Uppgradering av rökgasreningsystem

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Agenda

• 1st topic Introduction
  • 2nd topic Fuel flexibility
  • 3rd topic Regulations
  • 4th topic Particulate / Heavy metals
  • 5th topic Acid gases
  • 6th topic Summary & Conclusion
Introduction

- One of the more common reasons for upgrading a gas cleaning plant is an increase in production of heat and electric power
- Also there are more and more fuel fractions available on the market, that may offer better economy
- Such changes may lead to change in
  - gas flow
  - fly ash particle size and composition
  - gaseous compounds and concentration
- And most likely the gas cleaning plant has to be upgraded to meet new emission regulations
- This presentation will go through some available options to increase the performance of particulate and acid gas abatement

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Some Biomass Fired Plants
Gas Cleaning Options Simplified

Biomass classes
- Virgin wood
- Straw
- Contaminated wood
- Municipal Waste

Emissions
- Particulate
- Acid gas
- Heavy metal
- Dioxin

Cleaning system
- ESP or FF
- DAS or NID

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Some Biomass Fired Plants
Gas Cleaning Options Simplified

Biofuels heat value

Biofuels water content

- Most Biofuels Energy Density and Water Content makes it uneconomical to transport further distances
- In Sweden the average transport distance is 70 to 100 km
- The local composition of available Biofuel varies

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Typical Firing Diagram

50% influence on gas flow for the same energy conversion

Combustion process influence on particle size

Fly Ash Mean Particle Size

- Bark
- Wood
- Rape Press Reminder
Raw Gas composition range

- Huge variation of particulate concentration
- HCl and SO$_2$ variation is similar between EfW and Biomass
- Up to five time higher heavy metals concentration in EfW compared with Biomass

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Consequence of the IPPC and the new Industry Directive

Customers asks for lower ELVs in order to get public acceptance and permit

New plants with lower ELVs becomes BAT

Driving down the emissions

New plants are permitted with lower ELVs

New plants are built and commissioned with lower ELVs

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ESP experience for ESP after Grate Boilers fired with Woody Biofuels

Emissions < 10 mg/Nm³ are frequently achieved

ESP Separation Efficiency

Bimodal particle distribution

ESP separation efficiency
ESP Mechanical & Electrical upgrade

Some measures:

**Mechanical**
- Align the electrode distances or replace internals
- Secure optimal gas flow distribution
- Reduce sneakage above the electrodes and in the hopper
- Upgrade rapping system

**Electrical**
- Improve ESP controller
- Improve energy supply

**Other**
- SO₂ or NH₃ Conditioning
- Extension of one field
- Add one field

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**Gas sneakage effect**

**Inlet dust concentration**

\[ \frac{100 \times 000}{99.9\%} = 100000 \text{ mg/m}^3 \]

**Outlet dust concentration**

\[ \frac{0.1\%}{50} = 50000 \text{ mg/m}^3 \]

**Active area**

\[ = 9.99 \text{ mg/Nm}^3 \]

**Sneakage area**

\[ = 50.00 \text{ mg/Nm}^3 \]

**Total**

\[ = 60 \text{ mg/Nm}^3 \]
The cellular ESP field controller –
each bus section is individual

Energisation
- Spark control
- SemiPulse
- EPOQ Algorithm

Electrode cleaning
- Rapper control
- PCR - Power Control
- Rapping

Other
- Alarm handling
- Opacity optimization

Efficiency Improvements with EPIC & PCR
Ripple Difference Between SIR and Conventional T/R

No. of SIRs by Application & corresponding SIR emissions (2004)

Baseline - Emission with conventional T/Rs = 100%
Fabric filter

- **High removal efficiency**
  - dust emissions in the range of 5 mg/Nm³
  - occasionally levels down to 0.1 mg/Nm³
  - normally 99.9% or more of the inlet particulate matter also for sub-micron-sized particles.

- **Collection efficiency is not markedly affected by changes in:**
  - flue gas chemical composition
  - dust loadings
  - swings in boiler operating conditions and loads
  - flue gas temperature

- **Dual capacity of**
  - particulate control device and
  - highly efficient chemical reactor for absorption of gaseous components.

Sectional overview of Sunagawa FF
EP→FF conversion procedure

Bag plate under construction

Pressure tank under construction

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Some factors affecting acid gas abatement

- **Type of system**
  - Dry Absorption System
  - Semidry Absorption System
  - Wet System

- **Removal efficiency** is dependent on
  - Type of reagent (quick lime, slaked lime, bicarbonate)
  - Operating temperature (lower temperature gives higher removal)
  - Relative humidity (higher RH gives higher removal)

- **End Product**

Reagents

- **Limestone** used in an FB boiler is converted to burnt lime, which can be used in a NID system
- **Quick Lime** is used in the NID. The NID hydrator creates an efficient high surface area lime
- **Slaked lime** is used in the Dry or NID systems
  - Pore volume 0.08 – 0.1 cm$^3$/g
  - BET surface 15 – 20 m$^2$/g
- **Sorbacal** is used in the Dry or NID systems
  - Pore volume 0.2 cm$^3$/g
  - BET surface 40 m$^2$/g
- **Bicarbonate** temperature range 90 – 300 °C. Less sensitive to variations in RH. Needs to be milled before injection. SO$_2$ removal is not dependant on HCl in flue gas.
**Lime chemistry**

**Sulphur reactions**

\[ \text{Ca(OH)}_2 + \text{SO}_2 \rightarrow \text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O} + \frac{1}{2} \text{H}_2\text{O} \]

\[ \text{CaSO}_3 + \frac{1}{2} \text{O}_2 \rightarrow \text{CaSO}_4 \]

**Chloride reactions**

\[ \text{Ca(OH)}_2 + \text{HCl} (g) \rightarrow \text{CaCl}_2 + 2 \text{H}_2\text{O} (g) \]

\[ \text{Ca(OH)}_2 + \text{HCl} (g) \rightarrow \text{Ca(OHCl) + H}_2\text{O} (g) \]

**Combined reactions**

\[ \text{CaOHCl} + \text{SO}_2 + \frac{1}{2} \text{H}_2\text{O} \rightarrow \text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O} + \text{HCl} (g) \]

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**Dry Absorption System (DAS)**

![Diagram of Dry Absorption System](image)

- Conditioning tower
- Fabric Filter
- Water
- Flue Gas Fan
- Lime
- Activated Carbon
- Residue Silo
- Recirculation
**Söderenergi**

![Diagram of a power plant system with Boiler, Fabric Filter, Condenser, ID Fan, Lime, Bicarbonate, Activated Carbon, H₂O, To ash silo, To water treatment, ID Fan.](image)

**Combined system dry**

**Ferrara, Italy**

Semi Dry Absorption System (NID)

NID Mixer/Hydrator
Combined Systems

Jönköping, Sweden

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Summary & Conclusions

Several options are available to improve the performance of existing plants:

- Particulate removal
  - ESP upgrade
    - Mechanical
    - Electrical (EPIC and SIR)
  - ESP to FF conversion

- Acid gases, mercury and dioxin
  - Change of lime to high surface type
  - Change to bicarbonate
  - Introduce activated carbon
  - Add one filter to a dry scrubber
  - Add a wet scrubber