A Variety of Green Manufacturing Projects

Steven K. Srivastava
Graduate Research Assistant
Manufacturing Engineering
Outline

• Domains of Green Manufacturing
• Recycling
• Waste-to-Resource (Biomass & Biogas)
• LEED Certification
• Process Improvement
• Autophoretic Alternatives
• Lignin Applications
• Wheatboard Material
Domains of Green Manufacturing

- Recycling
- LEAN Manufacturing
- Waste-to-Resource
- Biomass Pellets & Anaerobic Digestion
- Chrome Plating, Automatic Doors, Autophoretics
- Lignin & Wheatboard
- Biodegradable Materials
- Alternative Energy
- Wind/Solar
- Energy Efficiency
- Product & Packaging Design
- Product End-Life

Seeking projects in this area
Recycling

• Common practice internally
• Do your products get recycled at end-life?
• EU required to reclaim or ensure recycling of products
• U.S. – Future regulations
Recycling

- Cultural Development
  - Gov’t Policy
  - Organizational Incentive
    - Build into product price
  - Concern for Environment

- System Development
  - Interface (web, email)
  - Mgmt system
  - Verification (from recycler)

- Environmental Impact
  - Earn Carbon Credits

- STS 304 Energy Demand
  - Virgin: 79 GJ/Mt
  - Recycled: 26 GJ/Mt

CO2 Emission
[MT-CO2/MT-STS]
Waste-to-Resource Biomass Pellet Fuel

- Biomass Fuel Source
  - Manufacturing waste
  - Primarily processed hydrocarbons

- BTU/LB
- % Moisture
- Usable BioFuel Source
- Chemicals (N, Cl, S, K)
Waste-to-Resource Biomass Pellet Fuel

- NOx Management

[Diagram of NOx formation rate and flame temperature]

[Graph showing temperature of flame and combustion gases with time]

[Schematic of suppressing the flame's hot spot]
Waste-to-Resource Biomass Pellet Fuel

- Combustion Method
  - Gasification/pyrolysis
  - Extract methane, ethane, and butane w/o oxygen
  - Potential reduction of PM10 and PM01
Waste-to-Resource Biomass Pellet Fuel

Dry Mfr. Waste → Biomass Pellets → Gasification/Pyrolysis Unit → Boiler

Biochar (Ash) → Soil Application (Nutrient Sponge)

Combined Heat & Power → Water and/or Space Heating

Turbine
Waste-to-Resource Biomass Pellet Fuel

• Research Agenda
  – Chemical Tests
  – Full load test
  – 2010 – 2011 heating season test
  – Land application of ash

– Observation of crop yield and nutrient requirement
– Economic analysis
– Feasibility study for potential targets
Waste-to-Resource
Anaerobic Digestion

A 4-phase biochemical conversion of biodegradable materials in the absence of oxygen

1) Bacterial Hydrolysis
   - Carbohydrates
   - Proteins
   - Fat, Oil, Grease

2) Acidogenic Activity
   - Sugar
   - Amino Acids
   - Lipids
   - Hydrogen
   - Ammonia
   - Organic Acids
   - CO2

3) Acetogenic Activity
   - Organic Acids
   - Acetic Acid

4) Methanogenic Activity
   - Acetic Acid
   - Hydrogen
   - Ammonia
   - Methane
   - Hydrogen Sulfide
   - CO2
Waste-to-Resource
Anaerobic Digestion

• Erdman Machine’s Goal
  – 100% of operation running on energy produced onsite
• Current
  – Anaerobic digester
    • w/ flare
  – OOC waste water treatment plant
  – Design for biodiesel plan

• Bio Feedstock Available
  – Meat shavings & fat
    • 75% Solids
    • Beef, chix, pork
  – Garlic butter byproduct
    • 40% solids
  – Cheese mfg. byproduct
    • 25% solids
  – Cow/pig manure
    • Goal: 10-15% solids
Waste-to-Resource Anaerobic Digestion

Resources produced by AD & Transesterification

Cheese Waste
Butter Waste
Meat Waste

Waste collected from external food mfg. processes

Feedstock Mixing Tank

Solid Meat Waste

Biogas AD Reaction Tank

Methane

Digestate: Soil Fertilizer

Biodiesel

Liquid Animal Fat

Transesterification

Waste-to-Resource Anaerobic Digestion

Resources produced by AD & Transesterification

Cheese Waste
Butter Waste
Meat Waste

Waste collected from external food mfg. processes

Feedstock Mixing Tank

Solid Meat Waste

Biogas AD Reaction Tank

Methane

Digestate: Soil Fertilizer

Biodiesel

Liquid Animal Fat

Transesterification
Waste-to-Resource Anaerobic Digestion

- Biogas can offset
  - NG
- Digestate can offset
  - Fertilizers
- Biodiesel can offset
  - Petroleum diesel, electricity, heating fuels

- ADRE Center @ MSU
- Biogas Assays
- 6-L Digesters
- Digester Equilibrium
  - Optimum feedstock blend [TVS/Gal]
  - Feed Rate [Gal/day]
  - Turnover Rate [#/day]
  - Retention Time [Days]
LEED Certification

LEED is either a professional accreditation (LEED AP) or ‘green’ building certification provided by the U.S. Green Buildings Council (USGBC)

- **LEED Categories**
  - Sustainable Sites
  - Water Efficiency
  - Energy & Atmosphere
  - Materials & Resources
  - Indoor Environmental Quality
  - Innovation & Design

- **Can you LEED certify your products?**
  - Not officially
  - Market case studies to prove capability to earn LEED points
LEED Certification

- Flo-Eco™ – Gas Fired Water Heater
- By Armstrong International
- 95% + Energy Efficient
- Conducting case study
- Case study to be used as marketing materials for engineers designing LEED systems
Process Improvement
Automatic Doors

- GMI Researchers
  - Nathan Christiansen
  - Ryan Kamm

- ASHRAE Handbook/Standards

- Provide analysis of potential replacement doors and operational mechanisms
  - Capital, Payback, ROI etc.
Autophoretics (autodeposition) Alternatives

Process which dips ferrous based components in a mildly acidic latex based pigment to add protective coating

• Process currently designated eco yellow moving to red
• Possible Projects
  – Recycling or re-conditioning of used coating material
  – Alternate uses of expended coating material
  – Reducing wastes and losses during process
    • Coating material splash/drippings
    • Thermal losses & optimization
Lignin Research

Bio waste product generated in paper and other bio manufacturing processes

• Possible projects
  – Possibility of alternative fuel source (combustion)
  – Feasibility as polymer substitute
  – Plastics industry alternatives
Wheatboard Research

Eco friendly alternative to wood based medium density fiber (MDF) board made from agricultural waste

• Possible Projects

  — Optimization with different base materials
    ~ Sunflower Stalks ~ Wheat chafe ~ Grasses
    ~ Rice chafe ~ Weeds ~ Vines
  — Eco friendly binders
  — Recyclability improvements
  — Cost reduction and feasibility
Following Presentations

Green Mfg.

- Recycling
- Waste-to-Resource
- LEAN Manufacturing
- Biodegradable Materials
- Alternative Energy
- Energy Efficiency
- Product & Packaging Design

Nate Christianson
Wind/Solar

Matt Johnson
Chrome Plating
Thank You

• Industrial Audience
• Dr. Patten for GMI Vision
• Dr. Meade and GMI personnel
• WMU
• DOE
Questions?