

REINHOLD ENVIRONMENTAL Ltd.



2010 APC Round Table & Expo Presentation

July 18-20, 2010, in Concord, NC / Hosted by Duke Energy

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Biomass 100% and Co-Firing Actual Experience

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Reinhold Environmental
2010 APC Round Table
Concord, NC
19 July, 2010

Today's Topics

Quick background - who is Nalco Mobotec, and what do we do?

Biomass types and characteristics.

Experience with some biomass conversion projects.

Recent detailed conversion study

Open session / questions

Who We Are

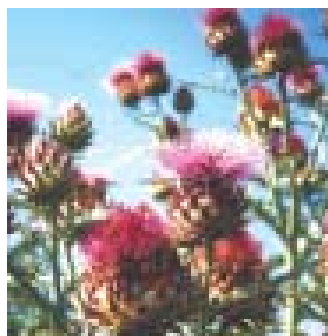
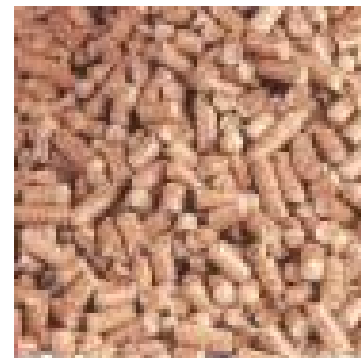
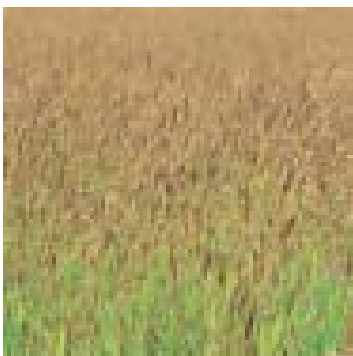
NALCO Mobotec is a Multi-Pollutant / Combustion Enhancement Technology Solutions Provider

Began as *Mobotec AB*, a Swedish Company, by Dr. Goran Moberg

Progressive development of multi-pollutant technologies for utility and industrial combustion sources

Became NALCO Mobotec in 2007

Various Types of Biomass



Biomass Characteristics

TYPICAL PROPERTIES OF SOLID FUELS									
Property	Coal	Peat	Wood without bark	Bark	Forest residues (coniferous tree with needles)	Willow	Straw	Reed canary grass (spring harvested)	Olive residues
Ash content (d)	8.5-10.9	4-7	0.4-0.5	2-3	1-3	1.1-4.0	5	6.2-7.5	2-7
Moisture content, w-%	6-10	40-55	5-60	45-65	50-60	50-60	17-25	15-20	60-70
Net calorific value, MJ/kg	26-28.3	20.9-21.3	18.5-20	18.5-23	18.5-20	18.4-19.2	17.4	17.1-17.5	17.5-19
C, % (d)	76-87	52-56	48-52	48-52	48-52	47-51	45-47	45.5-46.1	48-50
H, % (d)	3.5-5	5-6.5	6.2-6.4	5.7-6.8	6-6.2	5.8-6.7	5.8-6.0	5.7-5.8	5.5-6.5
N, % (d)	0.8-1.5	1-3	0.1-0.5	0.3-0.8	0.3-0.5	0.2-0.8	0.4-0.6	0.65-1.04	0.5-1.5
O, % (d)	2.8-11.3	30-40	38-42	24.3-40.2	40-44	40-46	40-46	44	34
S, % (d)	0.5-3.1	<0.05-0.3	<0.05	<0.05	<0.05	0.02-0.10	0.05-0.2	0.08-0.13	0.07-0.17
Cl, % (d)	<0.1	0.02-0.06	0.01-0.03	0.01-0.03	0.01-0.04	0.01-0.05	0.14-0.97	0.09	0.1*
K, % (d)	0.003	0.8-5.8	0.02-0.05	0.1-0.4	0.1-0.4	0.2-0.5	0.69-1.3	0.3-0.5	30*
Ca, % (d)	4-12	0.05-0.1	0.1-1.5	0.02-0.08	0.2-0.9	0.2-0.7	0.1-0.6	9	

d=dry basis

*= in ash

CEN-335 – Solid biofuels, Fuel specifications and classes. March 2003.

Out with the old, in with the new...



Our Focus Here is Wood Pellets



“Typical” Analyses Comparison

As Rec'd	Wood Pellets	Polish Coal
Fixed Carbon (%)	13	44
Volatile Matter (%)	80	25
Ash (%)	<1	16
Moisture (%)	5 to 10	12
Nitrogen (%)	< 0.5	1
Sulfur (%)	0.0's	0.5
Calorific Value (Btu/lb) HHV	8,000	11,000

Some of Our Experience...

Nalco Mobotec *Legacy*

Pulverized Wood Conversion Projects

- Hässelby (Sweden x 1) 100 MWt 90% Wood / HFO
- Norrenergi (Sweden x2) 90 MWt 90% Wood / HFO
- Jönköping (Sweden) 90 MWt 100% Wood
- Nordic Paper (Sweden) 53 MWt 100% Wood
- Helsingborg (Sweden) 240 MWt 100% Wood



HASSELBYVERKET - STOCKHOLM ENERGY AB, SWEDEN

PROJECT DATA

- Project : **100% Coal to Biomass – Unit 3 w/ ROFA & Rotamix**
- Unit Power Production : **25 MWe / 100 MWth**
- Pre-conversion Configuration: **Pulverized Coal - Poland**
- Firing Configuration : **Wall Fired**
- Biomass Fuel : **Progression of Coal - Wood Pellets/Olive Residue – FO – Achieving 100% Biomass Pellets (wood and bark)**
- Biomass Firing : **Direct in 4 Wall Burners**



SOLNAVERKET, NORRENERGI AB, SOLNA, SWEDEN

PROJECT DATA

- Project : **Conversion of HFO Boilers to Biomass**
- Unit Power Production : **2 x 40 MWth**
- Pre-conversion Configuration: **Heavy Fuel Oil**
- Firing Configuration : **Wall Fired**
- Biomass Fuel : **Wood Pellets**
- Biomass Firing : **Direct**



JONKOPING ENERGI SB2 MUNKSJO, SWEDEN



PROJECT DATA

- Project : **100% biomass Conversion**
- Unit Power Production : **90 MWth**
- Pre-conversion Configuration: **Mixed fuels**
- Firing Configuration : **Wall Fired**
- Biomass Fuel : **Wood Pellets**
- Biomass Firing : **Direct**



FORTUM, NORDIC PAPER, SAFFLE, SWEDEN

PROJECT DATA

- Project : **50% Biomass Cofiring with HFO**
- Unit Power Production : **50 MWth**
- Pre-conversion Configuration: **Heavy Fuel Oil**
- Firing Configuration : **Wall Fired**
- Biomass Fuel : **Wood Pellets**
- Biomass Firing : **Direct**



ORESUNDSKRAFT AB, VAASTHAMNSVERKET "HELSINGBORG", SWEDEN

PROJECT DATA

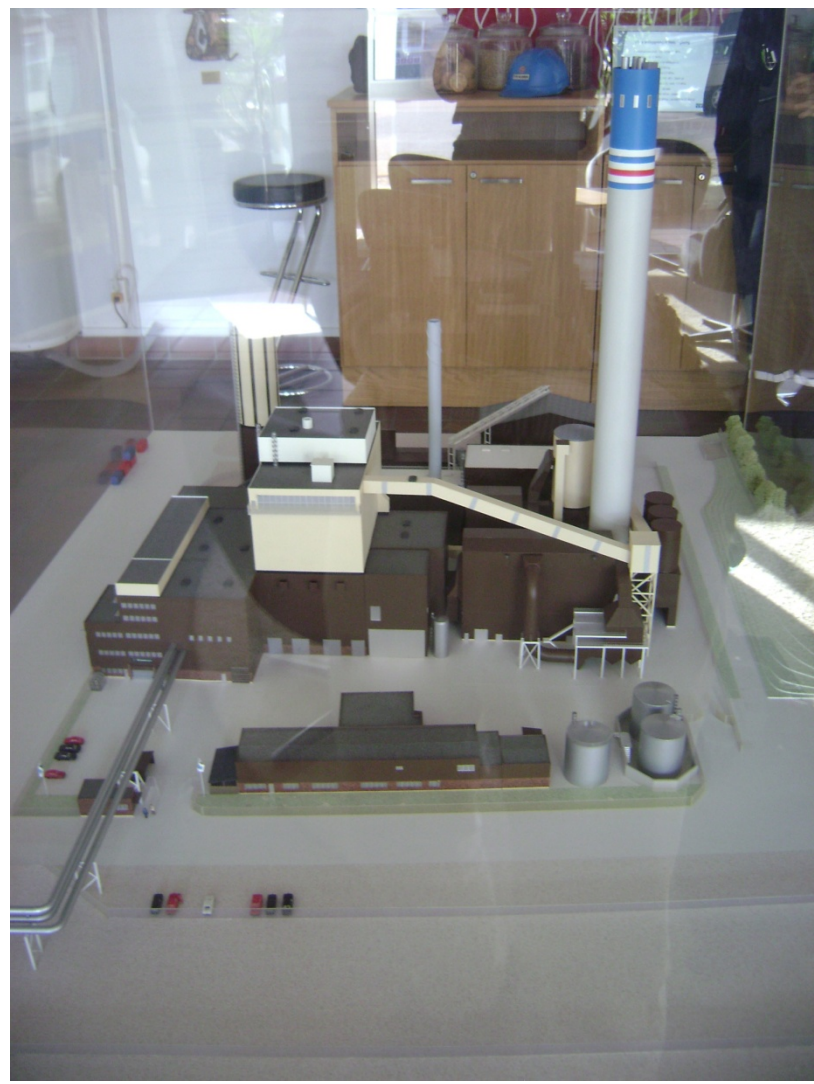
- Project : **100% Coal to 100% Biomass Conversion – ROFA & Rotamix**
- Unit Power Production : **69 MWe -138 MWth**
- Pre-conversion Configuration: **Pulverized Coal - Poland**
- Firing Configuration : **Tangential Fired**
- Biomass Fuel : **Wood Pellets, Wood Briquettes**
- Biomass Firing : **Direct**



Swedish Boiler

- Maskinverken (CE Licensee) boiler
 - 295 t/h steam flow (650,000 lb/h)
 - Electricity: 69 MWe
 - District heating: 138 MWt
- Corner fired
 - Originally designed for FO, but lengthened during construction to fire coal
 - Three Pulverizers, one serving each burner elevation
- APC System
 - Original Electrostatic Precipitator in use
 - Added Dry Scrubber
 - Added Fabric Filter Baghouse





100% Conversion Timeline

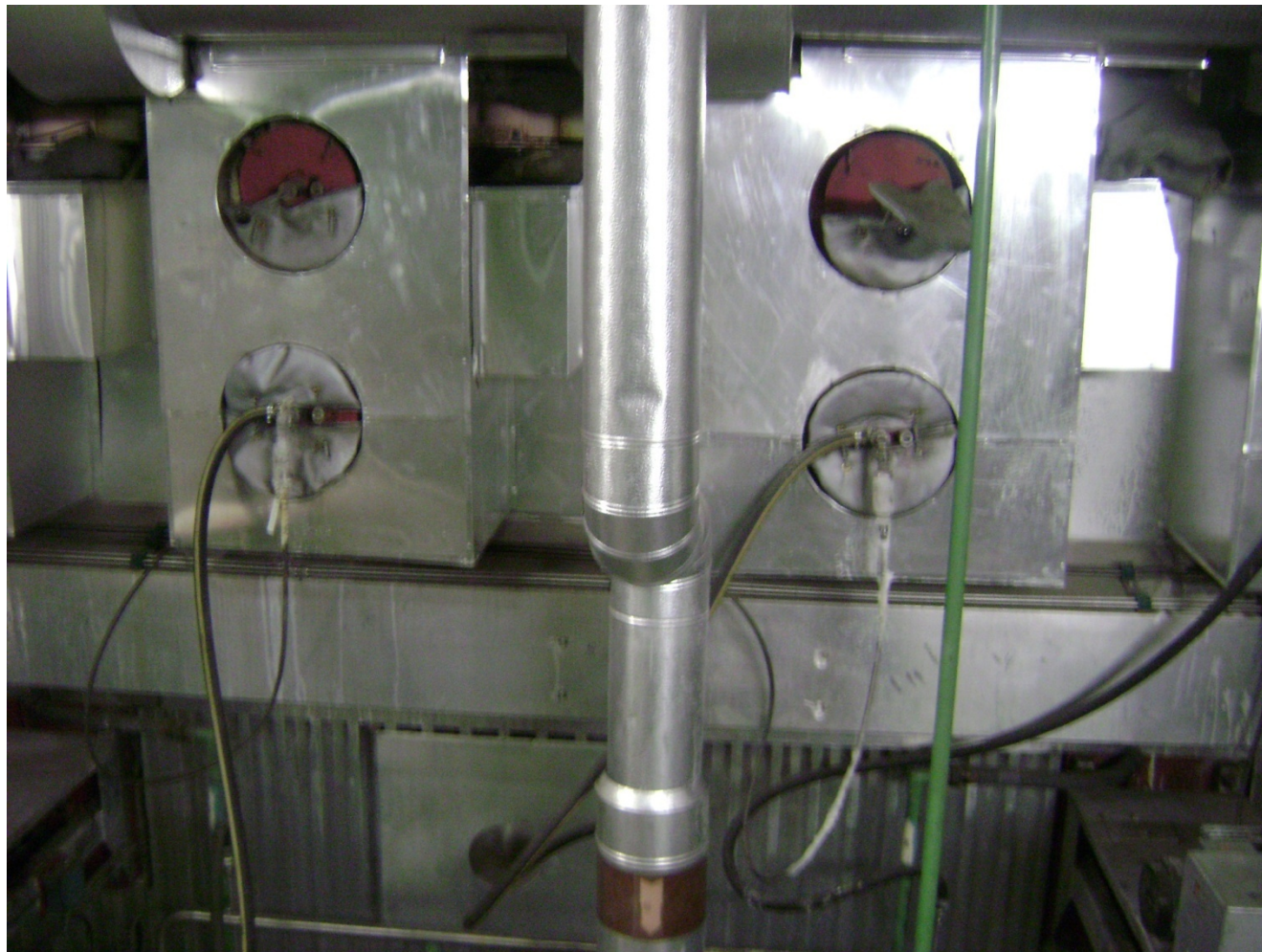
- Started with 15% Co-firing in 1998
- Increased to 30% Co-firing in 2000
- Reached 70% Co-firing in 2004
- 100% Biomass Conversion Concluded in 2005

Of Interest

Corrosion and Deposition Decreased by use of Ammonium Sulfate

Use of real time measurement of HCl for
feedback to chemical injection dosage rate

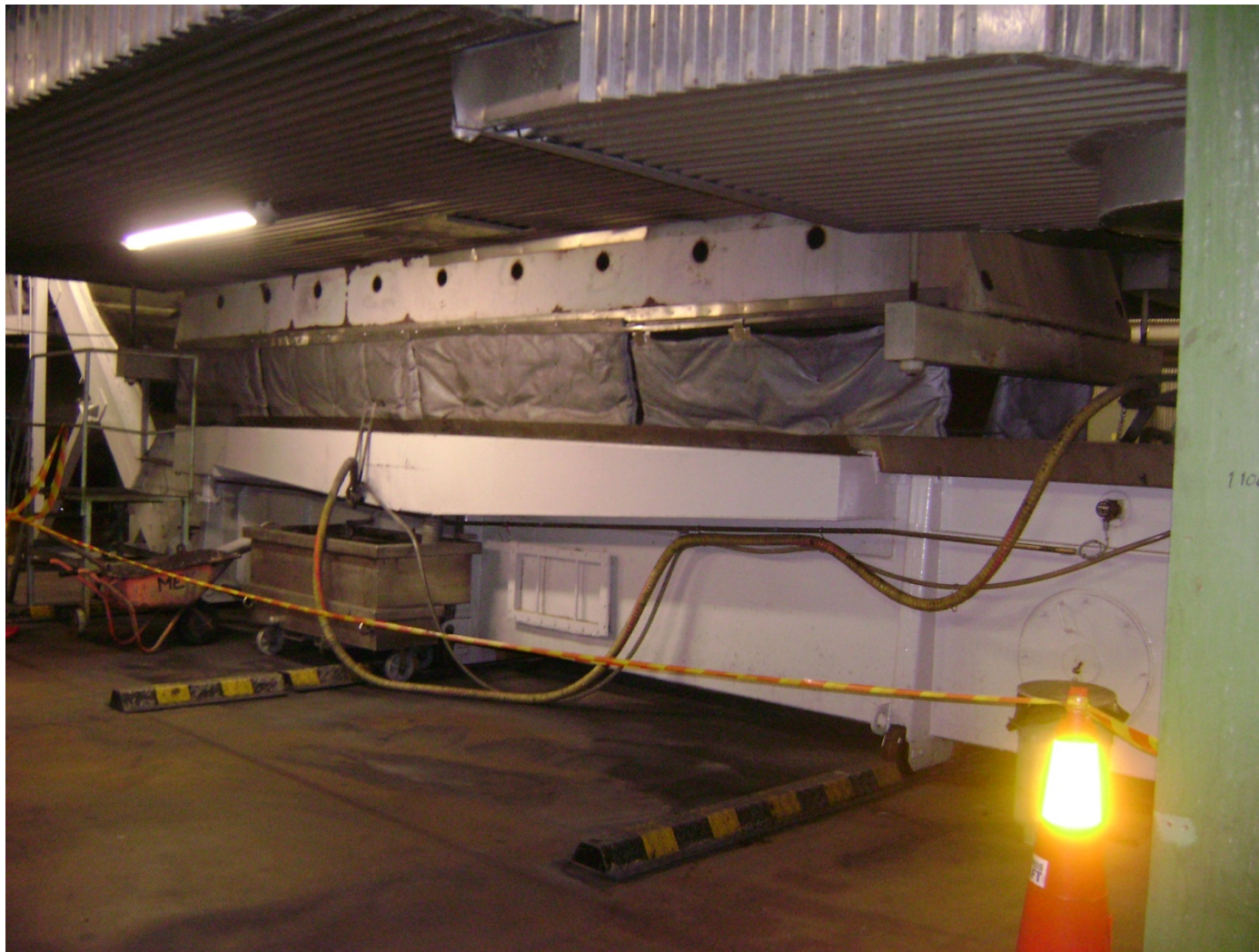
Chemical Injection in Furnace



Removed Ash Characteristics

- Fly Ash
 - 10 T/day @ 15 to 20% UBC
- Bottom Ash
 - 50 T/day @ 90% UBC

Submerged Bottom Ash Conveyor



Bottom Ash Removal



A-Frame Building Biomass Storage



Baghouse for A-Frame Storage



Multi - Silo Approach



Current Projects

Pulverized Wood Conversion

- Wraclaw (Poland) 70 MWe (55) 45 Wood / Coal
- Opole (Poland) 380 MWe 10% Wood / Coal

Why Biomass for Poland?

- Higher revenue
 - Subsidies for CO₂ neutral fuels (e.g., €/kWh)

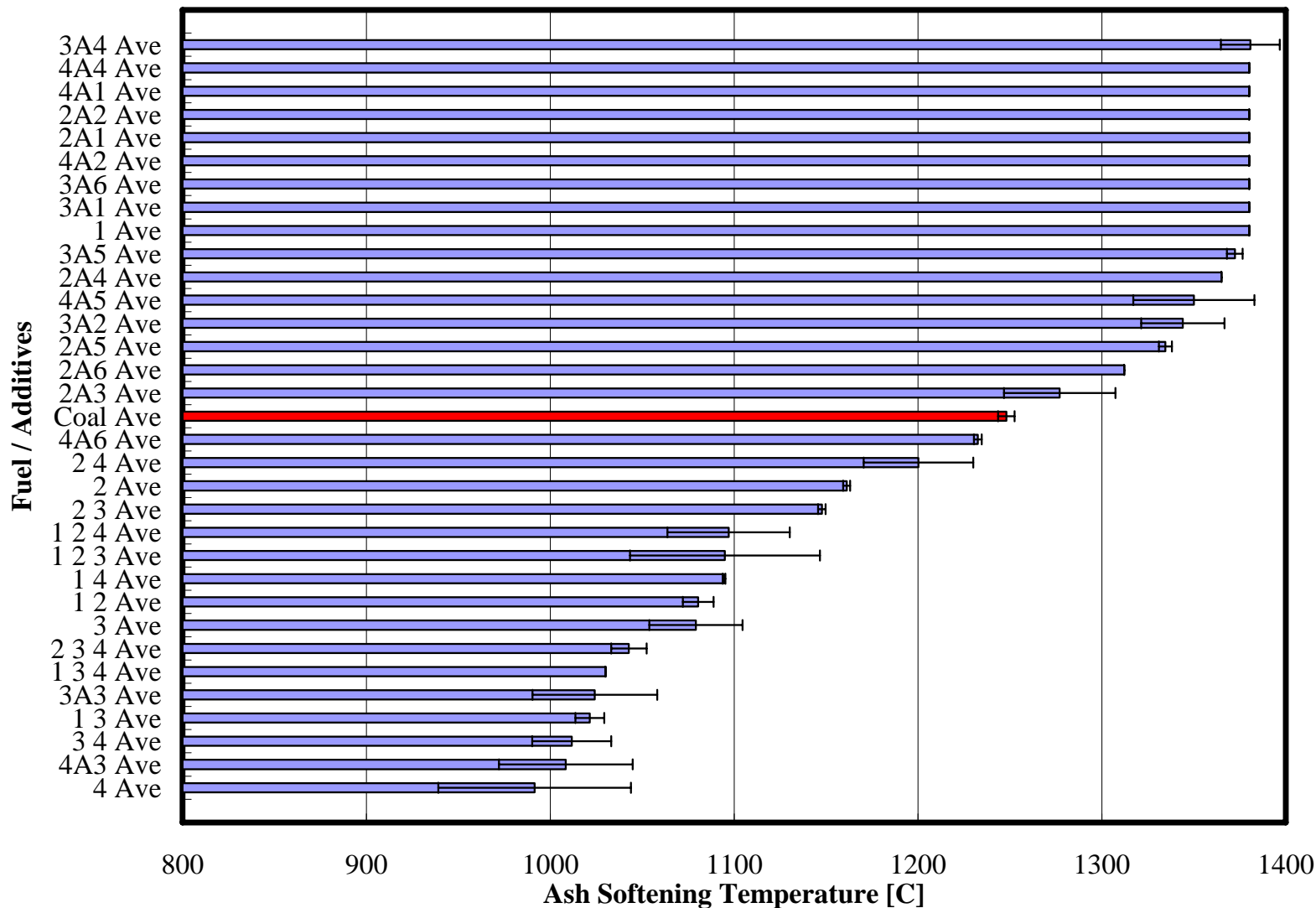
- Large Combustion Plant Directive (LCPD)
 - NO_x needs to be below 200 mg/Nm³ @ 6% O₂ in 2016
 - For wood:
 - 200 mg/Nm³ ~ 100 ppm @3% O₂ ~ 0.15 lb/MMBtu

- Drivers
 - Political
 - Regulatory
 - Economic Incentives

Wrocław

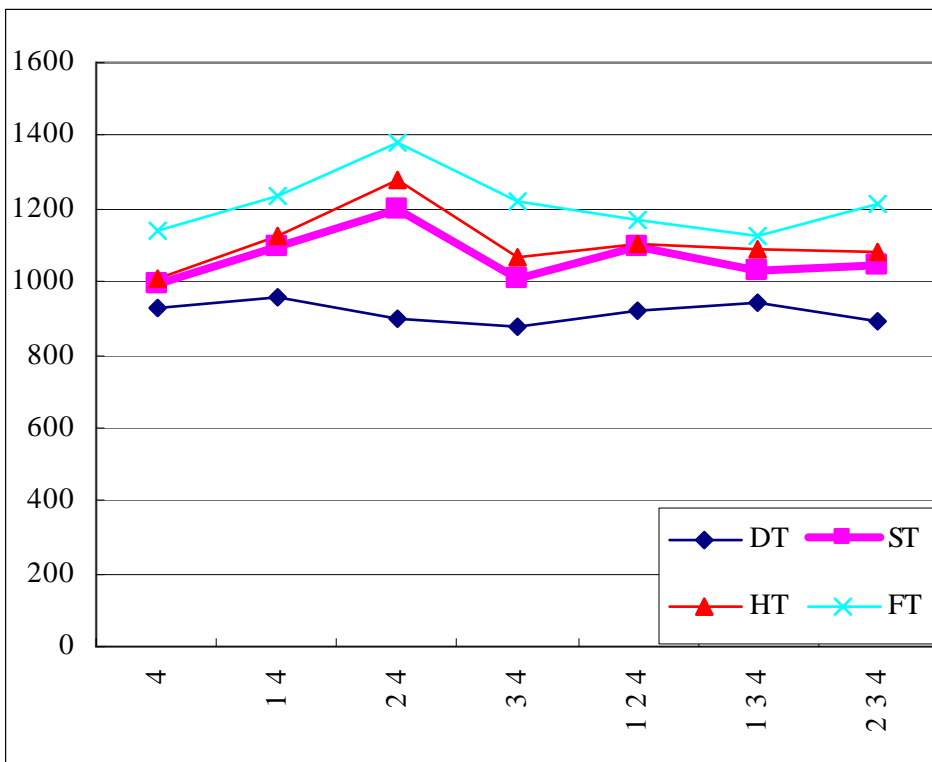


Ranking of Fuel Blends and Additives

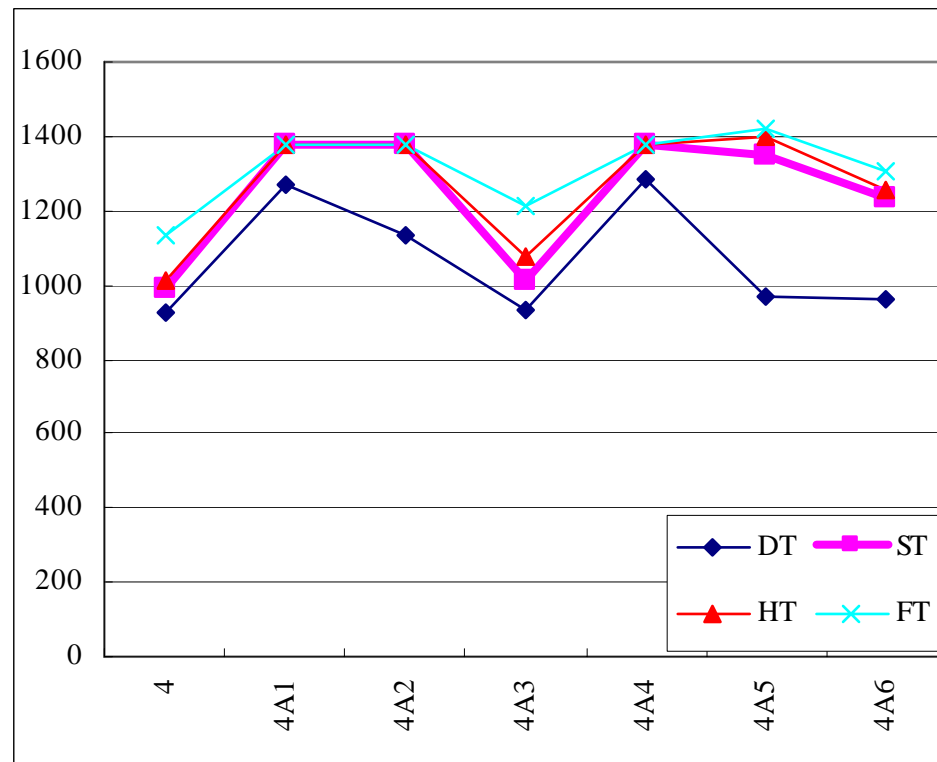


Ash Fusion Temperature for Biomass 4

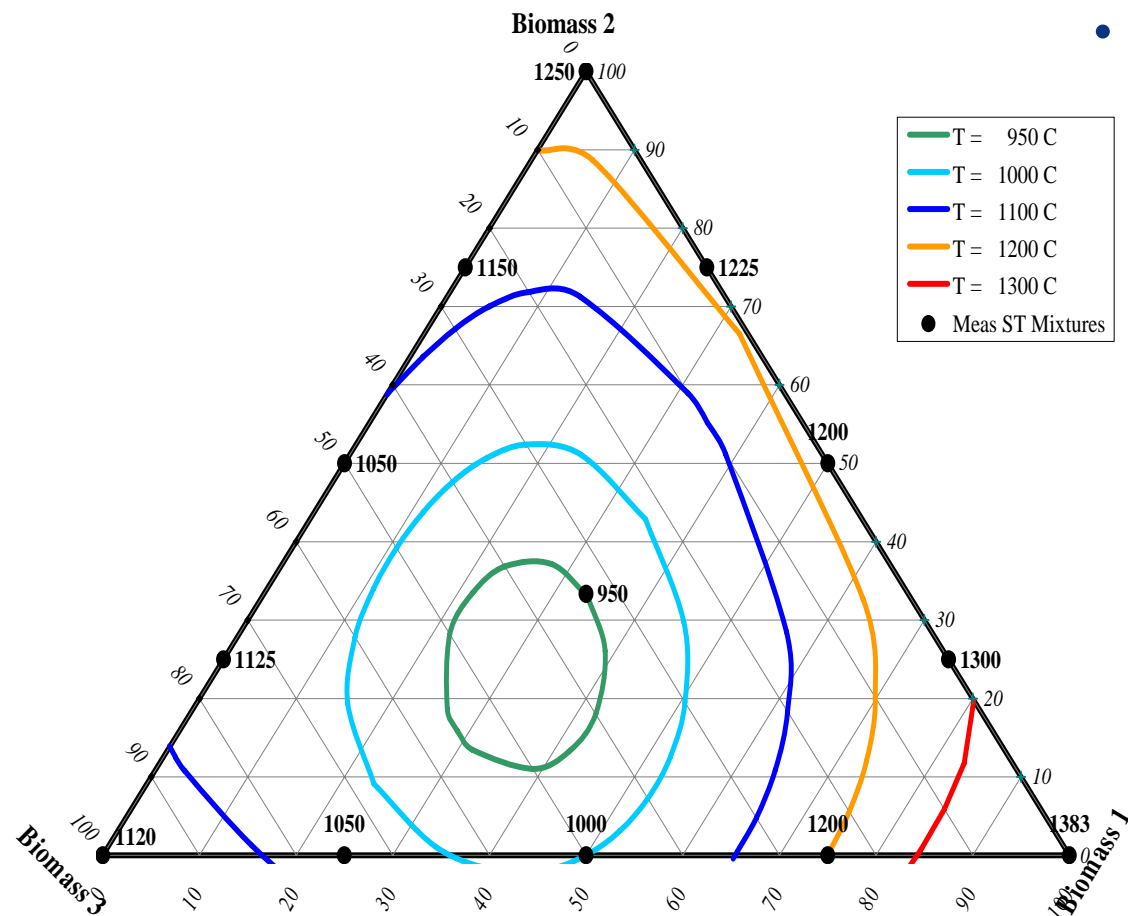
Biomass 4 and Blends



Biomass 4 and Chemical Additives



Biomass Fuel Blends



Softening Temperature Contour for three Biomass Blends

- Based on Fusion Temperature measurements, we can predict how different biomass blends will slag.
 - Recommend mixtures that work for a specified boiler (e.g. based on FEGT)
 - Avoid potentially problematic fuel mixtures
 - Determine fuel blends that require chemical additives
 - Potentially recommend which additives and at what concentration are required for different fuel blends

Hammer Mill



Milling System

A: Pellet Silo
B: Cyclone
C: Powder Silo



OPG Atikokan Generating Station







ESP Design Influences, the Basics

- ESP size (i.e., specific collection area or SCA),
- Applied corona power,
- PM size distribution and concentration,
- PM chemistry and loss on ignition (LOI),
- ESP gas velocity,
- Discharge and collecting electrode configuration,
- ESP electrical sectionalization, and
- ESP aspect ratio.

Issues with Biomass Fly Ash

- Biomass fly ash contains very significant unburned carbon
 - ranging up to 70% although 25 to 40% is more typical
- Biomass fly ash has a low specific gravity
 - 0.15 to 0.50 g/cm³
 - Has a large surface area to particle mass ratio - “flakey”

Issues with Biomass Fly Ash

- Biomass fly ash is more susceptible than coal fly ash to re-entrainment during electrode rapping in an (dry) ESP
 - because of its flakey, aerodynamic shape
 - Ash electrical resistivity issues
- It has also been observed that poor mechanical pre-collector and/or boiler operation and maintenance can increase ESP inlet PM loading by a factor of five

So What Else Can Go Wrong?

- *Potential for Fires.*
 - Biomass-fired boiler ESPs are subject to fires from ignition of carbon-rich fly ash, which can be collected as glowing embers.

Possible ESP Modifications

Replace the existing transformer-rectifier (T-R) set controllers with modern, fast-acting digital controllers

To allow for higher corona power densities needed to collect biomass fly ash; however, the ESP must also operate in a zero-sparking mode for prevention of fire ignition

Possible ESP Modifications (cont)

Install instrumentation and controls that will monitor and react to excess air excursions

Monitor percent O₂-dry at the exit of the ESP, and sound an alarm when operating above set point

(i.e., 5% O₂-dry and automatically trip all T-R sets when operating at or above 6% O₂-dry) - trials to confirm

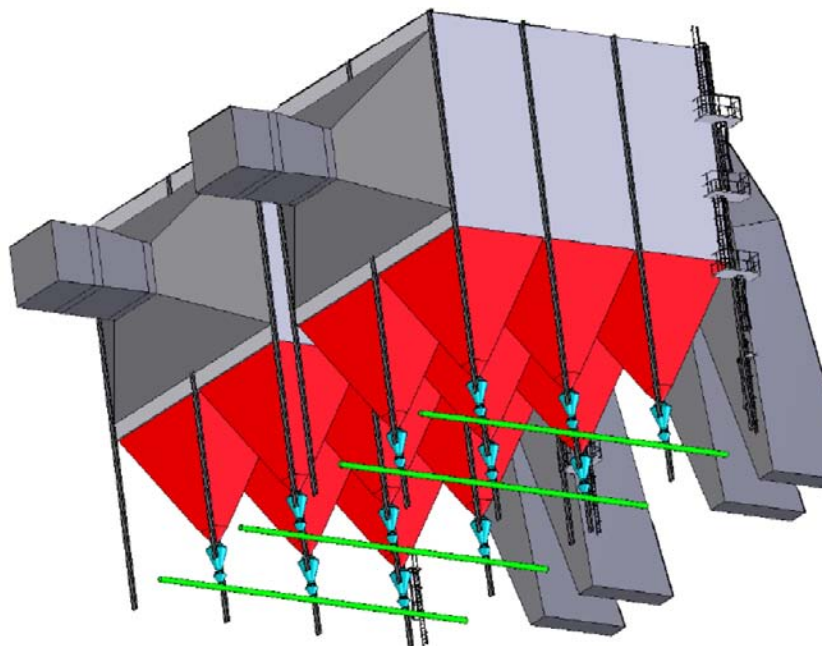
Possible ESP Modifications (cont)

Install flue gas temperature monitors at the inlet and outlet of the ESP

monitor the temperature differential across the ESP;
sound an alarm when the temperature differential above set points

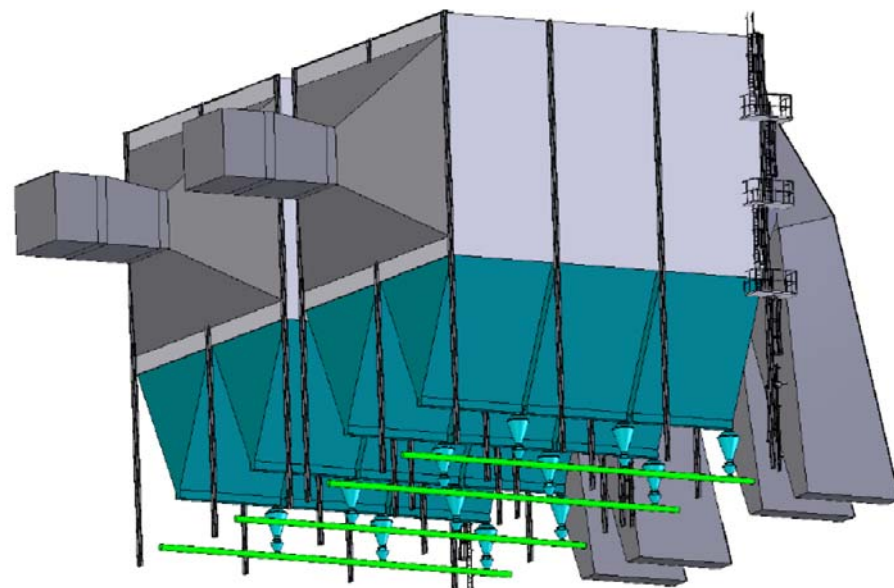
Possible ESP Modifications:

New Hoppers, TR Set Control Mods, O₂ Monitoring



Coal Firing Arrangement

Biomass Firing Arrangement



Good luck, and



Thank You