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SMALL SCALE SOLID BIOMASS FUELLED ORC PLANTS FOR COMBINED HEAT AND POWER



Intro

- In recent years the urge for utilizing all forms of available energy has increased significantly
- Solid biomass is a CO₂ neutral, renewable energy source
- Local availability of solid biomass, local heat demand and the development of smart grid urges for tuning plant size down
- Technology to convert also low grade biomass into electricity is now available for small scale plant





The Triogen ORC - Products

Triogen has developped a high temperature ORC to convert (waste) heat into valuable electricity and hot water.



The Triogen ORC is a standard product, offered in two versions:

- WB-1 Power Optimized for electrical production; 60 to 170kWe
- **WB-1 Vario** Ideal for cogeneration, the coolant temperature can be adjusted.



The Triogen ORC- the markets

Proven Technology; fleet >500,000 Running Hours; >90% Uptime

The first applications of Triogen's ORC were to convert the waste heat from internal combustion engines' exhaust gas into electricity.



Diesel Engines



Mine gas



Biogas Engines





Landfill Gas Engines



n

Flares

Over the last years, Triogen has installed almost ORC units in 11 European countries on several applications.

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Solid Biomasses

The term solid biomass refers to a large variety of organic substances:

•Woodchips and pellets from clean virgin wood

• Wood as by-product (pruning wood, residues from wood industry, demolition wood, etc.)

• Non-wood agricultural sub-products (rice hull, straw, (coco)nutshells, olive pits, horse manure, chicken litter, etc.)



Solid Biomass has been combusted for heating purposes for centuries.

Power generation from combustion of biomass is CO₂ neutral.

Biomass is a **renewable** alternative to fossil fuels for CHP plants.



Solid Biomass fuelled ORC plant

Several ORC power plant between 1 and 5 MWe have been installed over the last years, combined with a dedicated solid biomass burner (5-25 MWth), where a considerable amount of solid biomass is being used:

•Feedstock is collected in a large radius and transported to the plant.

•A large heat sink and extensive distribution network are needed

The Triogen ORC produces 170 kWe and requires a 1-1.5 MWth biomass burner:

•Less feedstock is needed, biomass is collected locally, transportation costs are minimized

•Heat and power are produced and consumed locally



Solid Biomass fuelled ORC plant

Thanks to the high chemical stability of its working fluid, Triogen is coupled directly with a hot gas generator biomass combustor An intermediate thermal loop is **NOT** required:

- Lower investment
- No extra pumping power required
- Increase total system efficiency
- Reduced cost of ownership
- Decrease the installation footprint
- Higher theoretical Carnot Efficiency



Triogen biomass fuelled CHP– Schemes



Triogen biomass fuelled CHP– Schemes





Triogen biomass fuelled CHP- use of heat

The condensation heat in the cooling water can be used to fulfill the heat demand.

Plant's flexibility and versatility are required

•The coolant temperature can be varied from 55°C to 80°C with minor effect on the plant performances

•The power plant load can be changed to follow the heat demand





Triogen biomass fuelled CHP- use of heat

- The ORC coolant circuit remains a closed loop.
- Heat is transferred to the thermal utilities via a water/water heat exchanger



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Triogen biomass fuelled CHP– Experience

ASME ORC 2013:

"Application of a High Temperature ORC for heat from the combustion of solid biomasses"

First approach to the biomass direct evaporation and the first experiences with the pilot project using virgin woodchips were presented.

2013-2015:

- Several cleaning systems to mitigate evaporator fouling were tested
- More CHP biomass fuelled units were installed in different countries
- Units are coupled with different thermal utilities.
- Different system layout were tested to improve plant efficiency
- Biomass range is expanded to low grade biomass and agricultural sub-products



Triogen biomass fuelled CHP– Experience

Plant	Fuel	Burner type	Operational since	Evaporator cleaning method	Heat use
Italy	Stem woodchips + low quantities of bark and pruning	Moving Grid burner	2012	Acoustic horn; once in 15 minutes. Manual cleaning every 2-3 months	Heat supply to offices (floor heating) and industrial equipment (55°C)
Italy	Stem woodchips with low quantities of bark and pruning	Fluidized Bed burner	2013	Acoustic horn	Heat supply to chicken stables and offices (floor heating 55°C)
Italy	Stem woodchips with low quantities of bark and pruning	Fluidized Bed burner	2014	Pneumatic cleaning	Heat supply to small swimming pool, houses and offices (55°C)
Slovakia	Residual wood from sawmill process: wood dust and woodchips from heartwood	"Push" grid burner	2014	Acoustic horn. Manual cleaning as preventive maintenance every 6 months	Heat from coolant used in wood dryer (80°C)
Czech Republic	Stem woodchips with low quantities of bark and pruning	Moving grid burner	Being Optimized	Pneumatic	Heat from coolant used in wood dryer (80°C)
Italy	Rice straw	Fluidized Bed burner	Being commissioned	Shot cleaning	Heat from coolant to be used in the rice treatment process (80°C)
Italy	Residual wood from sawmill process	Moving grid burner	Under construction	Acoustic horn.	Heat from coolant used in wood dryer (80°C)
Czech Republic	Stem woodchips	"Push" grid burner	Under construction	Acoustic horn.	Heat from coolant used for district heating (80°C)

Fuel / burner type	Operational since	Evaporator Cleaning	Heat use
Residual wood from		Acoustic horn,	Heat supply 80°C
sawmill process	2014	Preventive manual	to wood dryer
Moving grid		cleaning every 6 months	





Conclusions

- Biomass fuelled power plants are an answer to the urge of renewable power and optimal use of all sources of energy
- Technology is now available to use low grade biomass (e.g. agricultural and industrial waste) to produce electricity and heat
- Plant sizes in the range 100-300 kWe fits the local availability of solid biomass and the local heat demand
- Versatility and flexibility are required for biomass fuelled CHP where the produced electricity is a by-product to the heat demand
- The Triogen ORC generators are a valid solution for small scale solid biomass fuelled CHP



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