BICARB BULLETIN

Desulfurization of Power Station Flue Gases with Sodium Bicarbonate

SO_2 Removal with Dry Sodium Bicarbonate Injection at the SOLVAY Factory Oil-Fired Power Station in Heilbronn, West Germany

The effectiveness of sodium bicarbonate for removing SO_2 and HCl from the flue gases given off by a refuse incineration plant was proved during tests carried out at I.H.K. at Edegem (Antwerp). The effectiveness of sodium bicarbonate for removing SO_2 only from the flue gases of a coal-fired power station was proved by tests carried out at the OMNICAL plant in Ewersbach (West Germany). Prior to these tests, no data were available on the behavior of bicarbonate in the purification of oil-fired power station stack gases, which contain SO_2 in very steady concentrations.

Tests were carried out at the SOLVAY factory power station in Heilbronn from September 6 to October 27, 1988. They were monitored by the SOLVAY Research Centre in Dombasle (France), which also supplied the system for pulverizing and injecting the sodium bicarbonate into the gases to be purified and measured the level of pollutants in the gases.

The effectiveness of sodium bicarbonate for purifying gases containing SO_2 was then studied.

Description of the Installation

The installation consists of a radiant type boiler with the following characteristics:

- Thermal power = 34 MW
- Total steam production = 30 t/h
- Service pressure = 52 bar
- Fuel consumption = 2.4 t oil/hour (1% sulfur)

The bicarbonate is first pulverized in the Dombasle Research Centre's mobile unit (Alpine 315 UPZ pulverizer). It is then distributed in the chimney flue using a suitable dispersion device (see diagram no. 2). The residence time of the bicarbonate in this ducting is of the order of 5 seconds. A cyclone with a cut-off level of 40 µm collects part of the particles contained in the gas before it reaches the final bag filter which collects waste products. The maximum residence time in the installation between the bicarbonate injection point and dedusting at the bag filter is 24 seconds (this estimate does not take account of the probable short circuiting of certain portions of gas).

For any given batch of fuel oil, the level of SO_2 in the flue gases is very constant. For this reason it was simple to regulate very accurately the amounts of sodium bicarbonate required. In order to study the influence of the stoichiometric ratio on the effectiveness of the purification, the feed rate of the bicarbonate was varied between 100 and 250 kg/h.

The SO_2 content was measured by bubbling part of the flue gases through H_2O_2 solutions. The analyses were carried out on a DIONEX QIC anion chromatograph.

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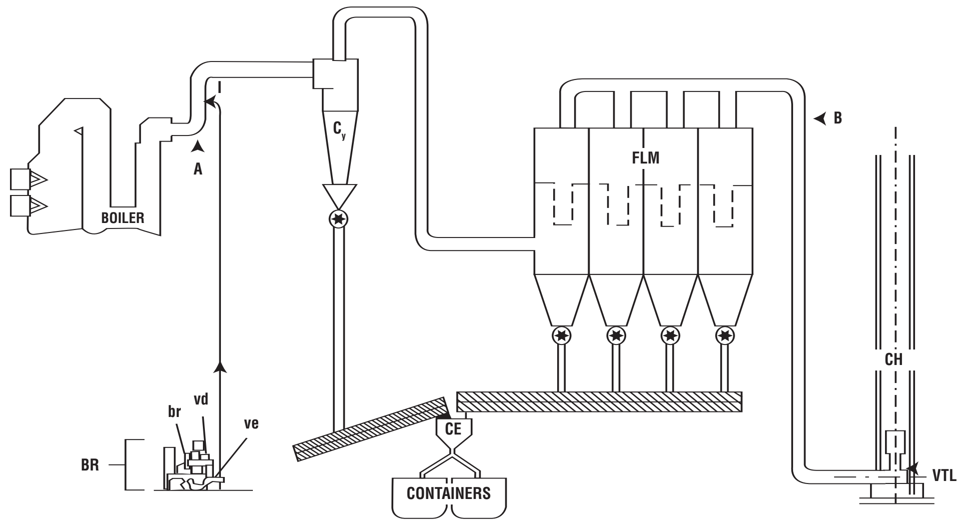
Diagram no. 1

Diagram of the Installation

Key

FLM: bag filter
C_y: cyclone
CH: chimney
I: injection of bicarbonate
CE: ashes
A, B: gas sampling points
BR: pulverization unit
br: pulverizer
vd: feed screw
ve: fan
VTL: fan



Stoichiometric Ratio

For removal of SO_2, the following global reaction applies:

$2\ NaHCO_3 + SO_2 + 1/2\ O_2 \rightarrow Na_2SO_4 + H_2O + 2\ CO_2$

In other words,

2 x 84/64 = 2.625 kg of $NaHCO_3$ are required in order to remove 1 kg of SO_2.

Testing

The following average values were measured at the bicarbonate injection point:

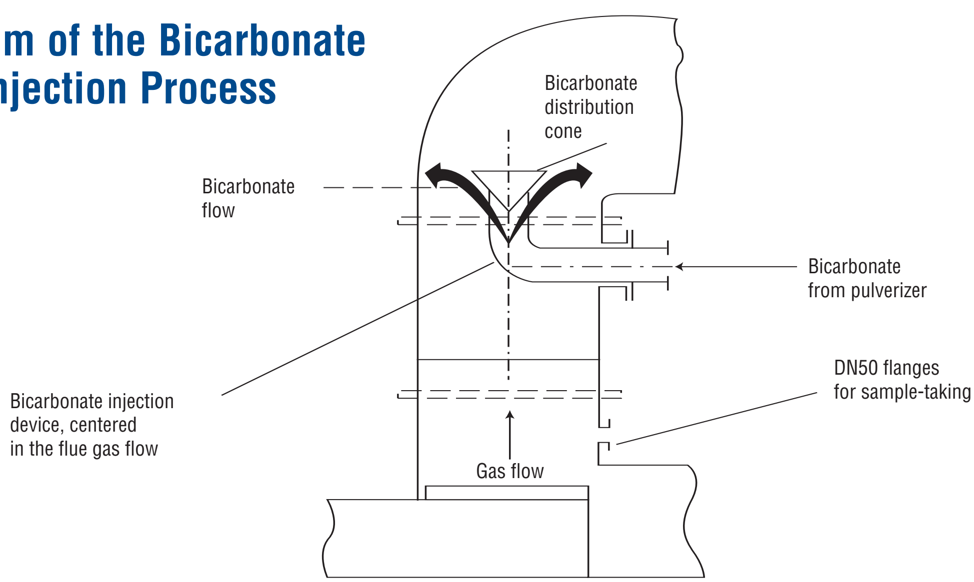
- Flue gas temperature: 200°C
- SO_2 content: 1600 mg/Nm^3 ± 4%

A range of stoichiometric ratios between 0.62 and 1.6 was covered.

The pulverized bicarbonate had an average diameter of the order of 10 µm.

Diagram no. 2

Diagram of the Bicarbonate Injection Process



Test Results

A stoichiometric ratio of 1 corresponds to 2 moles of $NaHCO_3$ for 1 mole of SO_2.

Table 1. Effectiveness of removal of SO_2

		Stoichiometric Ratio	
Pollutant	% Removal	Average	Maximum
SO_2	90	1.05	1.2
	95	1.15	1.35

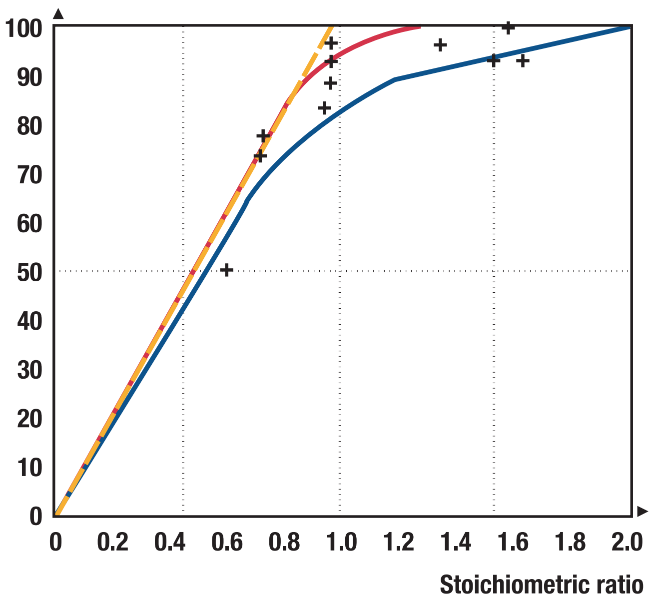
Table 2. SO_2 content of the purified gases

Pollutant	Content mg/Nm³ dry gas at 3% O_2	Stoichiometric Ratio	
		Average	Maximum
SO_2	100	1.15	1.25
	50	1.30	1.45

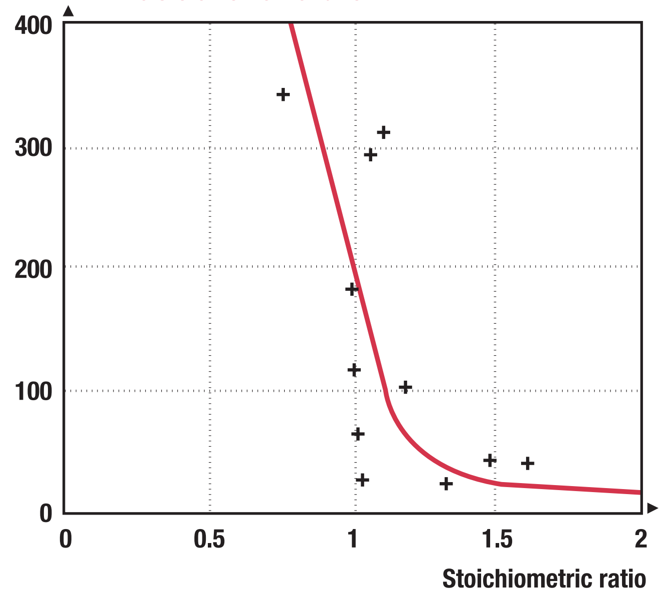
These results demonstrate the excellent effectiveness of sodium bicarbonate for desulfurizing flue gases. The low degree of variation in the SO_2 content enabled almost the maximum possible effectiveness to be obtained.

In calculating the maximum values given in the table, a 10% uncertainty margin was added to the average values, corresponding to the degree of error inherent in the measurement.

Graph 1: % SO_2 removed in relation to stoichiometric ratio



Graph 2: SO_2 content of purified flue gases as a function of the stoichiometric ratio



The SO_2 content is reported at a 3% oxygen dilution rate as required by the German standard.

Conclusion

These results confirm the very high level of effectiveness of sodium bicarbonate for desulfurizing flue gases in an oil-fired power station.

90% of the SO_2 present in the gases was removed with a stoichiometric ratio of between 1.05 and 1.2.

The low degree of variation in pollutant levels permitted optimal regulation of the amount of sodium bicarbonate required.