European Biofuels
TECHNOLOGY PLATFORM

Biofuel Fact Sheet

Liquid synthetic hydrocarbons

Introduction

Hydrocarbons are organic compounds consisting mainly of hydrogen and carbon. There are many sub-groups: paraffins, such as alkanes, alkenes, alkynes, naphthenes, such as cycloalkanes, and aromatics, such as xylene, benzene, as well as many other compounds consisting of hydrogen, carbon, nitrogen, and sulphur. Alkanes are saturated hydrocarbons in which all C-C bonds are single bonds. Alkenes are unsaturated hydrocarbons that have at least one C-C double bond. Cycloalkanes have at least one ring of C-atoms. Aromatics are hydrocarbons that have a C6 ring analogous to that of benzene.

Hydrocarbon fuels produced from natural gas, crude oil, or coal are referred to generically as fossil fuels, while those produced from biomass are called biofuels. When the fuels are produced via extensive processing, such as the XtL routes, they are generically called synthetic fuels.

See page two for Production Process.

State of the Art

Currently, there is no large-scale production of BtL fuels in Europe. The research project OPTFUEL, led by the Volkswagen Group, aims at demonstrating the production of BtL-based fuels made from wood and wood residues. In the OPTFUEL project fast growing biomass like willow or poplar are used as feedstock. The development of BTL production technology is still in progress and is not yet competitive.

CHOREN Industries Ltd. developed the so-called Carbo-V process, which is a three-stage gasification process resulting in the production of syngas:

- low temperature gasification
- high temperature gasification
- endothermic entrained bed gasification

After gas conditioning the Fischer-Tropsch process is then used to convert the synthesis gas into a crude product which is further processed using hydrocracking into products such as the automotive fuel SunDiesel™.

Currently, a pilot plant for a novel process, the so-called bioliq-process, is underway at the Karlsruhe Institute of Technology (KIT). The bioliq pilot plant will cover the process chain required for producing customized fuels from residual biomass, dry straw or wood. Furthermore, the integrated process chain enables production of both fuels and chemicals. The concept combines decentralized production of an energy-rich intermediate product "bioliqSynCrude" and centralized processing into products with final industrial-scale refinement.

In a joint venture with Stora Enso, Neste Oil works on a project to develop BtL technology for the production of synthetic diesel from wood residues. The project will focus on developing new gas cleaning technology and on using Fischer-Tropsch processes to make the biodiesel. VTT Technical Research Centre of Finland will join the two partners to implement the development phase and commercialize the technology.

Molecular Formula

C_xH_y (general), C_nH_{2n+2} (alkanes)

Properties of BtL

Density at 20°	0.76 kg/l
Viscosity at 20°C	4mm2/s
Heating value:	44.01 MJ/kg

Utilization

petrol, diesel, aviation fuel, marine fuel

Relevant fuel regulations

EN 590 (diesel fuel)
ASTM D7566 (50% FT fuel in Jet-A1)

Main feedstocks

Energy crops and trees, agricultural food and feed crops, agricultural crop wastes, wood wastes and residues

Scale of Production

Pilot test stage

Costs and GHG Balance

Production costs in Germany 2007 for BtL was 31 €/GJ with predictions for 2020 at 26 €/GJ

The expected yields per hectare of 4000 l/ha and savings of 2.5 kg CO_2/l provide higher GHG reduction per hectare for BtL.

Assumes crude oil at 50 US-$/bbl

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Production process

Hydrocarbon fuels are ideal for transportation applications because they have high energy content per volume or mass and since they are mostly liquids they can be easily transported and stored. A wide variety of hydrocarbon components are blended together to make motor fuels according to the specifications appropriate for cars, trucks, non-electric trains, or aeroplanes.

Liquid, synthetic hydrocarbons (XtL) can be used in petrol, diesel, aviation fuel and marine fuels. To what extent depends on their properties, which result from the specific manufacturing process and subsequent downstream processing. XtL is the generic name of synthetic liquid hydrocarbons, for distinguishing between the different raw materials; the abbreviations CtL (Coal to Liquid), GtL (Gas to Liquid) and BtL (Biomass to Liquid) are used. Their utilization as a transportation fuel requires no significant changes to the existing infrastructure and engines, because synthetic hydrocarbons can be processed to fit the specifications. Hence they are often referred to as drop-in fuels.

BtL is produced in a four-step-process:

1. Gasification – to produce raw syngas:

$C_xH_yO_z + AOa \rightarrow CO + H_2 + CO_2$

Exact reactions are multifold, e.g. any sulphur becomes H_2S and COS

2. Syngas conditioning – to achieve correct gas quality:

$CO + H_2O \Leftrightarrow CO_2 + H_2$

and removal of CO_2, and any H_2S and COS

Example projects on synthetic hydrocarbons

OPTFUEL - optimised fuels for sustainable transport (FP7)

BIOLIQ - Biomass to Liquid Karlsruhe

BioTfueL - a French/German project aims to integrate all stages of the BTL process chain and bring them to market

BRISK – European research infrastructure for thermal conversion technology, which aims to overcome fragmentation in experimental facilities and foster greater cooperation R&D (FP7)

CEA Bure Saudron - will use foresty and agricultural residues to produce ~23000 tonnes/year of biofuel (diesel, kerosene and naptha)

Rentech - US-based projects focusing on syngas production and synthetic hydrocarbon technology

Major stakeholders

Choren Industries GmbH, Germany

Volkswagen AG, Germany

Renault SA, France

Karlsruhe Institute of Technology (KIT), Germany

Lurgi, Germany

IFP, France

NSE Biofuels Oy (Joint venture Neste Oil and Stora Enso), Finland

UPM Kymmene, Finland

3. Synthesis via a type Fischer-Tropsch process:

$nCO + 2nH_2 \Leftrightarrow (-CH_2-)n + nH_2O$

or

synthesis via a Methanol-to-Gasoline process:

$CO + 2H_2 \Leftrightarrow CH_3OH$

$nCH_3OH + H_20 \rightarrow n/2CH_3\text{-}O\text{-}CH_3 + n/2\ H_2O \Leftrightarrow (CH_2)_n + nH_2O$

4. Product preparation – to achieve desired properties:

This can range from simple distillation to complex hydroprocessing and distillation. This is followed by preparation of final fuels, which is largely a skilled blending operation,

Generally, the production of BtL has a more favourable energy balance than that of first generation biofuels (i.e. greater levels of GHG reduction). Although biogenic fuels are sometimes referred to as carbon neutral, energy is required for fuel production, as well as transport, cultivation or processing of feedstock (this energy may come from fossil fuels). The EU-funded project BioGrace aims to harmonise calculations of biofuel greenhouse gas emissions, which form part of the sustainability criteria for biofuels within the Renewable Energy Directive (2009/28/EC). A number of schemes for certifying sustainable biofuels have now been approved by the EC.

Hydrotreated vegetable oils (HVO) are produced from vegetable oils or fats via direct hydrogenation (hydrogenolysis). It is possible to use the catalytic processes and catalysts similar to crude oil middle distillate hydro treatment, which is a commercial process. The liquid fuel is comparable to FT fuels.

Further information

Up-to-date information on synthetic hydrocarbons R&D&D is available on the Euorpean Biofuels Technology Platform website **www.biofuelstp.eu**.