Exploring the Dynamics of Natural Sodium Bicarbonate, Sodium Carbonate, and Black Ash in Spray Dry SO_2 Capture.

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Abstract

The viability of spray dry desulphurisation relative to wet flue gas desulphurisation (FGD) systems is determined by selecting a highly reactive scrubbing reagent. This research evaluated sodium-based reagents from natural and waste by-product sources for treating sulphur dioxide (SO_2). Sodium carbonate (Na_2CO_3) and sodium bicarbonate ($NaHCO_3$) were obtained from mineral sources, whereas the black ash-BA ($Na_2CO_3.NaHCO_3$) was sourced from the pulp and paper industry. The sorbents introduced in slurry form were subject to SO_2 absorption conditions in a lab-scale spray dryer, including inlet gas phase temperature of 120 to 180 °C, flue gas flow rate of 21 to 34 m^3/h, and sodium to sulphur stoichiometric ratio-SR (Na:S) of 0.5 to 2. The performance comparison was assessed based on %SO_2 removal efficiency ($\%\eta_{DeSO_x}$) and revealed that $NaHCO_3$ exhibited the highest overall effectiveness of 62% at saturation. BA was the second best-performing reagent, achieving a removal efficiency of 56%, and Na_2CO_3 demonstrated the lowest efficiency of 53%. The maximum SO_2 reduction of $NaHCO_3$ at individual operating conditions was seen at an SR of 1.75 (69%), a reaction temperature of 120 °C (73%), and a gas inlet flow rate of 34 m^3/h (80%). In summary, the sodium reagents produced notable SO_2 neutralisation of over 50% in their unprocessed state, which is within permissible bounds in small- to medium-sized coal-fired power plants considering retrofitting pollution mitigation systems.

Keywords: Black Ash, Desulphurisation, Emission control, Sodium Carbonate, Sodium Bicarbonate, Spray-dry.

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