Effect of SO_3^{2-} on wet flue gas desulfurization technology

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Abstract. From the point of view of sustainable development, wastewater zero discharge is undoubtedly one of the best measures. Saline wastewater reuse domestic power plant desulfurization system research is very few. This paper analyzes the effects of high concentration of SO_3^{2-} on wet flue gas desulfurization technology, discussing the possible negative impact on the wet flue gas desulfurization technology caused by SO_3^{2-}, as well as the mechanism of negative effect producing by high concentration of SO_3^{2-}. This study provides the reference for engineer practice when predicting the effect of the concentration of SO_3^{2-} on the wet flue gas desulfurization system.

Introduction

After SO_2 is absorbed by the FGD system, incomplete oxidation will cause the increase of the concentration of SO_3^{2-} in desulfurization wastewater. When high concentration salty wastewater back to used for desulfurization system, which containing SO_3^{2-} will affect the desulfurization performance of the system. For example, the limestone dissolution, the rate of SO_2 absorption, the desulfurization efficiency and absorption tower corrosion and scaling.

Mechanism of Action

The influence of SO_3^{2-} on the desulfurization efficiency.

Study found that the limestone dissolution process is influenced by the mass transfer and limestone particle surface reaction when SO_3^{2-} existing, limestone particle surface reaction is the controlling steps of limestone dissolution rate[1].

$$SO^2(aq) + H_2O \rightarrow H^+ + HSO^{3-} \qquad （1）$$

$$HSO^{3-} \rightarrow H^+ + SO3^{2-} \qquad （2）$$
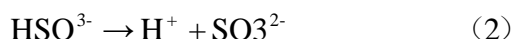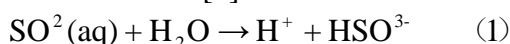
To make the absorption of SO_2 (reaction (1))proceed, it must neutralize the H+ ion of ionization, namely lowing alkalinity of absorption liquid. And SO_3^{2-} can react precisely with H+(reaction (2)), namely the existence of SO_3^{2-} can improve circulation of serum alkalinity. So, the increase of concentration of SO_3^{2-} can reduce the liquid phase mass transfer resistance, accelerating the absorption of SO_2.When the concentration of SO_3^{2-} excessive a certain value, which decrease the gas phase diffusion of SO_2, affecting the desulfurization efficiency.

SO_3^{2-} will inhibits the solution of $CaCO_3$[2] Happens when high relative saturation sulfite sulphite serious inhibition. Phenomenon of sulfite serious inhibition is the running pH falling, which running pH is out of control. The utilization rate of limestone cannot maintain the use ratio we want even in the setting pH value, and the limestone concentration in the slurry will increase.
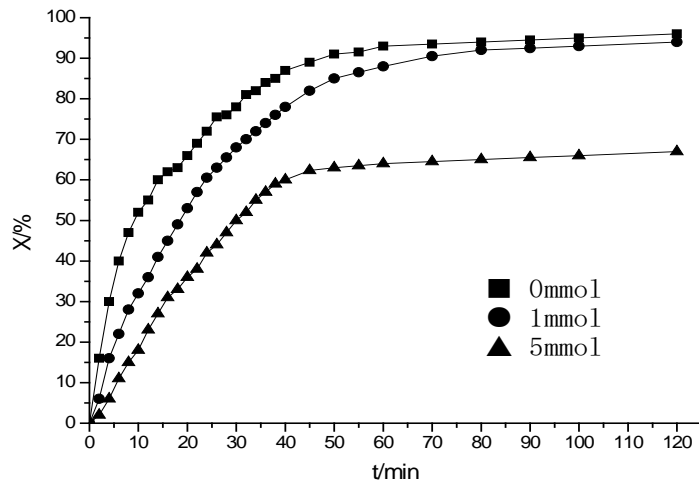
Figure 1 The impact of the concentration of SO_3^{2-} on activity of limestone dissolution
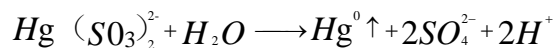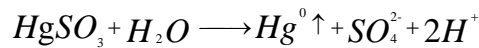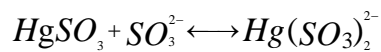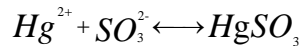
When the concentration of SO_3^{2-} reaching a certain value, the dissolution of the limestone on the surface inhibits the dissolution of $CaCO_3$ leading to a decline in the limestone solubility. In addition, SO_3^{2-} dissolved through congress will effect the gas diffusion desulfurization rate of SO_2. With the experimental results shows that, when the concentration of SO_3^{2-} arrives at 1mmol·L^{-1}, the dissolution rate of $CaCO_3$ has apparent effect, more than 2 1mmol·L^{-1}, dissolution rate fell sharply, as shown in table 1[3].So we must determine the appropriate operating parameters, strengthening oxidation, preventing the influence due to the excessive concentration of SO_3^{2-} limestone activity.

Table 1 Concentration of serum soluble sulfite (I - SO_3) and unreacted CaCO3 (T - CO_3)

Value of pH	I-SO_3(mmol·L^{-1})	I-CO_3(mmol·L^{-1})
5.37	0.49	78.4
5.32	1.05	103
5.30	6.5	406
5.05	7.7	384
5.33	22.1	486

The influence of SO_3^{2-} on the absorption tower corrosion and scaling

Hg^{2+} in serum will easily react with SO_3^{2-} releasing Hg^0 in the following reaction:

$$Hg^{2+} + SO_3^{2-} \longleftrightarrow HgSO_3$$
$$HgSO_3 + SO_3^{2-} \longleftrightarrow Hg(SO_3)_2^{2-}$$
$$HgSO_3 + H_2O \longrightarrow Hg^0\uparrow + SO_4^{2-} + 2H^+$$
$$Hg(SO_3)_2^{2-} + H_2O \longrightarrow Hg^0\uparrow + 2SO_4^{2-} + 2H^+$$

With the increase of concentration of SO_3^{2-},the speed of releasing Hg0 will increase. Hg0 increased in serum can cause erosion and friction on metal surface[4].
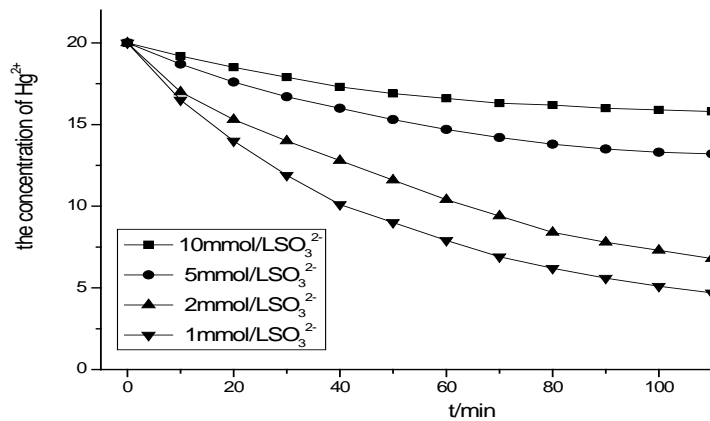
Figure 2 The impact of the concentration of SO_3^{2-} on the releasing of Hg^0

The concentration of SO_3^{2-} is obvious in the inhibitory effect on the dissolution of , when the addition amount exceeding 2.5 mmol/L, the inhibition of limestone become apparent[2].The amount of limestone in the slurry increasing will make the abrasion of slurry circulation system serious.

The test results show that the reaction rate increases with the increase of initial concentration of SO_3^{2-}.Sulfites accelerating oxidation, and calcium sulfate crystal level may be larger than the critical saturation value, so scale degree is more serious[5].
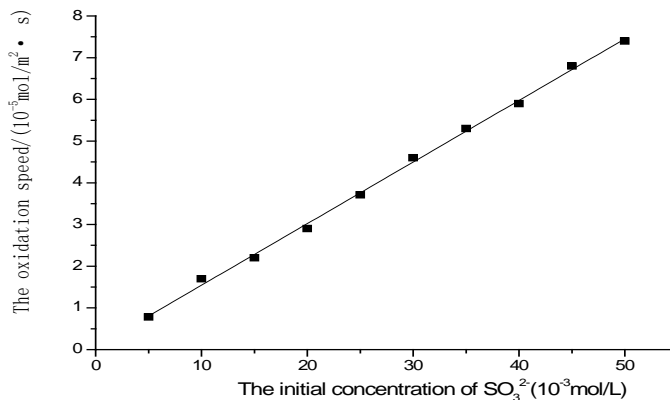

Figure 3 The influence of initial concentration of SO_3^{2-} on oxidation rate
（PH=5.5,T=318k,Q=$4.0\times10^7m^3$/s）

Conclusion

By analyzing ionic strength, ion balance between mobile and liquid phase mass transfer function , the increase of concentration of SO_3^{2-} will lead to equipment corrosion (chemical erosion and mechanical erosion), easy to promote the formation of fouling. In addition, it also seriously inhibits the solution of CaCO3 when the concentration of SO_3^{2-} exceeds a certain value. When high concentration salty wastewater use back to desulfurization system, SO_3^{2-} shall be reduced.

References

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