Fig. 1. The new the biomass gasification facility in Güssing, Austria.
Picture courtesy of Oxford Catalyst Group

▶ The start of a biomass-to-liquids demonstration project in Austria and the award of funding to a commercial bioethanol project in England highlight how close such processes are to competing with traditional fossil fuel sources. Sean Ottewell reports.

▶ Der Beginn eines Präsentationsprogramms für BtL-Kraftstoffe in Österreich und der Förderungspreis für ein kommerzielles Bioethanol-Projekt in England veranschaulichen die steigende Konkurrenzfähigkeit dieser Verfahren mit traditionellen fossilen Brenstoffquellen. Sean Ottewell berichtet.

▶ Le début d'un projet de démonstration biomasse-liquide en Autriche et l'attribution du financement d'un projet commercial de bioéthanol en Angleterre mettent en lumière combien ces procédés sont proches d'une concurrence avec les sources traditionnelles de carburants fossiles. Article de Sean Ottewell.

Biofuel processing takes a step closer to reality

A biomass-to-liquids (BTL) demonstration plant, jointly operated by the Oxford Catalysts Group and the Portuguese incorporated holding company SGC Energia (SGCE), at the biomass gasification facility in Güssing, Austria, is now up and running (Fig. 1). The plant is designed for the small scale distributed production of biofuels via the Fischer-Tropsch (FT) reaction.

The demonstration plant, which is being managed by SGCE, has been fully operational for over a month. Initial results indicate that the equipment – including the Güssing gasifier, a gas conditioning unit supplied by SGCE and an FT microchannel reactor skid developed by the US-based member of the Oxford Catalysts Group, Velocys, – is all operating smoothly.

The FT microchannel reactor, comprised of over 900 full-length microchannels, is working effectively. It is proving to be very efficient at controlling temperatures in highly exothermic (heat-generating) FT reaction and at maintaining isothermal conditions throughout the reactor. The demonstration plant is already producing over 0.75kg of high quality synthetic FT liquids per litre of catalyst per hour – 4 to 8 times greater productivity than conventional systems. The unit is also demonstrating robust responsiveness to shutdowns and start ups.

These results confirm the significant process intensification potential of the FT technology. Performance will improve further after the steam superheating section of the plant is debottlenecked at the next scheduled shutdown in the next couple of months. Going forward, the demonstration plant will be operated over a range of conditions to establish and confirm performance. It also will be tested in an extended three-month steady state run.

Roy Lipski, ceo of Oxford Catalysts Group, said: "Successful testing of our FT demonstration is an important step closer to validation of our technology in the field, paving the way for commercial roll out with our partner SGCE."

"As the managing company in charge of the Güssing demonstration, SGCE is very pleased with the initial performance. We remain on track to place a commercial order upon completion of the technical milestones, initiating worldwide commercialisation of the Group's FT technology," added Vianney Vales, ceo SGCE.

In terms of technology, the production of biofuels from non-food biomass and other wastes relies on the Fischer-Tropsch (FT) process, which was first developed in Germany in the 1920s and 1930s to produce liquid fuel from coal. In the FT process synthesis gas (syngas) composed of a mixture of carbon monoxide (CO) and hydrogen (H_2) is converted into various forms of liquid hydrocarbons using a catalyst at elevated temperatures.

Because they don't contain aromatics or sulphur-containing contaminants the liquid fuels produced are typically of higher quality and burn cleaner than petroleum-based diesel and jet fuels, resulting in lower emissions of NOx and harmful particulates. BTL fuels also offer substantial reductions in greenhouse gas emissions. They are compatible with the current fuelling infrastructure and offer several engine performance benefits over today's diesel and jet fuels. These benefits have been demonstrated and recognised by a number of prospective biofuel users, including the US Air Force.

The distributed production of biofuels involves the production of biofuels in small scale plants located near the source of the waste and the markets for the fuel.

Microchannel reactors are designed for economical production on a small scale. FT microchannel reactors are compact and have channels with diameters in the millimetre range. Conventional reactors are many times larger and have channel diameters in the centimetre range.

Because the smaller diameter channels in microchannel reactors dissipate heat more quickly than those in conventional reactors, more active catalysts are used to boost the conversion rates to an economic level (Fig. 2).

When used with a new FT catalyst developed by Oxford Catalysts, the Velocys microchannel FT reactor exhibits conversion efficiencies in the range of 70 per cent per pass. A single microchannel reactor block, measuring 60 x 60 x 60 cm, might produce over 30 barrels (bbls) of liquid fuel/day.

In contrast, conventional FT plants typically exhibit conversion efficiencies in the range of 50 per cent or less per pass. They are designed to work at minimum capacities of 5000 bbls/day, and function well and economically only at capacities of 30 000 bbls/day or higher.

The significant performance indicators achieved in the demonstration unit include: near isothermal reactor temperature profile; pressure drop as expected; high quality synthetic fuel being produced (alpha value >0.9); and robust responsiveness to shutdowns and start-ups.

An isothermal temperature profile indicates that the catalyst bed of a reactor is operating at an even temperature throughout, and that the temperature control system (in this case the microchannels) is working efficiently.

Pressure drop describes the difference between pressure upsteam and downstream of the catalyst bed. Minimisation of the pressure drop over a catalyst bed is important to minimise process costs for a given throughput.

Productivity is a measure of the amount of product that can be produced from a given unit of catalyst per hour. Volumetric productivity is the amount of product that can be produced per litre of catalyst per hour. The alpha value measures the probability of a hydrocarbon chain propagating rather than terminating (producing a shorter hydrocarbon); optimised FT catalysts should achieve an alpha value of 0.90 or above.

Robust responsiveness to planned and unplanned shutdowns and start-ups is required to ensure that activity and productivity can be recovered quickly and completely after an outage.

Meanwhile in the UK, INEOS Bio today announced that it has received an offer of a £7.3m grant towards £52m construction costs for the first commercial plant in Europe using its advanced BioEnergy Process Technology.

Fig. 2. Microchannel reactors dissipate heat more quickly than those in conventional reactors.
Picture courtesy of Oxford Catalyst Group

The plant, to be located at the INEOS Seal Sands site in the Tees Valley, is designed to produce 24 000 tonnes per year (30 million litres) of carbon-neutral road transport fuel and generate more than 3MW of clean electricity for export from over 100 000 tonnes per year of biodegradable household and commercial waste. This would provide the biofuel requirement of around 250,000 vehicles per year running on E10 (a blend of 10 per cent by volume bioethanol and 90 per cent by volume petrol) and the electricity needs of 6000 households.

Speaking about the announcement, Peter Williams, ceo of INEOS Bio, said: "Using our technology, the waste that is collected from homes and offices and otherwise thrown away, can be re-cycled into clean biofuel for cars and renewable electricity for homes and industry."

Subject to final agreements, this advanced bioethanol plant is due to be completed by 2012, creating around 40 new jobs at the plant and 350 jobs in the construction phase.

Following the completion of a feasibility study by INEOS Bio, DECC has approved funding of £4.5m for this next phase of the project. The Regional Development Agency One North East is also investing £2.8m, of which £1.8m has been secured through the Tees Valley Industrial Programme.

The INEOS BioEnergy process technology combines thermochemical and biochemical technologies to achieve energy-efficient and low-cost biofuel production from a wide range of biomass materials, including household and industrial waste. At the heart of the INEOS Bio technology is an anaerobic fermentation step, through which naturally occurring bacteria convert gases derived directly from biomass into bioethanol. This bioethanol production is integrated with combined heat and power generation. The process supports high recycling and high landfill diversion rates and an independent life cycle assessment indicates that the bioethanol produced would deliver 100 per cent green house gas savings compared to using petrol in today's cars. ■