Biomass based methanol

Lab Scale | Bench Scale | Pilot Plant | Demonstration | Production

Biomass based methanol CH_3OH

Methanol is the simplest form of alcohol and it is produced via synthesis gas (H_2 and CO) mainly derived from fossil feedstocks, such as natural gas and coal. Approximately 60% of the global methanol demand is currently used in the chemical industry, but the fuel and energy markets are increasing steadily and represent around 40% of the global use. Bio-methanol is a so called second generation or advanced biofuel and can be used blended with petrol, as marine fuel, or in fuel cells. Compared to conventional fossil based production of methanol, bio-methanol is currently produced at small scale.

Primary area of use

Today methanol is mainly used for production of chemicals like formaldehyde, acetic acid and MTO (methanol-to-olefins). Furthermore, through intermediate chemicals, many common products are produced from methanol, such as paints, antifreeze, plastics, and propellants.

Methanol can be used as a transportation fuel in several ways: blended with petrol, as a precursor to methyl tertiary-butyl ether (MTBE) which is used as an octane enhancer in petrol, in the transesterification process when making FAME (fatty acid methyl ester) biodiesel, and as a diesel replacement after conversion to dimethyl ether (DME) or oxymethyl ether (OME). Methanol demand for energy purposes has been increasing steadily over the last decade, driven mainly by growing demand as a transportation fuel in China, where methanol currently represents 7% of the total transportation fuel use.

Methanol has a high octane number making it a good alternative to fossil petrol, which has been demonstrated for e.g. M15, M85 and M100. The EU allows low blending up to 3% in petrol, but this is currently not commonly used. When the blend-in level exceeds 15%, modifications are required, e.g. higher fuel injection to compensate for the lower energy density, modification to the ECU (Engine

Properties

Chemical formula:	CH_3OH
Molecular mass:	32.04 g/mol
C (%wt)	37.5
H (%wt)	12.5
O (%wt)	50
Density at 20°C:	0,791 kg/cm³
Viscosity at 20°C:	0.59 mPa s
Heating value:	21.1 MJ/kg
Octane number:	RON of 107 & MON of 92

Methanol is a colorless and water-soluble liquid that burns with an invisible flame. It has a faint smell and boiling point of 65°C. It is more corrosive than petrol. Methanol is highly toxic to humans, but less toxic than petrol and not carcinogenic. An important benefit is that in case of spills, methanol is biodegradable.

Control Unit), as well as material modifications to endure the corrosiveness of methanol. Emissions in the form of carbon monoxide, nitrogen oxides and hydrocarbons are lower from methanol compared to petrol, and methanol contains very low levels of impurities of sulphur or metals. The energy content (Lower heating value, LHV) is 15.8 MJ/litre (or 19.8 MJ/kg), slightly less than half of that of petrol.

Due to the high hydrogen content, methanol is an excellent hydrogen carrier than can be converted to hydrogen for usage in fuel cells without prior fuel pre-treatment. Direct Methanol Fuel Cell (DMFC) as well as High Temperature Polymer Eloctrolyte Membrane (HTPEM) fuel cell technologies have the potential of fuel efficiencies of around 40%.

There is also significant interest for methanol as a marine bunker fuel, due to international regulatory changes and cost advantages relative to other fuels. Methanol is sulphur free with low emissions and can be produced to lower cost than marine distillate fuel (when produced from fossil sources).

Feedstock and production

Methanol can be synthesised from a wide range of raw materials via two production steps. First, the feedstock (currently mainly fossil fuels like natural gas and coal) is converted into a synthesis gas consisting of CO, CO_2, H_2O and H_2 through catalytic reforming or partial oxidation. In the second step methanol is synthesised catalytically. Each of these steps can be carried out in a number of ways using different technologies. The methanol process has a high selectivity leading to high production efficiency.

Recent developments in gasification technology provide opportunities to shift the use from fossil based feedstock to biomass, agricultural waste, municipal solid waste, and other lignocellulosic resources.

Distribution and storage systems

The technology for distributing and storing methanol is very similar to the current systems used for petrol and diesel, including pipelines, barges, chemical tankers, rail tankers and trucks. Material components must however be replaced to endure the corrosiveness of methanol. In Sweden, some distribution systems are adapted to alcohols, and systems adapted for E85 can also store M85 or GEM fuels (gasoline-ethanol-methanol).

Small risks are associated with the transportation and distribution of methanol. Methanol is highly toxic to humans and can cause blindness or even death on ingestion. Methanol is classified like petrol or diesel regarding toxicity, but is non-mutagenic and methanol vapour does not involve any health risks under practical conditions. Methanol biodegrades very rapidly in aerobic as well as anaerobic conditions and it will not persist in the environment. The half-life in groundwater is several hundred days shorter for methanol in comparison to petrol components.

Biomethanol projects

In Edmonton, Canada, Enerkem operates a commercial scale plant producing 38 million liters per year of methanol from municipal waste. A similar facility is planned in Rotterdam, the Netherlands, involving a number of European partners.

In Iceland, Carbon Recycling International is producing renewable methanol via CO_2 captured from geothermal power generation and hydrogen produced via electrolysis. The production capacity is 5 million liters per year.

BioMCN in the Netherlands produces and sells industrial quantities of bio-methanol, by converting biogas from waste digestion into methanol. The annual production capacity of bio-methanol is around 250 million litres, with plans to further expand the renewable share in the future.

Methanol production via gasification of black liquor has also been successfully demonstrated at pilot scale at the LTU Green Fuels plant in Piteå, Sweden, but operation was terminated in 2016.