Uppgradering av rökgasreningssystem

Bo Herrlander

Södertälje, 2010-02-03

ALSTOM

Agenda

ALSTOM

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

Introduction

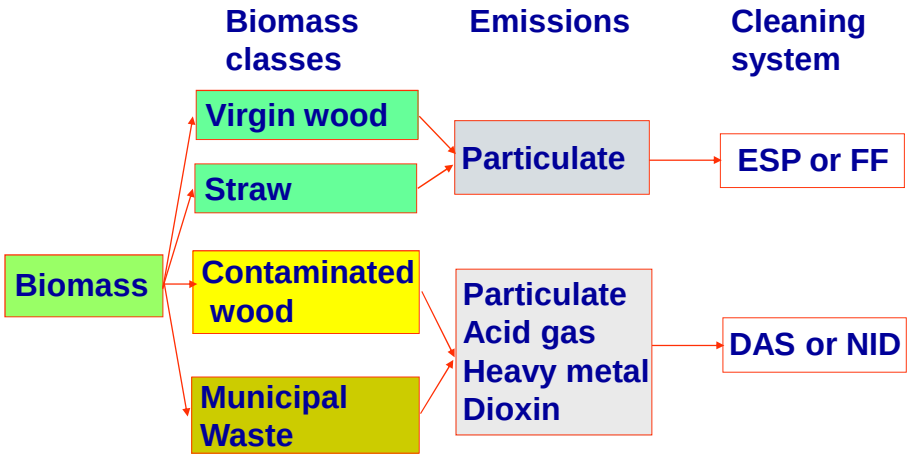
- One of the more common reasons for upgrading a gas cleaning plant is an increase in production of heat and electric power
- Also there are more and more fuel fractions available on the market, that may offer better economy
- Such changes may lead to change in
  - gas flow
  - fly ash particle size 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

Agenda

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

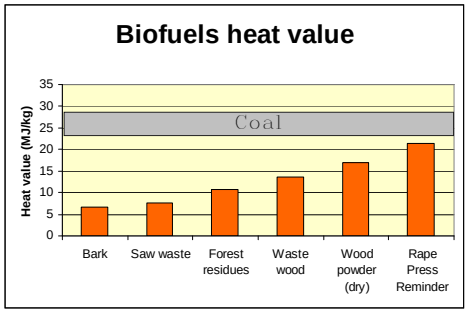
Some Biomass Fired Plants
Gas Cleaning Options Simplified

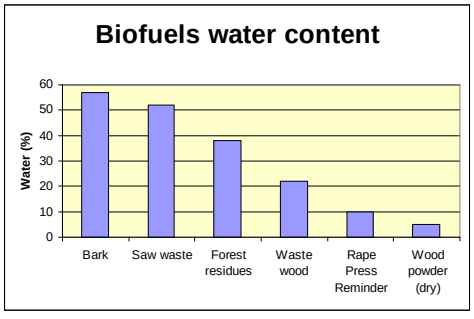
ALSTOM



Biofuels
Some examples

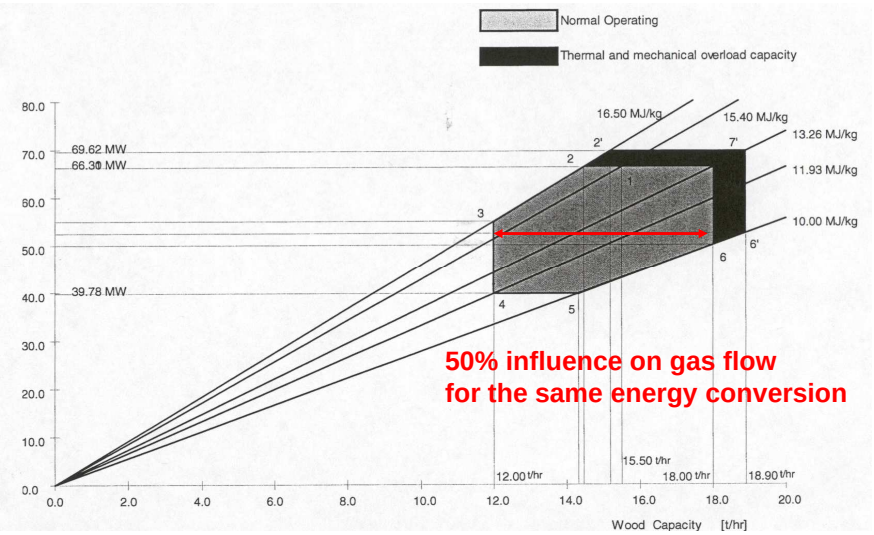
ALSTOM



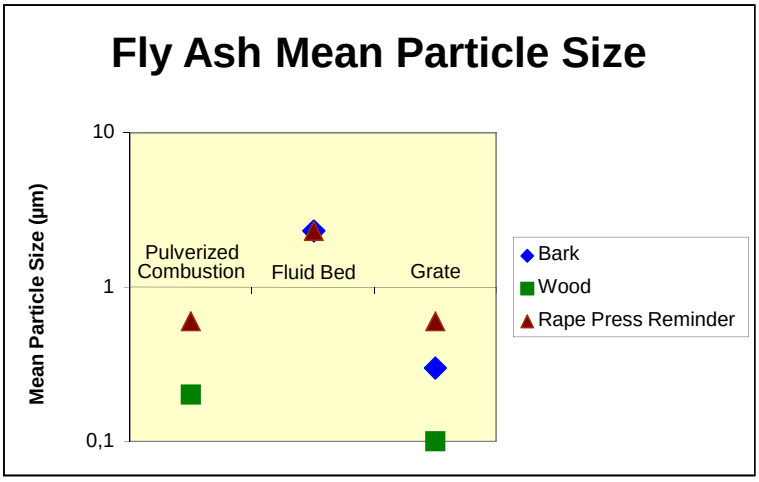


- Most Biofuels Energy Density and Water Content makes it uneconomical to transport further distances
- In Sweden the average transport distance is 70 to 100 km
- The local composition of available Biofuel varies

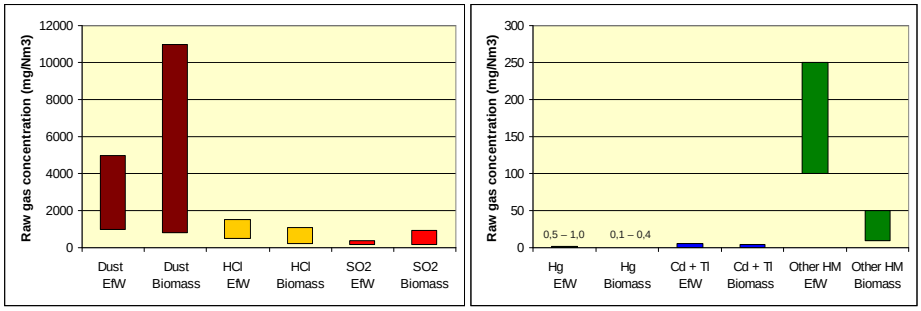
Typical Firing Diagram



Combustion process influence on particle size



Raw Gas composition range



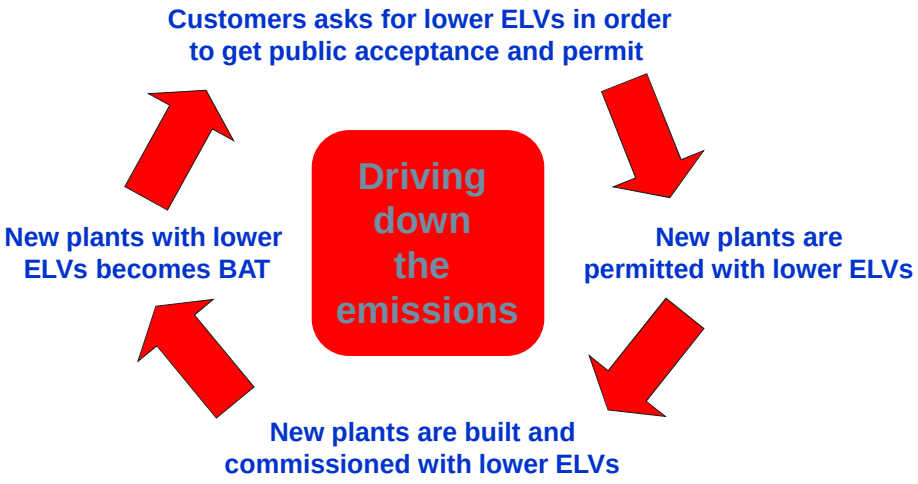
- Huge variation of particulate concentration
- HCl and SO_2 variation is similar between EfW and Biomass
- Up to five time higher heavy metals concentration in EfW compared with Biomass

Agenda

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

Consequence of the IPPC and the new Industry Directive

ALSTOM

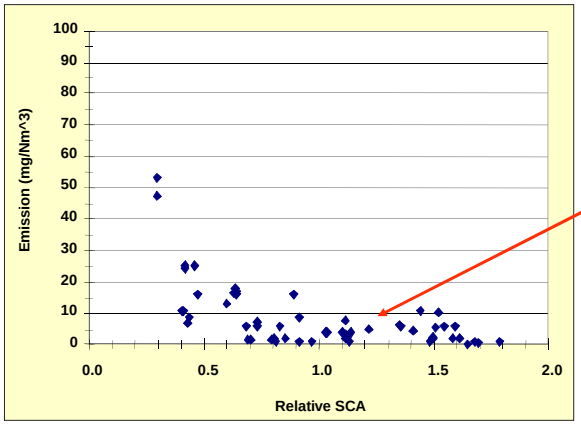


Agenda

ALSTOM

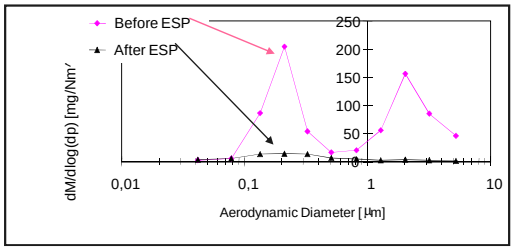
- 1st topic Introduction
- 2nd topic Fuel flexibility
- 3rd topic Regulations
- 4th topic Particulate / Heavy metals
- 5th topic Acid gases
- 6th topic Summary & Conclusion

ESP experience for ESP after Grate Boilers fired with Woody Biofuels

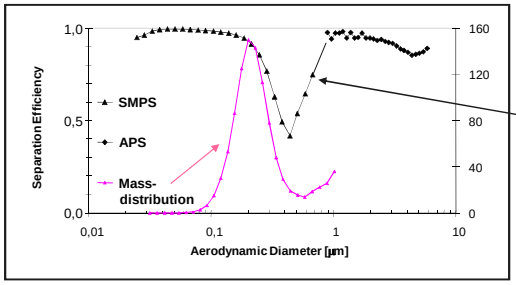


Emissions < 10 mg/Nm^3 are frequently achieved

ESP Separation Efficiency



Bimodal particle distribution



ESP separation efficiency

ESP Mechanical & Electrical upgrade

ALSTOM

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

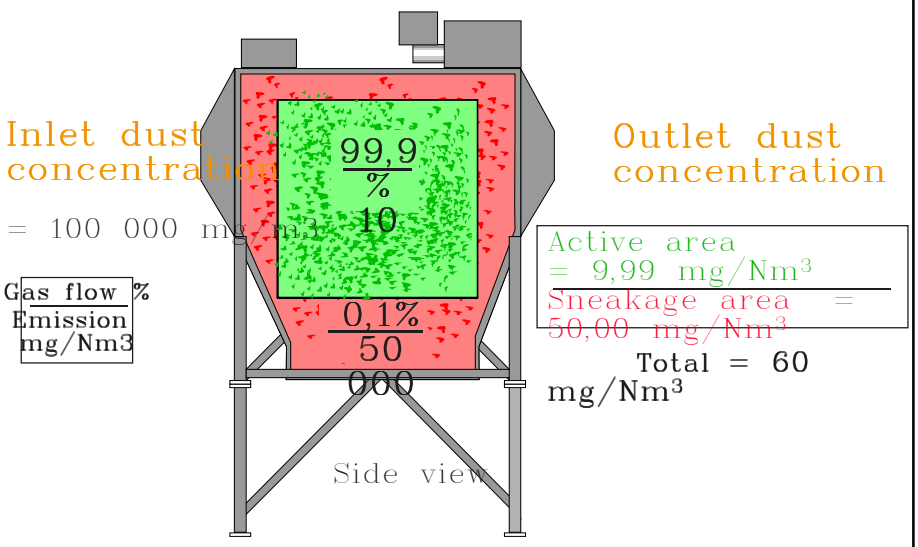
- **Improve ESP controller**
- **Improve energy supply**

Other

- **SO_2 or NH_3 Conditioning**
- **Extension of one field**
- **Add one field**

Gas sneakage effect

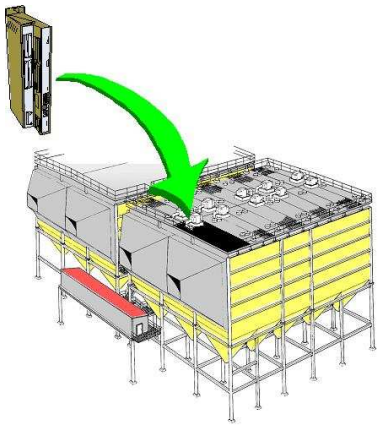
ALSTOM



EPIC III

ALSTOM

The cellular ESP field controller – each bus section is individual



Energisation

- Spark control
- SemiPulse
- EPOQ Algorithm

Electrode cleaning

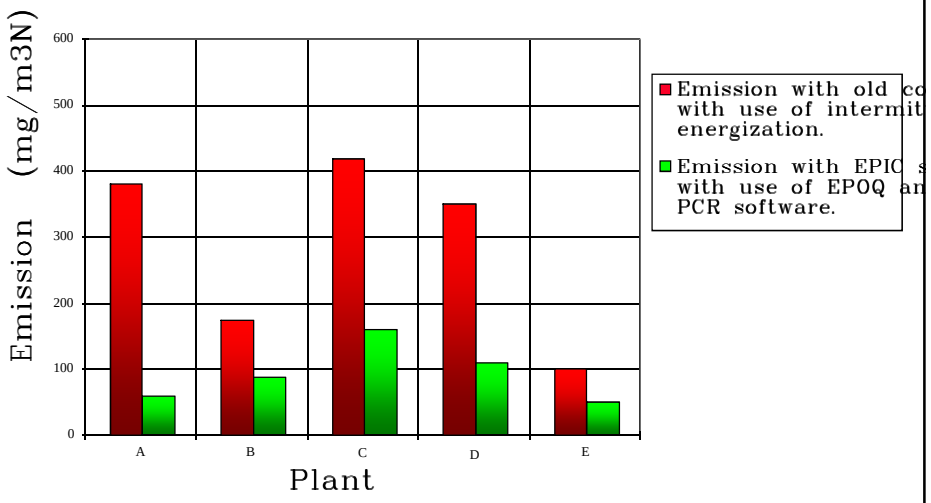
- Rapper control
- PCR - Power Control Rapping

Other

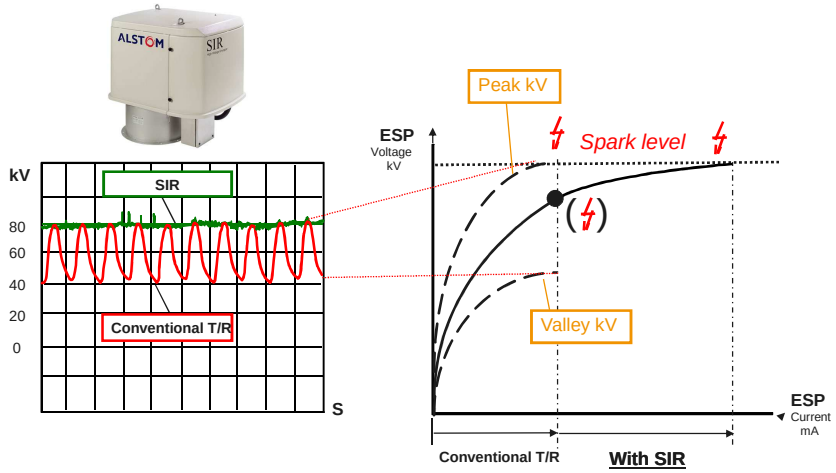
- Alarm handling
- Opacity optimization

Efficiency Improvements with EPIC & PCR

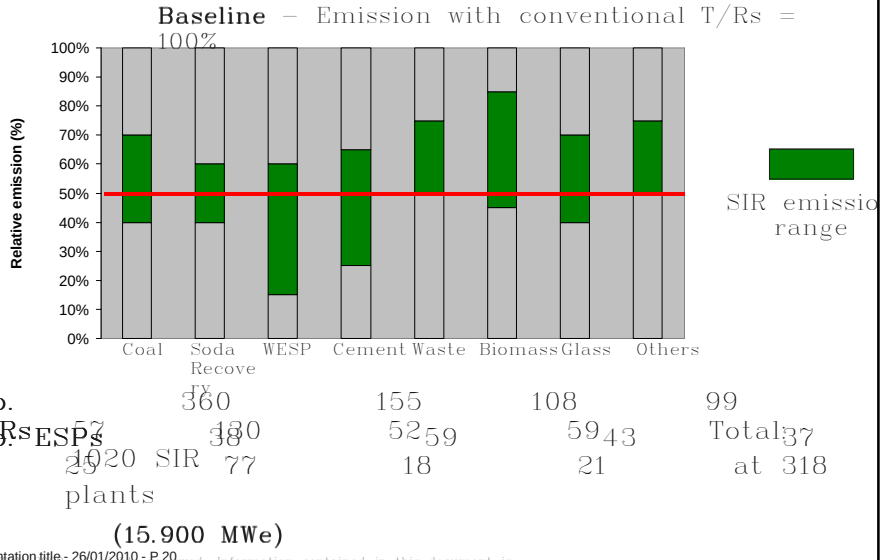
ALSTOM



Ripple Difference Between SIR and Conventional T/R



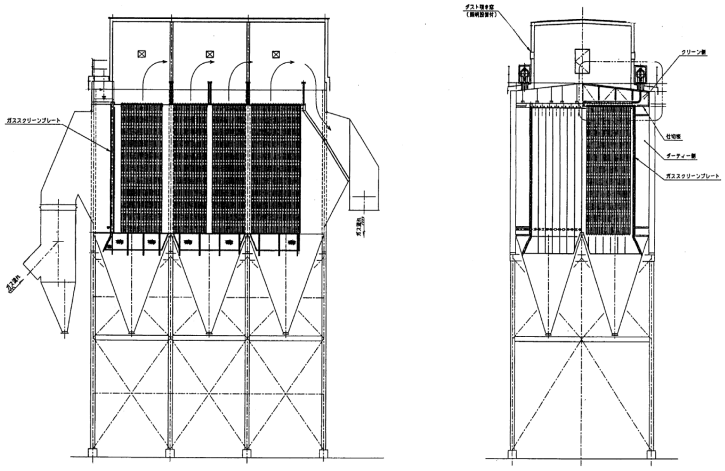
No. of SIRs by Application & corresponding SIR emissions (2004)



Fabric filter

- **High removal efficiency**
  - dust emissions in the range of 5 mg/Nm^3
  - occasionally levels down to 0.1 mg/Nm^3
  - 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

ALSTOM

Bag plate
under construction

Pressure tank
under construction

Agenda

ALSTOM

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

Some factors affecting acid gas abatement

ALSTOM

- **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

ALSTOM

- **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 ℃. 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

ALSTOM

Sulphur reactions

$Ca(OH)_2 + SO_2 \longrightarrow CaSO_3{*}1/2\ H_2O + 1/2\ H_2O$

$CaSO_3 + 1/2\ O_2 \longrightarrow CaSO_4$

Chloride reactions

$Ca(OH)_2 + HCl_{(g)} \longrightarrow CaCl_2 + 2\ H_2O_{(g)}$

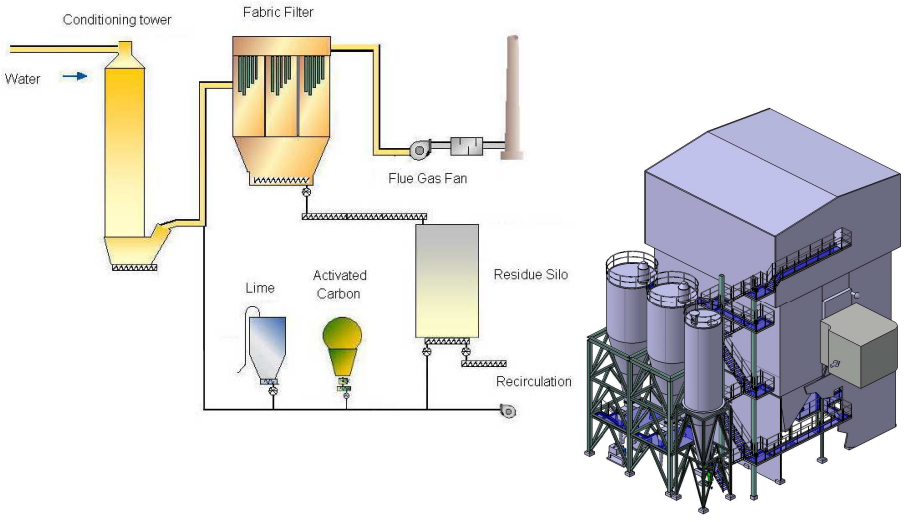
$Ca(OH)_2 + HCl_{(g)} \longrightarrow CaOHCl + H_2O_{(g)}$

Combined reactions

$CaOHCl + SO_2 + 1/2\ H_2O \longrightarrow CaSO_3{*}1/2\ H_2O + HCl_{(g)}$

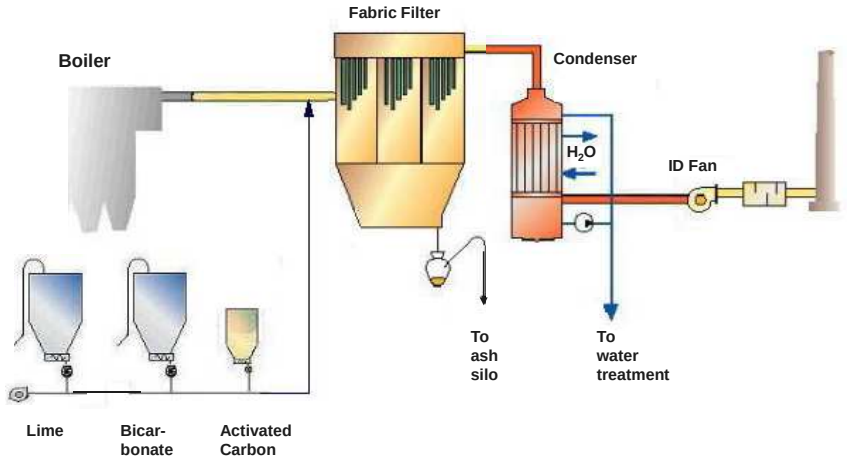
Dry Absorption System (DAS)

ALSTOM



Söderenergi

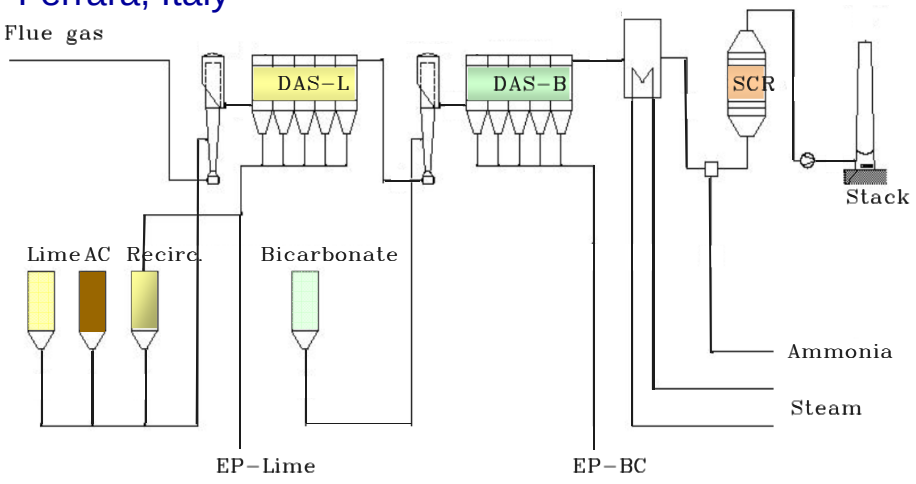
ALSTOM



Combined system dry

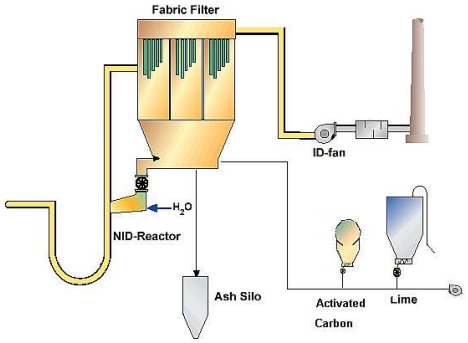
ALSTOM

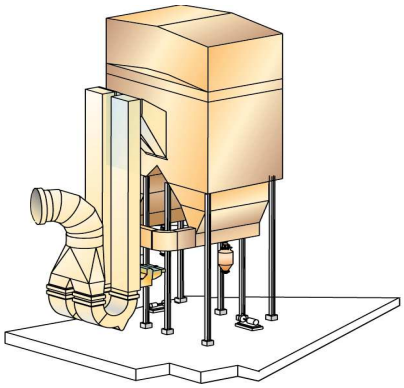
Ferrara, Italy



Semi Dry Absorption System (NID)

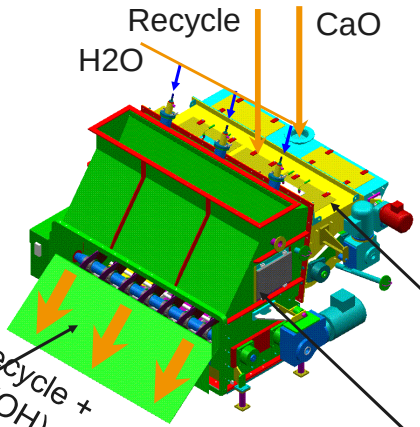
ALSTOM





NID Mixer/Hydrator

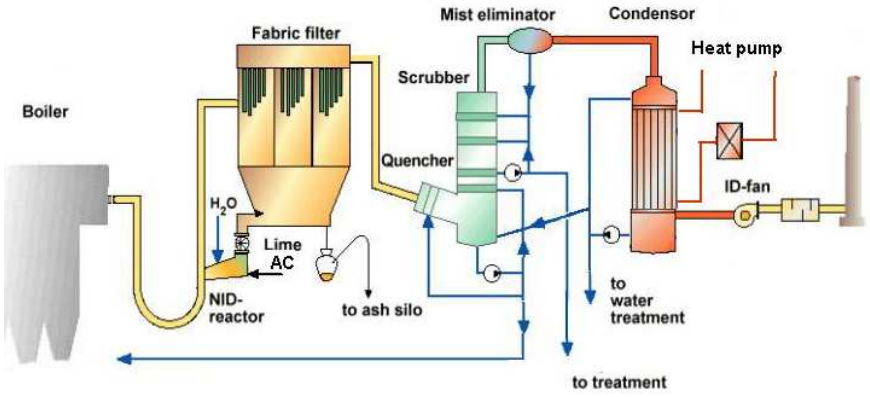
ALSTOM



Combined Systems

ALSTOM

Jönköping, Sweden



Agenda

ALSTOM

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

Summary & Conclusions

ALSTOM

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

www.alstom.com

ALSTOM