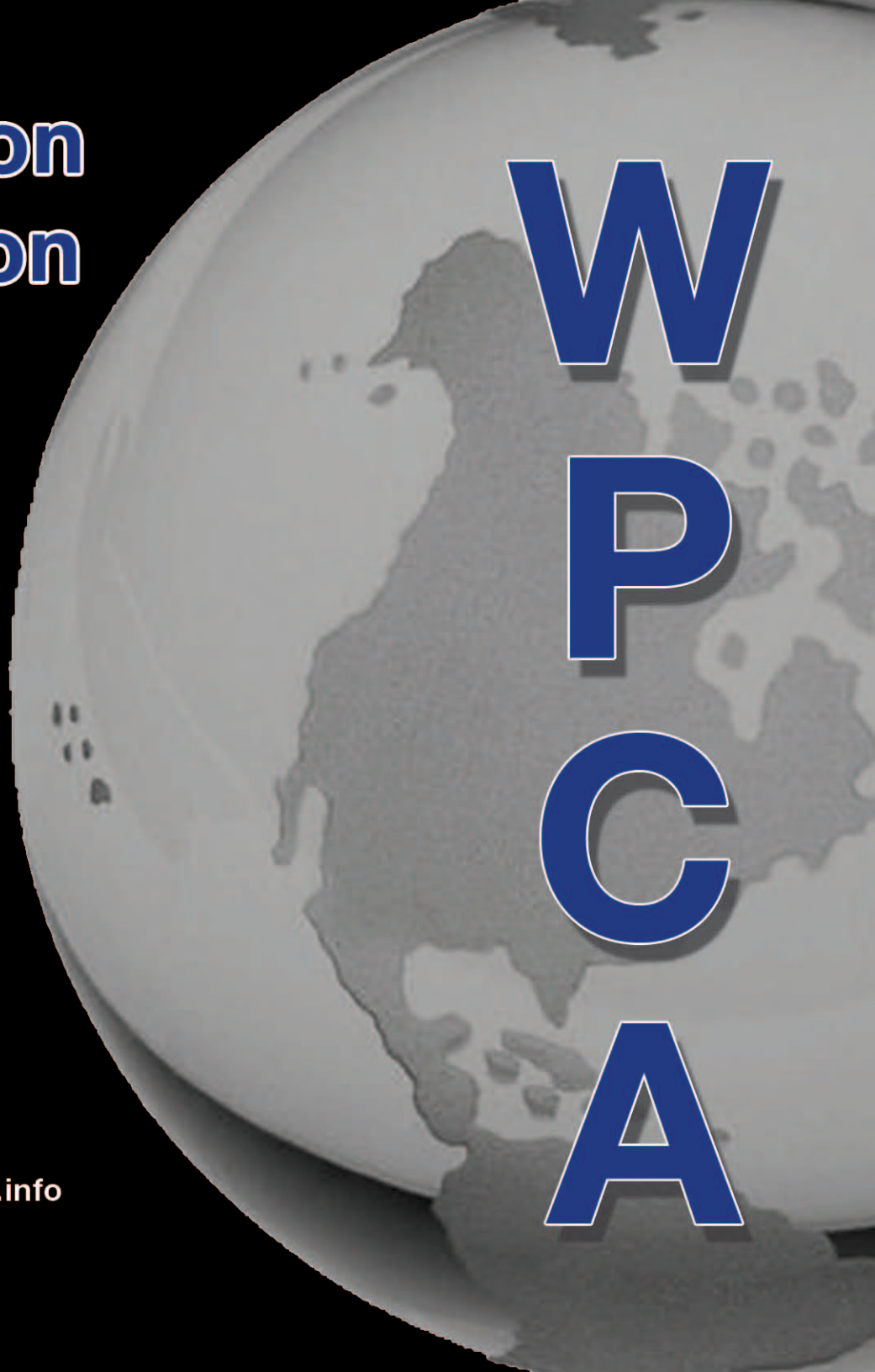
Worldwide Pollution Control Association

WPCA/FirstEnergy Biomass Seminar

Akron, Ohio
December 3, 2009

Visit our website at www.wpca.info



Air Pollution Control Considerations for Biomass Firing of Existing and New Boilers

Photosynthesis (Nature's Solar Storage Battery)

$CO_2 + 2H_2O + photons = (CH_2O)n + H_2O + O_2$

Carbon Dioxide + water + light energy = carbohydrate + oxygen + water

Cellular metabolism converts simple sugars into cellulose, lignin, oils, etc.

Combustion – Extracting the Stored Energy

$(CH_2O)_n + O_2 + heat = CO_2 + H_2O + Heat$

Carbohydrate + Oxygen + heat =

Carbon Dioxide + Water + **Heat**

Air Pollution from Biomass Combustion Sources

Air Pollution from Biomass Combustion Sources

- SO_X – typically not a significant source
  - S in fuel – 0.0-0.1% (Unless sulfur containing additives)
  - Stoker type boilers < 0.03 lb/mmBtu SO_2 (typical)

Air Pollution from Biomass Combustion Sources

NO_X

- 2 primary ways NOx is formed in industrial-scale combustion processes:
  - Oxidation of the Nitrogen in the fuel
  - Oxidation of the N_2 in the combustion air – 2800 degF and higher
- Typically, not a significant source
  - Fuel content typically <0.5%
  - Lower combustion temperatures
- Stoker type boilers , 0.05 lb/mmBtu – NO_2 (typical)

Air Pollution from Biomass Combustion Sources

- CO & VOC – Primarily functions of boiler design & operation

Air Pollution from Biomass Combustion Sources

Particulates

- 1-5% ash content; less than coal
- Lower Btu content than coal due to moisture

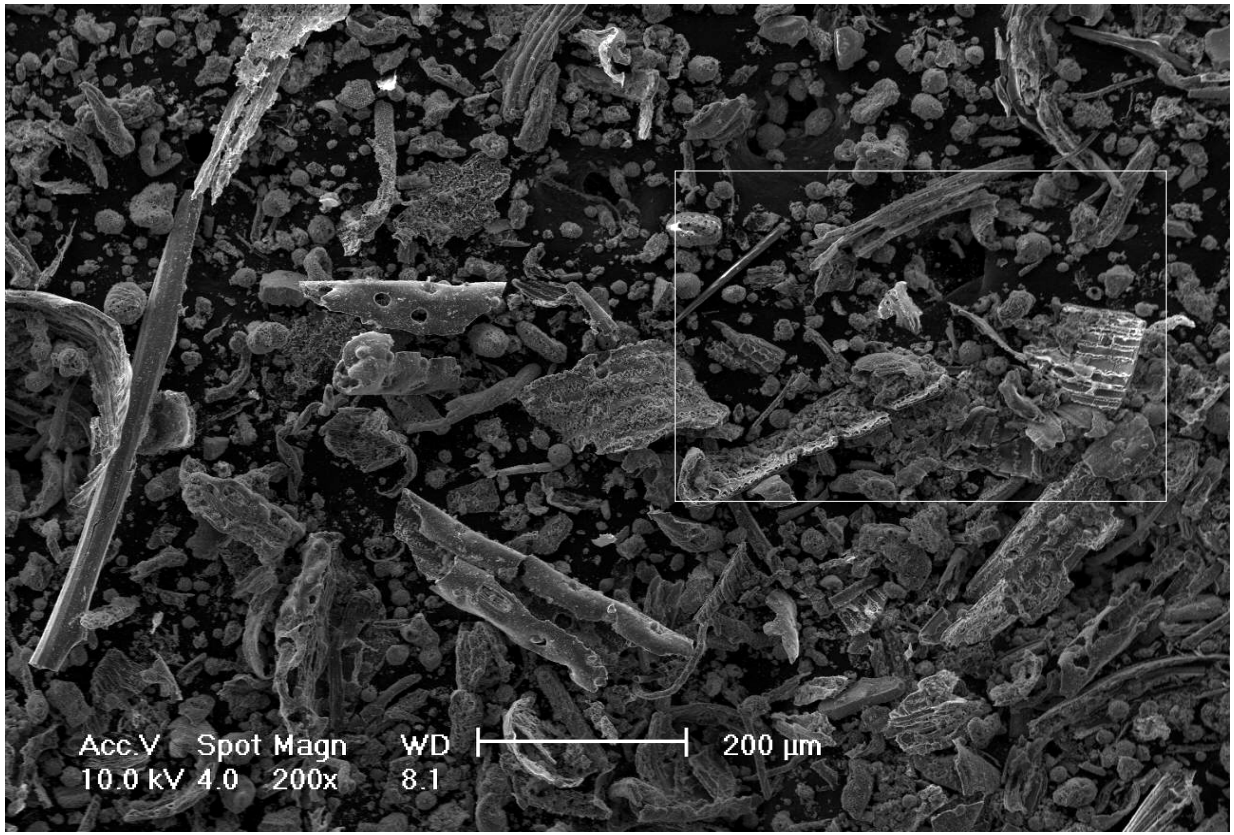
Air Pollution from Biomass Combustion Sources

- **Particulate Emissions from biomass combustion sources**
  - **Stoker Fired – high LOI, embers**
  - **Fluidized – low LOI, possible high grain loading due to media carry-over**
  - **Wall fired – generally co-fired with fossil fuels; fossil emissions dominate**

Ash Characteristics of Wood Based Fuels

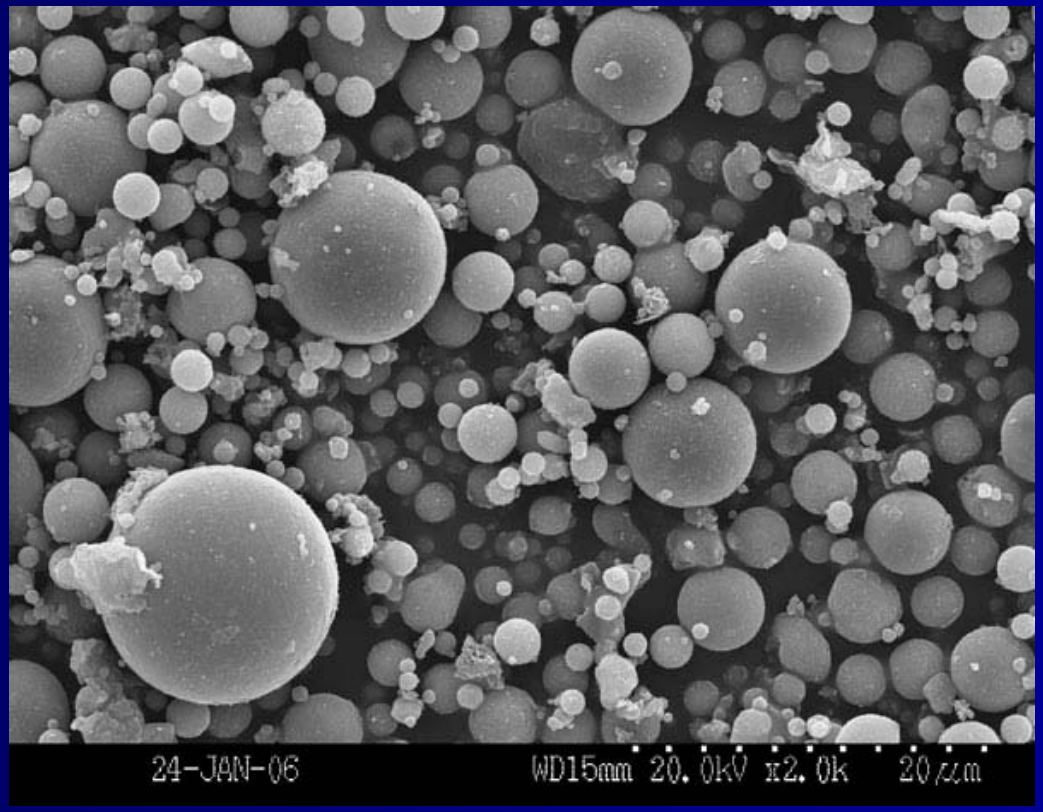
- Light and Flaky
- Low Resistivity
- High LOI – up to 75%, 20-40% typical (N/A fluidized bed)
- Can have high silica content (sand from logging, transport, & storage)
- Can have high sodium or potassium salts content (log transportation in brackish or saltwater)
- Can have high phosphorus content (fertilizer or phosphate soils)

Ash Characteristics of Wood Based Fuels



SEM Image of K295-15-5

Ash Characteristics of Wood Based Fuels

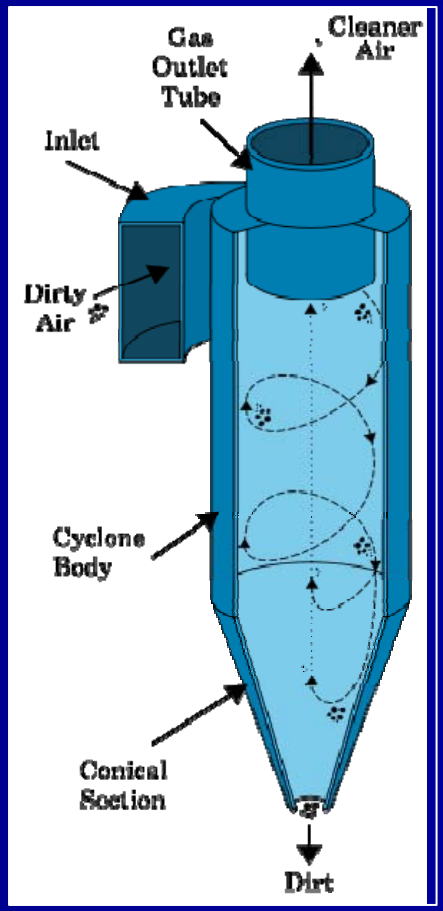


SEM Image of Coal Flyash

Existing Particulate Control Technologies for Biomass

Mechanical Collector (Cyclone, Multi-clone)

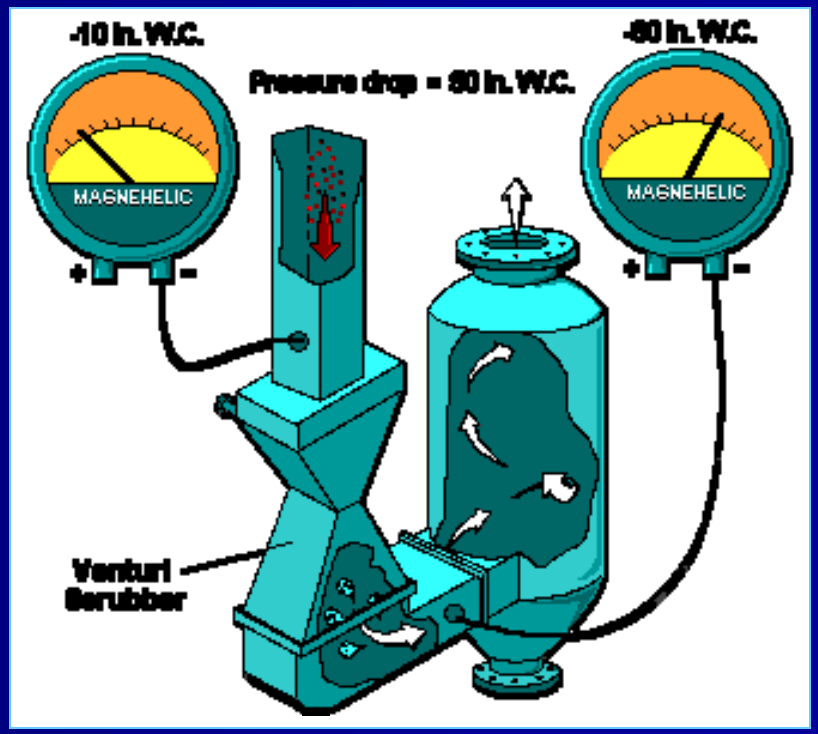
- Moderate Pressure Drop
- Suitable for >10.0 micron particles
- Excellent as spark arrestor



Existing Particulate Control Technologies for Biomass

Wet Scrubber

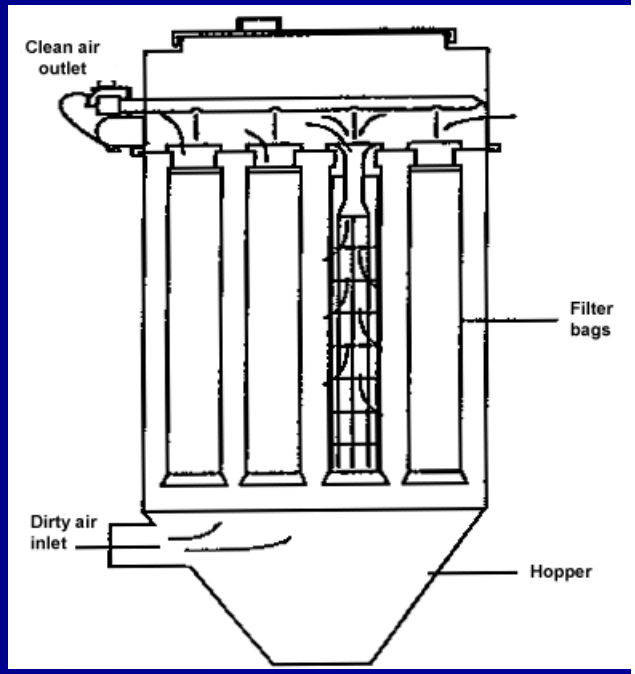
- High Pressure Drop
- Suitable for >2.5 micron particles
- Requires water treatment system
- Not susceptible to fires



Existing Particulate Control Technologies for Biomass

Fabric Filter (Baghouse)

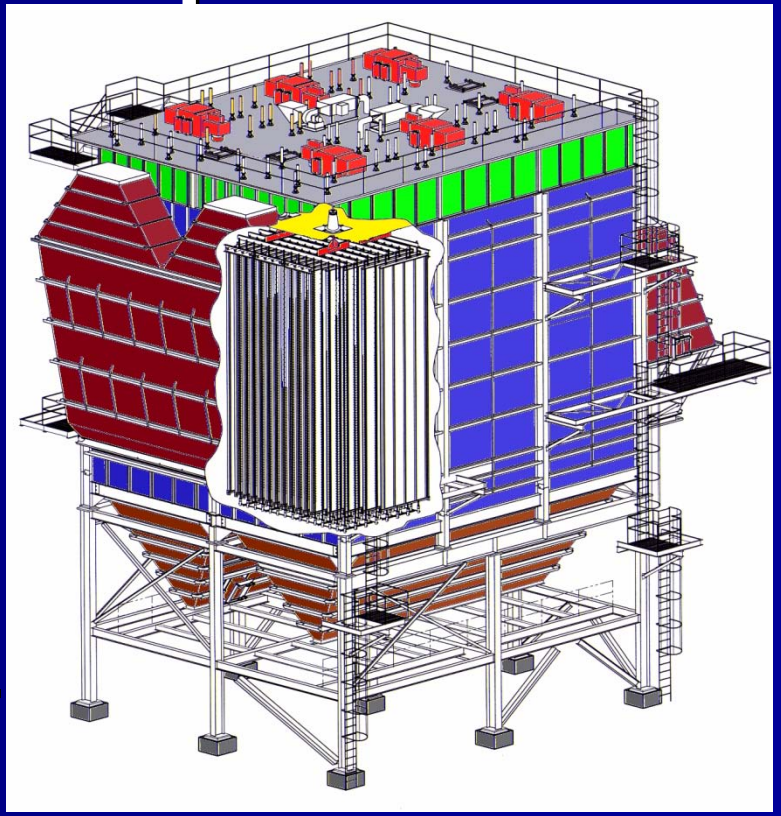
- Moderate to High Pressure Drop
- Suitable for sub-micron particles
- Temperature limited <400degF
- Susceptible to pinhole leaks
- Susceptible to fires (Stoker)
- Best suited for fluidized bed boilers



Existing Particulate Control Technologies for Biomass

Dry Electrostatic Precipitator

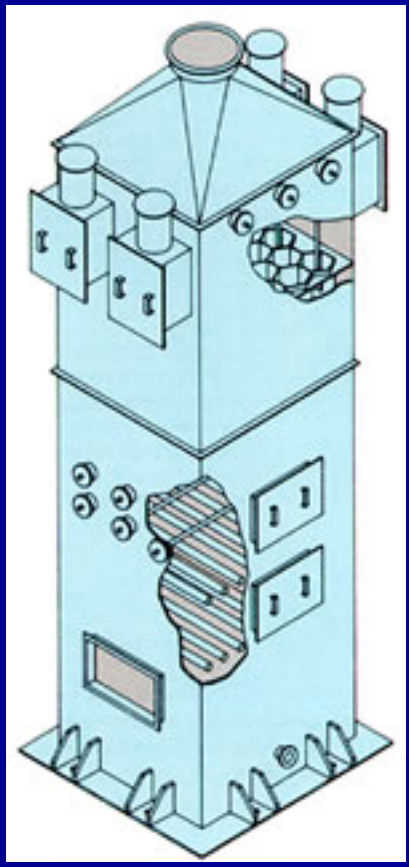
- Low Pressure Drop
- Suitable for sub-micron particles
- Suitable for all types of boilers
- Susceptible to fires (O_2 should be < 6%)
- Typically used with multi-clone for spark arrest



Existing Particulate Control Technologies for Biomass

Wet ESP

- Moderate Pressure Drop (when combined with scrubber or saturator)
- Suitable for sub-micron particles
- Requires saturated flue gas (wet scrubber or saturator)
- Requires water treatment system
- Materials of Construction - $$$



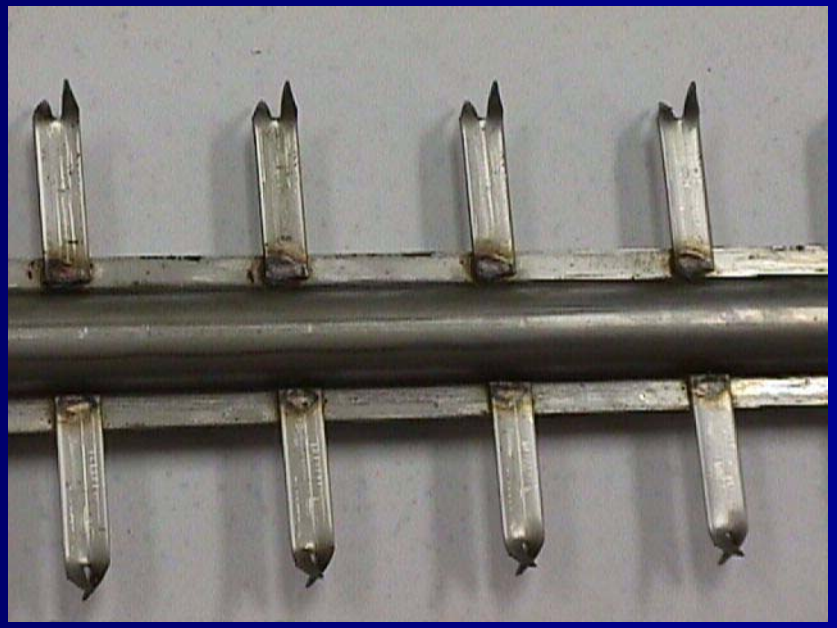
New Particulate Control Technologies for Biomass

New techniques are being applied to the existing Particulate Control Devices to greatly improve their performance

New Particulate Control Technologies for Biomass

New techniques for Dry ESP's

- Rigid Discharge Electrodes
  - SEI / ELEX RS opposed & staggered
    - VI characteristics tailored to each field



New Particulate Control Technologies for Biomass

New technologies for Dry ESP's (cont.)

- Switch-Mode Power Supplies
  - Micro-second vs. milli-second response
  - 3-5% ripple vs. 35-45%
  - Up to 30% better performance compared to conventional TR set.
  - Smaller, lighter vs. TR set
  - 3-ph with 0.94 pf vs. 1-ph with 0.63 pf = energy savings

New Particulate Control Technologies for Biomass

New techniques for Dry ESP's (cont.)

- **Wide Collecting Electrode spacing (16" +)**

  Greater clearances = higher field voltages = higher corona currents (charging) = higher power = higher collection efficiency

- **Marriage of the 3 previously mentioned "new" Dry ESP technologies results in a synergy that provides performance comparable to fabric filter without the associated O&M costs**

New Particulate Control Technologies for Biomass

- New technologies for Wet ESP's
  - Switch-Mode Power Supplies
  - Polymer Membrane Collecting Electrodes
    - Corrosion-proof polypropylene felt
    - Continuous flushing
    - Less $ than metal CE's
  - Super-aggressive Rigid Discharge Electrodes

New Particulate Control Technologies for Biomass

New Particulate Control Technologies for Biomass

Conclusions

- Air Pollution Control cannot be an afterthought, but must be an integral part of the Biomass decision-making process
- When deciding on which APC technology to use, the latest proven techniques of each should be considered – possibly a combination of technologies