Improving Precipitator Performance

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Proper Design Requires Operating Experience

Efficiency = 1 - $e^{-(w_k \cdot SCA \cdot C)^k}$

Where:

W_k = Modified Migration Velocity

SCA = Specific Collection Area

C = Constant (0.001968)

Design Procedure

From a reference facility, determine w_k for the target fuel

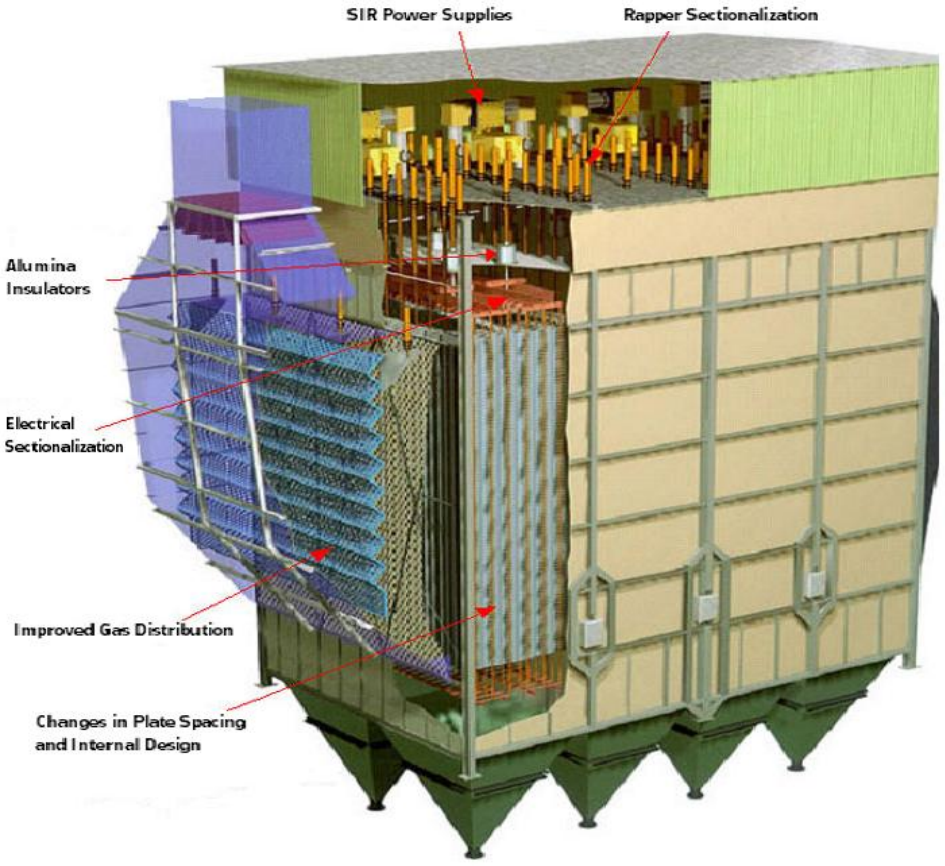
Find the Base w_k by adjusting the measured w_k for specific site conditions

Apply the Base w_k to the new installation to determine required sizing

Improve Migration Velocity and/or SCA by adopting one of the different technologies.

Sizing and Performance Prediction Requires a Representative Data Base

Methods Utilized For Performance Improvement



Potential Performance Enhancements

- **Evaluate design conditions**

  Coal & Ash analysis, gas flow rate, emission requirements

- **Upgrades to Enhance Performance**
  - Improved Gas Distribution
  - Increased SCA by Adding Plate Height or Treatment Length
  - Better Field Sectionalization
  - Improved Collecting and Discharge Electrode Systems
  - Better Rapping Systems or Rapper Sectionalization
  - Installation of New Controls
  - Installation of High Frequency Power Supplies

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Evaluation of Boiler and ESP Operations

Boiler Evaluation and Fuel Characteristics

- Boiler Operation
  - Gas Volume at the Precipitator in Line With the Precipitator Design?
  - Is the Air Heater Outlet Temperature Within Design Parameters?
- Fuel Characteristics
  - Does the Fuel Being Fired Meet the Criteria of the Precipitator Design Fuel?

ESP Operation Evaluation and Repairs

- Repair Misalignment
- Replace Missing or Damaged Electrodes
- Verify Proper Rapper Operation
- Insure all Auxiliary Systems are Functioning Properly
- Reduce the Amount of Plate Surface Being Rapped by One Device
- Consider Power-down/Power-off Rapping Where Advisable

ESP Upgrade Options
Typical Scope

Options for Upgrading ESP's to Meet Specific Emission Requirements

Improve Gas Distribution

- CFD/physical model study
- Modify gas distribution devices
- Address sneakage, casing leaks, etc.

Increase SCA

- Add treatment length
- Use inter-field space (rigid frame designs)
- Increase collecting plate height
- Alignment of C.E. Plates

Change electrode geometry

- Replace plates &/or change plate spacing
- Change discharge electrode design (RDE's)

Improve Field Sectionalization

- Consider splitting electrical fields
- Add additional T/R's

Upgrade rapping systems

- Change rapper design
- Increase rapper sectionalization
- Install additional rapping, if necessary
- Upgrade Controls
- Off-Flow Rapping

Install Improved Control Systems

- EPIC III AVC's
- ERIC Rapper controls

Replace Conventional T/R's

- SIR (Switched Integrated Rectifiers)
  - Increase average field voltage
  - Improve collection efficiency

Gas Conditioning

- To lower resistivity

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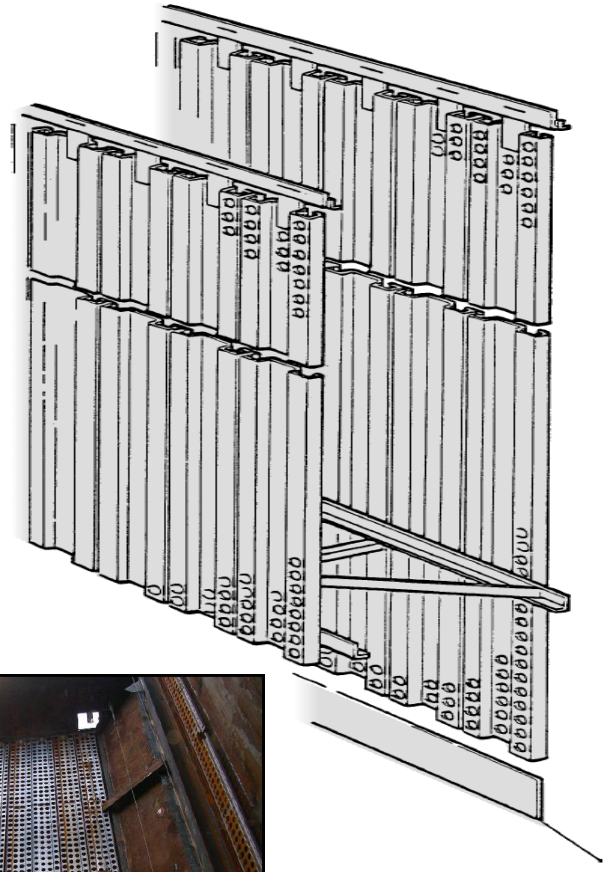
Improve
Gas Distribution

Alstom Gas Distribution Systems

- Many older installations were designed to lower gas distribution standards than exist today.
- Proper gas distribution (ICAC standards) should be verified with a field velometer study
- Modifications to the existing system may be capable of lowering emissions
- Major changes (field addition, etc.) usually require a flow study – CFD or physical model
- Alstom standard gas distribution system consists of:
  - Roll formed 16 gauge inlet perforated plates with sloped, adjustable baffles
  - Outlet channel grid to minimize buildup



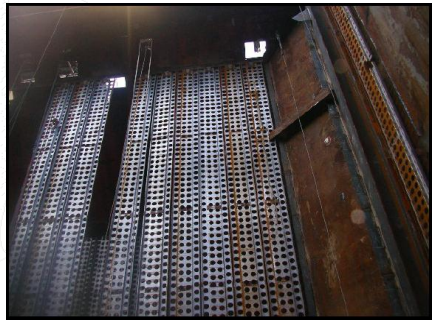


Plate Spacing_ Electrode Geometry

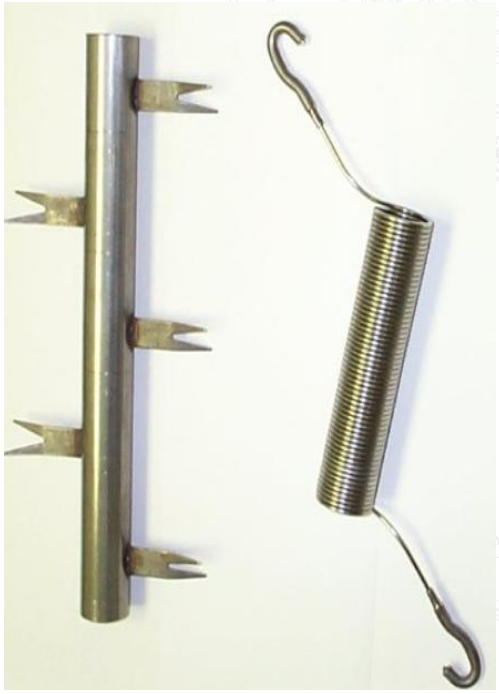
Options for Collecting Plate Spacing

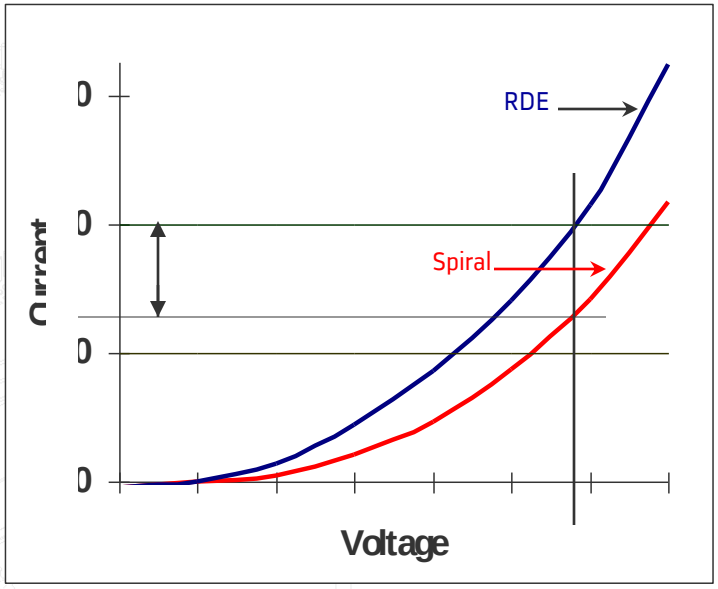
- Typical plate spacing for older ESP's range from 9" to 12"
- Alstom (CE-ESD), along with EPRI and Southern Research Institute, conducted fundamental research in the mid 1980's to study the viability of increased plate spacing
- Conclusion reached was that plate spacing in an existing ESP can be increased up to 16" with little to no adverse affect on collection efficiency
- Benefits include:
  - Lower initial cost
  - Lower long term maintenance cost
  - Reduced sensitivity to minor mis-alignment

Discharge Electrode System

Discharge Electrode Types

- RDE's for Moderate Resistivity Applications
- Spiral Wires for Moderate or High Resistivity Ash





Multipeak® RDE is ideal for low and moderate resistivity applications or in inlet fields where high space charge exists

Spiral wires achieve the higher field voltage levels needed in high resistivity situations or in the rear fields for most applications

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Optimize Rapping

Tumbling Hammer Rappers

Simple mechanical design

Cost-effective

Bottom rapping decreases ash build-up

Lower ash and resistance increases collection

Electromagnetic Impact Rappers

Simple, reliable design

PC Rapping can lower emissions on average 30%

Multi-rap operation reduces re-entrainment

Excellent rapping sectionalization

Electrical Upgrades- Bang for the buck

- **Electrical Upgrades**
  - Replace Conventional T/R's with High Frequency Power Supplies
  - Optimize Traditional T/R Controls
  - Install Automatic Voltage Controls with Advanced Control Functions
    - Integrated Rapping Control
    - Power-down/Power Off Rapping
    - Intermittent Energization
    - Opacity Optimization Algorithms

Summary

Evaluation of the total system needs to be taken into consideration

- Boiler and ESP operations
- Tuning and simple improvements to existing system can make big improvements
  - Gas Distribution
  - Collecting and Discharge Electrodes
  - Efficient Rapping
  - ESP Electronics
- Mechanical and electrical upgrades may be necessary
  - Increase SCA
  - Upgrade rapping design
  - Gas conditioning
  - Improve electrical fields and plate/electrode spacing
  - Increasing T/R's or HFPS's for sectionalization

Thank you for your time

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