Energy from Organic Wastes with Emissions Close to Zero using Flameless Pressurized Oxy-Combustion (FPO)

Peter Reineck
Presentation to Aqua Enviro conference
10 September 2015
Agenda

1. Itea FPO Process - Block Diagram
   a. FPO Reactor
   b. Ashes melted into vitreous slag
   c. Flue Gases
   d. Flue Gas Emissions
2. Benefits of FPO
3. FPO - Development Path
4. Today - 60 MWt FPO CHP EFW Plant at site in NE England
5. Way Forward
Solving the challenges of emissions and carbon capture associated with conventional combustion.
FPO Reactor

- Pressurised Oxy-combustion in atmosphere of water and CO2

**Traditional «flame» combustion:**
- "chaotic" / not locally controllable

**Itea «Flameless>> combustion:**
- "mild" / controllable

- Low emissions of NOx, carbon etc. in hot gas leaving reactor
- No fly-ash: all Incombustibles end in the slag
Both heavy and fly ash melted into vitreous slag.
Flue Gases

Flue Gas Treatment
- Desulphurisation
- HM Capture

MEETS 2000/60/CE

CO2 stream ready for capture
### Flue Gas Emissions

<table>
<thead>
<tr>
<th>Noxious Gas</th>
<th>EU 2010/77 [1]</th>
<th>FPO</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOx</td>
<td>150 mg/m³</td>
<td>&lt; 30 mg/m³</td>
</tr>
<tr>
<td>NOx</td>
<td>150 mg/m³</td>
<td>&lt; 100 mg/m³</td>
</tr>
<tr>
<td>CO</td>
<td>not stated</td>
<td>&lt; 1 mg/m³</td>
</tr>
<tr>
<td>Dust (total)</td>
<td>10 mg/m³</td>
<td>&lt; 1 mg/m³</td>
</tr>
<tr>
<td>- whereof PM 2.5</td>
<td>not yet regulated</td>
<td>&lt;10 µg/m³</td>
</tr>
<tr>
<td>- whereof SOOT</td>
<td>not yet regulated</td>
<td>Zero</td>
</tr>
<tr>
<td>TOC [3]</td>
<td>10 mg/m³, peak value 20</td>
<td>&lt;0.05 mg/m³</td>
</tr>
<tr>
<td>Heavy metals [3]</td>
<td>0.5 mg/m³</td>
<td>&lt; 0.1 mg/m³</td>
</tr>
<tr>
<td>Chlorine/compounds (HCl) [3]</td>
<td>10 mg/m³</td>
<td>&lt; 0.1 mg/m³</td>
</tr>
<tr>
<td>Polycyclic Aromatic Hydrocarbons [3]</td>
<td>0.1 mg/m³</td>
<td>&lt;0.0001mg/m³</td>
</tr>
<tr>
<td>Dioxins and Furans [2] [3]</td>
<td>0.1 ng/m³</td>
<td>&lt;0.0001 ng/m³</td>
</tr>
</tbody>
</table>

[1] Re combustion of solid fuels in new installations with a total rated thermal input of 300 MW or more; emissions of asbestos, fluorine /compounds, arsenic/compounds, cyanides, carcinogens and mutagens are not included above

[2] Polychlorinated dibenzodioxins and polychlorinated dibenzofurans

[3] Re waste co-combustion / incineration
Benefits of FPO

• High energy recovery from total combustion of wastes containing:
  – Up to 65% Water
  – Up to 40% Ash

• Emissions near zero:
  – SOx <30 mg/m3 after FGD
  – NOx is close to zero (organic nitrogen converted to nitrogen gas)

• Water in feedstock + water from burning carbohydrates purified by condensation

• No fly ash: heavy metals and other incombustibles are captured in non-leachable vitrified slag

• Enables CO2 recovery on an economically viable basis
FPO - Development Path

5 MWt Pilot Plant Unit started up in 2006 at Gioia del Colle R&D Centre, Italy

Proposed development

- 15 - 60 MWt units for Energy from Wastes (EFW)

15 MWt Commercial Unit started up in 2011 in Singapore, and operated by Itea until 2013
Today - 60 MWt FPO CHP EFW Plant in NE England

• 60 MWt CHP plant based on 4 X 15 MWt FPO units
  – 15 MWt FPO unit commercially proven in Singapore
  – Start-up 2018
  – Feedstock is combination of wastes:
    • Organic wastes
    • Hazardous Waste Fly Ash
    • Hazardous Waste Liquids
    • RDF

• Revenue streams – *to be confirmed in feasibility study*
  – Gate Fees
  – Power and steam generated by the FPO unit
  – Clean Water
  – Aggregate

• Potential additional revenue streams – *to be confirmed in feasibility study*
  – RHI / CfD
# CHP Plant Assumptions

<table>
<thead>
<tr>
<th>Typical Fuel</th>
<th>Slurry of organic waste and hazardous waste fly ash</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LHV</strong></td>
<td>7.6 MJ/kg</td>
</tr>
<tr>
<td></td>
<td>~98% bio-based</td>
</tr>
<tr>
<td><strong>Composition</strong></td>
<td>Incombustibles 7.5%</td>
</tr>
<tr>
<td></td>
<td>Water 60%</td>
</tr>
<tr>
<td><strong>Plant availability</strong></td>
<td>365 days pa</td>
</tr>
<tr>
<td>- Effective thermal capacity</td>
<td>53.1 MWt = 88.5% of maximum</td>
</tr>
</tbody>
</table>
## CHP Plant

### Consumption and Outputs

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Fuel / water slurry, as fired</td>
<td>295 ktpa</td>
</tr>
<tr>
<td>Oxygen</td>
<td>181 ktpa</td>
</tr>
<tr>
<td>Gross Power - capacity incl. Turbo-expanders</td>
<td>~26 Mwe</td>
</tr>
<tr>
<td>Parasitic power requirement</td>
<td>~6 MWe</td>
</tr>
<tr>
<td>Produce – Steam or Net Power</td>
<td>up to 80 tph</td>
</tr>
<tr>
<td></td>
<td>up to 19-20 MWe</td>
</tr>
</tbody>
</table>
Way Forward

• Technical and Economic Feasibility Study to be
  – Commissioned by Teesside Energy Solutions (TES)
  – Managed by Link2Energy
  – Sub-contracted as needed

• Feasibility Study will include
  – Identifying availability of specific waste streams for optimum feedstock profile
  – Projected revenues including gate fees, steam and power sales
  – Projected capex and opex
  – Financial projections