Multi-pollutant Control for Small Biomass Boilers

Lew Benson - Nalco Mobotec
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Overview of Talk

• Review of emission requirements for small biomass boilers for electricity and steam generation
  - ICI Boilers and Process Heaters major and area source final rules for air toxics
    • Biomass source category: >15% of heat input from biomass
  - Proposed air toxics rule for Electric Generating Units
    • Only for fossil-fuel fired boilers

• Control technology options to meet ICI Boiler major and area source requirements

• Recent requests for pollution control systems to meet ICI Boiler rules
Biomass fuel composition

- Usually wood, bark, hog fuel
- Wood chlorine content 0.02% by wt.
  - Fuel HCl 0.045 lbs/MM Btu
- Wood sulfur content e.g. 0.02% by wt.
- Paper mill clarifier sludge 0.05% Cl weight
  - Fuel HCl 0.2 lbs/MM Btu
- Bagasse
- Eucalyptus wood
ICI Boiler Air Toxics Rules

- Major sources
  - >25 TPY of air toxics or >10 TPY of single air toxic at site
- Area sources
ICI Boiler Major Source Limits
New Biomass Boilers

- Particulate matter (filterable) - 0.0011 lbs/MM Btu
- HCl - 0.0022 lbs/MM Btu
- Mercury - 3.5 lbs/T Btu
- Carbon monoxide
  - Stoker - 160 ppm at 3% O2
  - Fluidized bed - 260 ppm at 3% O2
  - Suspension/grate - 1500 at 3% O2
- Dioxins/furans
  - Stoker - 0.005 ng/Nm3 (TEQ)
  - Fluidized bed - 0.02 ng/Nm3 (TEQ)
  - Suspension/grate - 0.2 nm/Nm3 (TEQ)
ICI Boiler Major Source Limits
Existing Biomass Boilers

- Particulate matter (filterable) - 0.039 lbs/MM Btu
- HCl - 0.035 lbs/MM Btu
- Mercury - 4.6 lbs/T Btu
- Carbon monoxide
  - Stoker - 490 ppm at 3% O2
  - Fluidized bed - 430 ppm at 3% O2
  - Suspension/grate - 3500 at 3% O2
- Dioxins/furans
  - Stoker - 0.005 ng/Nm3 (TEQ)
  - Fluidized bed - 0.02 ng/Nm3 (TEQ)
  - Suspension/grate - 0.2 ng/Nm3 (TEQ)
ICI Boiler Major Source Limits
New Biomass Boilers

- Particulate matter (filterable)
  - 0.03 lbs/MM Btu for >30 MM Btu/hr
  - 0.07 lbs/MM Btu for >10 but <30 MM Btu/hr
ICI Boiler Area Source Limits
Existing Biomass Boilers

- No emission limits
Particulate Matter Control

- Filterable PM only controlled
- Existing units
  - ESP
  - Baghouse/fabric filter
  - Wet venturi scrubber - sometimes
- New units
  - Baghouse/fabric filter
  - ESP
- Aerosols from biomass
  - KCl vaporizes in furnace and condenses to aerosol
  - Venturi scrubbers have low efficiency for aerosols
**HCl Control**

- **Existing units - HCl limit (<28 ppmv)**
  - May be achieved without controls by low chloride content of biomass and Cl remaining as KCl particulate
  - E.g., wood with 0.02% Cl, 4500 Btu/lb
    - 0.046 lbs HCl/MM Btu if all fuel Cl converted to HCl
    - <0.035 lbs likely with fractional conversion of KCl
  - Dry alkali sorbent injection with baghouse or ESP
    - Sodium bicarbonate or trona
    - Hydrated lime
  - Circulating dry scrubber using lime
  - Wet venturi scrubber
  - Wet scrubber with NaOH
HCl Control

- **Existing units - HCl limit (<28 ppmv)**
  - Option to control HCl to <10 TPY at site to become synthetic minor source, fall under area source rule
  - Good combustion to lower CO may be necessary to keep total HAP’s at site <25 TPY

- **New units - HCl limit (<2 ppmv)**
  - Dry alkali injection with baghouse or ESP
  - Circulating dry scrubber using lime
  - Wet venturi scrubber
  - Wet scrubber with NaOH

- Alkali injection can affect PM emissions from ESP
CO Control

- Existing boilers are by far stokers
- New boilers mainly bubbling fluid bed or conversion of pulverized coal to stoker, occasionally pulverized dried biomass
- Challenging to reduce CO emissions for biomass firing
- Existing stoker combustion modifications
  - Over-fired air
  - Rotating Opposed-fire Air (ROFA)
  - SOFA
Dioxins/furans Control

- Unique pollutant formed after combustion process
- Biomass emissions inherently lower than municipal waste controlled emissions
- Existing and new boiler limits far lower than limits for municipal waste combustion
- Low D/F emission trends with low CO from good combustion
- Activated carbon injection for both existing and new boilers with baghouse or ESP
- Little reference data for determining required activated carbon injection rate
Mercury control

- Biomass inherently low in mercury
- Existing and new boiler limits similar to limits for coal for EGU major source MACT
- Activated carbon injection for both existing and new boilers with baghouse or ESP
- Sufficient reference data for determining required activated carbon injection rate
Requests for Control Systems to Meet ICI MACT limits for Biomass

- Existing boilers with baghouses and ESP
  - Stoker boilers
    - Activated carbon injection for D/F
    - Dry alkali (trona, hydrated lime) injection for HCl control
    - Plan to meet PM limit with existing ESP

- New boilers
  - Bubbling fluid bed boiler
    - Hog fuel plus clarifier sludge (high Hg)
    - Baghouse/fabric filter for PM
    - Alkali (trona, sodium bicarbonate, hydrated lime) for HCl, SO2, H2SO4 (SAM) control
    - Activated carbon for Hg, D/F control
  - 55 MW, 80 MW units permitted as synthetic minor sources by control of HCl to <10 TPY
    - Low uncontrolled HCl emission
    - Dry alkali injection with baghouse, ESP
    - <2 ppm HCl emission required
Summary of Talk

- Emission requirements for small biomass boilers for electricity generation
  - Existing boiler limits reasonable
  - New boiler limits very strict
  - All limit achievable though little reference data for control of D/F starting from low uncontrolled emissions

- Control technology options

- Requests for APC systems to meet ICI Boiler rules
  - Utility companies may opt for more capital intensive solution (semi-dry scrubber, circulating fluid bed scrubber)
  - Industrial companies asking for low capital, higher operating cost solutions (dry alkali)
  - Some new boilers applied for permit as synthetic minor sources