Swiss Biogas Engine

Presented By

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Alpine Energy Systems
Background

- Alpine Energy Systems is a Southern California Distributor
- Swiss Cogeneration System based on Liebherr engine produced in Bulle, Switzerland
- Manufactured by Avesco AG of Langenthal, Switzerland ([www.avesco.ch](http://www.avesco.ch))
- Avesco one of largest privately-held companies in Switzerland
- Avesco is mostly known as the Caterpillar distributor for the entire country of Switzerland
Liebherr Gas Engines

- Liebherr has produced industrial engines for many years
- Engines known for durability and efficiency
- Engine can operate on biogas, natural gas or a combination thereof
- V8 Engine (400kw)
- V12 Engine (600kw)
The Emissions Technology

- Liebherr sponsored research at the Technical University of Zurich
- Response to tougher emissions regulations in the Canton of Zurich
- Research focus was the use of exhaust gas recirculation coupled with a 3 way catalytic converter
- Engine is supercharged and intake mixture aftercooled (stoichiometric mixture)
- Engine knock no longer a limiting factor in emissions reduction like lean burn engines
- Research led to technology patented around the year 2000
Commercial Application of Technology

- Approximately 21 installations at wastewater treatment plants since 2006
- Several natural gas installations at hospitals, district heating networks, etc.
- Many successful years of operating history
- Turnkey servicing programs
Recent Testing in Switzerland

- July 8, 2014 at the Frauenfeld Wastewater Treatment Plant
- Liebherr V8 (250kw) engine
- Biogas cleaning system (activated carbon)
- Emissions testing performed by Total Air Analysis, Inc.
- Testing according to established EPA protocols
### Summary of Results

- **Facility:** Frauenfeld, Switzerland WWTP
- **Source:** Liebherr 250 KW GenSet
- **Date:** 7/8/2014

<table>
<thead>
<tr>
<th>Parameter/Condition Run No.</th>
<th>Units</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Limits SCAQMD</th>
<th>Pass/Fail</th>
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<tbody>
<tr>
<td>NOx</td>
<td>ppmv</td>
<td>3.28</td>
<td>1.98</td>
<td>1.09</td>
<td>Rule 1110.2</td>
<td>Pass</td>
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<tr>
<td>NOx @ 15% O₂</td>
<td>ppmv</td>
<td>0.93</td>
<td>0.56</td>
<td>0.31</td>
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<tr>
<td>CO</td>
<td>ppmv</td>
<td>78.75</td>
<td>53.68</td>
<td>27.48</td>
<td>250</td>
<td>Pass</td>
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<tr>
<td>CO @ 15% O₂</td>
<td>ppmv</td>
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<tr>
<td>Total Hydrocarbons Methane</td>
<td>ppmv</td>
<td>–</td>
<td>432</td>
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<tr>
<td>TOC, non-methane</td>
<td>ppmv</td>
<td>–</td>
<td>2.00</td>
<td>–</td>
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<tr>
<td>TOC @ 15% O₂</td>
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<td>–</td>
<td>0.57</td>
<td>–</td>
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<tr>
<td>O₂</td>
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</tr>
<tr>
<td>CO₂</td>
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<td>11.70</td>
<td>11.70</td>
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</table>
Conclusion

- Test demonstrated viability of low emission engine running on biogas
- Importance of biogas cleaning system to preserve catalyst
- Catalyst subject to routine cleaning on multiple occasions before replacement
- Economical operation with proper maintenance