Sodium Bicarbonate for Flue Gas Treatment
Continuum Industrial Solutions

Filtration & Flue Gas Cleaning

Milling

Analytics & Controll
Industrial Emission Directive
2000/76/EC

For Boilers (Power Generation):
- No regulation about HCl
- SO2 at stack: from 200 to 400 mg/Nm³ dry 6% O₂ (70 to 140 ppm)
- minimum SO2 mitigation rate from 80 to 97%

For Waste Incineration:
- HCl emission limit 10 mg/Nm³ dry 11% O₂ ~ 0.010 lb/MMBTU
- SO2 → 50 mg/Nm³ dry 11% O₂ (17 ppm) / HF → 1 mg/Nm³ dry 11% O₂ (1.1 ppm)
- Depending on the facility → results in 99.0% to 99.8% HCl mitigation
Benefits of Sodium Bicarbonate

Sodium Bicarbonate neutralises acid gases much more efficiently than other commonly used dry injection reagents, e.g. lime (Ca(OH)\(_2\)).

When Sodium Bicarbonate is dry injected into hot flue gases there is rapid thermal decomposition, creating a high surface area Sodium Carbonate. The surface area can increase by up to eleven-fold, depending on process conditions.

This fresh, high surface area Sodium Carbonate reacts quickly and efficiently with the acidic components of the gas.
Neutralisation Reaction Efficiency

Focusing on the two main acid gas components, the reactions with Sodium Bicarbonate are:

\[ \text{NaHCO}_3 + \text{HCl} \rightarrow \text{NaCl} + \text{CO}_2 + \text{H}_2\text{O} \]

\[ 2\text{NaHCO}_3 + \text{SO}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{CO}_2 + \text{H}_2\text{O} \]

\[ \text{NaHCO}_3 + \text{HF} \rightarrow \text{NaF} + \text{CO}_2 \]
Reaction Mass Balance

With 100% efficiency the following would occur (calculated from the stoichiometry of the above neutralisation reactions):

2.3 kg NaHCO₃ neutralises 1kg HCl

2.6 kg NaHCO₃ neutralises 1kg SO₂

Reductions of up to 99% in HCl emissions and over 95% in SO₂ emissions can be obtained. At such high removal efficiencies typical stoichiometric ratio of 1.25 is achieved.

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Acid gas</th>
<th>Residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Bicarbonate</td>
<td>HCl</td>
<td>0.7 tonnes</td>
</tr>
<tr>
<td></td>
<td>SO₂</td>
<td>0.8 tonnes</td>
</tr>
<tr>
<td>Lime</td>
<td>HCl</td>
<td>1.5 tonnes</td>
</tr>
<tr>
<td></td>
<td>SO₂</td>
<td>1.8 tonnes</td>
</tr>
</tbody>
</table>

The above calculations assume a 100% reaction.
Usage and Disposal Example
100,000 Nm$^3$/h

Less residues for same level of neutralisation
Sodium vs. Lime

More sorbent for same level of neutralisation
The **Continuum** Process Solution

- **Stack**
  - Mill + Fan
  - Sodium Bicarbonate Silo
  - adsorbent
  - Residual Sodium Chemicals Bag Filter
  - Sodium Bicarbonate Silo
  - Reactor
  - Bag Filter
  - SCR DeNO\(_x\)
  - Heat Recovery (recommended)
  - Stack

**Towards Zero Waste**

- Fly ash
- Residual Sodium Chemicals

Energy Recovery
- Electricity
- Steam

**respect of 2010/75/EU**
Installation Example

Power: 184 MW<sub>t</sub>

- Stack
- SCR DeNO<sub>x</sub>
- Contact reactor
- Sodium Bicarbonate Injection
  T~300° F
- BHF
- ESP
Continuum Classifier Mill
milling below $D_{90} = 30 \, \mu m$

- Milling **and**
  Classification in one step
- Milling of powders down to $D_{90} < 10 \, \mu m$
- High Productivity
Flow Optimized Injector CIM

- No movable parts
- High homogenity
- Minimal pressure loss
- Abrasion resistant

Low Operational Costs