Dry absorption of SO_2 with hydrated lime in spout-bed circulating dry scrubber system

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Different technologies have been developed for acid gas removal in emission from waste incineration, coal combustion and ore sinter process. The post-combustion acid gas removal technologies have been widely incorporated in the operation of large coal power plants in order to achieve the regulations of SO_2 and NOx mainly. These technologies are based on the use of sorbents, usually calcitic sorbents, such as $CaCO_3$, CaO in the desulfurization processes at high and medium temperatures, and hydrated lime in low temperature processes[1-2].

The methods of dry scrubbing and dry additive injection into furnace were emerged in the last decade including isolated moistening of absorbents (being a mixture of reaction products and fresh reactant), in such a way that it keeps the propertied of dry powder (having not more than 12 mass % of water). This method mitigates sticking of solids to apparatus walls and corrosion is minimized and the board use of carbon steel in apparatus manufacturing made possible. In the semi dry technologies that are mainly the subject of this paper, binding of acid gases goes mostly in water solution according to the reactions[3]:

$$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 \cdot 1/2H_2O + 1/2H_2O$$

$$Ca(OH)_2 + SO_3 \rightarrow CaSO_4 \cdot 1/2H_2O + 1/2H_2O$$

$$Ca(OH)_2 + SO_2 + H2O + 1/2O2 \rightarrow CaSO_4 \cdot 2H_2O$$

$$CaSO_3 \cdot 1/2H_2O + 1/2O_2 \rightarrow CaSO_4 \cdot 1/2H_2O$$

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

$$Ca(OH)_2 + 2HF \rightarrow CaF_2 + 2H_2O$$

Actually have appeared some type of so called dry calcium desulfurization methods in which absorption takes place on the moistened surface of sorbent. Their common advantage is simple construction of reactor in which the main process of SO2 bonding takes place as well as taking off desulfurization product in form of powder separated from clean gas in the conventional filtering equipment.

The spout-bed dry scrubber system was developed as a dry technology that would work for a wide range of plants which was able to treat all the important flue gas pollutants like SOx, HCl and HF as well as fine particulates. This system has the high chemical and physical heat and mass transfer rates of a circulating spout-bed system and used for the elimination of the pollutants. A diagram of the demo-scale spout-bed dry scrubber system which tested at the sinter process of steel making factory is presented in Figure 1. This sinter flue gas is taken from the duct of downstream of the sinter plant. The sinter flue gas flows into the spout-bed reactor via a gas distributing bottom. In the spout-bed reactor the flue gas gets in turbulent contact with absorbent so that pollutants like SO_2, SO_3 and HCl are removed in a high extent. Due to high velocities are discharged at the head of the reactor and separated in the directly adjoining bag filter.

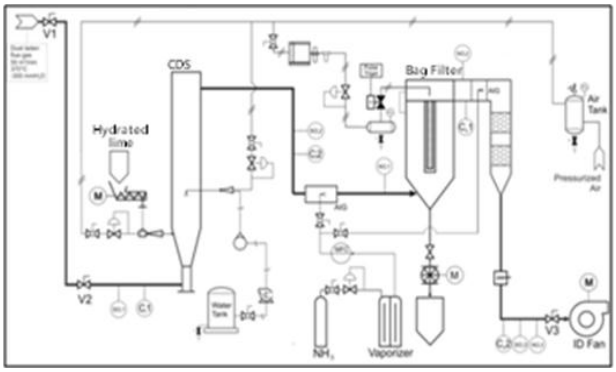

Figure 1. Flow diagram of the demo-scale spout-bed circulating dry scrubber system.

The aim of the present research is to remove of SO_2 in flowing sinter flue gas using the demo-scale spout-bed circulating dry scrubber. The effect of different properties of hydrated lime as absorbents was investigated with operating variables such as Ca/S molar ratio, mean particle size and surface area of hydrated lime and superficial gas velocity. The physical properties of 3-type of hydrated lime is given the Table 1.

Table 1 physical properties of 3-type of adsorbents

Sample	*C-1*	*C-2*	*C-3*
Surface area, m^2/g	40.4	37.4	46.5
Pore volume, cm^3/g	0.207	0.184	0.227
Mea particle size, μm	6.8	7.2	6.3

The volumetric flow rates of the demo-scale reactor vary from 2,000 to 3,000 Nm^3/hr. Their SO_2 control efficiency was in the range of 85% to 96%.

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