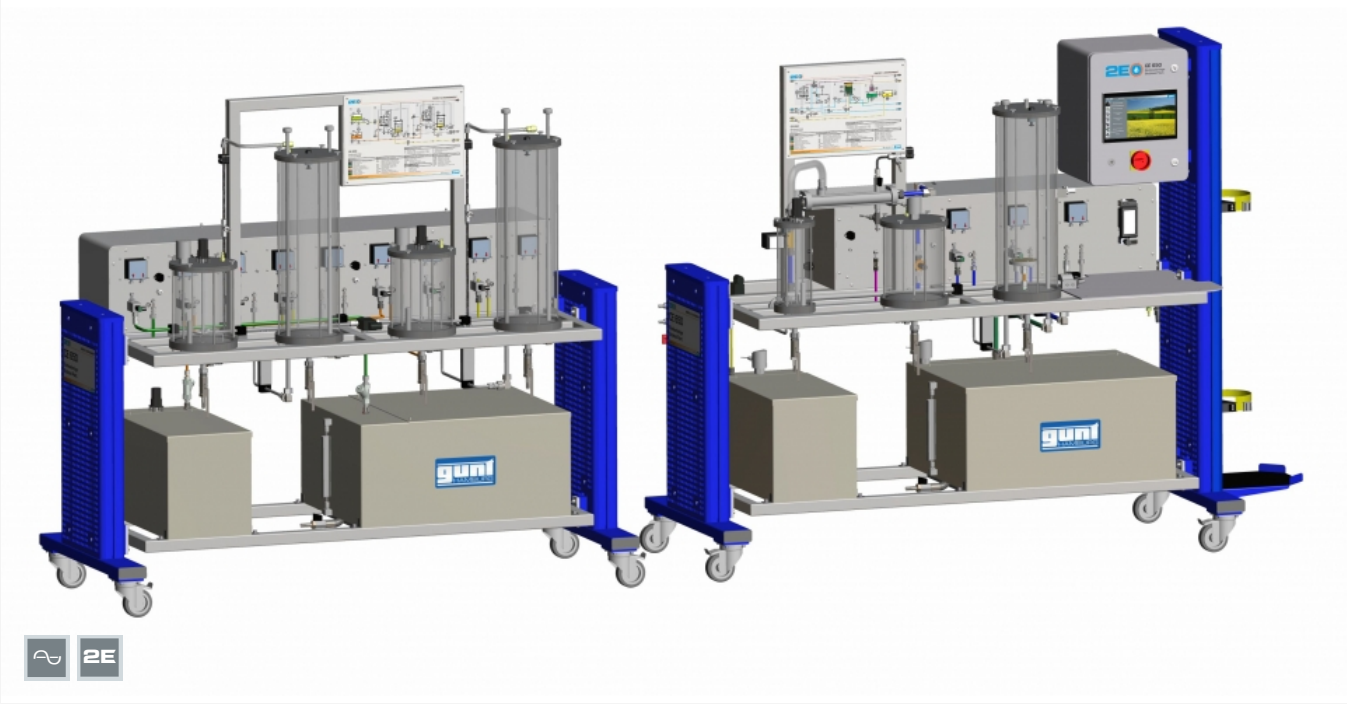
CE 650
Biodiesel plant



Description

- **chemical transesterification**
- **two-stage process**
- **plant controlled via PLC and touch panel**

The use of renewable energy carriers in the mobility sector can happen by replacing fossil fuels. One option is biodiesel, which is obtained from vegetable oils. It is produced by adding methanol and potassium hydroxide (as catalyst) and is a transesterification, a chemical equilibrium reaction. On a large industrial scale, production is carried out continuously in stirred tank reactors. This process is demonstrated on a small scale by the CE 650 experimental plant.

The chemical reaction takes place at temperatures of around 60°C. The products leave the reactor after a predefined dwell time. The products are a two-phase mixture: A biodiesel-rich phase and a phase with by-products. The by-products are pumped out of the following phase separator. The options for the biodiesel-rich phase are: Return to the reactor, second transesterification stage, methanol recovery (distillation) and biodiesel washing (absorption).

The biodiesel-rich phase contains residual amounts of methanol, potassium hydroxide and vegetable oil, in addition to the biodiesel. The remaining vegetable oil is reacted in the second transesterification stage. The methanol is distilled off in the methanol recovery stage. Residual amounts of the catalyst are removed in the biodiesel washing stage. Then the products are stored.

The rate of transesterification is dependent on the reaction time and the temperature. The chemical equilibrium is shifted by the separation of the by-products. The biodiesel produced is analysed in the laboratory. The process parameters can be varied to investigate the dependencies. The experimental plant is controlled by a PLC, which is operated by means of a touch panel. The GUNT software takes care of data acquisition.

Learning objectives/experiments

- production of biodiesel from vegetable oil
  - ▸ influence of dwell time
  - ▸ influence of temperature
- chemical transesterification
- phase separation in the gravity field
- distillation
- liquid-liquid extraction
- approach of a continuous process consisting of several basic operations

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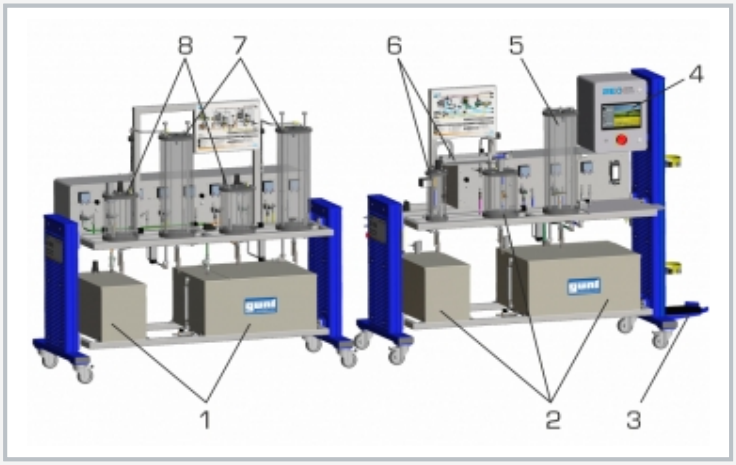
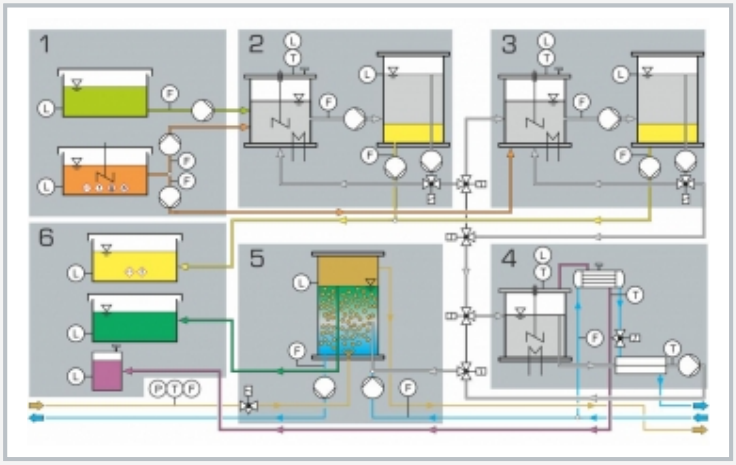


1 storage tank, 2 storage, 3 gas cylinder holder, 4 PLC with touch panel, 5 biodiesel washer, 6 methanol recovery, 7 phase separator, 8 reactor



Process schematic of the experimental plant with 1 supply, 2 transesterification 1st stage, 3 transesterification 2nd stage, 4 methanol recovery, 5 biodiesel washing, 6 storage

Start screen of the PLC for operation of the experimental plant

Specification

[1] chemical transesterification of vegetable oils
[2] two-stage, continuous process
[3] two heated stirred tank reactors for chemical transesterification
[4] two phase separators for separating products and by-products
[5] methanol recovery (distillation) to reduce the amount of methanol required
[6] biodiesel washing (absorption) to extract impurities from the biodiesel
[7] variation of process parameters to investigate the dependencies of biodiesel production
[8] PLC for controlling the experimental plant
[9] touch panel for operating the PLC
[10] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

Tanks
- stirred tank reactors: 2x 5L
- storage tank (vegetable oil): 110L
- storage tank (chemicals): 45L
- product tank: 110L
- by-product tank: 45L
- methanol tank: 6L
- phase separator/biodiesel washer: 3x 15L

Peristaltic pumps: max. 25L/h

Measuring ranges
- temperature: 6x 0...100°C
- pressure: 1x 0...6bar (abs.)
- flow rate: 1x 0...30L/h
- level:
  - 3x 1...22cm
  - 2x 1...29cm

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase; 120V, 60Hz, 1 phase
UL/CSA optional
1x LxWxH: 1900x790x1700mm
1x LxWxH: 2200x790x1700mm
Weight: approx. 560kg

Required for operation

Vegetable oil, potassium hydroxide, methanol, nitrogen, water connection, PC with Windows recommended

Scope of delivery

1 experimental plant
1 GUNT software CD + USB cable
1 set of instructional material