# Dry Sorbent Injection: Sodium Bicarbonate for $SO_2$ and HCl

Sodium bicarbonate for dry sorbent injection from the $SO_2$ and HCl loads, the removal wanted and the stoichiometric ratio (2 $NaHCO_3$ per $SO_2$, 1 per HCl).

**Method:** Stoichiometry 2 $NaHCO_3$ + $SO_2$ + ½ $O_2$ → $Na_2SO_4$ + 2 $CO_2$ + $H_2O$; $NaHCO_3$ + HCl → NaCl + $H_2O$ + $CO_2$

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Flue gas flow (dry, normal) | 100,000 | Nm³/h |
| $SO_2$ at the inlet (dry) | 800.00 | mg/Nm³ |
| HCl at the inlet (dry) | 150.00 | mg/Nm³ |
| $SO_2$ removal | 70.000 | % |
| HCl removal | 90.000 | % |
| Stoichiometric ratio (sorbent / stoichiometric for removal)<br>At least 1: below that the sorbent fed cannot remove the $SO_2$ and HCl asked for. | 1.3000 | |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Stoichiometric $NaHCO_3$ | 177.98 | kg/h |
| $NaHCO_3$ fed | 231.38 | kg/h |
| Sodium residue ($Na_2SO_4$ + NaCl, approx.) | 179.49 | kg/h |

**Notes for this case**

- Bicarbonate decomposes to reactive soda above about 140 °C; finer milling raises utilisation. Residue mixes with fly ash.

## Formula and method

$$\dot{m}_{st} = (2\eta_{SO_2}\dot{n}_{SO_2} + \eta_{HCl}\dot{n}_{HCl})M_{NaHCO_3}, \quad \dot{m} = SR\,\dot{m}_{st}$$

$$\dot{m}_{res} = \eta_{SO_2}\dot{n}_{SO_2}M_{Na_2SO_4} + \eta_{HCl}\dot{n}_{HCl}M_{NaCl} + \frac{(SR-1)\,\dot{m}_{st}}{2M_{NaHCO_3}}M_{Na_2CO_3}, \quad \dot{n}_i = \frac{\dot{V}_n c_i}{M_i}$$

### Variables

| | | |
|---|---|---|
| $\dot{V}_n$ | Flue gas flow (dry, normal) | Nm³/s |
| $c_{SO_2}$ | $SO_2$ at the inlet (dry) | kg/m³ |
| $c_{HCl}$ | HCl at the inlet (dry) | kg/m³ |
| $\eta_{SO_2}$ | $SO_2$ removal | - |
| $\eta_{HCl}$ | HCl removal | - |
| $SR$ | Stoichiometric ratio (sorbent / stoichiometric for removal) | - |
| $\dot{m}_{st}$ | Stoichiometric $NaHCO_3$ | kg/s |
| $\dot{m}$ | $NaHCO_3$ fed | kg/s |
| $\dot{m}_{res}$ | Sodium residue ($Na_2SO_4$ + NaCl, approx.) | kg/s |
| $\dot{n}_{SO_2}\$, \$\dot{n}_{HCl}$ | molar flows of $SO_2$ and HCl at the inlet | kmol/s |
| $M_i$ | molar masses (IUPAC) | kg/kmol |

### Method and standards

Stoichiometry with IUPAC molar masses: two $NaHCO_3$ per $SO_2$ removed and one per HCl removed. The residue counts the $Na_2SO_4$ and NaCl formed and the excess bicarbonate as $Na_2CO_3$ (two $NaHCO_3$ give one $Na_2CO_3$ on heating).

### Assumptions and limits

- Dry, normal basis. The concentrations are at the actual $O_2$, matching the actual dry gas flow; values corrected to a reference $O_2$ must be converted back first.
- The stoichiometric ratio must be at least 1.

### References

- Stoichiometry $2\ NaHCO_3 + SO_2 + ½\ O_2 \rightarrow Na_2SO_4 + 2\ CO_2 + H_2O$; $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

## Report details

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|---|---|
| Report reference | FCC-9F7W-7JZG (the same inputs always give the same reference) |
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| Method last reviewed | 13 November 2026 |
| Software release | FireCAD Calc, release of 17 November 2026 |
| Release checks | 2 reference cases of this calculator, computed independently, are checked on every release |

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

### This calculator online

https://calc.firecad.com/boilers-power-plant/emissions-stacks/sodium-bicarbonate-injection

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.