Opportunities for Biofuel-driven Microturbines

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Project Consortium

• WIP – Munich, Germany
• ETA – Florence, Italy
• EUBIA – The European Biomass Industry Association
  Energidalen, Sweden

Project Start: May 2003

This project is co-financed by the European Commission in the framework of the ALTENER Programme (AL-2002-011)
Basic components

- Turbo – Compressor package (compressor, turbine)
- Generator
- Recuperator (heat exchangers)
- Bearings (oil-lubricated, air bearings)
- Power electronics

Function diagram of Capstone Microturbine

Key producers of Microturbines (MT)

- Bowman Power Systems, UK, 80kW
- Capstone Turbine Corporation, USA, 30 & 60kW
- Cummins Power Generation, USA, 60kW
- Elliott Energy Systems, USA, 80kW
- Honeywell Power Systems, USA, 75kW
- IR PowerWorks, USA, 70 & 250kW
- Turbec, SWE, 100kW

Total installed MT systems in 2003: ~ 3000
Microturbines (20 – 100 kW) for Distributed Power and Heat Generation

Advantages
- Simple and compact technology
- Modularity
- Low emissions
- Low maintenance requirements
- Reliable provision of electricity and heat for stand-alone and grid-connected applications
- Potential operation on a variety of fuels (natural gas, diesel, gasoline, bio-fuels)

Application barriers for Microturbines
- High cost of produced kWh (~ $0.1/kWh)
- Large investment costs for total MT systems (~ $2000/kW)
- High internal consumption of produced energy (compressor, cooling of power electronics)
- Large amount of gas required (~ 25kg/h for 100kW power rate)
Biogas and Landfill Gas

Gas composition is highly variable from site to site depending on different factors, such as:

- age of landfill
- composition of digested material
- type of digestion process

Table 1. Typical fuel properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Landfill gas</th>
<th>Gas from anaerobic digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄</td>
<td>45 – 55%</td>
<td>55 – 75%</td>
</tr>
<tr>
<td>CO₂</td>
<td>&lt; 40%</td>
<td>Balance</td>
</tr>
<tr>
<td>N₂</td>
<td>&lt; 15%</td>
<td>&lt; 0.5%</td>
</tr>
<tr>
<td>H₂S</td>
<td>&lt; 50 – 500 ppm</td>
<td>&lt; 10 – 2000 ppm</td>
</tr>
<tr>
<td>Water vapour</td>
<td>Saturated at ambient temperature</td>
<td>Saturated at ambient temperature</td>
</tr>
<tr>
<td>LHV</td>
<td>4.5 – 5.5 kWh/Nm³</td>
<td>5.5 – 7.5 kWh/Nm³</td>
</tr>
</tbody>
</table>

Potential problems with Biogas use in MT

- Condensation of water in the compressor and at valves in the MT burner
- Corrosion due to H₂S impurities
- Particle formation due to Silane (SiH₄) impurities
- Flame stability problems due to reduced LHV
Examples of biofuel-driven Microturbines

- **TURBEC:**
  - In the framework of the EC co-funded project OMES (Optimised Microturbine Energy Systems) 15 Turbec T100 microturbine are installed, 3 installations fuelled with biogas

- **CAPSTONE**
  - Experimental installation of CAPSTONE C30 microturbine at ISET (Institut für Solare Energieversorgungstechnik), Germany
  - Test runs with reduced LHV gas

Outlook

- Microturbines provide the electric power industry with opportunities for the deregulated and competitive market
- The application of biofuel-driven microturbines are in line with main goals for the energy sector
  - Improvement of energy efficiency
  - Guarantee of security of supply
  - Environmentally friendly power & heat production
Acknowledgements

• Dr. Giuliano Grassi, EUBIA-Brussels; eubia@eubia.org
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