CE 642
Biogas plant

The illustration shows from left to right: supply unit, trainer and post-fermentation unit

Description

- **two-stage biogas plant**
- **extensive biogas analysis**
- **system control using a PLC, touch screen for display and operation**

In a biogas plant, microorganisms biologically degradate the organic starting substances (substrate) under exclusion of light and oxygen. The product of this anaerobic degradation is a gas mixture which primarily consists of methane. This gas mixture is called biogas.

The experimental plant CE 642 serves to demonstrate the generation of biogas in a practical manner. The substrate is a suspension of shredded organic solids. It is hydrolysed and acidified in the first stirred tank reactor. Here, anaerobic microorganisms convert the long-chain organic substances into short-chain organic substances. The biogas forms in the second stirred tank reactor in the last step of the anaerobic degradation. It contains mainly methane and carbon dioxide. This two-stage method enables the ambient conditions to be adjusted and optimised in both reactors separately. The digestate is collected in a separate tank.

Temperature and pH value are controlled in both reactors. The resulting biogas is dried in a column. The column is filled with silica gel. Subsequently, the flow rate, humidity, methane content, carbon dioxide content and temperature of the biogas are measured. The system is controlled by means of a PLC which is operated via a touch screen. The measured values can be transmitted to a PC via USB and analysed with the GUNT software.

The experimental plant enables both a continuous and a discontinuous (batch) operation mode. Anaerobic biomass from a biogas plant is required for the experiments. E.g. potatoes or maize can be used to produce the substrate. An inert gas (e.g. carbon dioxide) is required to flush the experimental plant.

Learning objectives/experiments

- achieving a stable operating state
- influence of the following parameters on the biogas generation
  - temperature
  - substrate
  - volumetric loading
  - pH value
- influence of the operation mode on the biogas yield
  - single stage or dual stage
  - with and without post-fermentation
  - continuous and discontinuous
- determining the following parameters depending on the operating conditions
  - biogas yield
  - biogas flow rate
  - biogas quality

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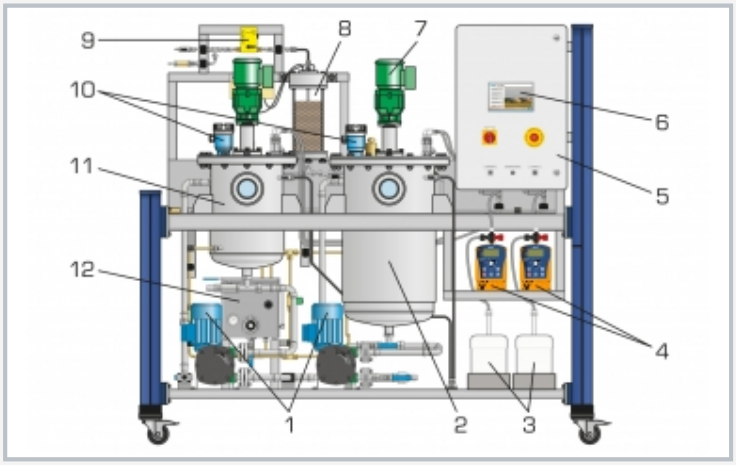
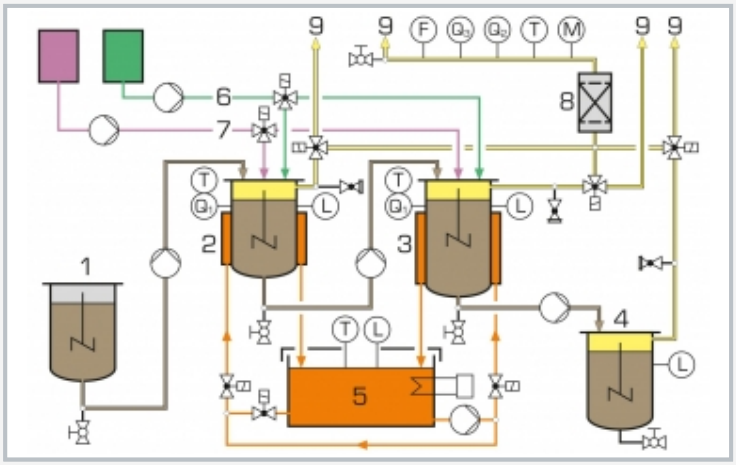
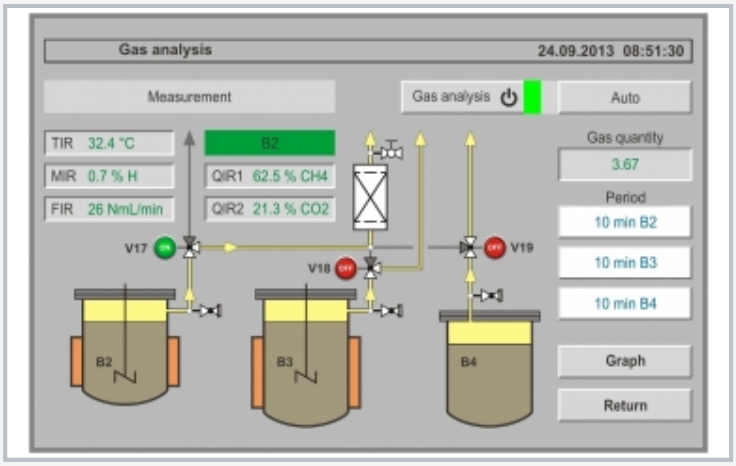


1 peristaltic pumps, 2 reactor (stage 2), 3 tanks for acid and caustic, 4 metering pumps, 5 switch cabinet, 6 PLC with touch screen, 7 stirring machine, 8 drying column, 9 flow meter (biogas), 10 capacitive level sensors, 11 reactor (stage 1), 12 heating water tank



1 substrate tank, 2 reactor (stage 1), 3 reactor (stage 2), 4 digestate tank, 5 heating water, 6 acid, 7 caustic, 8 drying column, 9 biogas; F flow rate, L level, M humidity, Q_1 pH value, Q_2 methane content, Q_3 carbon dioxide content, T temperature



Operating interface of the PLC: menu item "gas analysis"

Specification

[1] two-stage biogas plant (continuous or discontinuous operation possible)
[2] 2 stirred tank reactors made of stainless steel with capacitive level sensors
[3] separate supply unit with substrate tank and feed pump
[4] control of temperature and pH value in the reactors
[5] 2 metering pumps for acid and caustic
[6] heating water circuit with tank, heater, temperature controller and pump
[7] biogas is dried with silica gel
[8] biogas analysis: flow rate, methane content, carbon dioxide content, humidity and temperature
[9] control of the experimental plant using a PLC, operated by touch screen
[10] GUNT software for data acquisition via USB under Windows Vista or Windows 7

Technical data

Tanks made of stainless steel
- reactor (stage 1): approx. 20L
- reactor (stage 2): approx. 70L
- substrate tank: approx. 25L
- digestate tank: approx. 25L

Pumps
- 3 peristaltic pumps: each max. 25L/h
- 2 metering pumps: each max. 2,1L/h
- heating water pump: max. 480L/h

Stirring machines
- substrate tank: max. 200min^{-1}
- reactors: each max. 120min^{-1}

Measuring ranges
- methane content: 0...100%,
- carbon dioxide content: 0...100%
- flow rate (biogas): 0...30NL/h
- pH value: 2x 1...14
- humidity: 0...100%
- temperature (reactors and biogas): 3x 0...100°C

400V, 50Hz, 3 phases
400V, 60Hz, 3 phases; 230V, 60Hz, 3 phases
LxWxH: 1100x790x1400mm (supply unit)
LxWxH: 2060x790x1910mm (trainer)
LxWxH: 1100x790x1400mm (post- fermentation unit)
Total weight: approx. 770kg

Required for operation

Biomass from a biogas plant, substrate (recommendation: potatoes or maize), caustic soda, hydrochloric acid, intert gas (e.g. carbon dioxide); water connection, drain
PC with Windows recommended

Scope of delivery

experimental plant, 1 packing unit of silica gel, 1 set of accessories, 1 GUNT software CD, 1 USB cable, 1 set of instructional material