 4% ~ 8%; More than 30% of the sulphur in flue gas removed with condensed water, On this basis, Putting the DeNOx catalyst in appropriate temperature range(280 ~ 420 °C) and increasing ammonia injection device can make that integration of desulfurization DeNOx and energy saving. Two application model: DeNOx type ceramic honeycomb regenerator rotary air preheater application model, energy conservation and DeNOx type ceramic honeycomb regenerator rotary air preheater application model.

Integration technology for energy conservation and emissions reduction of ceramic honeycomb regenerator and module of Shenwu, as shown in Figure 1.

![Figure 1. The ceramic honeycomb regenerator and modules](image1)

Process flow diagram of DeNOx type ceramic honeycomb regenerator rotary air preheater model in application is shown in figure 2:

![Figure 2. DeNOx type ceramic honeycomb regenerator rotary air preheater model in application](image2)

Characteristics and advantages of the technology:
- DeNOx efficiency can reach 80-95%, used with SNCR and Induct-SCR;
- Low temperature corrosion, resistant of ABS, adhesion, abrasion resistance and other characteristics, and lower smoke temperature;
- Light weight, less dosage, low investment and operation cost;
- Long catalyst service life;
➢ To reduce gas pressure drop after air preheater;
➢ Regardless of using for active boiler or a new boiler unit, it has low investment, low transforming space, low operating cost and has the advantages of improving the efficiency of the boiler;

In order to meet the requirements of Power plant air pollution emission standards (GB13223-2011), All the power plants are requested to complete the DeNOx retrofit or new build in July 1, 2014, otherwise the closure. Recently all the DeNOx technology will not bring benefit to operation of the unit. Many factors lead to conventional DeNOx technology modification increases the cost, such as the increase of equipment, system of investment, gas system resistance, agent injection, heat dissipation and loss of catalyst etc., Application of this technology will combine energy saving and DeNOx together, enterprise, application of this technology, not only obtain national DeNOx subsidies, but also recover the investment. Process flow diagram of DeNOx type ceramic honeycomb regenerator rotary air preheater model in application is shown in figure 3:

Figure 3. Energy saving with DeNOx type ceramic honeycomb regenerator rotary air preheater application model

The figure 3 shows that smoke partly through by air preheater, partly by economizer. In smoke wind system, bituminous coal, for example, the ratio of actual air quantity and actual smoke gas in 0.95 or so, and because the smoke contains more CO₂, H₂O and N₂ than air, therefore flue gas enthalpy is higher than air. Without the economizer, the rise of temperature of the air side was greater than the temperature of flue gas side and the proportion is roughly 1.3, that is to say, if the temperature of flue gas decreases by 10 °C, the air side will raise about 13 °C. Coal determines the primary and secondary wind blast temperature, the selection of smoke in and exhaust temperature associated with parameters of boiler and the flue gas acid dew point, Without bypass economizer, the temperature of air must to rise, and the maximum theoretical is air preheater inlet smoke temperature, generally it lower than the air preheater inlet smoke temperature less than 20 °C, According to different boiler, therefore, if the gap of inlet flue gas temperature of air preheater and air outlet temperature is more than 50 °C or above, single set of ceramic honeycomb regenerator can achieve the effect of energy saving, but the efficiency is limited.

Based on existing draught flue and air system, and the currently widespread technology of implementation of "SCR DeNOx + retrofit of air preheater + low temperature economizer " technical innovation, in order to achieve better energy saving and DeNOx effect, Shenwu uses "ceramic honeycomb regenerator + bypass economizer" technologies (figure 3), the solution with following befits than regular method:

- Avoid to setting full scale SCR reactor ;
- Minimum the pressure drop on the solution;
- Save space and investment;
- Low temperature corrosion resistance, resistance to ABS adhesion, abrasion resistance, etc;
- Reduce the number of soot blower;
- To further reduce the flue gas temperature, increase the bypass economizer, improve the efficiency of boiler more than 3%;
- Less metal consumption;
- Economizer without danger of corrosion, water systems and control, convenient and no special temperature requirements;
- Improve the efficiency of dust collector;

The following methods could solve the catalyst abrasion by high gas velocity of air preheater. Conventional SCR DeNOx superficial velocity is between 4 ~ 6 m/s, opening rate between 70 ~ 80% of catalysts, so the hole flow rate is 5 ~ 8.6 m/s, however air preheater regenerator element hole velocity generally for 8 ~ 11 m/s, if the SCR hole velocity is 8 m/s, air preheater heat storage body flow velocity is 10.5 m/s, the wear rate is 2.4 times. Due to the wear usually occurs on the windward side and the end, enhancing a layer of about 100 mm height with consistent structural form of the metal or ceramic honeycomb catalyst on the top of the catalyst is useful. Because of good abrasion resistance of carbon steel and ceramic honeycomb, this measure can lives for fly ash.

3. Investment and benefit
The investment cost of application of "Integration of energy-saving DeNOx technology" is 100 ~ 150 yuan/kw, the payback period is less than 2 years. Operation and maintenance cost can save more than 20%. Compared to regular "SCR DeNOx + retrofit of air preheater + low temperature economizer" united technologies, the benefits are given as follows:
- This technology can even decreases the exhaust flue gas temperature to 70 ℃, the boiler efficiency can be increased by 3% - 8% base on existing.
- In replacing of Ceramic honeycomb and metal, the weight of heating cell can reduce more than 50%, and the cost of operation and maintenance decreased sharply; In a 600 mw boiler with air preheater for example, total weight of heat transfer is 458 tons, cost 5 million yuan, if replacement for the special design of heat resistance, abrasion resistance, acid corrosion of cellular body ,the total weight is 217 tons, cost less than 4.5 million yuan, the cost savings is more than 10%.

4. Conclusion
The successful application of this technology will bring a better economic efficiency for the thermal power plant, can save investment and cost of running during the DeNOx retrofit of emission control, and provide a new approach to save energy and reduce the pollution.

References
[1] ZHENG Zhi-wei, QIU Xing-qi, QI Feng-lei, MA Li, Experimental study of heat transfer and resistance characteristics on honeycomb in regenerator., 2013, Petro-Chemical Equipment,42(1) : 9-13
[4] Xie Daoqing, Wu Daohong, The research and application of high temperature air combustion technology
[5] Li Chaoxiang, Guo Wei, The numerical simulation of the heat transfer of the ceramics honeycomb in regenerator, 2003, 21(3):183-186