Turboden's ORC Turbogenerator in the Pellet Industry

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More than 30 Years in ORC

- Prof. Mario Gaia makes experience in the field of ORC within his research group at Politecnico di Milano
- 1976 – First prototype of a solar thermodynamic ORC
- 1980 – Prof. Mario Gaia founds Turboden to design and manufacture ORC turbogenerators
- 1998 – First ORC biomass plant in Switzerland (300 kW)

1980-1999

- Turboden installs ORC biomass plants, especially in Austria, Germany and Italy
- Turboden develops research projects in solar, geothermal and heat recovery applications

2000-2009

- Turboden plans to enter new markets, with focus on North America
- First heat recovery applications

2009-2013

- 2009 – Turboden achieves 100 plants sold
- United Technologies Corp. (UTC) acquires the majority of Turboden’s quota. PW Power Systems supports Turboden in new markets beyond Europe
- UTC exits the power market forming strategic alliance with Mitsubishi Heavy Industries
- PW Power Systems becomes an MHI group company

2013...

- MHI acquires the majority of Turboden. Italian quotaholders stay in charge of management

2015...

- More than 300 plants in 32 countries and 410 MW installed
The turbogenerator uses the **heat carrier** (e.g. hot temperature thermal oil) to pre-heat and vaporize a suitable organic working fluid in the **evaporator** (8→3→4). The organic fluid vapor powers the **turbine** (4→5), which is directly coupled to the **electric generator** through an elastic coupling.

The exhaust vapor flows through the **regenerator** (5→9) where it heats the organic liquid (2→8). The vapor is then condensed in the **condenser** (cooled by the water flow or other) (9→6→1). The organic fluid liquid is finally **pumped** (1→2) to the **regenerator** and then to the evaporator, thus completing the sequence of operations in the closed-loop circuit.
VIDEO Turboden ORC Cycle

Turboden ORC cycle.wmv
Turboden has more than 300 ORC plants worldwide...
Reference projects Canada and USA

Nechako Green Energy  (a subsidiary of Nechako Lumber)
Site: Vanderhoof, BC, Canada
ORC Unit: Turboden 22 CHP
Started up: Feb 2013
Electric power generated: 2 MW
Thermal power application: hot water temperature (60-90 °C) for future belt dryer connection

West Fraser Timber
2 Sites: Chetwynd and Fraser Lake, BC, Canada
ORC Unit: 4 x units Turboden 65 HRS (high efficiency up to 26 %)
Started up: Nov 2014
Electric power generated: 13 MW each site (total of 26 MW)

Manning Diversified Forest Products Ltd
Site: Manning, AB, Canada
ORC Unit: Turboden 32 HRS (high efficiency up to 26 %)
Started up: Feb 2015
Electric power generated: 3 MW

Furthermore, 2 heat recovery projects:
- 1 MW from Heat Recovery of a gas turbine in a Gas Compression Station (IST - TransGas) in Rosetown, SK, Canada. Started up: Dec 2012
- 1 MW from Heat Recovery of a sludge waste incinerator in Menands, NY, US. Started up: Jan 2013

Turboden
Turboden counts **28 ORCs in operation** integrated in a pellet making process and other **7 are under construction**

Countries where Turboden ORC is integrated in a pellet making process are: Germany, Austria, Italy, UK, Spain, Croatia, Russia, Poland, US and **Canada**.

- In total more than **1 Million hours worked** in pellet integration mode
- **40 MWel** installed and **30 MWel** more **under construction**
The integration between the Turboden ORC and an existing or brand new Pellet manufacturing process gives the possibility to diversify the business producing, at the same time, Pellet and Electrical Energy from Renewable Sources (i.e. biomass).
Wood Pellet Production with Belt Dryer

- **CHP units produce hot water** which can be used into a belt dryer;
- **No changes in the pellet making process**;
- **Production of pellet** and **Electrical Energy**;
Model: Turboden 30 CHP
Start-up: under construction, expected start-up Jan 2016
Location: Chetwynd, BC, Canada
Fuel: hog fuel
ORC Electric power: 3 MW
ORC thermal power: 14 MW
Belt dryer fed by water: In/out@ 77/110°C
Thermal Power to dry sawdust from 50% to 8%
Capacity Pellet production: 13 ton/hr
Wood Pellet Production with Rotary Drum Dryer

- Turboden High Efficiency ORC units produce hot water at low temperature which can be used by a low temperature user (green houses, swimming pools ...);

- No changes in the pellet making process;

- Production of Electrical Energy at high efficiency and Hot water
Maine Woods Pellet reference

Athens Energy LLC
(subsidiary of Maine Woods Pellet Company LLC)

- **Site**: Athens, Maine, US
- **ORC Unit**: Turboden 80 HRS
- **Status**: under construction, expected start-up Feb 2016

- **Fuel**: wood chips
- **Heat carrier**: thermal oil
- **ORC working fluid**: hydrocarbon
- **ORC electric power**: 8 MW
- **Electric Efficiency**: 25%
Turboden CHP in Pellet manufacturing process with ROTARY Drum Dryer
Dimensioning Parameters

<table>
<thead>
<tr>
<th>ORC Size</th>
<th>Pellet production capacity (dry product)**</th>
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</thead>
<tbody>
<tr>
<td>1 MWel and 4 MWth</td>
<td>30,000 t/y*</td>
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<tr>
<td>3 MWel and 13 MWth</td>
<td>85,000 t/y</td>
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<tr>
<td>5 MWel and 22 MWth</td>
<td>150,000 t/y</td>
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</tbody>
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Sample case:**

• ORC Unit: Turboden 10 CHP integrated in a Pellet plant
• Pellet production capacity = 4 tons/h
• Pellet production = 30,000 tons/y
• Biomass Consumption = 57,500 tons/y
• Boiler installed = 5.2 MWth
• Electrical power installed = 1 MWel
• Thermal power output = 4.1 MWth at inlet/oultet water temp. 60/80°C

**Assuming Turboden CHP and Belt dryer configuration
Technical feasibility vs Economical feasibility

The best configuration for an integrated plant strongly depends on the boundary conditions.
Advantages from Turboden ORC + Pellet

1) The Turboden ORC does not lead to significant changes to the conventional heat only plant for pellet production;

2) The high flexibility of the Turboden ORC can follow thermal request of the pellet manufacturing process.

3) The Turboden ORC adds value to an already available source;

4) The Turboden ORC allows the diversification of the business to gain a second and safe source of income;
Thank you for your attention!

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