Bioenergy Fact Sheet
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ETIP Bioenergy
European Technology and Innovation Platform

Methanol

LAB SCALE → BENCH SCALE → PILOT PLANT → DEMONSTRATION → PRODUCTION

DEFINITION

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 compounds. MeOH burns with an almost invisible flame and is biodegradable.

Without proper conditions, methanol attracts water while stored. Methanol is a safe fuel. The toxicity is comparable to or better than gasoline. It biodegrades quickly (compared to petroleum fuels) in case of a spill.

Molecular Formula

CH_4O

Comparison of fuel properties:

	Methanol	Petrol
Density at 20 °C [kg/l]*	0.79	0.74
Lower heating value [MJ/kg]*	19.7	43.9
Octane number*	> 110	92
Fuel equivalence*	0.48	1
GHG emission reduction versus fossil methanol**	Waste wood methanol: 86% Farmed wood methanol: 83%	

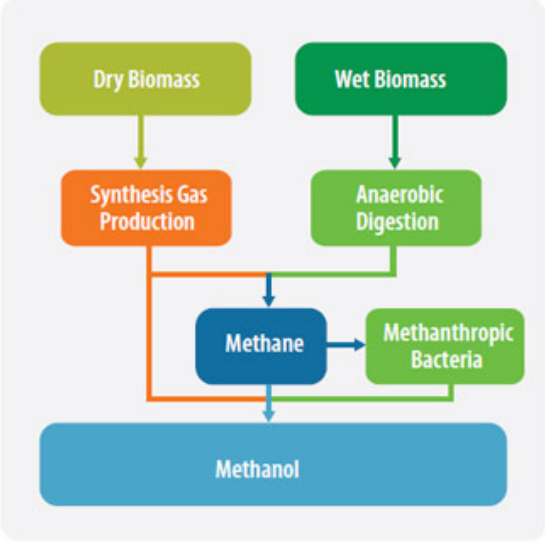
*Source: *FNR 2012, medium values are used for simplification, please refer to the standards for ranges. ** DIRECTIVE (EU) 2018/2001, total for cultivation, processing, transport and distribution*

PROCESS TECHNOLOGY

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

Currently, MeOH is mainly synthesized from natural gas, but also from coal, mainly in China and South Africa.

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

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
- Liquid-phase oxidation of methane
- Conversion through monohalogenated methane

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.
Another biochemical route uses methanothrophic bacteria that convert methane to MeOH if methane is the only available resource.

Biomethanol from pulp mills

During the pulping process in pulp mills, raw MeOH is formed in the digester by reaction of the wood chips with the cooking chemicals. While most pulp mills use it for heat and power production, it can also be upgraded for sale.

APPLICATIONS

MeOH is a building block for chemicals such as formaldehyde, acetic acid or methanol-to-olefin. It is also a versatile fuel for combustion engines and can be used in low blends with gasoline without technical adaptations and in higher blends or pure in diesel and dual-fuel engines e.g. in heavy-duty vehicles, and in ships. Furthermore, it can be used in fuel cells, constituting a very efficient and easy to store hydrogen carrier. Interest in renewable MeOH as an energy carrier in the transport sector has recently increased, since it can be made from biomass or as e-fuel from green electricity and CO_2. Renewable MeOH can contribute to the decarbonization of sectors that are hard to electrify, such as maritime transport. Maersk has one smaller vessel already operating on MeOH and ordered 8 ocean-going vessels that will operate on MeOH starting 2023. Current production levels of renewable MeOH are still low (less than 0.2 million tonnes in 2020), but could be ramping up quickly.

PRODUCTION FACILITIES (EXAMPLES)

Södra in Monsteras, Sweden
Capacity: 5,000 t/y
Technology: extraction from the pulp mill
https://www.sodra.com/en/global/pulp/production/sodra-cell-monsteras/

Enerkem in Edmonton, Canada
Capacity: 30,000 t/y
Technology: gasification and synthesis.
https://enerkem.com/products/methanol/

SOURCES

AMF Fuel Info:

- https://iea-amf.org/content/fuel_information/methanol

Renewable methanol production projects:

- https://www.methanol.org/renewable/
- https://www.methanol.org/wp-content/uploads/2020/04/IRENA_Innovation_Renewable_Methanol_2021.pdf
- https://www.etipbioenergy.eu/databases/production-facilities