SOx Emission Control in SNRB™ Demonstration

Desulfurization with Dry Sodium Bicarbonate at Babcock & Wilcox SOx-NOx-Rox Box Demonstration Project

The SOx-NOx-Rox Box (SNRB™) is an advanced air pollution control process patented by Babcock & Wilcox that significantly reduces the emissions of the oxides of sulfur (SOx) and nitrogen (NOx), as well as particulate matter (designated as Rox) from coal-fired boilers.

The process employs a high-temperature, pulse-jet baghouse (Box) and combines SOx removal through injection of an alkali sorbent, NOx reduction through ammonia injection and selective catalytic reduction (SCR) and particulate collection in a single unit.

This integrated control technology offers many benefits; however, in this case study, we will focus primarily on the SOx control parameters as impacted by sodium bicarbonate dry injection. This form of flue gas desulfurization has wide industrial application beyond the coal-fired utility boiler demonstration. Although this demonstration was limited in scale for a utility, it is equivalent in size and scope to many industrial applications.

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Use of sodium bicarbonate produced a dense fly ash with a pH of 10. Toxicity Characteristic Leaching Procedure analysis indicated the leach potential of the solids was well below the Resource Conservation and Recovery Act drinking water standard. As a result, the fly ash was disposed of at an off-site solid waste landfill.

Sodium Bicarbonate Performance

Two key operating parameters which differentiated the sodium bicarbonate sorbent from other sorbents in the demonstration were stoichiometry and temperature.

Effect of Stoichiometry on SO_2 Removal Efficiency: Testing demonstrated that sodium bicarbonate injected at stoichiometric range of 0.5 to 2.0 resulted in average SO_2 removal efficiencies from 52.5 to 98.4 percent during continuous monitoring at 460°F. (Refer to Table 1)

Table 1. **Effect of Na_2/S stoichiometry:** ***460°F operating temperature — No ammonia injection***

Na_2/S	SO_2 Removal (%)
0.5	52.5
1.0	83.7
2.0	98.4

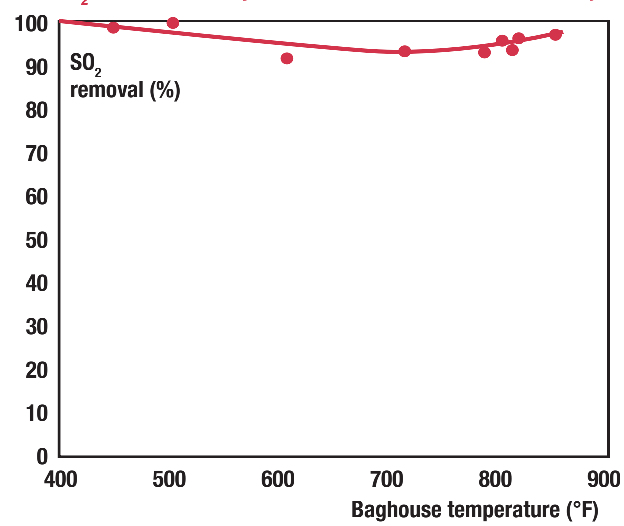
Effect of Temperature on SO_2 Removal Efficiency: Test results indicated that SO_2 removal was consistent over a range of operating temperatures. At a stoichiometric ratio of 1, with an operating temperature range of 425°F to 620°F, sodium bicarbonate injection yielded an average SO_2 removal efficiency of 74.8 percent. (Refer to Table 2) This resulted in high sorbent utilization efficiency of approximately 75 percent. In addition, sodium bicarbonate injected at a stoichiometric ratio of 2 over a range of 450°F to 850°F yielded SO_2 removals of 92 to 98 percent, reducing SO_2 emissions to less than 0.5 lb/10^6 Btu. (Refer to graph at right)

Based on these results, it is clear that the effects of temperature as a variable have minimal impact on sodium bicarbonate performance within the range tested. This, in turn, provides consistent emissions control and operating flexibility in the boiler and in the air pollution control equipment.

Table 2. **Effect of operating temperature:** ***Na_2/S stoichiometry of 1 — No ammonia injection***

Temperature (°F)	SO_2 Removal (%)
425	74.2
460	83.7
480	67.6
620	73.7

Graph 1: **Effect of operating temperature at high stoichiometry:** ***Na_2/S stoichiometry of 1.91 to 2.01 — No ammonia injection:***



Effect of Sodium Sorbent on NOx Reduction: Sodium bicarbonate injection alone provided a moderate level of NOx reduction – up to 32% at Na_2/S of 2.0 without ammonia injection. For most of the sodium bicarbonate tests, the baghouse was operated below the optimum temperature range of 750°F to 850°F for the existing zeolite catalyst. A promoted selective catalytic reduction (SCR) catalyst would be used for high efficiency NOx reduction at 425°F to 620°F.

Effect of Sodium Sorbent on Particulate Collection: With sodium bicarbonate injection, particulate emissions averaged 0.02 lb/10^6 Btu, which is below the New Source Performance Standard limit of 0.03 lb/10^6 Btu.

Conclusions

Results from the 5-MWe test facility demonstrated that high SO_2 removal was achieved with high utilization efficiencies of sodium bicarbonate. SO_2 emissions were reduced to well below the 1990 Clean Air Act Amendments Phase II emission limit of 1.2 lb/10^6 Btu. Removal efficiencies surpassed the initial project goal of 70 percent and exceeded 90 percent using sodium bicarbonate.

Additionally, these high removal efficiencies were obtained over a broad range of operating temperatures. This technology is attractive for a variety of retrofit installations and hybrid applications with minimal impact on existing boiler and heat recovery equipment. Moreover, the use of sodium bicarbonate injection provides maximum operating control flexibility.

The lower operating temperature attainable by using sodium bicarbonate in conjunction with SNRB™ also may permit use of a lower cost fabric for the filter materials, resulting in up to a 50 percent savings on construction materials. This approach also tends to favor improved removal of metals, dioxins and volatile organic compound (VOC) emissions, although no test data was generated to support this hypothesis.

Other key benefits include convenient dry material handling; excellent flow and storage characteristics; slightly enhanced NOx reduction; and beneficial neutralizing effects on fly ash.

Other industries where this technology may be applicable include waste-to-energy (refuse derived fuel and municipal solid waste) plants. In these applications, it is anticipated that use of sodium bicarbonate sorbent also would result in high HCl removal.

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