Cogeneration with waste biomass

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by

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Cogeneration with waste biomass

- Introductions & acknowledgements.
- Cogeneration alternatives.
- Case study in Victoria
  - Background to project.
  - Assessing design alternatives.
  - Construction.
- Summary.
Enecon: Over 40 bioenergy studies, reports & projects since 1998
Acknowledgements

- Australian Tartaric Products.
- Australian Industry Group.
- Bono, gTET.
Cogeneration – alternative approaches

- Combined production of heat and power ("CHP")
- Greater energy recovery *may* lead to better economics
- MUST have long-term use for heat

Cogeneration may arise from a wish to:
1. Use excess heat to produce power
2. Make productive use of "waste" heat from power unit
Cogeneration – alternative approaches

1. Use of excess heat to produce power
   - Analyse the heat and power needs on site
   - Is the heat load variable either daily or seasonally?
   - Is excess feed available?
   - Can we generate power at times of low heat use?
   - May be alterations to heat plant for power generation
Cogeneration – alternative approaches

2. Productive use of waste heat from power unit
   - Different heat and power needs to previous example
   - Initial focus is on power generation
   - Heat recovery will impact on power generation efficiency
   - Heat recovery may impact on equipment selection
Cogeneration – plant sizing

- Bioenergy plants have significant capital costs
- They should be run continuously
- Feed may be in excess of site energy needs
- Larger bioenergy plants offer economies of scale
- External customers generally offer lower prices than internal customers.

What is the optimal size for a plant?
Case study - Australian Tartaric Products

- Process plant near Mildura in Victoria.
- Feed: grape marc, up to 50,000 tpa.
- Products: tartaric acid, tartrate, ethanol.
- Continuous operation with two main seasons.
- Spent marc is major by-product.
ATP – biomass feed

Spent grape marc:
• High moisture
• High ash
ATP: energy use

- Process steam, for diffuser and distillation.
- Heat for dryer.
- Electricity for motors and lighting.
ATP: previous energy generation

- Steam - via two on-site boilers, fired by LPG and fuel oil.
- LPG – also used to heat air for drying.
- Electricity - bought from grid.
Schematic for previous energy system

Heat and power requirements for the process plant

- LPG-fired boiler
- Fuel oil-fired boiler

Fuel Oil

LPG

For air heating

Low Pressure Steam

Electricity from grid

Cold water
New energy system – the opportunity

Increasingly competitive marketplace.

Energy costs rising... can they be reduced?

• Consider a bioenergy system fired on spent marc to replace fossil fuels and grid electricity

• Italian parent company already using spent marc (superheated boiler with steam turbine).
New bioenergy system – the challenges

• Spent marc - wet, and high inorganics.
• ATP’s site has two distinct operating “seasons”.
• Operability - bioenergy plant must not compromise process plant operation.
• Water - low availability and low quality.
• Operation - attended or unattended?
• Electricity export?
Design options – (1) heat production

Steam system?

- Low pressure saturated steam for process.
- How to generate electricity?
- How to pick up other thermal loads in plant?

Hot oil system?

- No history of hot oil use on site. Is it easy to operate?
- How will it provide LP steam and thermal loads?
- Benefits for electricity generation?
Design options – (2) power generation

Steam turbine?
- High pressure and superheat for good efficiency
- Issues with new, higher water specification for site

Steam engine?
- Availability of supplier
- Maintenance issues

Organic Rankine Cycle unit?
- Offer considerable flexibility in size and operation
- Limited experience in Australia
Organic Rankine Cycle units

- Package units for electricity generation
- Can also provide useful heat.
- Turbine, using organic liquid instead of steam.
- Wide range of input & output temperatures.
- Suppliers in Europe, USA, Australia.
- Range <200 kWe to >20 MWe, plus heat.
- Flexible, unattended operation possible.
Organic Rankine Cycle (small scale)

Pratt & Whitney “Pure Cycle” ORC unit at Gympie Timbers, Qld

gTET ORC unit at Reid Bros Timbers, Vic.
Organic Rankine Cycle (large scale)

Turboden ORC unit

Ormat - 26 MW geothermal ORC plant in New Zealand
Cogeneration system selected for ATP

- **Heat and power requirements for the process plant**

  - **Biomass-fired boiler**
    - (10 MW<sub>th</sub>)
  
  - **LP steam**
  
  - **ORC power unit**
    - (600 kW<sub>e</sub> gross)

- **Flue gas**
- **Electricity to plant**
- **Spent marc**
- **Ash**
Construction at ATP’s site
Boiler construction
Boiler construction
Boiler construction
ORC unit
ORC unit
ORC unit
Summary

- Waste biomass offers alternative to fossil fuels.
- Cogeneration allows optimal use of bioenergy.
- Analyse customer needs.
- Need return on capital *and* operability.
- Analyse feed characteristics.
- Consider process alternatives: steam, hot oil.
- Consider size alternatives: economy of scale versus product values to different customers.
Thank you – questions?

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