

# HCl Control with Dry Injection of Sodium Bicarbonate or Trona

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# Presentation Outline

- **Introduction : US and EU Regulations**
- **Case study : MSWI in Europe & Power Plant in US**
- **SOLVAir<sup>®</sup> sorbents**
  - ▶ **Physical / chemical properties**
  - ▶ **Processing**
  - ▶ **Way of use**
- **Acid Gas mitigation chemistry**
  - ▶ **Basics**
  - ▶ **Performance**
  - ▶ **Comparison with lime**
  - ▶ **Residuals**
- **Guidelines to design a dry injection of SOLVAir<sup>®</sup> Sorbents**
- **Conclusion**

# US Emission Limits

- **Current boiler MACT – HCl limits**

Fuel	Existing Boilers (lb/MMBtu)	New Boilers (lb/MMBtu)
Coal	0.035	0.0022
Biomass	0.035	0.0022
Gas	0.0017	0.0017
Oil	0.00033	0.0031

- **Proposed Utility MACT – HCl Limits**

Fuel	Existing Boilers (lb/MMBtu)	New Boilers (lb/GWh)
Coal	0.002	0.30
GAS (IGCC)	0.0005	0.30
Solid Oil Derived Fuel	0.005	0.30

# EU Emission limits

- **New Industrial Emission Directive (2010/75/EU)**

→ *To be implemented in EU member states before Jan. 7<sup>th</sup> 2013*

- **For Boilers (power generation) :**

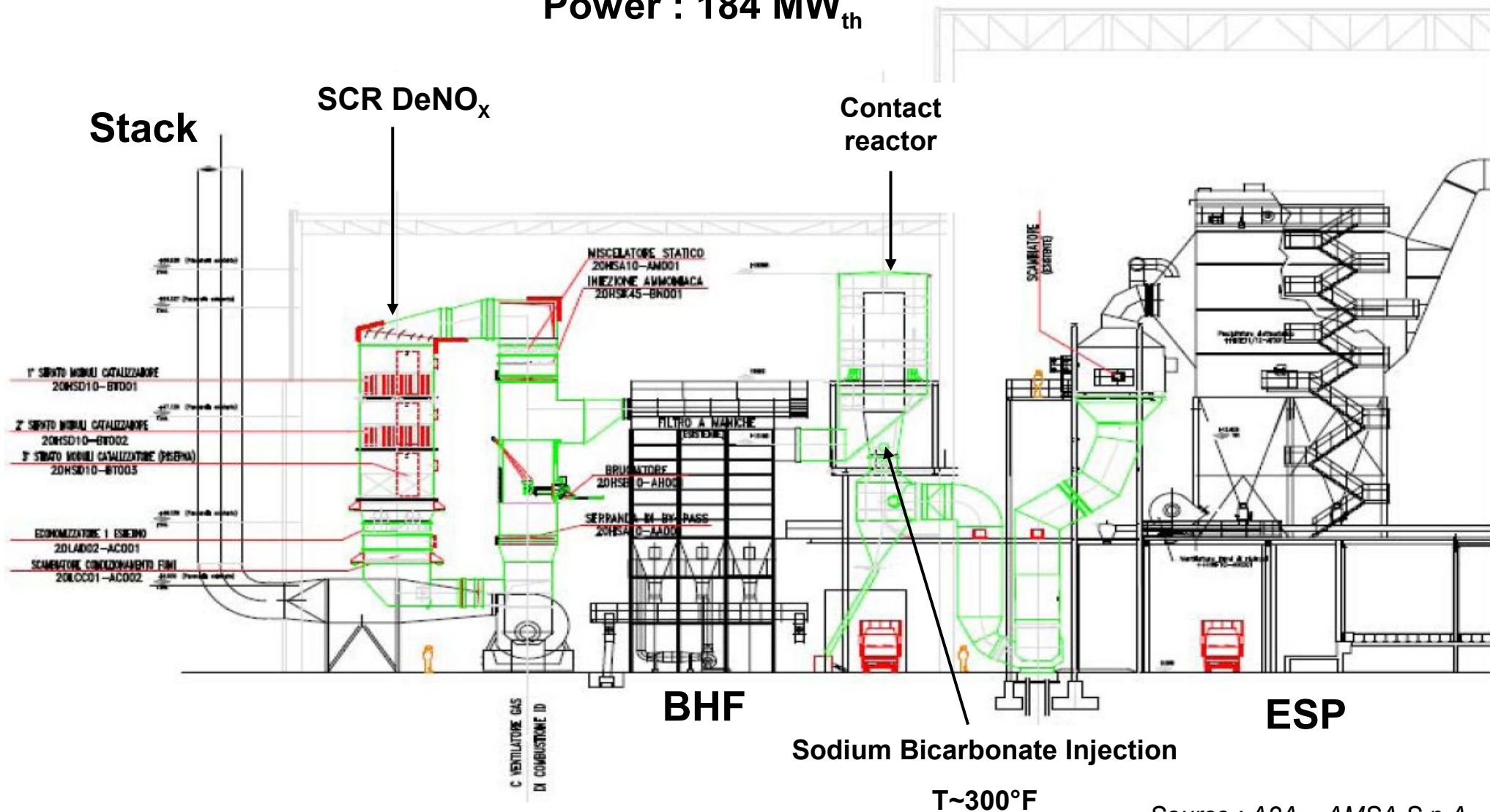
- No regulation about HCl
- SO<sub>2</sub> at stack: from 200 to 400 mg/Nm<sup>3</sup> dry 6% O<sub>2</sub> (70 to 140 ppm)
- or minimum SO<sub>2</sub> mitigation rate from 80 to 97% !!

- **For MSWI :**

- HCl emission limit 10 mg/Nm<sup>3</sup> dry 11% O<sub>2</sub> ~ 0.010 lb/MMBTU
- SO<sub>2</sub> → 50 mg/Nm<sup>3</sup> dry 11% O<sub>2</sub> (17 ppm) / HF → 1 mg/Nm<sup>3</sup> dry 11% O<sub>2</sub> (1.1 ppm)
- Depending on the facility → results in 99.0% to 99.8% HCl mitigation

# HCl mitigation example: MSWI in Europe

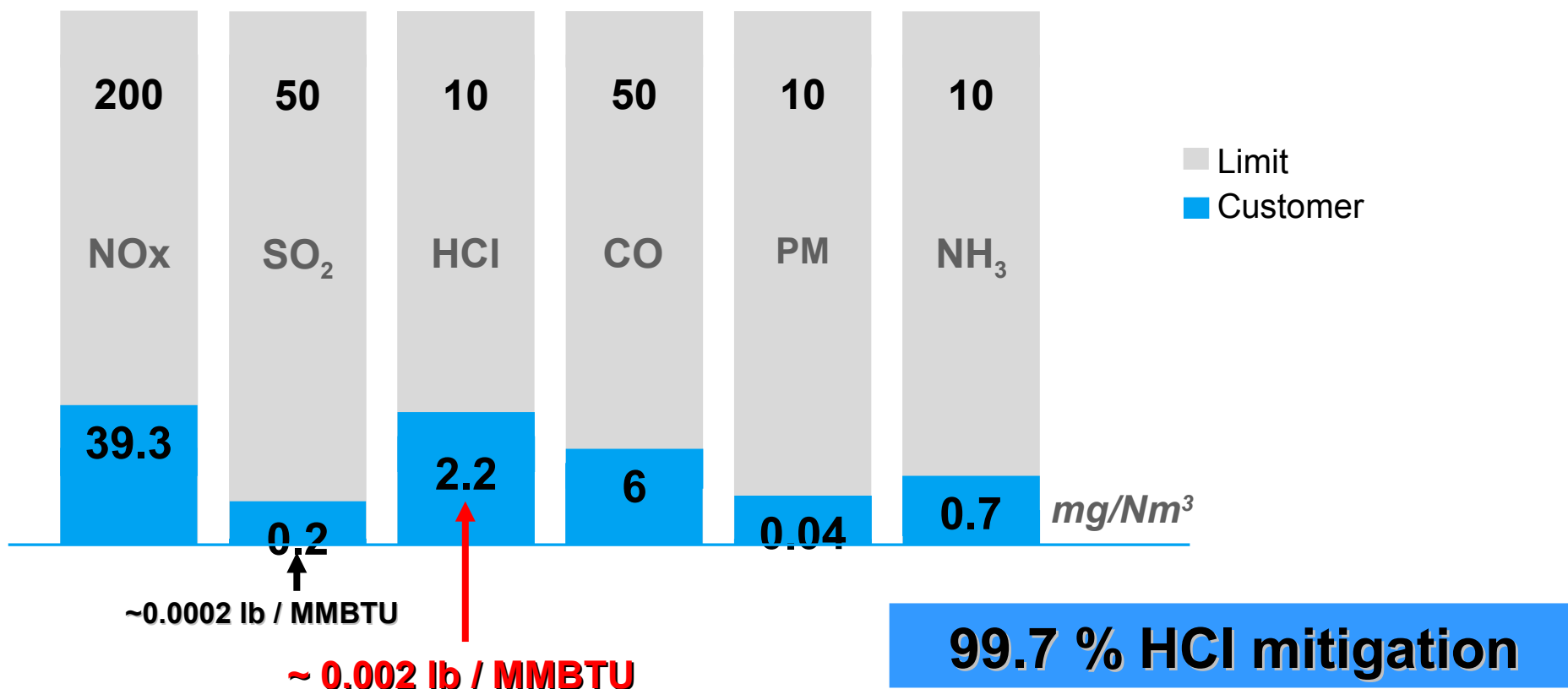
Power : 184 MW<sub>th</sub>



Source : A2A – AMSA S.p.A.

# HCl mitigation example: MSWI in Europe

## Emissions vs. EU regulations



Source : A2A – AMSA S.p.A.

# HCl mitigation: Trona & Sodium Bicarb. in US

- Trials already performed on a coal-fired utility boiler
  - ▶ 100 MW burning low-sulfur coal (SO<sub>2</sub> : 1.2 lb / MMBTU)
  - ▶ **Trona or Sodium Bicarbonate** injected upstream of **hot-side ESP** (T~650°F)
  - ▶ SO<sub>2</sub> removal rate was ~70%
  - ▶ Total PM, PM<sub>2.5</sub> and PM<sub>10</sub> lower than without sorbent injection (ESP boosted) and below the permit limits

	HCl (lb/MBtu)	HCl Removal Rate (%)	HF (lb/MBtu)	HF Removal Rate (%)
Trona	0.0011	98.8	0.0008	78.4
Sodium Bicarbonate	0.0013	97.8	0.0002	88.0
<b>Permit Limit</b>	<b>0.0072</b>		<b>0.0026</b>	

\* The proposed Utility MACT limit for HCl: 0.002 lb/mmBTU

Source : Y. Kong, SOLVAY Chemicals, Inc.

# SOLVAir® Sorbents

Sorbent	US Sodium Bicarbonate (SOLVAir® Select 300)	US Trona (SOLVAir® Select 200)	EU Sodium bicarbonate (BICAR® TEC 0/50)
Appearance	White powder	Off-white powder	White powder
Formula	$\text{NaHCO}_3$	$\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$	$\text{NaHCO}_3$
Product purity	> 97%	> 95%	> 98%
Particle Size :	~ 150	~ 30	~ 130
Free-flowing bulk density (lb / cu. ft)	63	49	62
Flue gas temperature range for injection	275 – 1,500°F	275 – 1,500°F	275 – 1,500°F
SO <sub>2</sub> mitigation	> 95%	> 90%	> 95%
HCl Mitigation	> 99%	> 99%	> 99%
DSI Layout	Silo + Mill + Air transportation + BHF	Silo + Air transportation + BHF	Silo + Mill + Air transportation + BHF
Price	Medium	Low	Medium

# Sodium Bicarbonate & Trona manufacturing

- In the US :



- ▶ Trona is an ore mined underground (sodium sesquicarbonate)
- ▶ Green River, WY has billions of tons of Trona
- ▶ Sodium Bicarbonate S300 is processed from Trona in Green River, WY (carbonation of the  $\text{Na}_2\text{CO}_3$  part)
- ▶ Nameplate capacity of 275,000 short tons / year of sodium bicarbonate (2 plants)

- In EU :



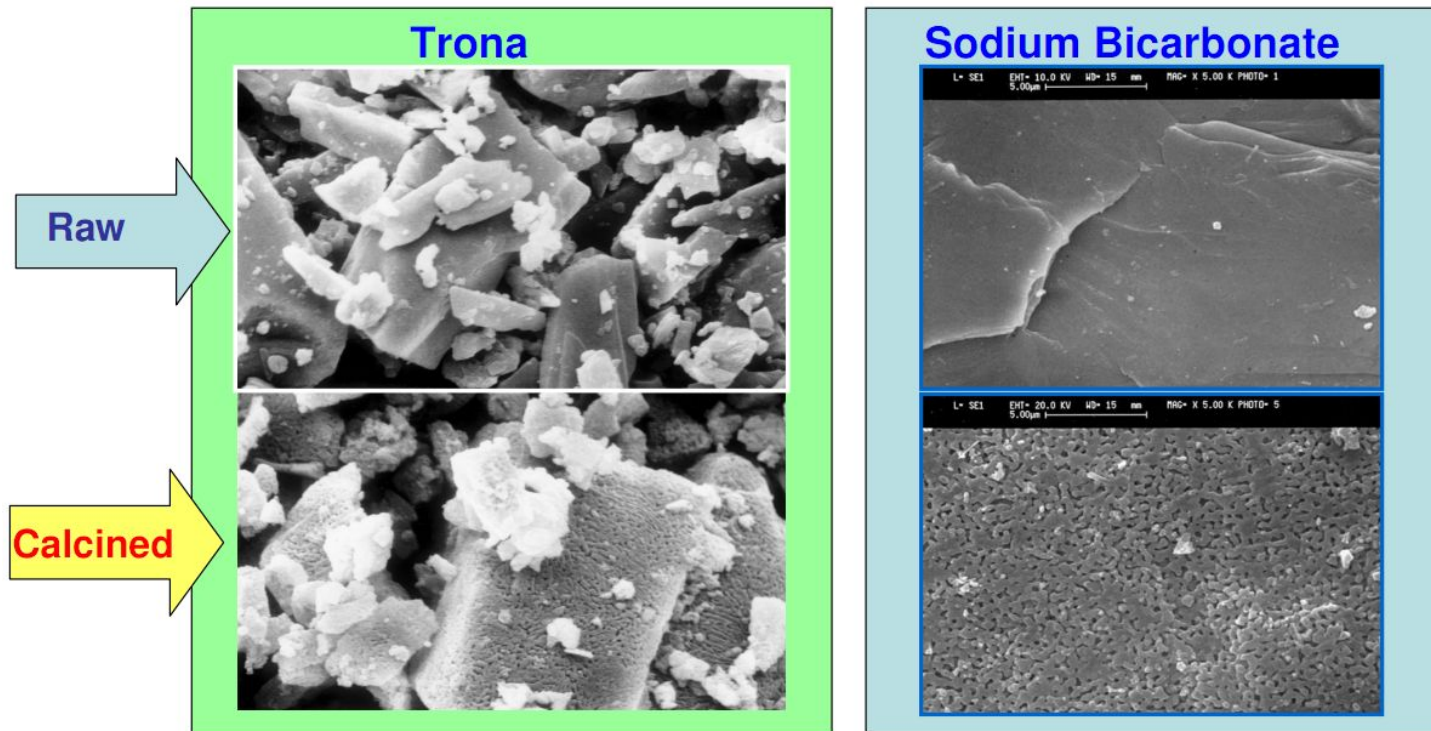
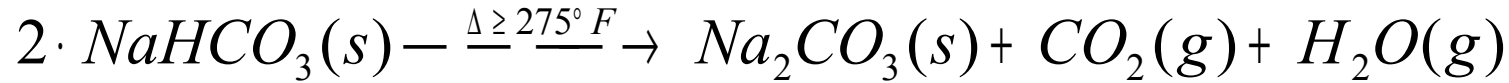
- ▶ Soda Ash plant with SOLVAY process using brine ( $\text{NaCl}$ ) and limestone ( $\text{CaCO}_3$ )
- ▶ Natural and huge deposits of raw materials
- ▶ Sodium Bicarbonate is processed from light soda ash with carbonation columns
- ▶ Nameplate capacity of sodium bicarbonate is 730,000 metric tons / year (7 plants)

# Calcination

- Trona Calcination

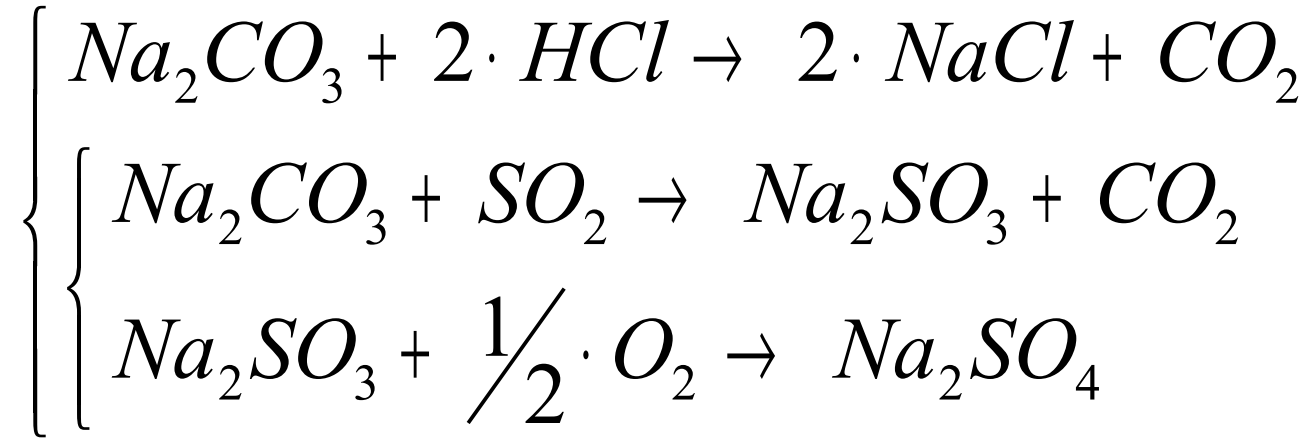


- Sodium Bicarbonate calcination



# Acids Mitigation

- Acid mitigation by activated sodium carbonate

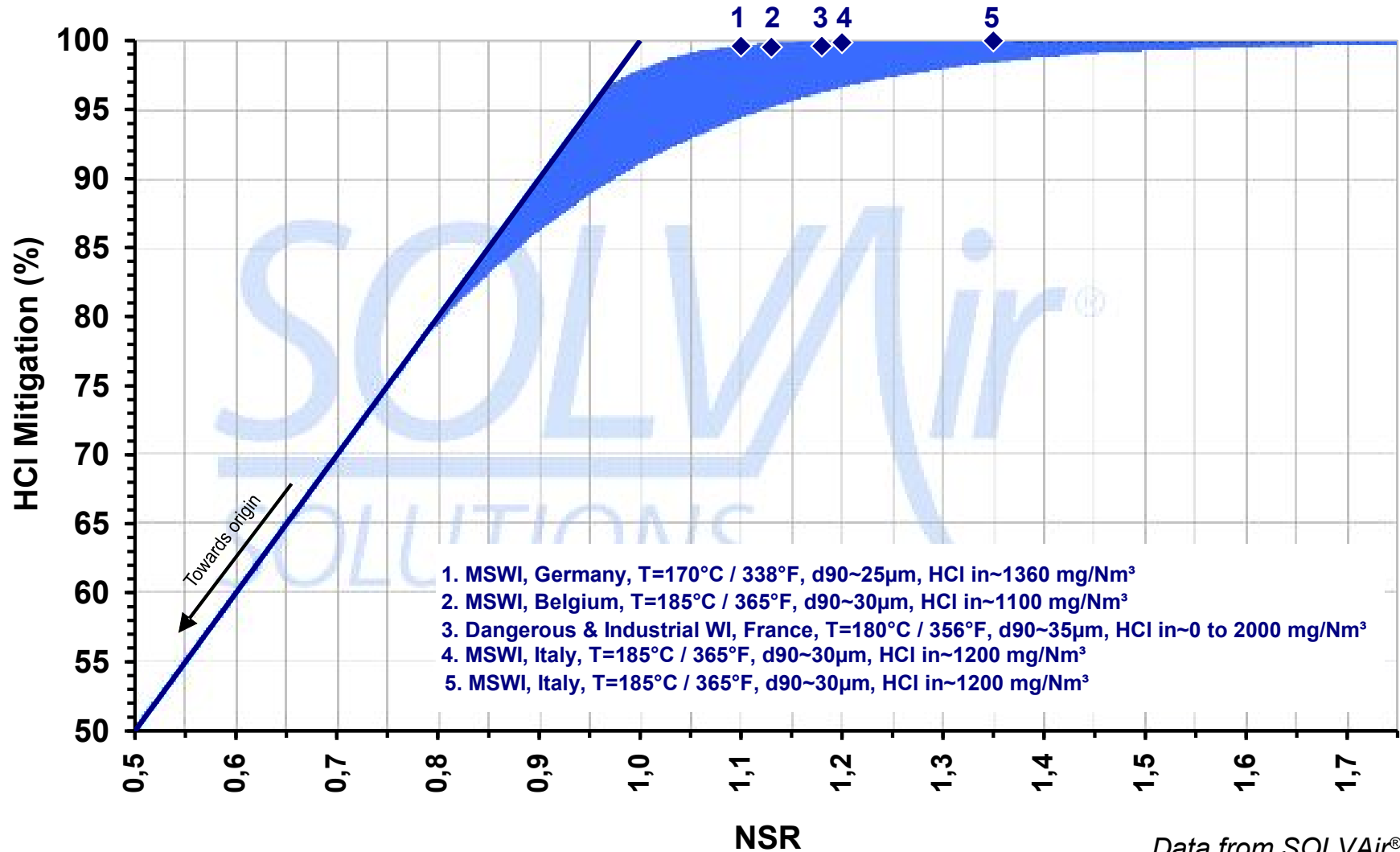


- Definition of the Stoichiometric ratio : NSR (for Sodium Bicarbonate)

$$NSR = \frac{BICAR_{massflowrate}}{2.3 \cdot [HCl]_{massflowrate} + 2.63 \cdot [SO_2]_{massflowrate}}$$

# HCl mitigation performances (Sodium Bicarbonate)

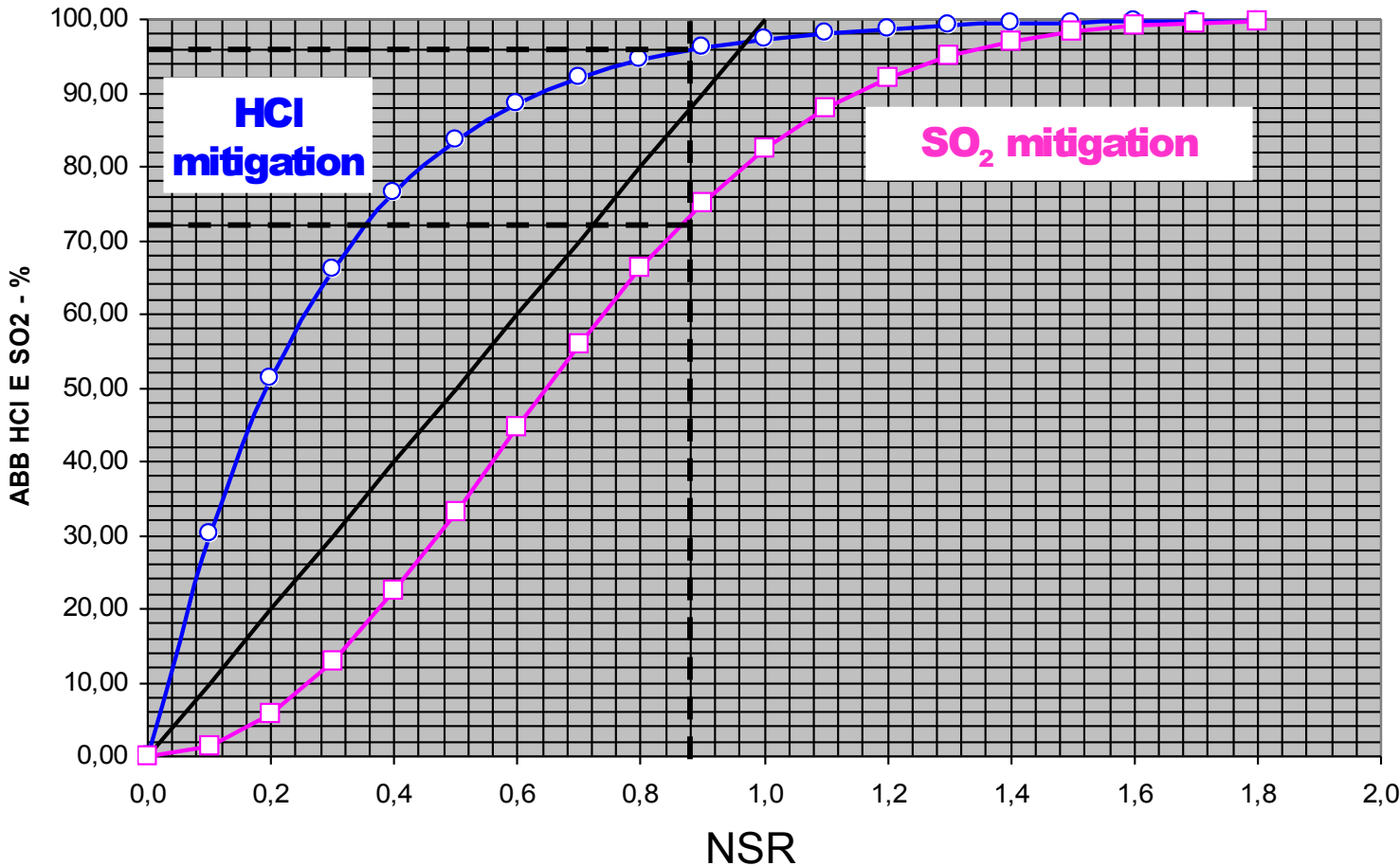
## Sodium bicarbonate HCl mitigation on a baghouse filter



# About HCl / SO<sub>2</sub> competition while mitigating...

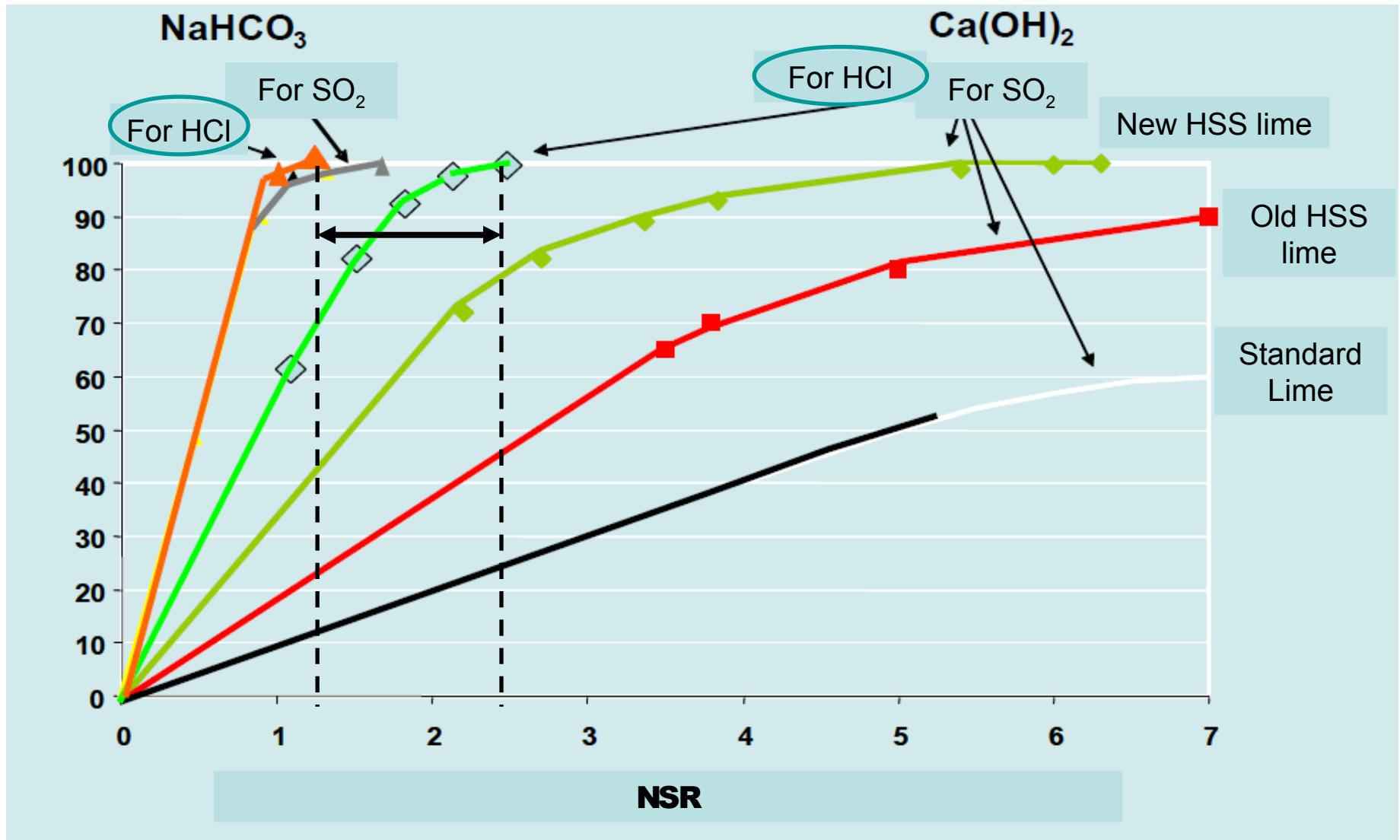
Sorbent : Sodium Bicarbonate

$$[SO_2] = 2 * [HCl]$$



- At low NSR, sodium sorbents go first to HCl and then SO<sub>2</sub>!
- Example : for 70% SO<sub>2</sub> mitigation, 96% HCl removed

# Sodium bicarbonate vs. HSS Hydrated Lime (BHF)



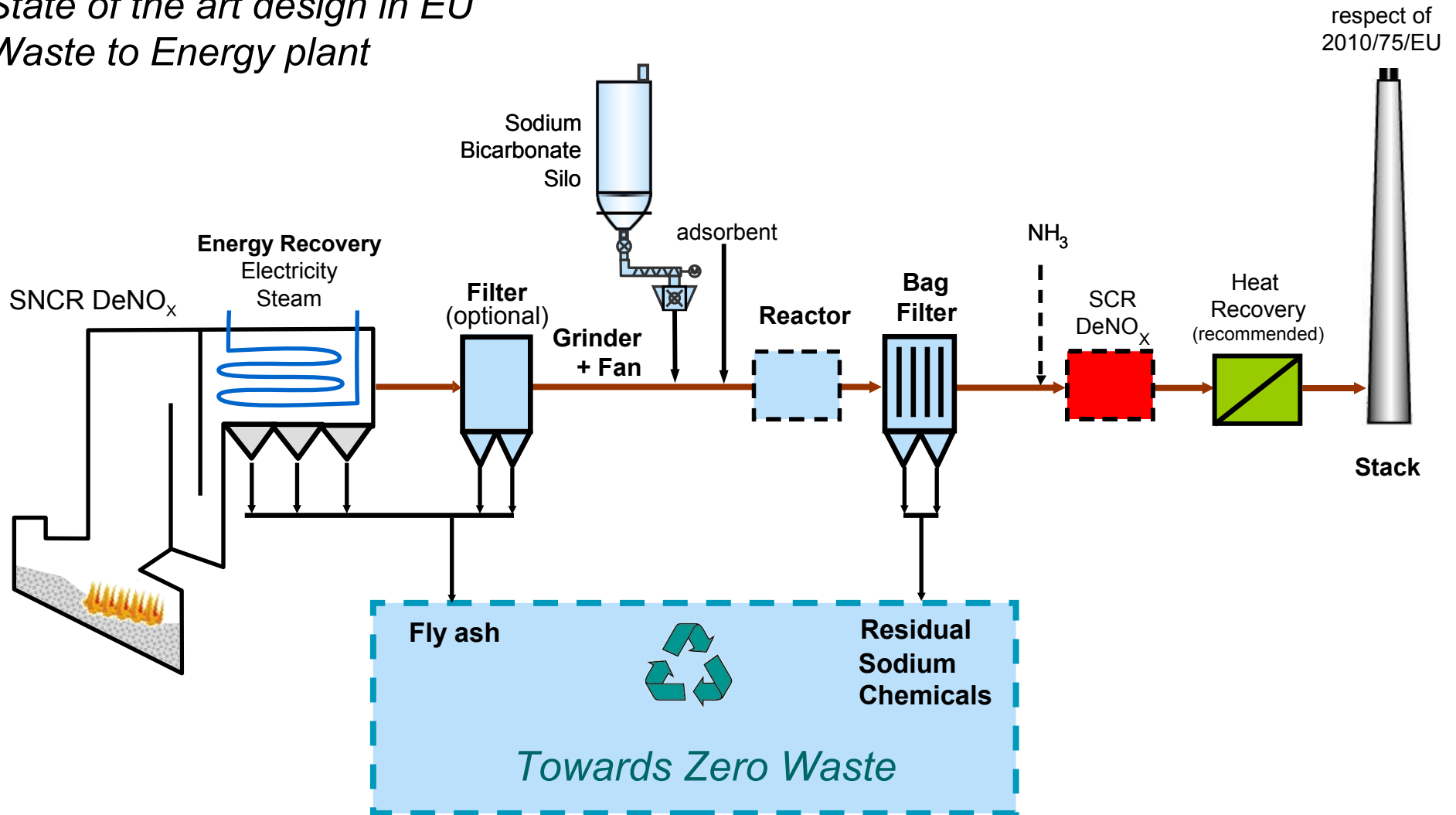
Source : DrySoTech GmbH – Dr. Bernd Morun

## DSI : Sodium Bicarbonate vs. HSS Hydrated Lime

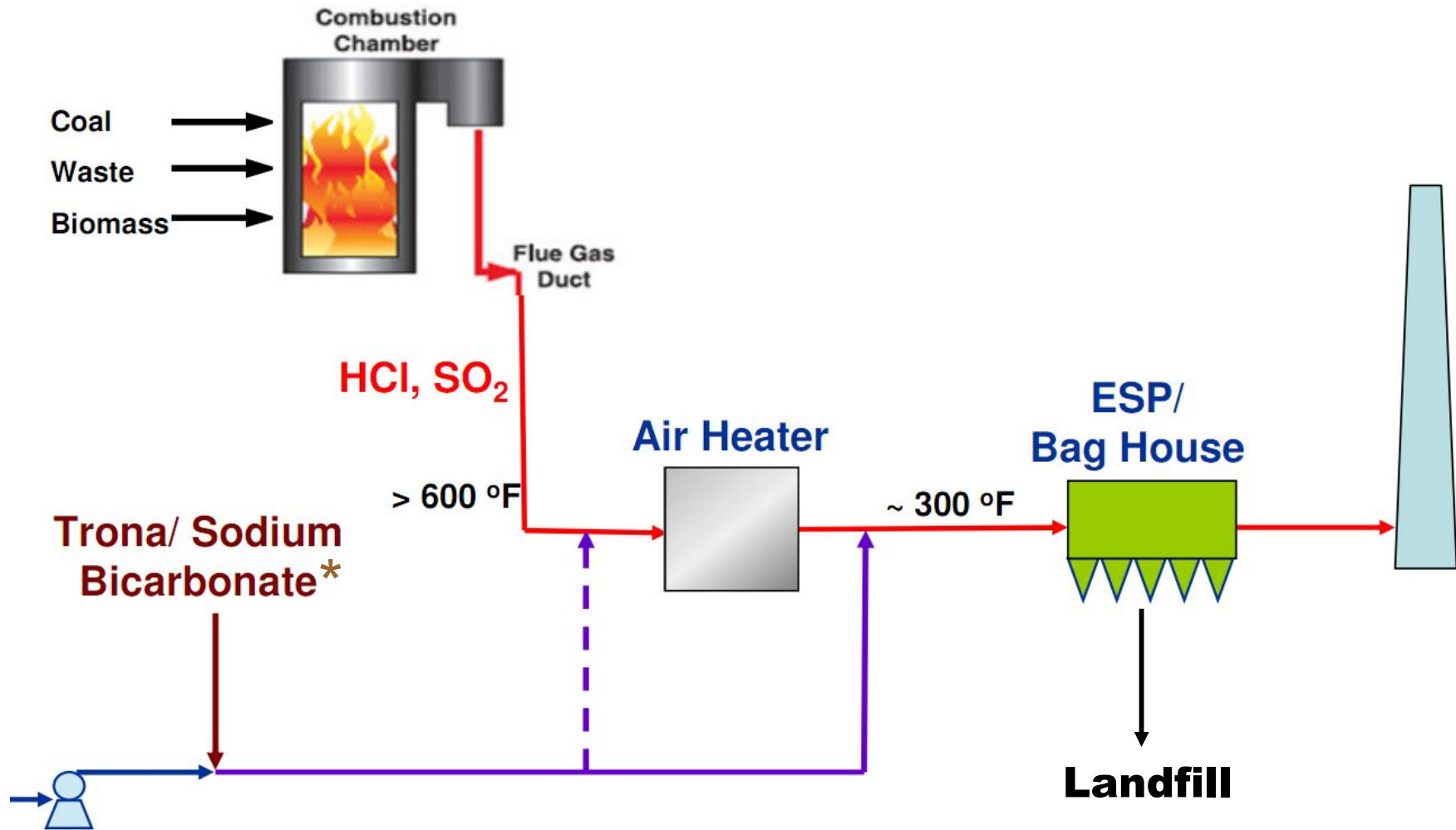
Sorbent Type	Sodium Bicarbonate	Dry Lime	Units
Incinerated Waste	1,000	1,000	lbs
NSR	1.15	1.60	-
Sorbent Consumption	15	16	lbs
Fly ash production	29	29	lbs
Salts production	11	25	lbs
Residues total	40	54	lbs

**+ 35% (minimum) of total residues**

## State of the art design in EU Waste to Energy plant



# SOLVAir® Solutions with S300 or S200



*\*if S300, has to be milled*

- **Reminder - Key parameters for a good efficiency are:**
  - ▶ Flue gas temperature, above 275°F
  - ▶ Sorbent mix with the flue gas
  - ▶ Sorbent residence time (> 1 sec)
  - ▶ Sorbent particle size :  $d_{90} < 35\mu\text{m}$  for S300 for HCl removal
  - ▶ Conveying air T < 140°F

# CONCLUSION

- **Dry injection of trona or sodium bicarbonate is a cost effective way to mitigate HCl in the frame of new boiler MACTS:**
  - ▶ **Low capital cost**
  - ▶ **Low operation cost : high HCl affinity even in presence of SO<sub>2</sub>**
- **Very high mitigation possible for HCl (>99%), already done in EU facilities**
- **Wide range of applications thanks to its simplicity**
- **SOLVAir® Solutions has more than 200 hundred worldwide references**

- **QUESTIONS ?**



**Visit our worldwide website**  
**<http://www.solvairsolutions.com>**

