European Biofuels
TECHNOLOGY PLATFORM

Biofuel Fact Sheet

# Methanol from biomass

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

## Introduction

Methanol, also known as methyl alcohol, wood alcohol, or wood spirits, is often abbreviated as MeOH. It is the simplest alcohol, and is a light, volatile, colourless, flammable liquid with a distinctive odour. At room temperature it is a polar liquid. MeOH is miscible with water, petrol and many organic solvents. MeOH has a high toxicity in humans. If ingested, as little as 10 ml can cause permanent blindness by destruction of the optic nerve. A fatal dose is typically 100–125 ml.

*See page two for Production Process.*

## State of the Art

Today methanol from biomass is produced through gasification of glycerine, a by-product of biodiesel production, by BioMCN in the Netherlands. The thermochemical conversion of syngas to methanol is well known from fossil feedstocks and the basic steps are not different for biomass. The main issue faced is the economic feasibility of gasification of biomass at elevated pressures and conditioning of the raw synthesis gas.

In the past there was some small-scale production of methanol from biomass. In 2004 the German company Choren Industries GmbH produced Methanol from wood using its Carbo-V process. In the Chemrec AB pilot plant in Piteå, Sweden about 6 tons per day of methanol is used as an intermediate in the production of BioDME.

While the biochemical route through methanothrophic bacteria is still in a quite early state of development the conversion of biogas to methanol has been proven on bench scale. ZSW has proven that methanol could be produced from biogas at a decentralised level.

### Major stakeholders

Chemrec AB, Sweden
VärmlandsMethanol AB, Sweden
BioMCN B.V., Netherlands
B.T.G. BIOMASS TECHNOLOGY GROUP BV, Netherlands
Choren Industries GmbH, Germany
Karlruhe Institute for Technology (KIT), Germany
ZSW, Germany
DECHEMA, Germany
Technical University of Vienna, Austria
Technical University of Graz, Austria

### Molecular Formula

$CH_4O$

### Properties of methanol

Molecular mass: 32 g/mol
Density at 20°C: 0.7918 g/cm$^3$
Viscosity at 20°C: 0.59 mPa s
Heating value: 19.94 MJ/kg
Vapour pressure at 20°C: 13.02 hPa

### Utilization

Chemical feedstock, petrol blend component

### Relevant fuel regulations

EN 228

### Main feedstocks

Natural gas, coal, biomass

### Scale of Production

Industrial scale

### Costs and GHG Balance

| Origin | GHG [g $CO_2$eq/km] | Production cost [€/GJ] |
|---|---|---|
| Waste wood | 18 | 15.8 |
| Farmed wood | 14 | 18.9 |
| Black liquor | 11 | 8.2 |

*Assumes crude oil at 50 US-$/bbl*

### Projects on methanol

**SUPER METHANOL** - Reforming of crude glycerine in supercritical water to produce methanol for re-use in biodiesel plants (FP7-212180)

**MTO/OCP Project** - Methanol-to-olefins/olefin cracking process (€45m project funded by Total)

# Methanol from biomass

**Biofuel Fact Sheet**

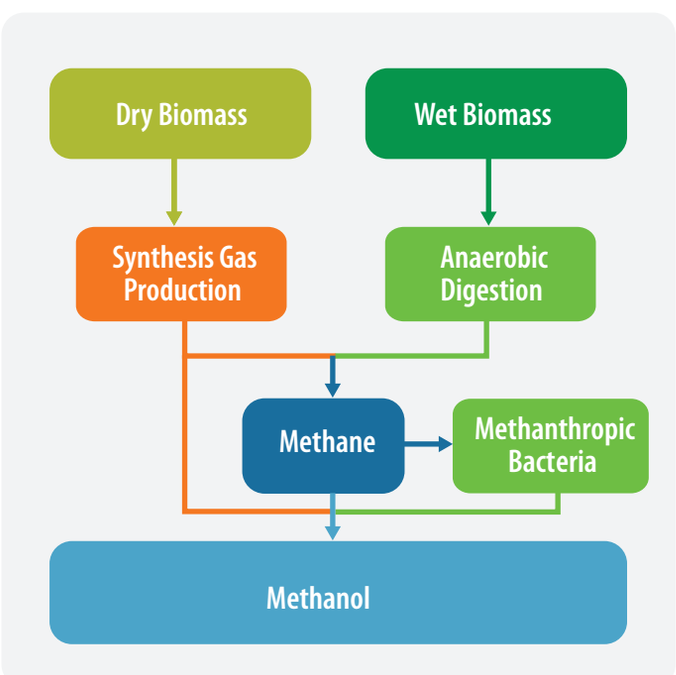
## Production process

In nature MeOH is produced via anaerobic metabolism by many bacteria. It is also formed as a by-product during the ethanol fermentation process. MeOH also occurs naturally in many plants, especially in fruits.

Historically MeOH was first produced from wood by destructive distillation, as early as 1661 by Robert Boyle

In 1923 the German company BASF introduced industrial MeOH production based on coal gasification. Since then MeOH has grown into one of the largest chemical synthesis feedstocks. Key uses include production of formaldehyde, MTBE/TAME (gasoline components), acetic acid, DME and olefins and direct use as a petrol blend component. Today MeOH is mainly synthesized from natural gas, but also from coal, mainly in China and South Africa. The leading MeOH production processes are the pressurized syntheses developed by ICI and Lurgi. In 2007 the world production of MeOH amounted to 40 million tonnes with a forecast compound annual growth rate of 4.2% for the period 2008-2013 excluding captive production for the methanol-to-olefins (MTO) route.

Biomass can be converted to MeOH via thermochemical and biotechnological pathways as shown in the following diagram.




## Thermochemical pathways

The thermochemical conversion paths to MeOH are basically the same as for fossil feedstocks, such as coal or natural gas.

The biomass is gasified and the resulting synthesis gas, a mixture of CO, $H_2$ and $CO_2$, is adapted to the quality requirements of MeOH synthesis.

During synthesis the following reactions occur:

$CO + 2H_2 \Leftrightarrow CH_3OH$

$CO_2 + 3H_2 \Leftrightarrow CH_3OH + H_20$

$CO_2 + H_2 \Leftrightarrow CO + H_20$

The formation of MeOH is exothermic and is favoured by high pressures and low temperatures. For reasons of process simplification, investment cost reduction and energy consumption reduction, alternatives are under development, which could also be used for MeOH from biomass

Direct oxidation of Methane: $2CH_4 + O_2 \Leftrightarrow 2CH_3OH$

Liquid-phase oxidation of Methane

Conversion through monohalogenated methanes

## Biochemical pathways

One biochemical route is via methane formation by anaerobic digestion. This process is well developed due to the rise of biogas production from municipal waste or landfill sites.

The biogas has to be cleaned to obtain a gas with high methane content and MeOH is then produced from the methane as described above.

Recently a genuine biochemical route using methanothrophic bacteria has been investigated. For example, bacteria such as *Methylococcus capsulatus* will convert methane to MeOH if methane is the only available resource.

## Further information

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