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Analysis Flue Gas Denitration Technology for Small and medium sized coal-fired industrial boilers

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Abstract: In this paper, flue gas denitration technology in the application of small and medium sized coal-fired industrial boilers are analyzed and discussed. To 65t/h CFB(Circulating Fluidized Bed) industrial boiler, study small and medium sized coal-fired industrial boilers flue gas SNCR denitration technology solutions, and analyzes economic and environmental benefits for small and medium sized coal-fired industrial boilers flue gas SNCR denitration technology.

Foreword

The current atmosphere issues of regional is outstanding, the phenomenon that atmospheric haze of part urban is highlighted,and complex air pollution have become increasingly prominent. Coal-fired boiler is one of the major sources of pollution. As China begin to strengthen air pollution control, many coal-fired utility boilers have been installed SCR or SCR-SNCR denitration devices,but small and medium sized coal-fired industrial boilers have not yet carried out an effective control of nitrogen oxide emissions.With the promulgation of "Boiler air pollutant emission standards" (GB13271-2014), NOx concentration of small and medium sized coal-fired industrial boilers flue gas will be limited by stage.Therefore,for small and medium sized coal-fired industrial boilers, the control of NOx pollution is imperative.In this paper, discusse flue gas denitration technology for small and medium sized coal-fired industrial boilers,and analyze the economic and environmental benefits of SNCR denitration technology solutions.

Coal-fired boiler flue gas denitration technology

Coal-fired boiler flue gas denitration technology, including denitration technology during combustion and post-combustion flue gas denitration technology.Denitration technology during combustion is that low NOx combustion technology,including low-NOx combustion,air staged combustion,fuel staged combustion technology.Using denitration technology during combustion, project investment and operating costs are low,but denitration efficiency is low,difficult to meet environmental requirements.Post-combustion flue gas denitration technology,including selective non-catalytic reduction (SNCR) denitration,selective catalytic reduction (SCR) denitration and SNCR-SCR denitration technology combined.

Selective non-catalytic reduction (SNCR) denitration technology.SNCR is in the absence of catalyst, at an appropriate temperature region (850-1050˚C), the reducing agent (ammonia or urea) is injected into the furnace zone, reducing agent react with NOx of flue gas selectively, generate N_2 and H_2O of non-pollution[1-3].When SNCR denitration technology is applied to large-scale coal-fired boiler,denitration efficiency is low.But it is applied to small and medium sized coal-fired boiler, due to the small size of the furnace,reducing agent is mixed with the flue gas more evenly, can achieve a higher efficiency of denitration.

Selective Catalytic Reduction (SCR) denitration technology.SCR is in the role of a catalyst, at an appropriate temperature region(320-400˚C),reducing agent react with NOx of flue gas selectively,generate N_2 and H_2O of non-toxic, non-pollution[4-5]. The SCR reducing agents include ammonia,urea,ammonia.Using SCR denitration technology,denitration efficiency can reach 80% -90%,but project investment and operating costs are high.

SNCR-SCR denitration technology.SNCR-SCR denitration technology is combined with SNCR technology and SCR technology.That is reducing agent is injected into boiler furnace that the area is of the right temperature, reducing agent react with NOx of flue gas selectively, generate N_2 and H_2O.Then, excess NH_3 together with the flue gas enter into the SCR reactor, in the role of a catalyst,occurred selective catalytic reduction (SCR) with NOx of the flue gas,and further denitration[6].With this technology,can reduce the amount of the catalyst,project investment and operating costs are lower than SCR,while the denitration efficiency can reach 80%-90%.

Comparison of three kinds of denitration technology. Comparison of SNCR,SCR and SNCR-SCR denitration technology in Table 1.

Table 1 Flue gas denitration technology comparison

No.	Name	SNCR	SCR	SNCR-SCR
1	Reaction temperature	850-1100˚C	320-400˚C	Front：850-1100˚C Back：320-400˚C
2	Amount of catalyst	no	more	less
3	Denitration efficiency	30-75%	70-90%	70-90%
4	NH3 escape	＜10ppm	＜3ppm	＜3ppm
5	System pressure loss	no	high	low
6	Project investment	low	high	medium
7	Operating costs	low	high	medium

According to the comparison of three technology in table 1,using SNCR technology,project investment and operating costss are lowest.Therefore,SNCR should be considered a priority denitration technology for small and medium sized coal-fired industrial boilers.

Small and medium sized coal-fired industrial boilers flue gas SNCR denitration technology solutions

To 65t/h CFB(Circulating Fluidized Bed) coal-fired boiler, small and medium sized coal-fired industrial boilers flue gas SNCR system mainly consists of the ammonia mixed preparation system, ammonia delivery system,ammonia distribution system,ammonia injection system,atomizing media distribution system,PLC control system,gas-line detection system.SNCR denitration system processes shown in Figure 1.

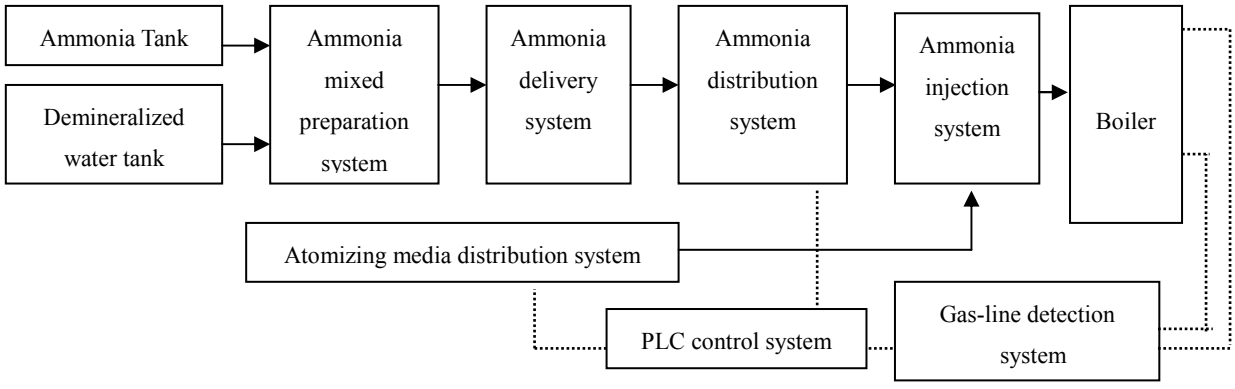

Figure 1 SNCR process flow diagram

Ammonia and demineralised water are fed to ammonia mixed preparation system by two independent pipeline systems,concentrated ammonia is formulated as dilute ammonia with a concentration of 16%.Ammonia delivery system includes pump for ammonia and ammonia pipeline.By pump for ammonia and ammonia pipeline,dilute ammonia is fed to the ammonia distribution system.Each branch pipeline for ammonia is equipped with an electric valve and a flowmeter,and through the control system to control the ammonia flow of the various branches,in order to achieve that the amount of ammonia spray for the various branches is be precise controled. At the upper part of the boiler furnace and the cyclone inlet,12 ammonia injectors are layered arrangement.Injector is made of high-temperature materials.Atomizing medium is compressed air. Compressed air can avoid nozzle clogging,can cool nozzle,and can achieve the desired atomization.At the flue outlet of coal-fired boiler,NOx and NH_3 on-line detection device are set, and ammonia injection system is interlocked with NOx and NH_3 on-line detection device.Based on the NOx and NH_3 emission concentration by online testing,the control system adjust the amount of ammonia spray automatically,can reduce system operating costs while ensuring denitration efficiency,and can avoid secondary pollution that caused by excessive spray ammonia.

Economic and environmental benefit analysis

To 65t/h CFB(Circulating Fluidized Bed) coal-fired boiler, the designed volume of flue gas is $16\times10^4 m^3/h$,the initial concentration of NOx in flue gas is 400 mg/m^3, the denitration efficiency is 60%.

Economic Benefit Analysis. The Operating costs are mainly project materials and power consumption,including ammonia, demineralized water, compressed air and electricity consumption. Operating costs are shown in Table 2.

Table2 Statistics of operating costs

No.	Name	Unit	Quantity	Cost (1×10^4￥/year)	Remark
1	Ammonia consumption	t/a	861.30	60.29	
2	Compressed air consumption	1×10^4Nm3/year	54.49	4.36	
3	Demineralised water consumption	t/a	215.33	0.078	
4	Power consumption	1×10^4kw/year	11.88	9.50	
5	Labor costs	People	4	12	
6	Equipment Maintenance	1×10^4￥/year		2.0	
7	Equipment depreciation	1×10^4￥/year		11.5	
Total	Operating costs	1×10^4￥/year		99.73	

As shown in table 2, the total operating cost of the boiler SNCR denitration system is 997,300￥/year(The evaporation of boiler is 65t /h, production date is 330 days per year).

Environmental Benefit Analysis. After the SNCR denitration project put into operation, denitration efficiency can reach 60%.Annual reduction in nitrogen oxide emissions by about 304 tons,which can effectively improve the atmospheric environment that boiler business is located in, environmental and social benefits are significant.

Conclusions

Selective non-catalytic reduction (SNCR) denitration technology is suitable for small and medium sized coal-fired industrial boiler flue gas.By SNCR denitration technology,NOx concentration of the small and medium sized coal-fired industrial boiler flue gas,can achieve"boiler air pollutant emission standards"(GB13271-2014)requirements.At the same time,small and medium sized

coal-fired industrial boiler SNCR denitration system can achieve the targets that the project investment and operating costs are economically reasonable, environmental and social benefits are significant.

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