Analysis Denitration Technology for Iron-steel Sintering Flue Gas

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Abstract: This paper analyzes and discusses the flue gas denitrification technology in the application of sintering flue gas,combining the characteristics of the steel industry sintering flue.To 400m^2 sintering machine,study on sintering flue gas ozone oxidation simultaneous desulfurization and denitrification technology plan,and analyzes environmental and economic benefits for sintering flue gas ozone oxidation simultaneous desulfurization and denitrification Technology.

1 Foreword

With the promulgation of "Steel sintering and pelletizing industry air pollutant emission standards" (GB 28662—2012),the NO_X concentration of the Steel sintering flue gas must be less than 300 mg/m^3 since January 1,2015[1]. Sintering industry as a major source of emissions of the steel industry,facing a severe situation of flue gas denitration.In this paper,in connection with the characteristics of sintering flue gas,discusse denitrification technology for sintering flue gas,study on sintering flue gas ozone oxidation simultaneous desulfurization and denitrification technology plan,and analyze the economic and environmental benefits of ozone oxidation simultaneous desulfurization and denitrification technology plan.

2 The Characteristics of Sintering Flue Gas

2.1The source of nitrogen oxides in the sintering flue gas

NO_X emissions is from flue gas of the head of sintering machine.Nitrogen in th fuel or air reacts with oxygen,the reaction product is NO_X,including the thermal type NO_X, fuel type NO_X and fast type NO_X [2].

Thermal type NO_X is that during sintering process,N_2 and O_2 in the air reacts NO_X at high temperatures.Thermal NO_X is proportional to N_2,O_2 concentration and reaction temperature.When the combustion temperature exceeds 1000 ℃ ,thermal NO_X began to increase,when the combustion temperature exceeds 1500℃,thermal NO_X increases significantly.Sintering process commonly used blast combustion,the bed temperature is between 1100-1400℃.In this condition,the reaction rate of N_2 and O_2 is slow.Large and medium sized iron and steel enterprises of domestic have basically adopted the low temperature sintering production technology,the maximum temperature of sintering flue gas is less than 1300 ℃ .Therefore,small amounts of thermal NO_X is generated during the sintering process.

Fuel NO_X is that during sintering process, nitrogen in the fuel reacts with oxygen in the air, generate NOx.

Rapid type NO_X is that during sintering process, hydrocarbons in the fuel reacts rapidly with N_2 in the air at a high temperature flame,generate NO_X.Since the generation amount is small, generally not considered.

So NO_X in the flue gas of the sintering process mainly is fuel NO_X.

2.2The characteristics of sintering flue gas

Because the sintering process is long,the kind of fuel and raw materials is more,firing conditions and temperature changes,sintering flue gas is different with the general combustion flue gases.The main features of sintering flue gas as follows [3].

Flue gas volume is large.Since the air leakage rate and solids circulation rate is high, there is a considerable part of the air does not pass the sinter layer,so sintering flue gas is greatly increased.Each producing 1t sinter, sintering flue gas generation amount is 4000-6000m^3.Currently the average size of new sintering machine production is 379 m^2,and there are further large-scale trend.Therefore flue gas volume of large-scale sintering could reach 2-3 million m^3/h.

Flue gas temperature is fluctuate.With different sintering conditions,flue gas temperature in the range of 120-180℃.

NO_X concentration of flue gas is low.NO_X concentration is generally in the range of 200-400 mg/m^3,instantaneous concentration is up to 650 mg/m^3.

Dust concentration of flue gas is high.Dust is mainly iron and its compounds.Due to the use of different materials may also contain trace amounts of heavy metal elements.Dust concentration in the flue gas is generally up to 10g/Nm^3,the average particle diameter of dust is 13-35μm.

The moisture content is large.In order to increase the permeability of the sinter bed,water was added to the mixture before sintering.Moisture content is generally about 10%.

The oxygen content is high.General oxygen content of sintering flue gas is 12% to 18%.

SO_2 concentration of flue gas is relatively low.With the sulfur content of different raw materials,SO_2 concentration of sintering flue gas of domestic enterprises generally is 1000-3000mg/m^3.

Containing harmful gases.Flue gas not only contains SO_2 and NOx,but also contains a certain amount of HCl and HF,etc.

3 Sintering flue gas denitrification technology

3.1Selective Catalytic Reduction (SCR)

Selective catalytic reduction (SCR) is that ammonia as a reducing agent to remove the NO_X of exhaust.Under the effect of a certain temperature and catalyst,NO reacts with NH_3,NO_X will be reduced to N_2,while generating water [4-5].Use of the catalyst can reduce the activation energy of the reaction,so the reaction temperature was lowered to 350-420℃.The process is a practical method capable of removing NOx in an oxidizing atmosphere.NOx removal rate of the process up to 90%.Sintering flue gas temperature is generally 120-180℃,using the above method to remove NO_X of flue gas,sintering flue gas must be heated to the reaction temperature.Power consumption is large,the economy is poor.So SCR denitration process in sintering flue gas is difficult.

3.2 Activated carbon adsorption process

Principle of activated carbon adsorption process is that sintering flue gas is sent to activated carbon adsorption tower,and ammonia is add at the entrance of the tower adsorption.SO_2 and NO_X of flue gas react with NH_3 in the adsorption tower,the resulting ammonium salt is removed by activated carbon adsorption.Activated carbon adsorption of ammonium salt is sent to desorption tower.When activated carbon is heated to about 400℃,SO_2 of high concentrations can be desorbed. Desorbed SO_2 can be used to produce high-purity sulfur or sulfuric acid.Regenerated activated carbon be cooled and removed impurities,returned to the absorber for recycling.Activated carbon adsorption process not only can remove SO_2 and NO_X of the flue gas,but also can remove HCl,HF,As,Hg and other trace substances of the flue gas.But the investment and operating costs of such a process is too high,the economy is poor,so it could not be replicated in the steel industry.

3.3 Selective non-catalytic reduction (SNCR)

Selective non-catalytic reduction (SNCR) is that reaction temperature is 900-1100℃,without the presence of catalyst,ammonia or urea selectively reduce with NO_X of the flue gas,the reaction product was N_2 and H_2O[67].In the sintering industry,there is no suitable temperature ranges for SNCR denitration.So SNCR denitration technology is unsuitable in sintering flue gas denitration.

3.4Ozone oxidation simultaneous desulfurization and denitrification technology

Ozone oxidation simultaneous desulfurization and denitrification technology is that NO is oxidized to NO_2 by ozone,NO_2 and SO_2 is absorbed along with $Ca(OH)_2$ or CaO,to achieve the goal of simultaneous desulfurization and denitrification.Using this technique,we can make full use of the existing desulfurization equipment for sintering,denitrification equipment without a separate building,saving equipment investment,reducing the cost of flue gas pollutant emission control.Denitration facilities does not need alone building,saving equipment investment,reducing the treatment costs of flue gas pollutants.Denitrification efficiency of the process can be over 60%.Therefore,combinating the characteristics that NO_X concentration of sintering flue gas is low,ozone oxidation simultaneous desulfurization and denitrification technology is reasonable.

4 Sintering flue gas ozone oxidation simultaneous desulfurization and denitrification technology program

To 400m^2 sintering machine,ozone oxidation simultaneous desulfurization and denitrification technology system mainly consists of lime slurry preparation system,absorber systems,ozone oxidation systems,the reaction product dewatering systems,process water systems,accident slurry systems,compressed air systems and automatic control system.The process is shown in Figure 1.

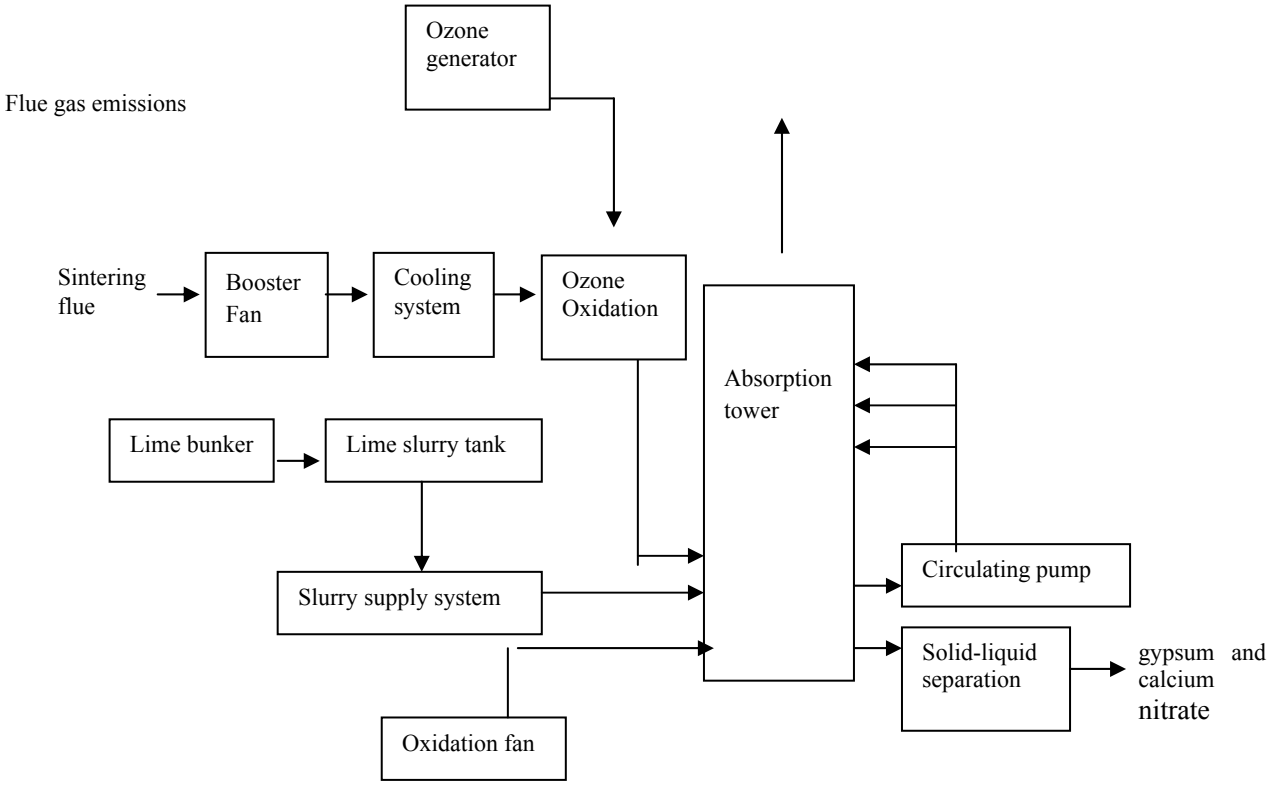

Figure 1. Ozone oxidation simultaneous desulfurization and denitrification process

Sintering flue gas is boosted by booster fans,and cooled by cooling system,then join ozone in the flue,the NO is oxidized to NO_2.Flue gas is sent to absorber tower,the flue gas is contact with the absorbent slurry in the absorber tower,SO_2 and NO_2 is absorbed.After the water droplets in the flue gas is removed by a demister,flue gas is returned to the chimney emissions.

Lime slurry is pumped to the absorption section through the circulating pump,absorb SO_2 and NO_2 of flue gas.In the bottom of absorption tower,the reaction product is oxidized to $CaSO_4$ and $Ca(NO_3)_2$ by bubbling air. $CaSO_4$ and $Ca(NO_3)_2$ slurry discharged from the crystallization zone,after the solid-liquid separation, becomes gypsum and calcium nitrate solids.

5 Analysis of the economic and environmental benefits

To 400m^2 sintering machine,flue gas volume is 110× $10^4 m^3/h$,the initial concentration of NO_X in flue gas is 400 mg/m^3,denitration efficiency is 50%.

5.1 Economic Benefit Analysis

Operating costs are mainly absorbent material and power consumption.Operating costs of various expenses are shown in Table 1.

5.2 Environmental Benefit Analysis

After the denitrification projects of production line put into operation,the denitration efficiency can exceed 50%.Denitrification system can reduce nitrogen oxide emissions by about 1584 tons/year,which can effectively improve the atmosphere that the iron and steel business is located in,environmental benefits and social benefits is significant.

Table 1. Statistics of operating costs

No.	Name	Unit	Quatity	Cost ten thousand yuan /year	Remark
1	Lime consumption	t/a	1951	59	
2	Power consumption	kw/a	926×10^4	555	
3	Labor costs	number	8	32	
4	Equipment maintenance	ten thousand yuan /a		9	
Total	Operating costs	ten thousand yuan /a		655	

As the table shows,the total operating costs of the production line denitration system is 652 million/year(Production Days of the production line is 300 day/year).

6 Conclusions

Ozone oxidation simultaneous desulfurization and denitrification technology is suitable for sintering flue gas.Using this denitration technology,NO_X concentration of the sintering flue gas can achieve "Steel sintering and pelletizing industry air pollutant emission standards" (GB 28662-2012)requirements.At the same time achieving the targets that the investment of denitrification system for sintering flue gas is reasonable, environmental benefits are obvious.

Acknowledgements

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