Downdraft Biomass Gasification Development, Grid Export of Power [2002-2006]

My second article last week focused on fast pyrolysis, however, I was working on multiple projects at that time, one which started "life" in 1999 with Shawton Engineering [SEL], which then moved into a subsidiary, Biomass Engineering Ltd. [BEL] on downdraft gasification. So, this week's article focuses on gasification and there are some published reports – now impossible to get – and papers.

There were several lines of activity at SEL and BEL from 1999 until 2006:

- Delivery of a 55 kWe/100 kW_{th} downdraft gasification system to Ballymena ECOS Centre, Northern Ireland [2000]
- Testing of a backpulsable ceramic candle filter to clean up producer gas. [https://www.osti.gov/etdeweb/servlets/purl/20367960]
- Testing of a Capstone C30 micro-gas turbine on producer gas with Advantica [https://careltd-thermal.com/DevelopmentOfAMicroturbinePlantToRunOnGasifierProducerGasContractNumberB-U1-00762-Report.pdf]
- Scale-up of the current 55 kWe system to 250 kWe net export []

I was engaged by SEL in 1999 to rectify "deficiencies" in their existing gasifier to reduce the tar in the producer gas and improve efficiency as this was going to be part of a small CHP plant to be installed inside a renewable Demonstration centre, in my hometown, of Ballymena, Northern Ireland, in 2000 for the Millennium. I re-designed the gasifier to give tar levels in the raw gas of ~ 11 $mg/_nm^3$ – which was well below the proposed limit of 20 $mg/_nm^3$ for an IC Engine. The other projects followed from that with the filter and MGT testing on a small gasifier at the SEL premises.

I was also working on other pyrolysis activities con-currently with Aston Universality, namely on the RenuResin Project [Techno-economics of production of renewable resin from biomass derived pyrolysis liquids [EC funded project QLK5-CT2002-RENURESIN]] and BIOTOX [https://task34.ieabioenergy.com/wp-content/uploads/sites/3/2017/04/BIOTOX-Final-Publishable-report.pdf].

Scale-up of the 55 kWe downdraft gasifier to 250 kWe (net)

The Ballymena ECOS Centre Project was installed and commissioned in 2000. The engine was in a pit, with the exhaust used to dry batches of woodchips. The unit once mechanically and electrically complete was commissioned in less than 4 weeks – and that was it, left in the hands of the Council to fill once a day, run for 8 hours and shutdown as per the project scope. Heat from the engine was used to heat the building.

SEL then wished to scale this unit to 250 kWe (net) due to demand and improved economies of scale, so I designed a suitable unit for woodchip. This was funded partially by the UK Government, and I've attached the full final report to this post, so I won't repeat that extensive document here.

The gasifier installation worked. Plant was installed in 2002, took 2 years to export power, but the unit was successful and this lead to the formation of BEL and the expansion of the technology to projects in Germany, Italy and within the UK.

Laimet HP25 wood chipper and 225 kg/h downdraft gasifier and hot gas filtration

This project, one of the few to actually export power was a clear demonstration of the potential for gasification to export power to the grid, even at small scale.

Lessons learnt

- BEL assumed we could just buy the right sized woodchip- we couldn't. We ended up buying a Laimet HP25 chipper to make very consistent woodchip, dried by the engine exhaust.
- Biomass handling equipment: you don't always need to buy new – there is a massive market in 2nd hand, perfectly useable hardware to meet your requirements.
- Exporting power to the grid took almost 2 years to get organised: final cost of ~ £35,000 was to hook 2 wires onto the 11kV lines. This was a major stumbling block, and nothing could be done about it. Transformer and room with 2 modems needed onsite – an additional cost not originally allowed for.
- No foul sewer onsite, which we were not aware of, so condensate had to be disposed offsite.
- Some engines may need a CO catalyst on the exhaust.

Conclusions

Sales of gasifiers only work when clients can see their potential unit up and running. Several clients carried out their own onsite testing, measuring tars, particulates, emissions, mass and energy balances independently. This led to sales in Germany and the UK

Publications 2003-2006

Fully refereed-journal

- A. Oasmaa, D. Meier, G.V.C. Peacocke and S. Gust, ''Norms and Standards for Pyrolysis Liquids. 1. End-User Requirements and Specifications'', Energy & Fuels; (Article); 2005; Vol 19, No. 5, p. 2155-2163.

10.1021/ef040094o

Book/Proceeding Chapters

- S. Gust, R.J. Mclellan, D. Meier, A. Oasmaa, D. Ormrod and G.V.C. Peacocke, ''Determination of Norms and Standards for Bio-Oil as an alternative renewable fuel for electricity and heat production'' Fast Pyrolysis of Biomass: A Handbook Volume III, A.V. Bridgwater (ed.), CPL Press, Newbury, 2005, p 9-18.

Fully refereed-conference

- G.V.C. Peacocke, A.V. Bridgwater and J.G. Brammer, ''Techno-economic assessment of power production from the Wellman Process Engineering Ltd. and BTG fast pyrolysis processes'', Science in Thermal and Chemical Biomass Conversion, Bridgwater, A.V. and Boocock, D.G.B., (eds.), CPL Press, 2006, vol. 2, p. 1785-1802.
- G.V.C. Peacocke, A. Connor, G. Jackson, and S. Langlois, ''Gasification of leather wastes in a downdraft gasifier: initial results and emissions'', Science in Thermal and Chemical Biomass Conversion, Bridgwater, A.V. and Boocock, D.G.B., (eds.), CPL Press, 2006, vol. 1, p. 725-733.

Non-refereed or partially reviewed

- S. Gust, R.J. Mclellan, D. Meier, A. Oasmaa and G.V.C. Peacocke, ''Determination of basic fuel quality standards for biomass-derived pyrolysis liquids'', Pyrolysis and Gasification of Biomass and Wastes, Bridgwater, A.V., (ed.), CPL Press, May 2003, p. 161-168.
- G.V.C. Peacocke, '' UK Country Report – October 2003, GasNet, Issue 5, February 2004, p.18, published by BTG, the Netherlands.