

Fossil-free diesel fuel in sight

Finnish fuel producer Neste Oil is developing a new generation of fossil-free diesel fuel. Governor of California, Arnold Schwarzenegger, has given the Finns official permission to sell their product, NExBTL, as “renewable diesel”.

| by Reiner Gatermann

Sami Oja is bursting with optimism. ‘Technically speaking, we are several years ahead of our competitors.’ The marketing director of the Finnish fuel producer Neste Oil is referring to NExBTL, the second generation ‘renewable diesel fuel’. Production began in autumn 2007 at Porvoo, 40 km east of Helsinki, and is set to double to 340,000 tonnes per year by 2009. As part of a joint venture with Neste, OMV AG is building a 200,000 tonne refinery at Schwechart in Austria for completion by 2009, as well as a refinery with a capacity of 800,000 tonnes per year in Singapore, which will be in operation by the end of 2010.

Sami Oja sees very few similarities between next generation biomass-to-liquid fuel (NExBTL) and its forerunner Fame. They both use bio-oils as a basic raw material, but while Fame is produced by esterification, NExBTL is produced using the catalytic hydrotreating process at the heart of the Porvoo refinery. As part of this process, vegetable or animal fats are hydrated after being pre-treated with phosphoric acid and caustic soda at temperatures of 320 to 360°C and up to 80 bar pressure, before being pumped into hydrotreating reactors. In these reactors, oxygen is removed and the fuel (triglyceride) is converted into separate branched-chain paraffins. This produces paraffinic hydrocarbons with the chemical formula C_nH_{2n+2} . At this

point, the Finn emphasises that ‘this is the same formula as that of our ultimate goal: synthetic diesel from biomass (BTL) using the gasification process based on the Fischer-Tropsch method’.

But it may take many years to achieve this. Although the process has existed for decades, industrial manufacture has not been possible at acceptable prices. Research is now moving apace and in 2009 Neste will commission a pilot plant in partnership with the Finnish-Swedish forest products and paper group Stora Enso in Varkaus, Finland.

Superior properties |

The advantages of NExBTL compared to Fame are considerable. First generation bio-diesel cannot be added to more than about 5% of the fossil fuel without risking engine damage, while there is no limit for NExBTL. In theory, a truck can be run almost 100% on ‘renewable diesel’ without any engine modifications. The fuel is sulphur, oxygen, nitrogen and aromatic-free and has a very high cetane number (84–99). In addition, it can be used at temperatures as low as -300 C and has good storage properties. This is in addition to environmental and performance benefits. Depending on how it is driven, a NExBTL-fuelled vehicle (Euro 4 motor) produces 40-60% less greenhouse gas emissions, up to 45% fewer particles, up to 20% less nitrogen oxide and up to 78% less carbon

monoxide compared to sulphur-free diesel. In a study commissioned by Neste Oil, the Institute for Energy and Environmental Research (IFEU) in Heidelberg concluded that ‘NExBTL has superior properties over current diesel products or alternative renewable fuels’ and ‘the results show a clear, but quantitatively different advantage in the energy and greenhouse gas balance if NExBTL is used to replace conventional diesel fuel.’

This opinion is shared by a large number of car manufacturers. The major players, such as Audi, MAN, Mercedes Volvo, Scania and Volkswagen have been testing NExBTL over a long period, together with Bosch as a key supplier. This has led MAN to conclude that ‘due to the disadvantages of Fame, biobased hydrocarbon diesels, such as NExBTL, will be favoured.’ At Volkswagen the view is that ‘hydrogenated plant oil is much more suitable as a fuel, compared to Fame.’

Since January, Neste has been conducting comprehensive tests lasting 10 months in Alberta, Canada. Following laboratory tests, the new diesel fuels are now to be tested under realistic traffic and weather conditions. As part of this ‘Alberta Renewable Diesel Demonstration’, some of the 60 heavy goods vehicles will be driven using a NExBTL mixture. Jarmo Honkamaa, deputy chairman of the Finnish group, is confident of success, partly due to ‘our



Biodiesel plant 1 in Porvoo, Finland. Erkki Ollikka/Neste Oil

superior properties at low temperatures'. In the Finnish capital Helsinki buses and refuse collection trucks are already being run on the 'renewable diesel' as part of tests lasting several years, while negotiations are underway in Sweden for similar projects.

During the refinery process, slurry, gases and petrol residues are produced at the Finnish plant, but fuel gas and biogasoline are described in the IFEU Analysis as 'important by-products'. In the analysis they are "credited" according to the useful functions they perform. In Porvoo all the fuel gas is used in the cogeneration plant. A production cost comparison with Fame is difficult, however. Investment levels are high and the cost of manufacture per tonne depends greatly on the raw material mix. However, the considerably higher quality compared to Fame should justify a price premium, according to IFEU.

Palm oil |

The use of raw materials is one of the key remaining problems. Neste mainly uses palm oil from Malaysia, which has been criticised not only by Greenpeace but also by a number of potential customers. For example, the Stockholm ferry company Waxholmsbolaget insists that it has only supplied with NExBTL that originates from animal fats. The ferry company travels between the skerries close to the

capital. Due to public pressure, a Swedish oil company has ceased to supply NExBTL.

Neste Oil currently uses both vegetable and animal fats, with palm oil representing the major proportion. The Finns, however, set great store by the fact that their palm oil is not produced from Malaysian plantations that were recently created on land where rain forests have been cleared. 'In order to verify this, we know the origin of the palm oil that we use exactly by segregating our raw material flows. The sustainability of the production has been audited by an independent auditor. We are also committed to the use of certified palm oil when it becomes available and we are working to develop non-food raw materials. We are not aware of any other company that has the same level of sustainability in the biofuel, or in any other industry', emphasises Sami Oja. 'We publicise the origin of our raw materials, which is not exactly common practice in this sector'.

Of course, palm oil is currently the best energy source. According to IFEU, compared to the same quantity of fossil diesel, one tonne of NExBTL saves 44 GJ of primary energy and 1.4 tonne of CO₂ equivalents. The people in Heidelberg have also tested alternative raw materials and concluded that 33 GJ of primary energy and 25 t CO₂ can be saved by using rapeseed sourced from

EU countries. Even the use of rapeseed from non-European countries would produce a saving of 30GJ and 1.2 t CO₂.

One of the Finns' next objectives is to produce NExBTL without using any edible raw materials. But, as Sami Oja says, 'there are still insufficient non-food bio oils'. For this reason, rapeseed, palm oil and soy oil still dominate the market, but in future non-food bio-oils such as tallow, jatropha and castor will be used. The Finns set great store by next generation renewable diesel, particularly algae oil, while the ultimate goal is the use of 'waste biomass from forestry waste'.

The Finns have fought long and hard for a distinction to be made between Fame and NExBTL and found a strong advocate in the Governor of California, Arnold Schwarzenegger. As a result, only first generation biofuel (Fame) is described as a biodiesel, while second generation biofuels (NExBTL) trade under the name of renewable diesel. The description 'synthetic diesel from biomass' (BTL = biomass to liquid) is ultimately reserved for the third generation. But Neste believes it has already achieved this quality with its NExBTL.

Neste Oil, in which the Finnish state holds a 50.1% stake, hopes to be able to profit by its technical edge. However, in the medium term 'we need other competitors with other technologies', says Sami Oja, 'we are too small on our own'. ■