Aircraft Deicing Fluid Recovery System

Presentation to:
Airports Going Green Conference - 2012

Presented by:
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Discussion Topics

- **ThermoEnergy Corporation**
  - Company
    - Twenty-eight years experience in wastewater processing
    - Located in Worcester, MA
  - Technology
    - Wastewater Recovery; ADF, Ammonia, Sugar
    - Water Recovery in Oil & Gas Hydrofracking
    - Clean Energy from Power Generation (Coal Plants)
  - Proprietary technology for recovery of process chemistry (from metals to fluids) and water
    - CAST technology provides “GREEN” solution for recovery of Deicing Fluid
      - Separation vs. Dilution
      - Converts Disposal Costs into Revenue
  - Case Studies
  - Benefits
• We are an established provider of custom process equipment
• Proprietary technology for the recovery of process chemistry and water
• 90+ installations
• 25,000 sq. ft. facility in Worcester, MA
ThermoEnergy Services

• Pilot Testing (Laboratory and Mobile)
• Design
• Engineering Support
• Manufacturing
• Installation
• Start-up
• Operations and Maintenance
Controlled Atmosphere Separation Technology (CAST)

Flash Vacuum Distillation
- Large evaporative surface
- No process internals
- No scaling
- Closed loop (no emissions)

Separation not Treatment
- Recovery of process chemistry and water

Small Footprint
- Fits into most plants

Over 90 Systems Installed
- Proven lifecycle and maintenance performance over many applications.

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CAST Process Flow Diagram

CAST Process Vessel

CAST Feed/Concentrate Tank

Heat Exchanger

Venturi

Condenser

Cooling Water Supply/Return

CAST Distillate Tank

Distillate Vacuum Pump

Hot Water Supply/Return

600 micron bag filter

100 micron prefilter

Liquid Waste Disposal

WW From Customer

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CAST System Benefits

- **Flash Vacuum Distillation**
  - Evaporation takes place inside CAST vessel
- **Continuous or Batch**
- **Physical principles**
  - Reduced boiling point due to applied vacuum
  - Low operational vessel pressure
- **Integrates well with other technologies**
- **Ion exchange, MBRs, RO**
The ADF Pollution Problem: Contamination of Surface Waters with ADF

- Aircraft Deicing Fluid is a mixture of Glycol & Water
  - Usually mixed to 50/50 percent
  - Sprayed heated on aircraft as a freeze point depressant during winter weather conditions
  - Remove snow, ice and other frozen contamination prior to departure

- Glycol (in USA) is normally Propylene (non toxic) vs. Ethylene (toxic)

- Propylene has a High Biochemical Oxygen Demand (BOD)
  - Pure PG has a five-day Biochemical Oxygen Demand (BOD5) concentration of approximately 1,000,000 milligrams/L
  - Mixed 50/50 with water ADF has BOD5 of 500,000 mg/L
  - Adversely affects aquatic life (robs the oxygen)
The ADF Pollution Problem:
Contamination of Surface Waters with ADF

- ADF (PG mixed 50/50 with water) has BOD5 of 500,000 mg/L
- By comparison: Raw Sewage has a BOD5 of 200 mg/L
- The amount of ADF applied per plane varies on size & weather, could be several hundred or several thousand gallons
- Deicing a single jet can generate a BOD5 load greater than 1 Million Gallons of raw sewage
- A large hub airport has several hundred flights each day
Our Glycol Recovery Solution

Two Step Solution

• Dewater
  – Reduces volume (gallons for disposal) by at least 50%
  – Lower boiling point

• Glycol Separation
  – Removes Glycol from ADF Additive Package
  – Sell (recycle) glycol for other applications
  – Dispose of Additive Package (~2%)

• Recovered glycol meets General Motors and ASTM Standards

• Systems from 1,000 to 10,000 GPD
Propylene Glycol is used in a wide variety of other applications:

- As an ingredient in the oil dispersant Corexit (*used during Deepwater Horizon oil spill*)
- In pharmaceuticals (*including oral, injectable & topical formulations*)
- As a food additive (*labeled as E number E1520*)
- As a moisturizer (in medicines, cosmetics, food, toothpaste, shampoo, mouth wash, etc.)
- As coolant in liquid cooling systems
- As a lubricant in air conditioning compressors
- As a component in newer automotive antifreezes & deicers
## Operating Cost Comparison ($/Gallon SADF and Storm Water Treated)

<table>
<thead>
<tr>
<th>Volume (Gallons)</th>
<th>250,000</th>
<th>1,000,000</th>
<th>2,500,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADF Concentration</td>
<td>25%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Disposal</td>
<td>($1)</td>
<td>($1)</td>
<td>($1)</td>
</tr>
<tr>
<td>Discharge</td>
<td>($0.35)</td>
<td>($0.08)</td>
<td>($0.08)</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td>($0.17)</td>
<td>($0.17)</td>
<td>($0.17)</td>
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<tr>
<td>MVR</td>
<td>($0.49)</td>
<td>($0.04)</td>
<td>($0.04)</td>
</tr>
<tr>
<td>Recovery</td>
<td>$0.51</td>
<td>$0.09</td>
<td>$0.17</td>
</tr>
<tr>
<td>Recovery Payback (Years)</td>
<td>4.4</td>
<td>7.7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

RED = Cost  
BLACK = Revenue
Case Study #1
Inland Waters of Ohio at Cleveland Hopkins Airport

Inland Provides Environmental Services to the Airport Industry

- Dewater ADF (PG)
- 6,000 gallons per day
- Water recovery rate > 98%
- Payback less than two years
- Operational costs $0.40 per gallon recovered
- Total results since contract award
  - Managed 142,000,000 SADF gallons
  - Recycled 4,000,000 gallons of >10%
  - Produced 3,200,000 pounds ~100% PG for reuse in manufacturing, industrial and commercial applications

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Case Study: Recycle Fluid Technologies
Battle Creek, MI

- 3,000 gallons per day
- EG and PG recovery
- Glycol purity > 99%
- Meets ASTM WK25513
- Water recovery rate > 98%
- Operational costs $0.45 per gallon recovered
Case Study: Thermo Fluids
Las Vegas, NV

- 6,000 gallons per day
- 900,000 gal per year
- Antifreeze (Ethylene Glycol)
- Meet or exceed ASTM D6210 Type 03, ASTM D-3306, E-1177
- Recovered Glycol purity >98%
Environmental Sustainability at RECYCLE TECHNOLOGIES

As a “leading edge” recycler of antifreeze for most of the last 2 decades with clients that include major corporations, fleet operators, car dealers, utilities and an array of repair and quick lube facilities, Recycle Technologies (RTI), dba MAXSAFE, considers itself to be in a “green” industry. It recycles a product that takes a lot of energy to produce, and which can be detrimental to the environment if improperly disposed. RTI's existing recycling process generates only one fifth of the greenhouse gases generated by producing virgin antifreeze.

In 2007, RTI installed a distillation process in order to upgrade the quality of RTI's recycled antifreeze, which now meets or exceeds Original Equipment Manufacturers (OEM) and ASTM specifications. Distillation has allowed RTI to recycle a larger variety of antifreeze waste streams. It has also allowed RTI to provide a more environmentally friendly high quality alternative to virgin antifreeze.

MAXSAFE’s Green³ Initiative

The culture and mindset of our entire organization is to reduce the carbon footprint and offer products that meet or exceed national standards. As a GREEN-minded company, MAXSAFE Antifreeze is structured to consider the environment first when taking on any new project. We are proud to offer GREEN³ to our clientele:

- 4,500 gallons per day
- Antifreeze (Ethylene Glycol)
- Glycol purity >98%
ThermoEnergy’s ADF Recovery Benefits

- Positive cash flow based on the sale of recovered glycol
- Market Value Estimate (50% dewatered / 90% concentrate)
- Recover a high purity glycol (99+%) with the highest market value
- Significantly lower environmental impact
- Meet ASTM E1177-09 specification for recycled glycol
- Handles any concentration of SADF in stormwater
- 90+ systems total in operation / 4 glycol recovery systems
- Long-term operating history with very low maintenance and operational costs
Thank you for your time!

Questions?

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