Dry Sorbent Injection of Sodium Sorbents by Solvay Chemicals

Emission Control and Measurement Workshop

March 24-25, 2010

Presentation Outline

- What are the sodium sorbents?
  - We'll talk about Trona and Sodium Bicarbonate
- How effective are sodium sorbents in mitigating SO_2 and SO_3?
  - We'll review some data.
- Which sorbent is better?
  - We'll discuss the factors affecting the decision.
- What parameters impact the effectiveness of DSI?
  - We'll look at how we optimize systems and factors that limit effectiveness.

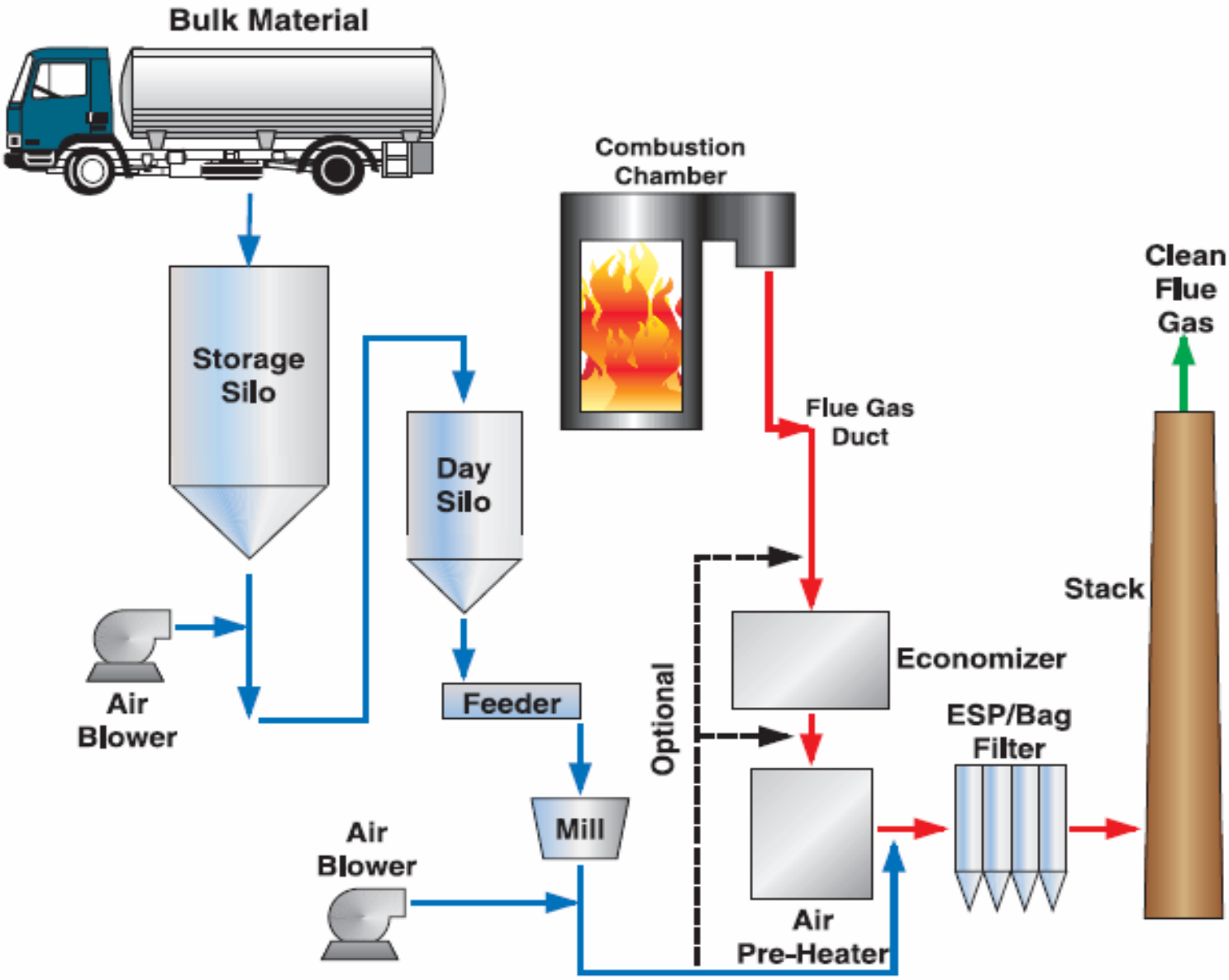
What Is Trona?

- It is a naturally formed sodium sesquicarbonate rock
  - (Na2CO3• NaHCO3•2H2O)
  - The Green River WY deposit is the largest and purest in the world
- Solvay mills this rock into a fine powder
  - Average particle size 30 – 35 microns
  - Material for FGD is sold under the trade name SOLVAir Select 200
  - Select 200 is the product known as trona in the industry
- Select 200 is very dry, typically less than 0.03% moisture
  - It is a good idea to keep it dry, wet trona is tough to handle.
  - Contact with water will cause problems.
- Select 200 can compact while stored
- Select 200 calcines instantly at 280^{o}F
  - Trona gives up water when it calcines
  - At 140^{o}F Trona begins to calcine

Sodium Bicarbonate

- Sodium Bicarbonate is a downstream product made from Trona
  - It is the same baking soda you add to food
  - It is a purified processed product made from soda ash, so it is more expensive
  - But is much more reactive with SO_2
- Bicarbonate has to be milled prior to use
  - Milling on site to d90 less than 20 microns with direct injection gives the best results
  - Premilled material with a D90 less than 40 microns is available
  - Handling issues become severe as d90 approaches 20 microns.
- New capacity for sodium bicarbonate
  - A new process that skips the soda ash step makes a more economical Flue Gas grade.

Typical Dry Sorbent Injection System



Advantages of Sodium DSI

- Dry Sorbent Injection systems are the lowest capital cost option to treat acid gases.
  - Small utilities and industrial boilers can't afford wet scrubbers
- Sodium DSI is compatible with ESP particulate control
  - Even with higher loading, sodium salts reduce ash resistivity and usually lower opacity and particulate emissions.
- Sodium DSI is also effective on HCl and HF
- Removal rates can adapt to changing conditions by adjusting the feed rate.
  - Fuel changes, load changes, regulation changes

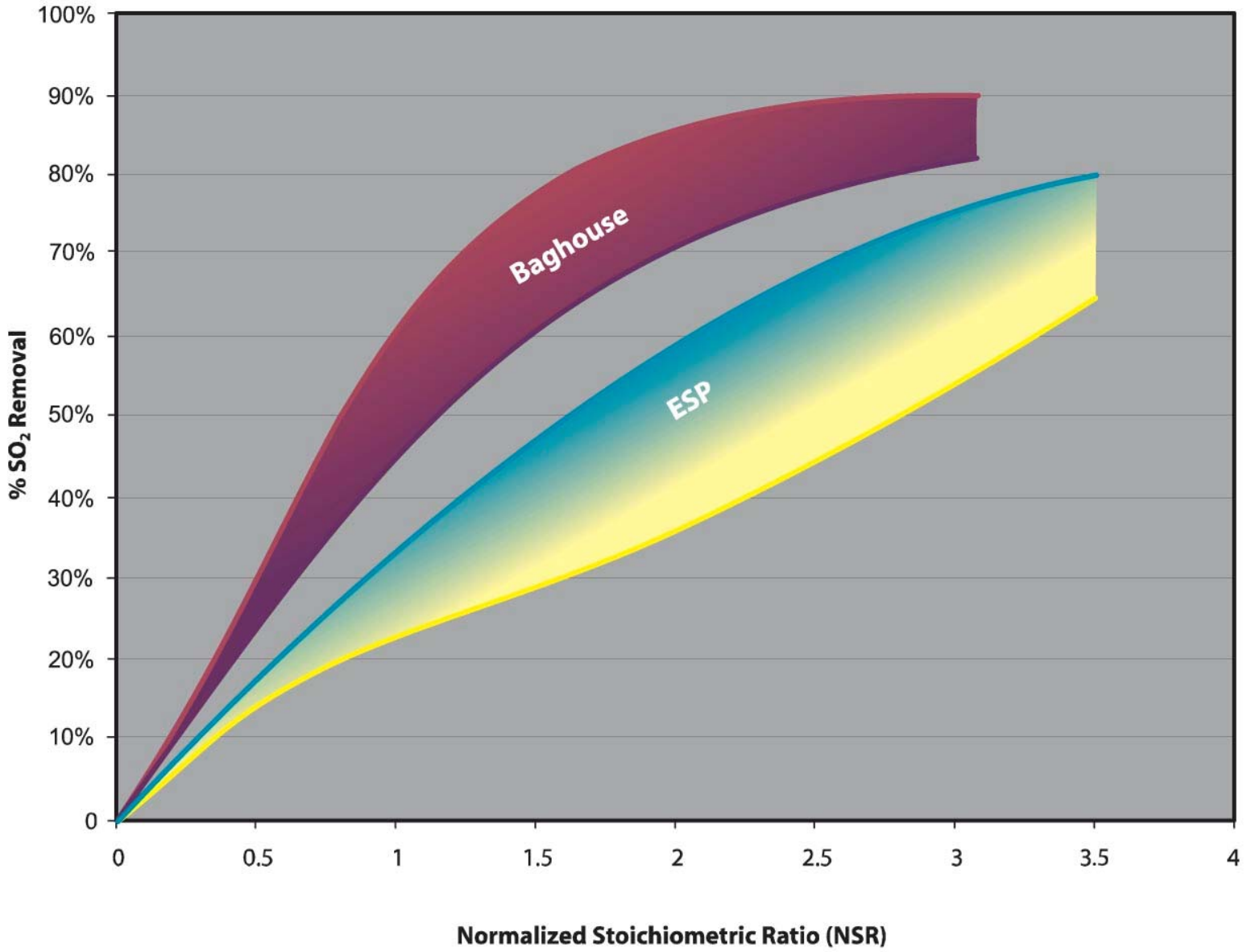
Trona compared to Lime

- Trona is more efficient than lime so less material is needed
- Trona is easier to handle and less prone to plugging
- Trona enhances ESP performance
- Trona can be added further upstream, even ahead of the economizer
- Lime is less expensive per ton on a delivered basis
  - Delivered trona costs are highly freight dependant
- Lime is more compatible with beneficial use of fly ash
  - Sodium levels in the ash of less than 1.5% are typically acceptable

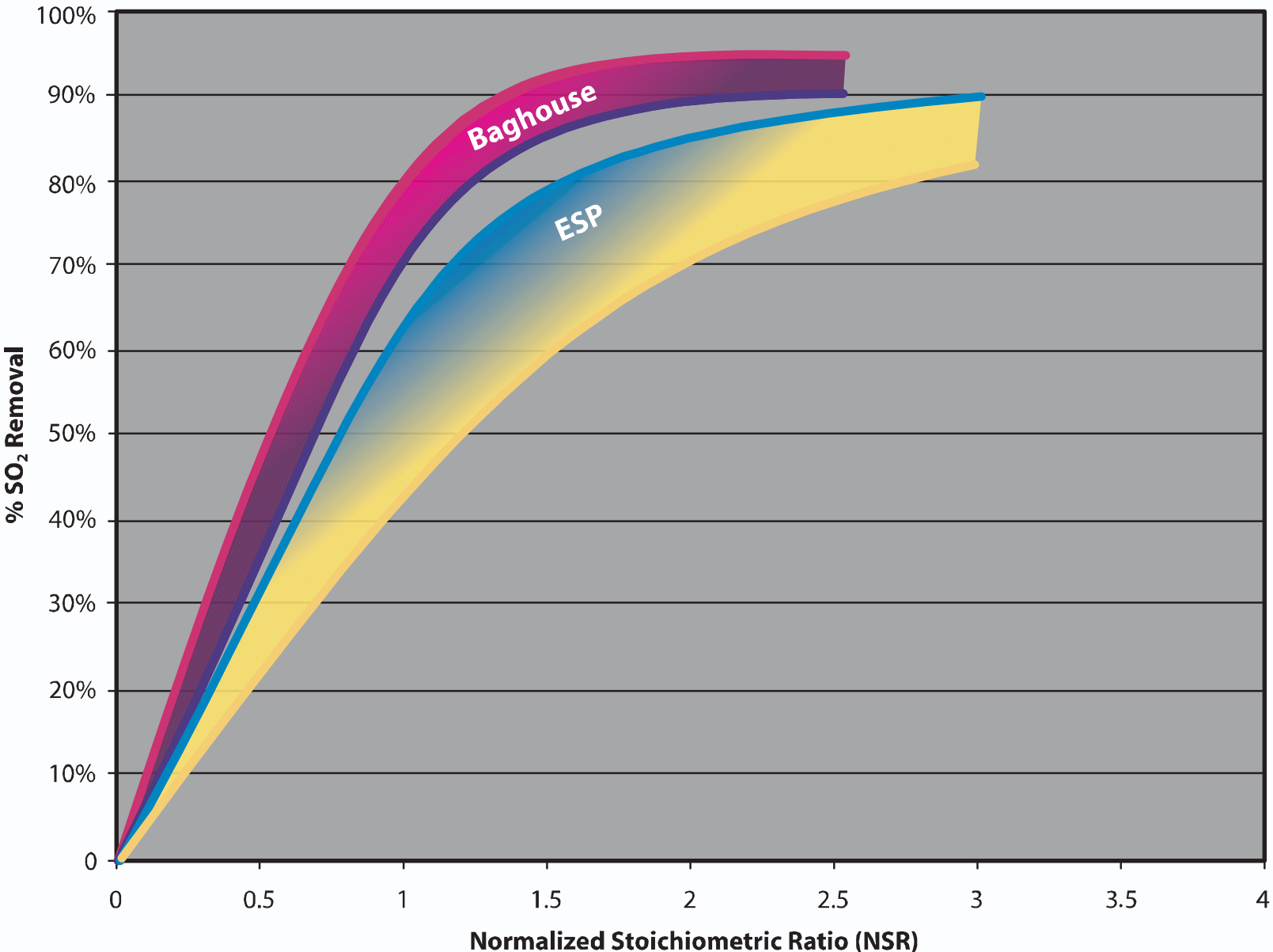
What we mean by NSR

- **Normalized Stoichiometric Ratio**
  - MW trona is 226 MW SO2 is 64 MW SO3 is 80
  - **2 moles trona for every 3 moles SO2 or 452/192 = 2.35**
  - **2 moles trona for every 3 moles SO3 or 452/240 =1.88**
  - MW bicarbonate is 84
  - **2 moles bicarbonate for every mole of SO2 or 168/64 = 2.62**
  - *To fully calculate the amount of sorbent for an NSR of 1, all acid gasses must be accounted for. For trona, figure 97.5% purity.*

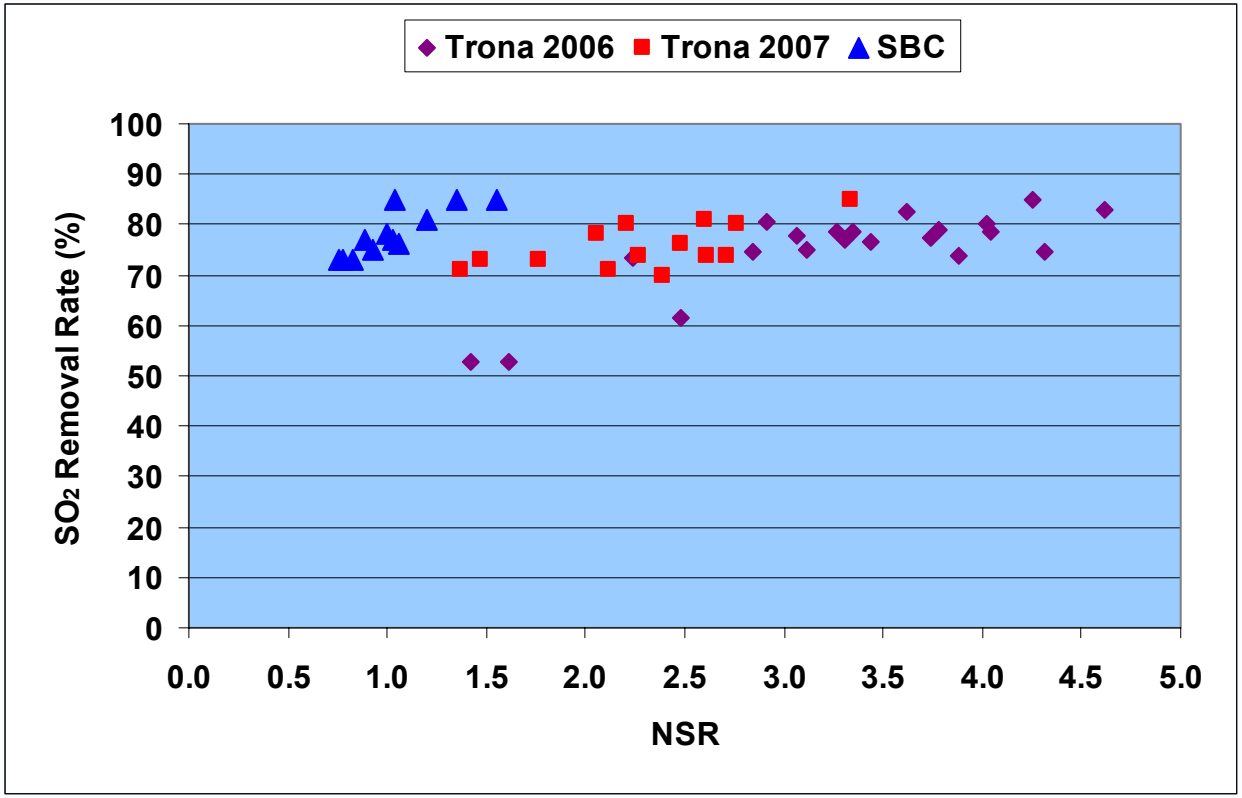
Trona Performance Curve



Sodium Bicarbonate Performance Curve



Comparison of SO2 Treatment Rates with Trona and Sodium Bicarbonate (SBC)

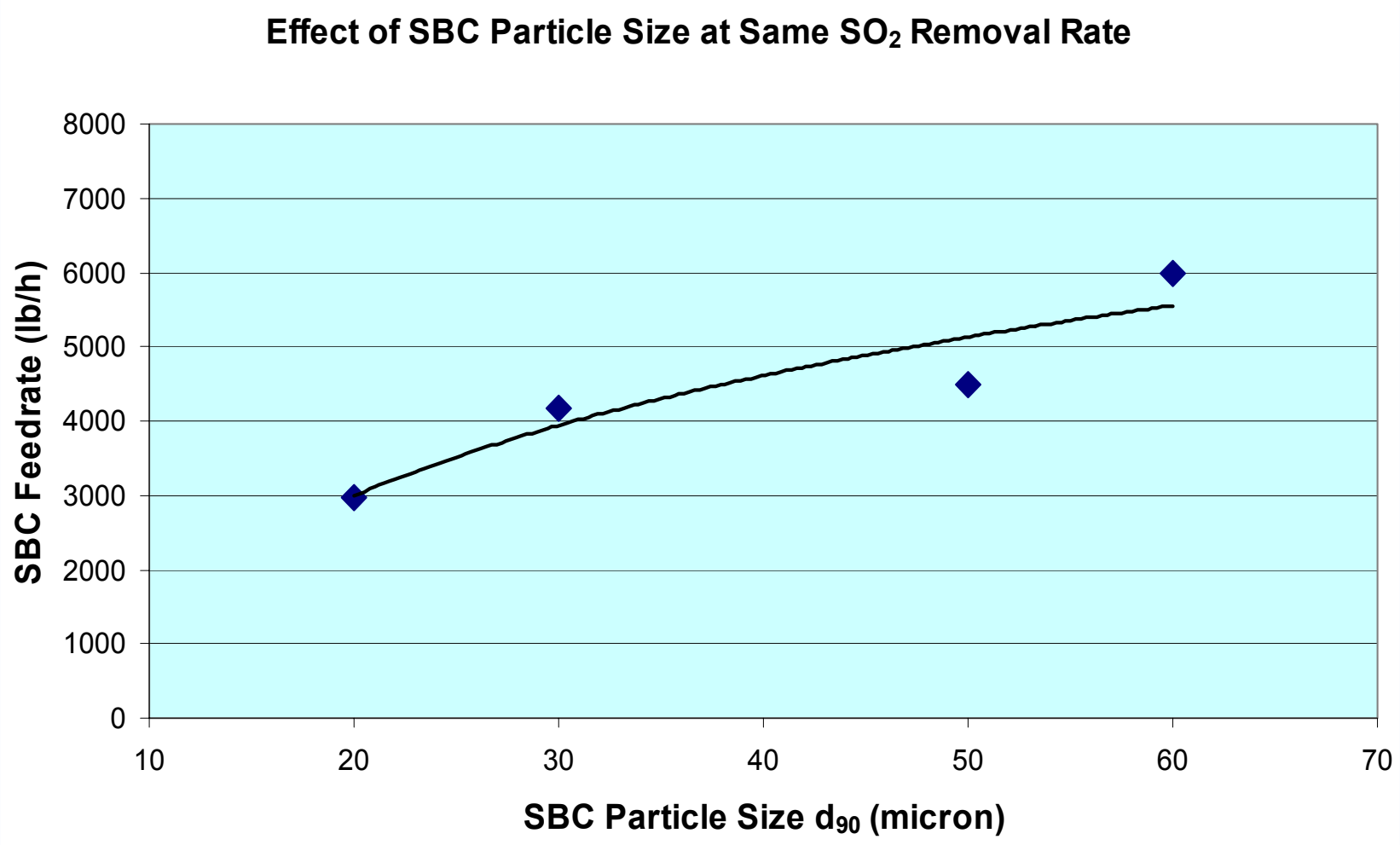


- The 2006 data was obtained during a test using a temporary set up.
- The 2007 data was generated from a permanent installation
- Unmilled trona Select 200: d_{90} = 140 µm, d_{50} = 30 µm

Should You Use Trona or Sodium Bicarbonate

- Sodium bicarbonate becomes more economical to use than trona as the following situations exist
  - An ESP is the particulate control device
  - Higher SO_2 removals are required
  - Injection is after the air heater
    - Bicarbonate needs less than 800^{o}F
    - Trona efficiency increases as temperature and residence time increase
  - On site milling is available
  - Freight costs are high
  - Fly ash disposal costs are high
- Use of sodium sorbents results in higher sodium content in the fly ash. The customers should check the fly ash properties for beneficial applications or disposal.

Effect of Sodium Bicarbonate Particle Size



*** Outlet SO_2 concentration @ 0.3 lb/mmBTU for all tests**

Fly Ash Considerations

- Higher sodium content in the fly ash.
- Ashes from SO_2 treatment typically not suitable for applications in concrete or structural fill
- Solubility of sodium compounds in the fly ash (i.e. Na_2SO_4, Na_2CO_3)
- Disposal issues should be investigated early in the process. Customers encouraged to check properties and work closely with their fly ash marketers.

Other Benefits

- High removal efficiencies for HCl and HF
- Mercury removal is enhanced at locations that have high sulfur coal
- Selenium and arsenic are also removed from the flue gas.

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