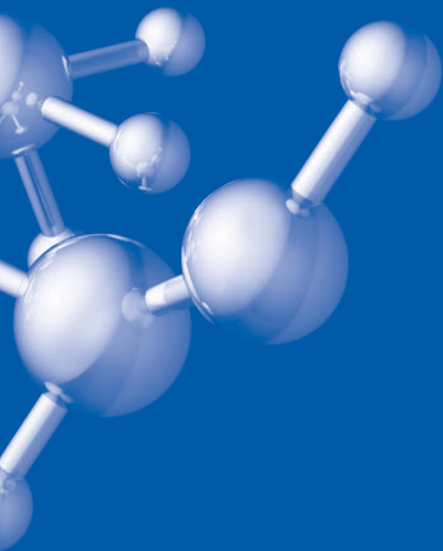




Biodiesel





Biodiesel from Renewable Resources

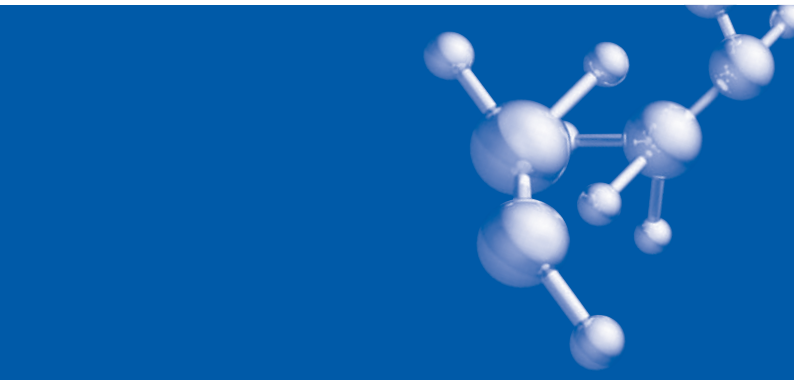
The 'Kyoto Protocol' – which is the United Nations framework convention on climatic change – requires the introduction of biofuels into the transport fuel market in order to reduce greenhouse gas emissions.

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 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 has become a vital part of our energy supply and may be used either as a fuel additive mixed in any ratio with

mineral diesel or as a pure product. In either case fuel quality requirements are critical and expectations are rising. Lurgi, a world-leader in the field of oleochemicals, is able to provide the industry with a multi-purpose technology able to process in principle most vegetable and animal oils and fats to biodiesel.

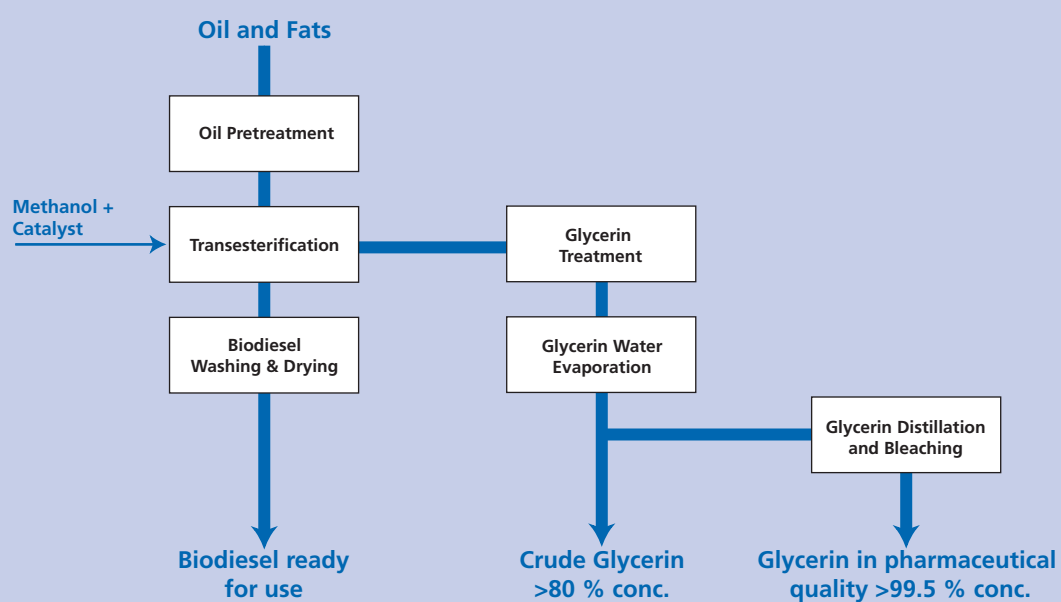
Lurgi has been building biodiesel (methyl ester) plants for over 15 years and is the marketleader in designing plants to meet the industrial demand for higher capacities, improved economy and better quality – total capacity of plants, under design, construction and operation amounts to approx. 8 million tons per year.

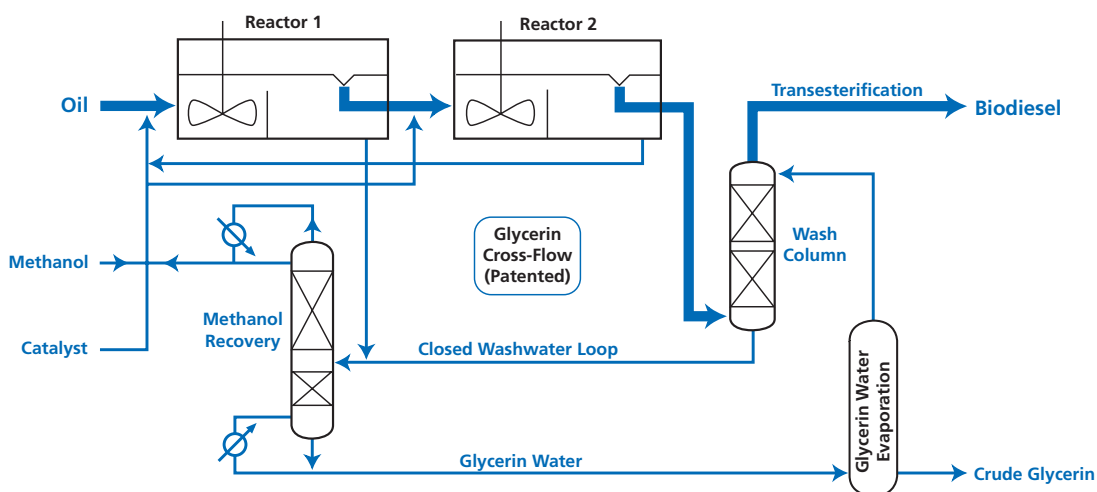
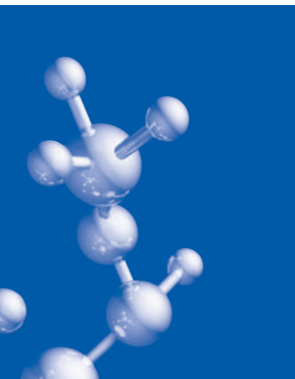


Advantages of Biodiesel

- Bio-degradable
- Nearly closed CO₂ loop
- Minimum greenhouse gas emissions
- Sulfur-free
- Less dependence 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
- Safest diesel fuel to store and handle (i.e. flashpoint biodiesel at 150° C is higher than petrol diesel at 70° C)

Block Flow Diagram Biodiesel Production





Transesterification Process

Principle of Process

Transesterification is based on the chemical reaction of triglycerides with methanol to form methyl esters and glycerin 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 methyl esters as the light phase from glycerin water as the heavy phase. A subsequent countercurrent washing step for the methyl ester removes minute by-product components and gives a biodiesel "ready for use" after the final drying step. The surplus methanol contained in the glycerin 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 glycerin water purification additional steps of chemical treatment, evaporation, distillation and bleaching may follow optionally.

Feedstock

In principle most edible oils and fats – vegetable and animal – can be transesterified. For fuel-specific properties, pretreated oils from rape, but also alternative feedstocks like soya and sunflower seeds are used in Europe. Pretreatment and/or esterification as optional process steps are required if the feedstock quality does not meet the following specification:

FFA content	max.	0.1 %
Water content	max.	0.1 %
Unsaponifiables	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 glycerin:	approx.	125 kg
■ Pharmaceutical-grade glycerin:	approx.	90 kg
■ Technical-grade glycerin:	approx.	5 kg

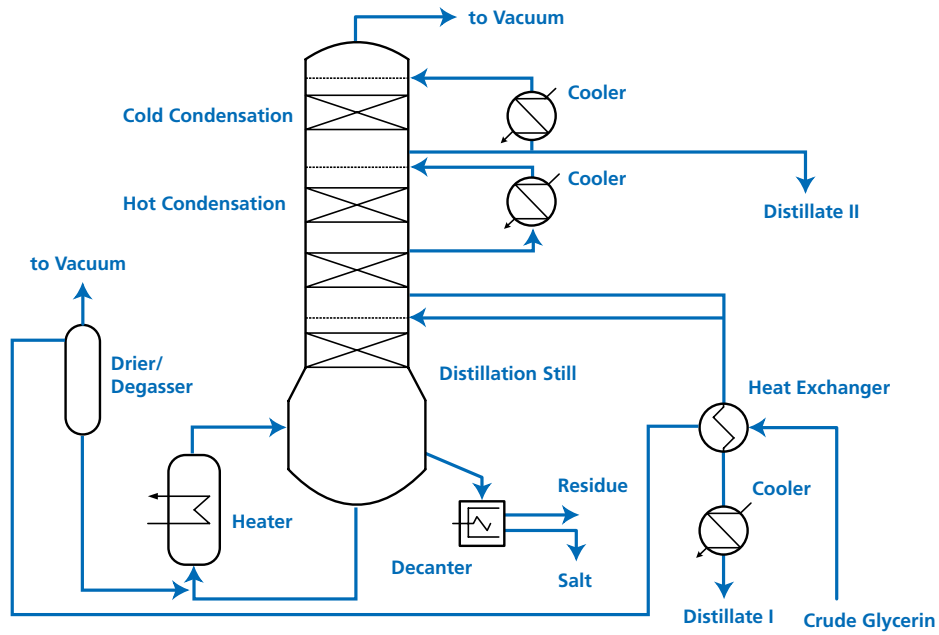
Final Products

- Biodiesel: E DIN 51606 / EN 14214
- Crude glycerin: British Standard 2621
- Pharmaceutical-grade glycerin: EU Pharmacopoeia 99.7

Consumption figures

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

■ Steam consumption:	approx.	320 kg
■ Cooling water consumption: ($\Delta t = 10^\circ\text{C}$)	approx.	25 m ³
■ Electrical energy:	approx.	12 kWh
■ Methanol:	approx.	96 kg
■ Catalyst: (Na-Methylate 100 %)	approx.	5 kg
■ Hydrochloric acid (37 %):	approx.	10 kg
■ Caustic soda (50 %):	approx.	1.5 kg
■ Nitrogen:	approx.	1 Nm ³
■ Process water:	approx.	200 kg



Glycerin Refining

Pharmaceutical Glycerin Production

Pharmaceutical Glycerin Production apart from the biodiesel process Lurgi offers its clients the proven glycerin distillation technology. Crude glycerin of approx. 80-85 % is processed into a pharmaceutical grade product with a glycerin concentration of > 99.5 %. Lurgi offers this process concept on the basis of several decades of technological leadership. Innovative design features have been added to optimize the technical and economical plant performance for the benefit of the owners”



Glycerin Distillation

Biodiesel Plant 2 x 100,000 t/d,
NEW 1 and NEW 2, Marl, Germany

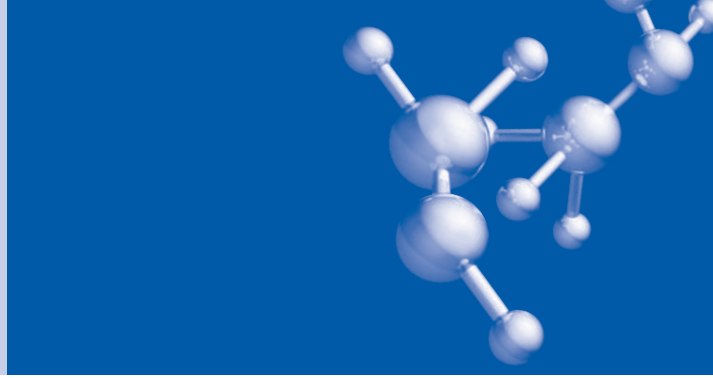


Special Features of Lurgi's Biodiesel Technology

- Fully automatic continuous transesterification process
- High quality biodiesel and glycerin
- 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 20,000–250,000 tons per year, and more
- Optional pharmaceutical-grade glycerin add on

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 (investor or owner of the plant)



References

Germany's largest Biodiesel Plants

Plants with capacities of 250,000 t/y have built and are successfully operated by the clients. Many of these plants are being built by Lurgi as lump sum turnkey projects under single-line responsibility. Lurgi is presently implementing biodiesel plants worldwide with feedstocks ranging from rapeseed, soya, sunflower, palm and other oils.

Biodiesel and glycerin plants with a total capacity of nearly 8 million tons per year have been designed and realized or are projected by Lurgi worldwide.



Transportation of pre-installed Biodiesel plant, Australia
Capacity: 100,000 t/y



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



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

Lurgi is a leading technology company operating worldwide in the fields of process engineering and plant contracting. The strength of Lurgi lies in innovative technologies of the future focusing on customized solutions for growth markets. The technological leadership is based on proprietary technologies and exclusively licensed technologies in the areas gas-to-chemical products via synthetic gas or methanol and synthetic fuels, petrochemicals, refinery technology and polymer industry as well as renewable resources/food.

Lurgi is a member of the Air Liquide Group. 

Lurgi GmbH

Lurgiallee 5 • D-60295 Frankfurt am Main

Phone: +49 (0) 69 5808-0 • Fax: +49 (0) 69 5808-3888

E-Mail: communication@lurgi.com • Internet: www.lurgi.com

