ICM Gasification Technology

USDA-ARS Presentation

February 8, 2011
ICM Engineering, Manufacturing, Construction and Management

Construction Management

Rotary Drying Equipment

Installation Services

Manufacturing

Process Engineering

Process Automation
ICM Technology: 102 Facilities across North America

Serving the U.S. and Canadian Ethanol Industries

- Process engineering, project management, training, and start-up services for 102 plants
- General contracting services for 27 plants
- Retrofits, operations and engineering assistance to other fuel ethanol technologies
ICM’s Auger Gasification Technology

- Successfully developed in the late ‘70s early ‘80s
  - Tested 250 TPD using MSW and wood wastes
  - Supported by DOE and Boeing

- After extensive technology review and installation of another gasification technology ...
  - Licensed technology
  - Fuel flexible
  - Greater control
  - BioChar capable
  - Shop fabricated
Reducing Ethanol’s Carbon Footprint

- Provide a proven, robust gasification technology
  - Reduce the Ethanol Industry’s dependence on natural gas

- Gasification technology that is fuel flexible
  - Fiber from the dry fractionation of corn
    - Separation of starch from food grade corn oil and proteins
  - Local corn stover, wood chips, other biomass/energy crops
  - Municipal solid wastes and sludge

- Promote sustainable agriculture through co-production of BioChar
ICM’s Commercial Demonstration Gasifier

- Located in Newton, Kansas
- 150 - 200 ton/day capacity
ICM’s Commercial Demonstration Gasifier

- Evaluate feedstock performance
  - Maximum feed rate and turndown
  - Mass & energy balance and carbon conversion
  - Emissions testing services
ICM Gasifier

- **Better Control**
  - Mass input
  - Low rpm auger
    - Retention time
  - Wet gas bypass
    - 10% - 50% mc
  - Zoned air input

- **Robust Design**

- **Small footprint**
  - 8 ft x 40 ft = 150 ton/day

- **Low energy**
  - Minimal size reduction
  - < 5 hp for auger
  - < 15 hp air fan
  - Fluid bed >> hp
Gasifier Operations: March 2009 – Nov. 2010

- **6,850 tons** gasified
- 20 months in operation, 2100 hrs
- **Two 100 hour continuous runs**
  - 100 hours on corn stover
  - 100 hours on wood chips
- **35 day continuous run**
  - Wood chips, stover and straw
  - Independent engineer’s review

- Wood Chips 4,000 tons
- Corn Stover 1,000 tons
- Wheat Straw 400 tons
- Sorghum Stalks 400 tons
- C & D 200 tons
- Paper Pulp + Plastics 100 tons
- Switchgrass 50 tons
- Corn Bran + Syrup 50 tons
- Auto Shredder Res. 50 tons
- MSW (RDF) + Tires 350 tons
- Chicken Litter 200 tons
- Dairy Manure 50 tons
- Manure + Woodchips 50 tons
Applications

- **1st OPPORTUNITIES:** Steam & Power, 10-60 MW<sub>e</sub>
  - RDF, RDF+TDF, Wood chips
  - ICM also providing startup and long-term O&M services

- **Domestic and International**
  - 20 MW<sub>e</sub> WTE for Charlotte, NC, etc.
  - Early stages in permitting, preliminary engineering and financing
More Applications

- **In DEVELOPMENT:** IC engine to Power, 5-20 MWₑ
  - Gasifier ⇒ ⇒ Gas Cleanup ⇒ ⇒ IC Engines & CHP
  - RDF, RDF+TDF, Wood chips
  - Harvey County Kansas

- **Targeting smaller municipalities**
  - Lower capital requirements
  - No high pressure steam, boiler certifications, etc.

- **Other Opportunities**
  - Industrial applications – waste disposal
  - Process residuals
Flue Gas Emissions Control

- Particulate removal
- Staged injection of air & flue gas recycle
- NOx - Selective non-catalytic reduction
- Dry sorbent injection
- Dual-field Wet ESP
  - Strategic alliance with EISENMANN Corp.
  - IC Engine gas cleanup
BioChar
Co-Production
Research and Development

- Can the ICM gasifier produce high quality biochar?
  - Pyrolysis is not the only path to biochar
- To date - supplied over 100 tons Biochar to ...
  - Research institutions
  - Community organization
  - Private entrepreneurs
- Continued interest in promoting biochar and sustainable agriculture
High Adsorption, High Carbon BioChar

- High quality biomass, low gasification temperatures
  - S. yellow pine bark biochar @ 92-94% carbon

![Graph showing adsorption of R134a at different temperatures]
Germination Testing on High and Low Carbon BioChars

Lettuce Seed Germination Tests

- 3 replications, 20 seeds per rep

Bed Temps.
- Wheat Straw: 540-600°C
- Wood chips: 600-700°C
- MSW & Tires: 750-820°C

**Graph:**
- Control
- Wheat Straw (34.2 % C)
- Corn Stover (12.4 % C)
- G.Sorghum Stalks (5.2 % C)
- Wood Chips (87.7 % C)
- Switchgrass (34.7 % C)
- 75% MSW 25% Tires (32.0 % C)
- Chicken Litter (28.4 % C)

Key:
- 10%wt BioChar 102 MT/ha (45 t/acre)*
- 25%wt BioChar 254 MT/ha (113 t/acre)*
- 50%wt BioChar 508 MT/ha (227 t/acre)*

* First 10 cm (4") of top soil; soil bulk density: 1.0 g/cm3 (52 lb/cf)
## High and Low Carbon BioChar

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<tr>
<th>Feedstock Input</th>
<th>Feedstock</th>
<th>%ash, db</th>
<th>%C, db</th>
<th>Carbon Conversion</th>
<th>%C to syngas</th>
<th>Biochar Production</th>
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<tr>
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<td>S. Yellow Pine Bark</td>
<td>1.8%</td>
<td>52.6%</td>
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<td>Urban Wood Waste</td>
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<td>Wheat Straw</td>
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<td>Corn Stover</td>
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<td></td>
<td>Chicken Litter</td>
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<td>Switchgrass</td>
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Co-Production of Power and BioChar

- **Three commercial gasifiers**
  - 4.5 MW - 136 MT/day (150 TPD)
    - Same scale as demonstration facility; footprint: 2.0m x 12m (6.0’ x 39’)
  - 9.0 MW - 272 MT/day (300 TPD)
    - Same scale as original DOE demonstration footprint: 2.6m x 12m (8.5’ x 39’)
  - 13.5 MW - 408 MT/day (450 TPD)
    - 1.5x original DOE demonstration; footprint: 3.0m x 12m (11’ x 39’)

- **Example: wood chips and corn stover**
  - **Yellow Pine**  1.3% ash db  25% mc  90% carbon conversion to syngas
  - BioChar with 80% carbon content (6.5% biomass db)
    - 4.5 MW – 7.3 MT/day  2,560 MT/y
    - 9.0 MW – 14.6 MT/day  5,120 MT/y
    - 13.5 MW – 21.9 MT/day  7,680 MT/y
  - **Corn Stover**  8.3% ash db  18% mc  90% carbon conversion to syngas
  - BioChar with 36% carbon content (13% biomass db)
    - 4 MW – 16.0 MT/day  5,600 MT/y
    - 8 MW – 31.9 MT/day  11,200 MT/y
    - 12 MW – 47.9 MT/day  16,750 MT/y
BioChar Currently Available

- 2+ ton of S. yellow pine bark BioChar
  - 92-94% carbon content
  - Free … just pay shipping costs
  - 80-100lb bags

- 200+ ton from woodchips for Apr-May 2011
  - >90% carbon content
  - Most going to academic institutions
  - Some may be available @ $250/ton + shipping
ICM Torrefaction Technology
100-150k TPY Demonstration Facility

- TORREFACTION REACTOR
  - Precise Control
    - Retention Time
    - Reactor Temperature

- DRYER

- FEED METERING BIN

- TORREFIED PELLET STORAGE AND LOADOUT

- THERMAL OXIDIZER

- ROLLER MILL

- SURGE BIN

- PELLET MILL

- COOLER

- WATER COOLING

- REACTOR GAS
Questions?

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