European Biofuels
TECHNOLOGY PLATFORM

Biofuel Fact Sheet

Liquid, synthetic hydrocarbons

Lab scale | Bench scale | Pilot Plant | Demonstration | Production

Introduction

Hydrocarbons are organic compounds consisting of hydrogen and carbon. There are many sub-groups: paraffins, such as alkanes, alkenes, alkynes, naphthenes, such as cycloalkanes, and aromatics, such as xylene and benzene, as well as many other related compounds consisting of hydrogen, carbon, nitrogen and sulphur.

Hydrocarbon fuels 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 and Applications.

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 production 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.

Molecular Formula

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

Comparison of Fuel Properties

	BtL**	Diesel
Density at 20 °C [kg/l]*	0.76	0.83
Lower heating value [MJ/kg]*	43.9	43.1
Viscosity at 20 °C [mm^2 / s]*	4.0	5.0
Cetane number*	>70	50
Fuel equivalence*	0.97	1
GHG [gCO_2eq/ MJ]*	n.a.	

*Source: FNR 2012. * Median values are used for simplification. Please refer to the standards for ranges. ** Figures based on FT.*

Utilization

petrol, diesel, aviation fuel, marine fuel, Chemicals (naptha)

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

Liquid, synthetic hydrocarbons

Biofuel Fact Sheet

Production process

A wide variety of hydrocarbon components are blended together to make fuels according to the specifications appropriate for cars, trucks, 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 abbreviation for synthetic liquid hydrocarbons. To distinguish between the different raw materials; the abbreviations CtL (Coal to Liquid), GtL (Gas to Liquid) and BtL (Biomass to Liquid) are used. 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

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.

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.

Applications

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.

Major stakeholders

Some major stakeholders in the EU are listed below:

Volkswagen AG, Germany

Renault SA, France

Karlsruhe Institute of Technology (KIT), Germany

Lurgi, Germany

IFPEN, France

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

UPM Kymmene, Finland

Uhde, Germany

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 current specifications. Hence they are often referred to as drop-in fuels.

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

Further information

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