Sodium Bicarbonate for Flue Gas Treatment
Tata Chemicals Europe is part of Tata Chemicals Limited, which is the world’s second largest soda ash producer and the only one operating on four continents.

Tata Chemicals produces 5.5 million tonnes of Soda Ash and 200,000 tonnes of Sodium Bicarbonate every year.

Our products are essential in the manufacture of a wide range of staple and specialist goods, with customers worldwide as diverse as glass makers, bath additive producers, sugar extractors and suppliers of haemodialysis treatments.

All our products are supplied from all our operations under the internationally recognised quality standard ISO 9001:2000.

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**Sodium Bicarbonate**

Sodium Bicarbonate is a versatile product used in the manufacture of a wide variety of goods in everyday use.

We are the second largest producer of Sodium Bicarbonate in Europe with two manufacturing facilities in the UK, one of which is dedicated to Briskarb®.

We produce 50 variants of graded product which service a diverse range of applications including environmental, pharmaceutical, medical, personal care products, food and animal nutrition.

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**Flue Gas Treatment (FGT)**

We are leading experts in all aspects of Sodium Bicarbonate technology and applications. One of the many areas we service is the fast-growing FGT sector.

Briskarb® is tailor-made by Tata Chemicals Europe for use in this sector. We understand that every facility is unique and has specific emission challenges. We are equipped and willing to work with our customers to maximise the effectiveness of Briskarb® in their emission control process.
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**Briskarb**® – Tata Chemicals Europe  
Flue Gas Treatment reagent  

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Acid flue gases are produced during waste incineration and many other industrial processes involving combustion.

It is important to manage these gases effectively to comply with environmental legislation.

Briskarb®, a special grade of Sodium Bicarbonate is a proven, effective reagent for the neutralisation of such gaseous emissions.

The legislation

Waste Incineration Directive 2010/75/EC on Industrial Emissions regulates all environmental discharges into air, soil and water resulting from incineration and co-incineration of waste.
Combustion processes generate acid gases in varying concentrations. Municipal and clinical waste incinerators generate relatively high concentrations of hydrogen chloride (HCl), while glass furnaces and power generators using fossil fuels predominantly produce oxides of sulphur (SOx).

Legislation controls the release of these gases into the atmosphere. It stipulates maximum emission limits and requires the operator to apply Best Available Techniques (BAT).

### Air emission limit values

European Directive 2010/75/EC on the incineration of waste sets out the following limits:

<table>
<thead>
<tr>
<th>Daily Average</th>
<th>Limit*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen chloride (HCl)</td>
<td>10mg/Nm³</td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>50mg/Nm³</td>
</tr>
<tr>
<td>Hydrogen fluoride (HF)</td>
<td>1mg/Nm³</td>
</tr>
</tbody>
</table>
| Nitrogen oxides (NOx)                              | 200 mg/Nm³ (>6te/hr)  
                                                             400 mg/Nm³ (<6te/hr) |
| Total dust                                          | 10mg/Nm³        |
| Gaseous and vaporous organic substances expressed as total organic carbon | 10mg/Nm³ |

* dry gas @ 11% O₂
The benefits of Briskarb®

Briskarb® neutralises acid gases much more efficiently than other commonly used dry injection reagents, e.g. lime (Ca(OH)₂).

When Briskarb® 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.

\[
\begin{align*}
2 \text{ NaHCO}_3 & \xrightarrow{HEAT} \text{ Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O} \\
\end{align*}
\]

Scanning Electron Microscope (SEM) images showing this effect. The images on the right hand side clearly have more porosity and therefore surface area.
Effectiveness

Neutralisation reactions
Focusing on the two main acid gas components, the reactions with Briskarb® are:

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

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

\[
\text{NaHCO}_3 + \text{HF} \rightarrow \text{NaF} + \text{CO}_2 + \text{H}_2\text{O}
\]

Efficiency

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.

* Stoichiometric Ratio = \( \frac{\text{quantity of reagent actually used}}{\text{quantity of reagent theoretically required (100% efficiency)}} \)
Factors affecting efficiency

Temperature
Briskarb® is effective over a wide temperature range:

Below about 140°C the reaction rate becomes too slow. Above 400°C sintering of sodium carbonate occurs and the benefit of a high surface area is reduced, decreasing the effectiveness of the reaction.

Particle Size
The particle size can influence the effectiveness of reaction because fine powders react more efficiently than coarse crystals.

Why Briskarb® is better
The key business benefits of Briskarb® are:

Enhanced environmental performance – Briskarb® removes acid gases very effectively, resulting in cleaner flue gases from the combustion processes.

It is more cost effective – Lower consumption and residue formation makes Briskarb® a very cost effective option for FGT.

Lower capital investment is needed – A simple, dry powder injection system is needed for Briskarb®. Compared with other alkaline reagents for the neutralisation of acid gases, Briskarb® gives:

1. **Lower consumption of reagent through better reactivity** – typically a stoichiometric ratio of 1.25 for Briskarb® which is substantially lower than other reagents.
2. **Lower levels of HCl and SO₂** – enabling efficient compliance with Industrial Emission Directive limits.
3. **Reduced HCl and SO₂ emission spikes** – rapid reaction times enable compliance with half-hourly averages.
4. **Lower disposal costs** – less FGT residues are generated.
5. **Greater efficiency with dry once-through system** – no need for recirculation.
6. **Better thermal efficiency** – no need for water injection to control gas temperatures.
7. **Effective over a wide temperature range (140° - 400°C)** – same consumption regardless of gas temperature.
8. **Reduced maintenance** – residues from Briskarb® reaction are non-scaling.
9. **Ease of handling** – Briskarb® is non-hazardous and non-irritant.

Reaction Time
The reaction occurs within seconds. Longer contact between the reagent and the gas increases efficiency. This could be achieved for instance by using a bag house filter.

The reactivity of Briskarb® after thermal activation means that there is no need for recirculation of flue gas treatment residues.
How much flue gas residue will you create?

Using Briskarb® means less FGT residues.

The following table shows the solid FGT residues that would be generated per tonne of reagent used for neutralisation of either HCl or SO₂ compared with the most commonly used alternative reagent.

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Acid gas</th>
<th>Residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briskarb®</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.

A model for usage and disposal

<table>
<thead>
<tr>
<th>BRISKARB®</th>
<th>HYDRATED LIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl 10 mg/Nm³</td>
<td>HCl 1000 mg/Nm³</td>
</tr>
<tr>
<td>SO₂ 50 mg/Nm³</td>
<td>SO₂ 200 mg/Nm³</td>
</tr>
<tr>
<td>Gas flow rate 65kNm³/hr</td>
<td>Gas flow rate 65kNm³/hr</td>
</tr>
</tbody>
</table>

- 217 kg/hr Briskarb®
- 192 kg/hr Lime
- Briskarb® residues 168 kg/hr
- Lime residues 234 kg/hr
Can Briskarb® be used in your industry?

**Energy from waste**

The excellent HCl abatement properties of Briskarb® make it an attractive choice for municipal and clinical waste treatment plants, where variable amounts of plastics and other chlorine-containing materials can cause problematic spikes in HCl emissions. Briskarb® is compatible with the high combustion temperatures used in specialist plants for the treatment of hazardous waste. Briskarb® has become the reagent of choice for both small- and large-scale plants disposing of animal carcasses and by-products because of the simplicity and flexibility of dry, once-through abatement systems.

**Biomass**

Use of biomass in power stations as a carbon-neutral fuel is increasing. Briskarb® is used in the FGT systems of such facilities.

**Glass manufacture**

Briskarb® is a very effective reagent for the treatment of acid gases arising from glass furnaces.

The sodium-based residues can be recycled into the glass furnace, making Briskarb® a very economical option.

**Metal processing**

Briskarb® is used in the treatment of gases from metal smelting operations such as aluminium. Emissions challenges in this industry include the removal of acid gas species such as HCl and HF. Briskarb® reduces the concentrations of these species efficiently. Briskarb® can also treat the acid chloride species associated with secondary aluminium production. As an additional benefit, the resultant sodium chloride can be recovered by filters and then re-charged to the furnace.

**Chemical manufacture**

The adaptability of Briskarb® means that it can meet the specialist abatement needs of many different chemical manufacturing processes.

**Cement kilns**

Burning of alternative fuels such as tyres in cement kilns results in the generation of acid gases which are effectively removed with Briskarb®.

Electrostatic precipitators are commonly used in this industry because of the relatively high flue gas temperatures. Briskarb® can be injected into the flue gas duct upstream of the precipitators to provide effective abatement.
Questions & Answers

1. Will I need new equipment when I switch to Briskarb®?
   No, the facilities for dry reagents can be used for Briskarb® with only minor adjustments to settings.

2. Will I need new investment if emission limits become tighter?
   No, more stringent limits on acid gases can be met by simply injecting more Briskarb®.

3. What is the minimum suitable flue gas temperature for Briskarb®?
   Minimum temperature of 140°C is recommended. Briskarb® consumption does not vary with temperature.

4. Is Briskarb® a proven technology?
   Yes, use of Sodium Bicarbonate in flue gas treatment is considered as Best Available Technique (BAT). There are over 200 reference sites worldwide.

5. Is Briskarb® safe to use?
   Yes. Briskarb® is classified as non-hazardous.

6. What is the classification of the FGT residue?
   This depends on the type of combustion process involved. European Waste Catalogue sets out the classifications for different industries.

7. Will Briskarb® give me any operational cost savings?
   Yes, in many cases the total cost of reagent plus residue disposal will be lower compared to other reagents such as lime.

8. How can I calculate the total benefit of switching to Briskarb®?
   The Tata Chemicals Europe team of experts can help you to fully assess Briskarb® in your application, carry out trials and optimisation work and calculate total benefits.

Call us on 01606 724 000 to discuss your needs with Tata Chemicals Europe’s experts, or e-mail us at briskarb@tatachemicals.com