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EXPERIMENTAL STUDY ON INFLUENCING FACTORS OF NO_x EMISSION IN IRON ORE SINTERING PROCESS

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Through the sintering pot test, the effects of coke breeze ratio, sinter mixture moisture, sinter mixture basicity and material bed depth on NO_x emission were studied. The results show that reducing the ratio of coke breeze is beneficial to reducing NO_x emission under the condition of certain sintering time and not affecting the quality of sinter. At the same time, adopting low moisture and deep bed sintering can also achieve the purpose of reducing NOx emission. The basicity of sinter mixture has little effect on NO_x emission.

Key words: iron ore sintering, NO_x emission, coke breeze ratio, basicity, bed depth

INTRODUCTION

NO_x is the main component of air pollutants, which can not only cause direct harm to human body, but also cause acid rain, ozone hole and photochemical smog pollution. Sintering is the main process of iron and steel production, and also the main source of NO_x emissions in the iron and steel industry. The nitrogen oxide emission of sintering process accounts for more than half of the total emission of iron and steel process [1]. The emission concentration of NO_x from sintering in China is generally in the range of 200 – 310 mg/m^3, up to 700 mg/m^3 [2]. In the face of the increasingly serious NO_x emission problem, China has formulated stricter emission standards, the latest NO_x emission standard is less than 50 mg/m^3. Therefore, sintering NO_x emission reduction is imperative.

At present, NO_x control in sintering process mainly depends on terminal control, and its methods include selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR) and activated carbon method, etc. [3-6]. The cost of terminal control is high and it is difficult to reach the standard stably, so it is urgent to upgrade the technology from terminal pollution control to the whole process pollution control.

This project started with reducing the emission of NO_x in the sintering process, studied the influence of different sintering process parameters on the generation of NO_x in the sintering process, and carried out the process control of the sintering process, so as to achieve the purpose of reducing the emission of NO_x from the source of sintering flue gas.

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EXPERIMENTs

The effects of coke breeze ratio, sintering mixture moisture, the basicity of sintering mixture and the depth of sintering bed on NOx content in sintering flue gas were studied through sintering pot test. From the beginning of ignition of the sintering pot, the process parameters of the sintering pot and the emission data of the flue gas analyzer were recorded every 1 minute. And after the experiments, the data were compared and analyzed. Chemical compositions of raw material used in the experiments are given in Table 1 and the industrial analysis of coke breeze is shown in Table 2.

Table 1 **Chemical composition of raw material / wt. %**

Ore	TFe	SiO_2	Al_2O_3	CaO	MgO
SFLA	64,33	5,16	0,80	0,03	0,04
Atlas Fines	64,61	4,29	1,74	0,07	0,03
Canadian Fines	65,76	4,38	0,20	0,51	0,49
SFCJ	66,14	1,46	1,09	0,03	0,04
Yandi Fines	56,82	5,77	1,80	0,06	0,08
Limestone	0	0,96	0,17	50,99	2,50
Dolomite	0	1,16	0,14	31,55	20,42
Quicklime	0	0,84	0,16	78,35	3,02

Table 2 **Industrial analysis of coke breeze**

FC_d	A_d	V_d	$S_{t,d}$	M_{ad}
84,40	13,11	1,88	0,74	0,61

RESULTS AND DISCUSSION

In the experiments, the coke breeze ratio was increased from 3,6 % to 3,9 % to investigate the influence of different coke breeze ratio on NO_x generation of sintering flue gas. Different coke breeze ratio, sintering time and average NO_x content in sintering flue gas are

Table 3 **Average NO_x content with different coke breeze ratio**

Coke breeze ratio / %	3,6	3,7	3,8	3,9
Sintering time / min	38,5	33,9	41,7	40,2
Average NOx content , mg / m^3	180	214	190	190

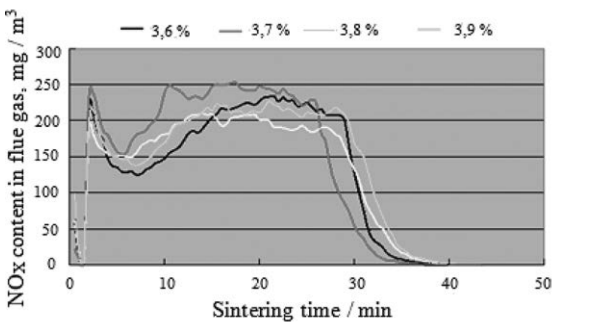

Figure 1 Effect of coke breeze ratio on NO_x content in flue gas

shown in Table 3. Under the condition of different coke breeze ratio, the variation trend of NO_x content in flue gas with sintering time is shown in Figure 1.

It can be seen from Table 3 and figure 1 that when the coke breeze ratio is 3,7 %, the NO_x content in sintering flue gas is the highest, which is 214 mg/ m^3. When the coke breeze ratio is 3,8 % and 3,9 %, the NO_x content in the flue gas is the same, both 190 mg/ m^3. When the ratio of coke breeze is 3,6 %, the NO_x content is the lowest, 180 mg/ m^3. It can be concluded that there is no strong correlation between NO_x content in flue gas and coke breeze ratio, which may be related to the permeability of sintering bed and sintering time at that time. When the permeability of sintering bed is good, the sintering speed is fast, and the combustion of coke breeze and oxygen is sufficient, the flue gas emission speed is fast, which is easy to cause the increase of NO_x content in flue gas. It can also be seen from table 3 that when the coke breeze ratio is 3,7 %, the sintering speed is the fastest, the sintering time is 33,9 min, and the NO_x content in the flue gas is the highest. When the ratio of coke powder is 3,6 %, the sintering time is 38,5 min. Although the sintering time is shorter than that of 3,8 % and 3,9 %, the content of NO_x in flue gas is slightly lower than that of 3,8 % and 3,9 % because of its low ratio and low N content in fuel.

The content of NO_x in sintering flue gas is affected by the ratio of coke breeze and sintering time. Under the same sintering time, the higher the ratio of coke breeze, the higher the content of NO_x in sintering flue gas. Under the same coke breeze ratio, the shorter the sintering time, the higher the NO_x content in the sintering flue gas.

The average NO_x content in sintering flue gas with different sintering mixture moisture is shown in Table 4. As can be seen from Table 4, when water content is 6,7 %, NO_x content is relatively low, which is 157 mg/ m^3. When the water content is 6,8 % and 6,9 %, the NO_x content is similar, 188 mg/ m^3 and 181 mg/ m^3, respectively. When the water content is 7,1 %, the NO_x content was the highest, which is 212 mg/ m^3. It can also be seen

Table 4 **Average NO_x content with different water content**

Water content of mixture / %	6,7	6,8	6,9	7,1
Average NOx content , mg / m^3	157	188	181	212
Sintering time / min	41,3	41,7	38,5	40,2

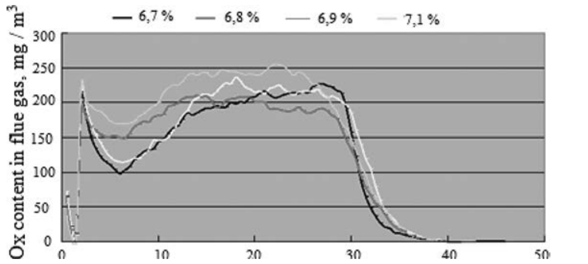

Figure 2 Effect of water content on NO_x content in flue gas

from Figure 2 that with the increase of water content of sinter mixture, NO_x content in the sintering flue gas tends to increase.

The sinter basicity was adjusted by adjusting the ratio of quicklime, and the influence of different basicity on NO_x content of sintering flue gas was studied. NO_x content in sintering flue gas with different ratio of quicklime is shown in Table 5, and the variation trend of NO_x content in flue gas with sintering time is shown in Figure 3.

Table 5 **Average NO_x content with different quicklime ratio**

Quicklime ratio / %	1,8	2,4	3,0	3,6
Average NOx content, mg / m^3	188	200	180	178

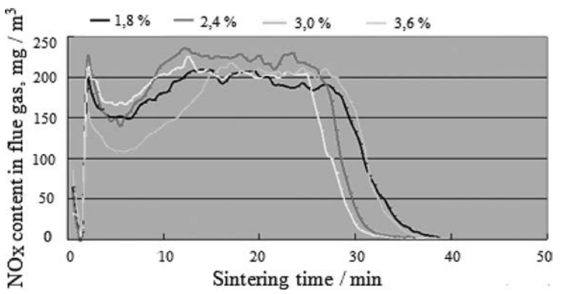

Figure 3 Effect of quicklime ratio on NO_x content in flue gas

As can be seen from Table 5, when the quicklime ratio is 2,4 %, the NO_x content in sintering flue gas is the highest, up to 200 mg/ m^3. When the quicklime ratio is 1,8 %, the NO_x content is slightly lower than that of quicklime ratio of 2,4 %, about 188 mg/ m^3. When the ratio of quicklime is increased to 3,0 % and 3,6 %, NO_x content decreases to 180 mg/ m^3 and 178 mg/ m^3, respectively, which are equivalent. It can also be seen from Figure 3 that increasing basicity within a certain range has a certain effect on reducing NO_x content in sintering flue gas, but the effect is not very obvious.

The effects of different sintering bed depth on NO_x content in sintering flue gas were investigated. The depth of the test sintering bed was set as 700 mm and 550 mm respectively, and the NO_x emission in the flue

Table 6 **Average NO_x content with different sintering bed depth**

Bed depth / mm	700	550
Average NOx content , mg / m^3	188	202

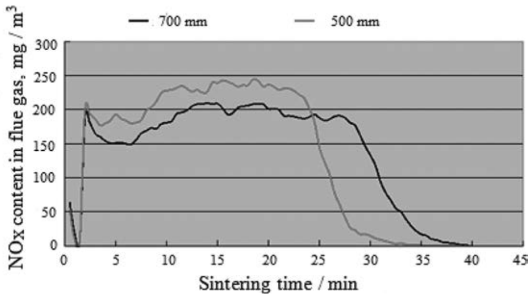

Figure 4 Effect of sintering bed depth on NO_x content in flue gas

gas was observed. The experimental results are shown in Table 6 and Figure 4.

It can be seen from Table 6 that when the depth of sintering bed is 700 mm, the NO_x content in the flue gas is 188 mg/ m^3, and when the depth of sintering bed is 550 mm, the NO_x content is 202 mg/ m^3. The lower the depth of sintering bed is, the higher the NO_x content in flue gas is. This is because the depth of sintering bed is low, the sintering speed is fast, the sintering time is short, and the NO_x release rate in the flue gas is fast. It can be seen from Figure 4 that in the early stage of sintering, when the depth of sintering bed is 550 mm, the NO_x content in the flue gas is significantly higher than that of 700 mm, while in the later stage of sintering, when the depth of sintering bed is 550 mm, the NO_x content in the flue gas decreases rapidly. Therefore, increasing the depth of sintering bed can reduce the content of NO_x in sintering flue gas to a certain extent.

CONCLUSIONS

The purpose of this study is to obtain the process parameters for reducing NO_x emissions through the sintering pot test, so as to achieve the purpose of reducing NO_x emissions from the source.

In the actual production process, when the sintering time is fixed, in order to reduce NO_x emission in the sintering process, the “automatic heat accumulation” principle of deep bed sintering should be used to reduce the ratio of coke breeze, so as to reduce NO_x emission. Low moisture sintering shall be carried out without affecting the quality of sinter. The basicity of sinter has little effect on NO_x emission.

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Note: The responsible translator for English language is S. P. Wang, Shijiazhuang, China