

From Crops to Fuels - Biodiesel



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Biodiesel from Renewable Resources

The 'Kyoto Protocol' – which is the United Nations framework convention on climate change – requires the introduction of biofuels into the transport fuel market in order to reduce greenhouse gas emissions.

The 'EU Biofuels Regulation' urges the member states to ensure the increase of the market share of biofuels in the transport fuel market from 2% in 2005 to a remarkable 5.75% in 2010.

Future shortage in petroleum supply and surging prices for petroleum based fuels will significantly increase the shift towards the alternative fuels sector.

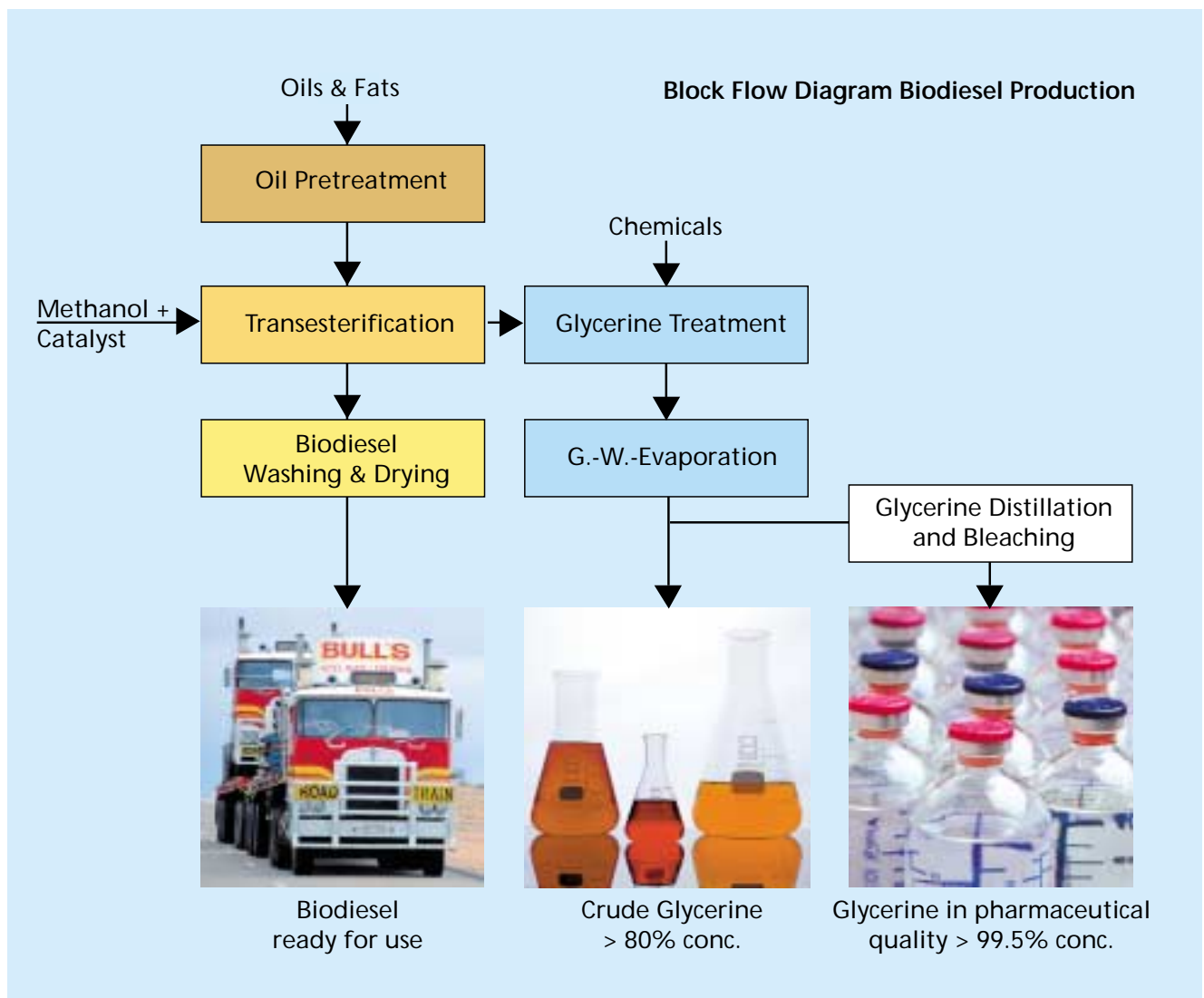
Biodiesel will become a vital part of our energy supply and may be used either as a fuel additive mixed in any ratio with biodiesel from renewable resources, a mineral diesel or as a pure product. In either case fuel quality requirements are critical and expectations are rising.

Recognizing this trend at an early stage Lurgi, a world-leader in the field of oleochemicals, is able to provide the industry with a multi-purpose technology able to process in principal all vegetable and animal oils and fats.

Lurgi has been building biodiesel (methylester) plants for over 15 years and is the marketleader in designing plants to meet the industrial demand for higher capacities, improved economy and better quality – total capacity of plants under design, construction and operation amounts to more than 1 million tons per year.

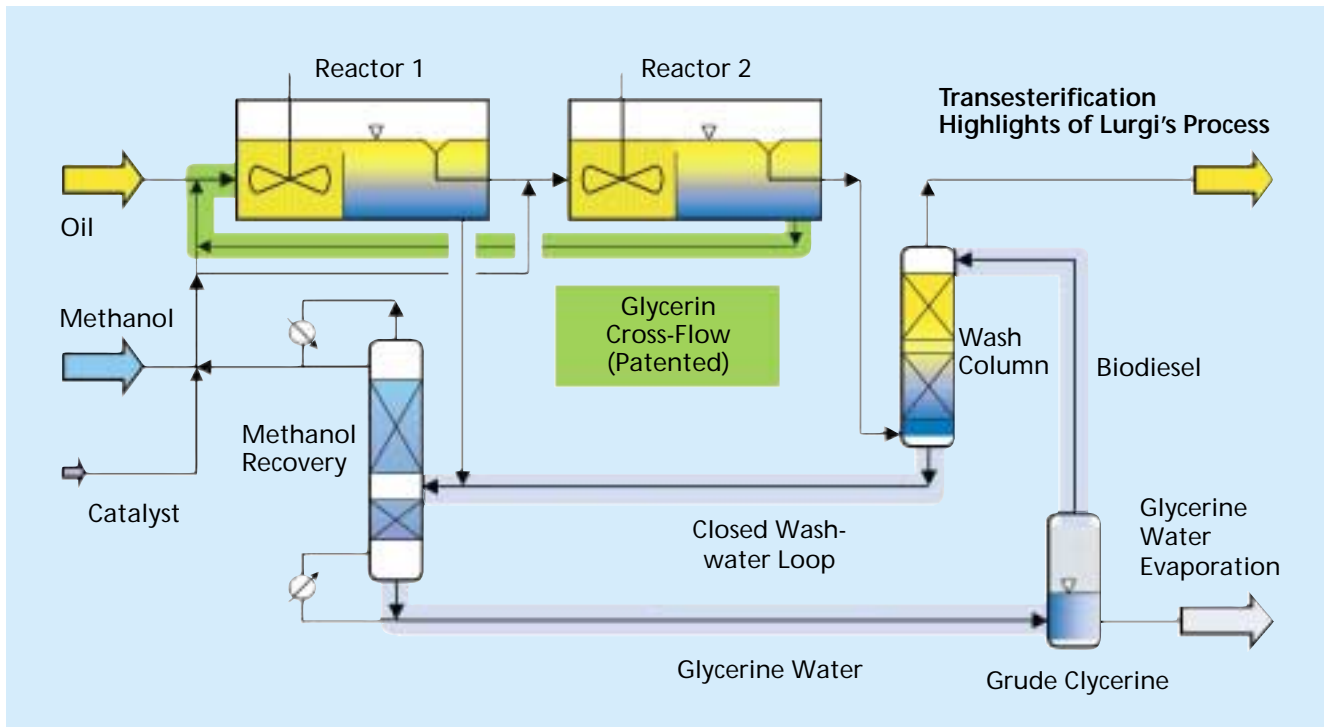
Advantages of Biodiesel

- Bio-degradable
- Closed CO₂ loop
- Minimum greenhouse gas emissions
- Sulfur-free
- Less dependance on fuels from mineral oils
- Non-toxic
- Reduction of particulates (smoke) emission by approx. 50%
- Biodiesel does not contain benzene or other aromatics
- Higher engine efficiency and durability
- Improvement of ignition and lubricity
- Flash point at approx. 150°C - petroleum diesel at approx. 70°C
- Safest fuel to store and handle



Transesterification Process

Flowsheet of the process



Principle of Process

Transesterification is based on the chemical reaction of triglycerides with methanol to form methylesters and glycerine in the presence of an alkaline catalyst. This reaction is effected in a two-stage mixer-settler unit. Transesterification takes place in the mixing section, while the subsequent settling section allows for the separation of methylesters as the light phase from glycerine water as the heavy phase.

A subsequent countercurrent washing step for the methylester removes minute by-product components and gives a biodiesel "ready for use" after the final drying step.

The surplus methanol contained in the glycerine water is removed in a rectification column, which yields methanol in a condition and purity ready for use as a recycle stream to the process. For further glycerine water purification additional steps of chemical treatment, evaporation, distillation and bleaching may follow optionally.

Feedstock

In principle all edible oils and fats – vegetable and animal – can be transesterified; fatty acids can be esterified. For fuel-specific properties, pretreated oils from rape and sunflower seeds are preferred in Europe.

Pretreatment and/or esterification as optional process steps are only required if the feedstock quality does not meet the following specification:

FFA content	max. 0.1%
Water content	max. 0.1%
Unsaporiﬁables	max. 0.8%
Phosphorus content	max. 10 ppm

Yields

1,000 kg of dried, degummed and deacidified rapeseed oil will give:

■ Biodiesel:	approx. 1,000 kg
■ Crude glycerine:	approx. 128 kg
■ Pharmaceutical-grade glycerine:	approx. 93 kg
■ Technical-grade glycerine:	approx. 5 kg

Final Products

- Biodiesel: E DIN 51606 / EN 14214
- Crude glycerine: British Standard 2621
- Pharmaceutical-grade glycerine: EU Pharmacopoeia 99.5

Consumption figures

The consumption figures – without glycerine distillation and bleaching – stated below are valid for the production of 1 ton of rapeseed methylester at continuous operation and nominal capacity.

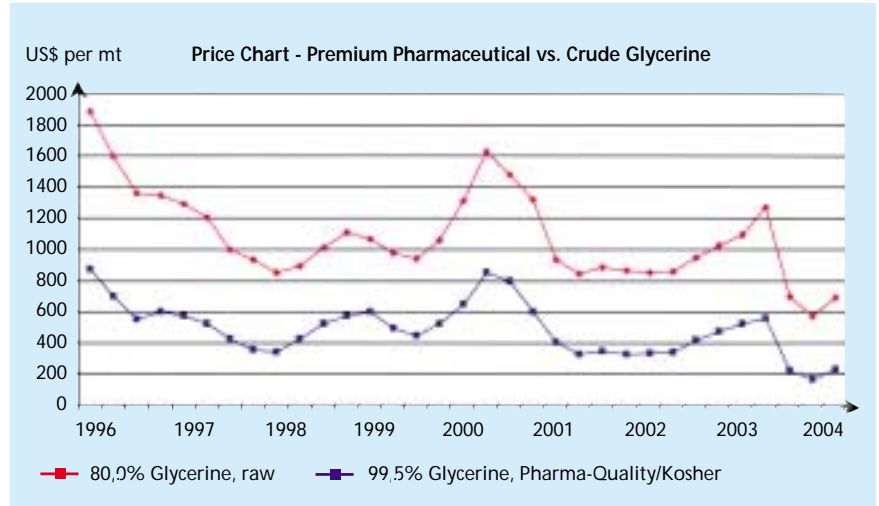
- Steam consumption: approx. 415 kg
- Cooling water consumption: ($\Delta t=10\text{ }^{\circ}\text{C}$) approx. 25 m³
- Electrical energy: approx. 12 kWh
- Methanol: approx. 96 kg
- Catalyst: approx. 5 kg (Na-Methylate 100%)
- Hydrochloric acid (37%): approx. 10 kg
- Caustic soda (50%): approx. 1.5 kg
- Nitrogen: approx. 1 Nm³
- Process water: approx. 20 kg

Profitability

Increased Profitability by Pharmaceutical Glycerine Production

Apart from the economic attractiveness of the biodiesel production Lurgi offers its clients an increase in profitability by adding a glycerine distillation unit in where the crude glycerine is processed to pharmaceutical grade with a quality of > 99.5 %. Lurgi offers this process combination in a single line responsibility concept based on decades of technological leadership in the field of oleochemicals.

The increased profitability is based on a 400-600 \$/t premium paid in the market for pharmaceutical-grade as opposed to crude glycerine.



Special Features of Lurgi's Biodiesel Technology

- Fully automatic continuous transesterification process
- High quality Biodiesel & glycerine
- Na-Methylate as catalyst
- Solutions for various feedstock
- Operation at atmospheric pressure and low temperature (appr. 60 °C)
- Low catalyst consumption
- Highly efficient process - 1 kg of raw material yields 1 kg of biodiesel
- Environmentally friendly process
- Open steel structure
- Compact layout
- Clear phase separation by special gravity process (no centrifuges required)
- Easy operation
- Low operating and maintenance cost
- Lurgi offers Biodiesel plants with capacities from 20,000 - 500,000 tons per year
- Optional pharmaceutical-grade glycerine integration

Lurgi's Expertise

- Basic Engineering
- Detail Engineering
- Procurement and supply
- Construction and construction supervision
- Commissioning and start-up
- Single-line responsibility
- Fast-track realization
- Own R & D facilities
- Plant lifecycle partnership between Lurgi as technology licensor and client



References

Germany's largest Biodiesel Plant

Since March 2002, the biodiesel plant in Marl has been producing 100,000 tons per year Biodiesel and 12,000 tons crude glycerine. The plant was built by Lurgi as lumpsum turnkey project under single-line responsibility.

Biodiesel and glycerine plants with a total capacity exceeding 5,000,000 tons per year have been designed and realized or are projected by Lurgi world-wide.



*Biodiesel plant Marl, Germany
Capacity: 100,000 t/y*



*Biodiesel plant Malchin, Germany
Capacity: 50,000 t/y*



*CAD construction, Biodiesel plant Neckermann, Germany
Capacity: 60,000 t/y*

