

# Pulp mills to supply low-CO<sub>2</sub> fuels

Black liquor is a by-product of pulp mills. To date, hardly any effective use has been found for it. Now the Swedish company Chemrec has developed a gasification process by which black liquor can be turned into a new biofuel, methanol/dimethyl ether (DME). The implications could be considerable.

| by Reiner Gatermann

From the spring of 2010, the first 14 Volvo trucks running entirely on methanol/dimethyl ether (DME), made from black liquor, will be rolled out in Sweden. The fuel will be supplied by the Chemrec pilot plant based in the northern Swedish town of Piteå, which has been operating since 2005. A larger, full-scale plant is to start production around 2012.

Chemrec is also active in the US. Since 1996, the Weyerhaeuser mill in New Bern, North Carolina, has been processing 15% of all the black liquor it produces, into a synthetic gas, called Syngas. So far this has only been used in district heating in New Bern. Chemrec is planning to build a new DME production plant at the New Page mill in Escanaba, Michigan, by 2012. Both the Swedish and US plants – still referred to as pilot plants – are supplied by pulp mills, which provide the black liquor. The two plants each have an annual production capacity of 40,000 tons of DME. From 2013/14, this is expected to be expanded to 550,000-700,000 tons.

The black liquor gasification process was developed by Jan Erik Kignell for Chemrec as early as 1986, but it proved extremely complex and expensive to implement it on an industrial scale. When Chemrec ran into financial problems in 2002, the development of the black liquor process also stalled. 'Four lost years,' says Ingvar Landälv, Vice President Technology of Chemrec AB since 1997.

In 2003, Chemrec was taken over by the Swedish company Nykomb Synergetics, owned by the energetic Stefan Jönsson. Following his sudden death, the company's ownership structure

was reorganised at the end of 2006. The US venture capitalist Vantage Point Venture Partners acquired a stake of about 40%. Other stakeholders, in addition to Nykomb, are Volvo Technology Transfer, a new venture capital arm of engine manufacturer AB Volvo (not to be confused with the automobile producer Volvo) and the Environmental Technologies Fund (ETF), one of the largest European venture capital funds dedicated to cleantech. 'They needed help and new capital and we found this to be an interesting project that fit well into our business plan,' explains Anders Brännström, chief executive of Volvo Tehnology Transfer, in describing the situation back then.

According to an EU study (Renew) on second generation biofuels, DME made from biomass gasification provides the greatest reduction in greenhouse gases at the lowest cost. Instead of feeding the black liquor back into pulp production via the soda pan, as has been the norm to date, Syngas is produced in a gasification reactor under pressurised conditions (30 bar) at high temperature (1000°C) and is ultimately fed into power or fuel production systems via a cooling unit.

Methanol/DME could make a considerable contribution in terms of low CO<sub>2</sub> fuels or green electricity. An average-sized pulp mill supplies around 1,000 to 1,200 tons of dry pulp per day, and 1,800 to 2,100 tons of black liquor. The black liquor that is produced in Swedish plants alone would be enough to replace around 30% of the diesel consumed or 5-7% of the electricity consumed today. And in the US, where more than half the world's pulp is produced, 'a fully developed pulp mill biorefinery industry could be twice



The Chemrec DME pilot plant in North Sweden. Photo: Chemrec AB 2008

the size of the current corn ethanol industry or even bigger,' according to Eric Larson of Princeton University. The Americans have set themselves the target of producing 858 million barrels of renewable fuel annually by 2020 (renewable fuels standard, RFS), which is about 12% of total current oil consumption. According to a Princeton University study, a total of 176 million barrels of DME each year could be supplied by 2034 following the introduction of the black liquor gasification process across the entirety of the American pulp and paper industry.

Chemrec took an important step in developing DME in the autumn of 2008, when the EU decided to support the Swedish concern with its BioDME project. Through its Seventh Framework Programme (FP7) and together with the Swedish Energy Authority and 7 industrial partners, a functioning test system is to be set up by the second quarter of 2010, to examine the economic viability of DME. Volvo is to provide 14 lorries for the test launch, which will run exclusively on DME. Above all, a new fuel injection system is needed. Chemrec will supply 4 to 5 tons of DME each day from an ancillary plant at the Piteå mill, while Sweden's largest oil company, Preem, is to establish filling stations for DME in the cities of Piteå, Stockholm, Gothenburg and Växjö. The Energy Technology Centre (ETC) in Piteå contributes its expertise on syngas and catalysts and evaluates the plant's performance characteristics. The Danish company Haldor Topsøe contributes with its synthesis process for producing DME and the French company Total will develop fuel and lube oil specifications. €28 million has already been provided for the project and each of the 14 lorries is to cover around 100,000 km each year.

Volvo has already been testing 7 types of fuel from renewable sources for some time. These are biodiesel, produced by the esterification of vegetable oils; synthetic diesel, a blend of synthetically generated hydrocarbons; DME, which is produced by the gasification of biomass; methanol/ethanol, methanol being a product of biomass gasification, while ethanol is produced by fermentation from crops with high sugar or starch content; biogas, a gaseous fuel consisting mainly of the hydrocarbon methane; biogas + biodiesel, which are supplied by separate tanks and injection systems and used in combination; and hydrogen + biogas, which can be mixed in low concentration, in this case 8 percent by volume. Volvo gave top marks to black-liquor based DME in 5 out of 7 of the test criteria (climate impact, energy efficiency, land use efficiency, fuel potential and fuel cost). The weakness for DME is infrastructure, where it scored a 2. The distribution infrastructure is similar to that of liquefied petroleum gas (LPG).

According to Per Salomonsson, BioDME project leader and R&D manager with Volvo, 'the choice of fuel comes down to how much fuel a hectare of land will produce'. It would be a lot easier for Volvo Group to put synthetic diesel into its vehicles, but according to their estimates, DME will deliver over 65% more kilometres of travel per hectare. Compared with conventional biodiesel produced from vegetable oil, the advantage is five to one. He adds: 'Biomass will be in short supply in the future. In the long run we can't afford to have anything but the most efficient process.' ■