Cogeneration and Biofuels

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MWEA  Biosolids and Money
Going Green, Saving Green
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Who is PyroGen, LLC

- We are a new joint venture Company formed thru the partnership of US Innovations Group and I Power Energy Systems
- Our Company was formed to design, integrate, market and sell PyroGen™ Systems utilizing proprietary technologies that integrate:
  - Pyrolytic thermal conversion systems manufactured by USIG
  - Prime power distributed generation systems manufactured by I Power
Pyrolyzation

Pyrolysis is the decomposition of organic materials (even those that cannot be digested) during heating in oxygen-free atmosphere to produce gas, liquid and solid residuals:

\[ C_{x}H_{y}O_{z} \rightarrow C_{A}H_{B}O_{D} + C_{E}H_{F}O_{G} + H_{2} + CO + CO_{2} + C \]

- Organic polymer
- Polymer oils
- Hydrocarbon gases
Cogeneration Heating Strategy

Exhaust from the PyroGen™ System is “processed” thru a proprietary emissions reduction system in the I Power Genset(s) and meets the most stringent emissions requirements found anywhere today.

Safe Burner-less Technology
Operational Overview

- Feed Input
- Stage 1
- Transfer Point
- Stage 2
- Scrubber System
- Char Discharge
- Gas Output
- Oil/Water Discharge
Inside the PTC Process

- Anaerobic Process Environment
- Pyro-Gas Flow
- Waste Flow
- Stainless Steel Process Chamber
- Hot Gas Flow
- Steel Heating Chamber with Ceramic Insulation
Alternative:
Some sludges are capable of being pumped directly into the process change, thus eliminating the feed side airlock system.
Safety First

High Grade Insulation
- Reduces shell temperature to prevent burn hazards
- Improves thermal efficiency

Burst Vent
- Prevents overpressure condition

Direct Drive Gear Motors
- Safe, consistent, & reliable

Low Pressure Operation
- System operates at pressures less than atmospheric (~2 inches H2O)
- Gas stream header open to atmosphere via hydraulic seal
PyroGen Power Configuration

Natural Gas Supply → Pyro-Gas Blending System → EN1365 GenSet → Heat Recuperation → PTC4000 Thermal System → 2.2MW PyroGen System → 2.2 MW → Pyro-Oil → Pyro-Char
Ecological “PyroGen” Benefits

- Carbon Sequestration
  - Using Char as the carbon source
- Waste Minimization
- Green ‘Distributed’ Energy
  - Utilizes Pyro-Gas for electricity
- Valuable By-products:
  - Pyro-Char
  - Pyro-FOG or Pyro-Oil
## Analytical Summary

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1 ASR / Auto Shredder Residue (Bulk Large Cut)</td>
<td>1,280.00</td>
<td>2.00</td>
<td>Fuel Oil</td>
<td>18,000.00</td>
<td>0.38</td>
<td>0.33</td>
<td>51%</td>
</tr>
<tr>
<td>2 NY City Sewage Sludge (Approx 50% Moisture)</td>
<td>710.00</td>
<td>1.30</td>
<td>FOG</td>
<td>0.35</td>
<td></td>
<td></td>
<td>18%</td>
</tr>
<tr>
<td>3 Undigested Sewage Sludge (Over 70% Moisture)</td>
<td>1,050.00</td>
<td>0.60</td>
<td>FOG</td>
<td>0.08</td>
<td></td>
<td></td>
<td>13%</td>
</tr>
<tr>
<td>4 Algae Wheel Sewage Sludge (Dried)</td>
<td>650.00</td>
<td>2.50</td>
<td>FOG</td>
<td>0.23</td>
<td></td>
<td></td>
<td>33%</td>
</tr>
<tr>
<td>5 Sorted MSW / Municipal Solid Waste (No food waste)</td>
<td>970.00</td>
<td>2.20</td>
<td>Fuel Oil</td>
<td>9,900.00</td>
<td>0.31</td>
<td>0.38</td>
<td>43%</td>
</tr>
<tr>
<td>6 RDF / Refuse Derived Fuel (Engineered to be 12000 BTU/lb)</td>
<td>955.00</td>
<td>2.70</td>
<td>Fuel Oil</td>
<td>18,700.00</td>
<td>0.19</td>
<td>0.55</td>
<td>52%</td>
</tr>
<tr>
<td>7 Tire Chips</td>
<td>1,090.00</td>
<td>2.10</td>
<td>Fuel Oil</td>
<td>15,700.00</td>
<td>0.44</td>
<td>0.30</td>
<td>46%</td>
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<tr>
<td>8 Poultry Litter (Dried)</td>
<td>405.00</td>
<td>3.00</td>
<td>Tar</td>
<td>0.43</td>
<td></td>
<td></td>
<td>24%</td>
</tr>
<tr>
<td>9 Swine Manure (Dried)</td>
<td>794.00</td>
<td>3.10</td>
<td>Tar</td>
<td>0.41</td>
<td></td>
<td></td>
<td>49%</td>
</tr>
<tr>
<td>10 Rye Straw (small percentage swine manure - Dried)</td>
<td>618.00</td>
<td>3.90</td>
<td>Tar</td>
<td>0.40</td>
<td></td>
<td></td>
<td>48%</td>
</tr>
<tr>
<td>11 Extruded Plastic Waste</td>
<td>1,347.00</td>
<td>1.90</td>
<td>Fuel Oil</td>
<td>0.13</td>
<td></td>
<td>0.22</td>
<td>51%</td>
</tr>
</tbody>
</table>

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*2T2MW is a 2 ton/hr 2 megawatt system.*

**Offset is the amount of PyroGas vs Natural Gas used for operation (ie: 51% PyroGas and 49% Natural Gas)**
What is an algaewheel?

- An algaewheel is a device used to mass produce algae for a variety of uses.
  - Wastewater Treatment
  - Renewable Energy
  - Greenhouse Gas Capture
AlgaeWheel Concept

- Controlled Environment
- Exponential Surface Area
- Constant Nutrient Saturation
- Automated Harvesting

= The Efficient Mass Production of Algae
Inside the algaewheel?

Algae uses solar energy to treat the water through photosynthetic growth. Algae also produce oxygen as food for bacteria.

Water displacement causes surging which enhances nutrient removal.

Bacteria grow on the internal plastic media and convert some of the waste nutrients into food for the algae.

Air bubbles serve solely as an energy efficient means to rotate the wheel.
Comparison of Algae Systems

- Algaewheel
- Pond
- Photo Bio-Reactor
- Raceway
Why Algae?

- Algae are extremely efficient at removing contaminants from the environment, either directly or indirectly.

- Fossil fuels such as coal, oil, and gas were largely derived from plant life, and algae was the primary source for oil:
  - The earth slowly converted the algae to oil using pressure and heat over millions of years.
  - Current technology can replicate the earth's processes in a matter of seconds.

- CONCLUSIONS: Mass producing algae efficiently and economically will create a cleaner environment and will allow man to manufacture renewable fuels.
Efficiency and Economics

- **Efficiency:** Algaewheel systems treating wastewater generate more energy than they use.

- **Economics:**
  
  Multiple Benefits = Multiple Users = Multiple Revenues

- A single algaewheel facility can treat wastewater, capture tons of greenhouse gases, and produce algae for energy. All of these revenue streams can be captured for about the same cost of a traditional wastewater facility. Truly amazing.
Bio-Town, USA (cont’d)

- Algaewheel vs. Mechanical Plant

**Legend**
- PROCESS FLOW

**Flowchart**

- **CONVENTIONAL AERATION SYSTEM (O2 DITCH) (SBR)**
  - SEWAGE → SCREEN → 1st CLARIFIER → 2nd CLARIFIER → DISINFECTION → DISCHARGE

- **ALGAEWHEEL SYSTEM**
  - SEWAGE → SCREEN → 1st CLARIFIER → ALGAEWHEEL → 2nd CLARIFIER → DISINFECTION → DISCHARGE
Bio-Town, USA (cont’d)

Algaewheel vs. Mechanical Plant

Legend:
- PROCESS FLOW
- GREENHOUSE GASES
- SLUDGE/BIO-SOLIDS
- RENEWABLE ENERGY

Sewage → Screen → 1st Clarifier

CONVENTIONAL AERATION SYSTEM (O2 DITCH) (SBR)

CO2

DIGESTER → LAND APPLICATION

2nd Clarifier → Disinfection → Discharge

Sewage → Screen → 1st Clarifier

ALGAEWHEEL SYSTEM

CO2

2nd Clarifier → Disinfection → Discharge

ELECTRICITY

BIO-OIL

BIO-GAS

FERTILIZER
Hopewell, Virginia (cont’d)
Wisconsin Biofuels LLC
169 Industrial Drive Burlington, WI 53105
262-716-6645

1 Million Gallon per year Biodiesel System.

- Solid acid catalyst Esterif
- Flash evaporator for removal of methanol/water from Esterification
- 40 gallon mixing tank for initial mixing/refining
- 2 stages of sonic reaction
- 180 gallon settling tank for partial glycerin removal
- Liquid/Liquid centrifuge for glycerin removal
- 2 stages of flash evaporation for methanol recovery
- 2ea 200 gallon dry wash vessels. This resin can be regenerated, useful life of 3-4 years
- Liquid ring vacuum system to remove and condense methanol
- Explosion proof electrical equipment and nitrogen blanketing for added safety
- All stainless steel construction
- Comes with a complete distillation tower for methanol purification
- Methanol recovery from glycerin
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