CE 640

Biotechnical production of ethanol

Description

- **practical process for production of ethanol from starch-based biological raw materials**
- **system control using a PLC, touch screen for display and operation**
- **PC aided data acquisition via USB interface**

As well as its great importance for the chemical and foodstuffs industries, ethanol (alcohol) is increasingly used as a fuel. The CE 640 can be used to conduct realistic experiments for the production of ethanol from starch-based raw materials such as potatoes. The experimental plant consists of three main components: a mash tank, a fermentation tank and a distillation unit.

A mixture of water, finely chopped potatoes and alpha-amylase (enzyme) is filled into the mash tank. To dissolve the tightly packed starch chains in the potatoes, heating steam is injected into the mixture via a nozzle (gelatinisation). This increases the flow resistance of the mash, which would prevent further processes. The alpha-amylase breaks up the starch chains (liquefying) thereby reducing the flow resistance. Gluco-amylase is used to convert the starch into sugar (saccharification).

This enzyme requires lower temperatures and pH values. The temperature is reduced using the water cooling jacket around the mash tank, the pH value is adjusted by the addition of acid and caustic. After saccharification the mash is pumped into the fermentation tank. During the fermentation process in this tank, ethanol is produced. A water cooling system controls the temperature. After the fermentation process, the mash is pumped into the distillation unit. This is equipped with a bubble cap tray column for separation of the ethanol. Two tanks are available, one for the spent mash, the other for the distilled ethanol.

The experimental plant has comprehensive measurement, control and operating functions, which are controlled via a PLC. A touch screen displays measured values and permits the operation of the system.

The steam supply occurs via laboratory network or an optionally available electrical steam generator (CE 715.01).

Learning objectives/experiments

- familiarization with the necessary individual steps and system components for production of ethanol:
  - gelatinisation by steam injection
  - liquefaction by use of alpha-amylase
  - saccharification by use of gluco-amylase
  - fermentation: conversion of sugar into ethanol by yeast cultures under anaerobic conditions
  - distillation: separation of ethanol from the mash

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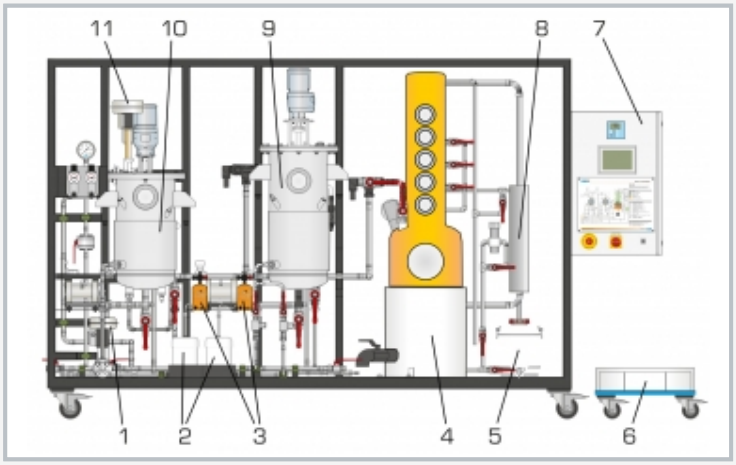
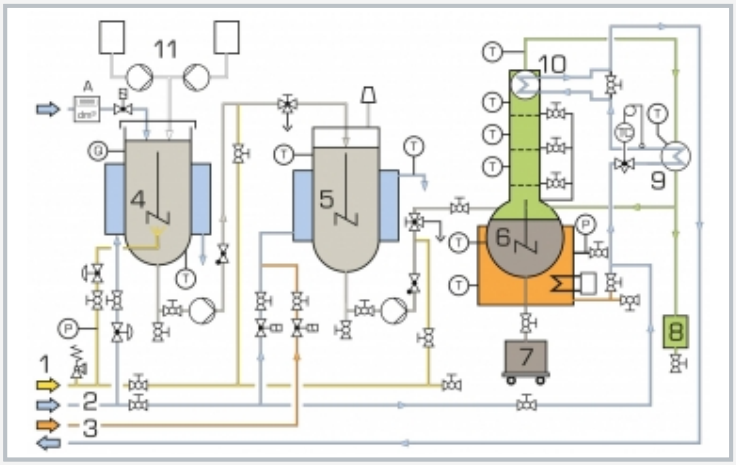
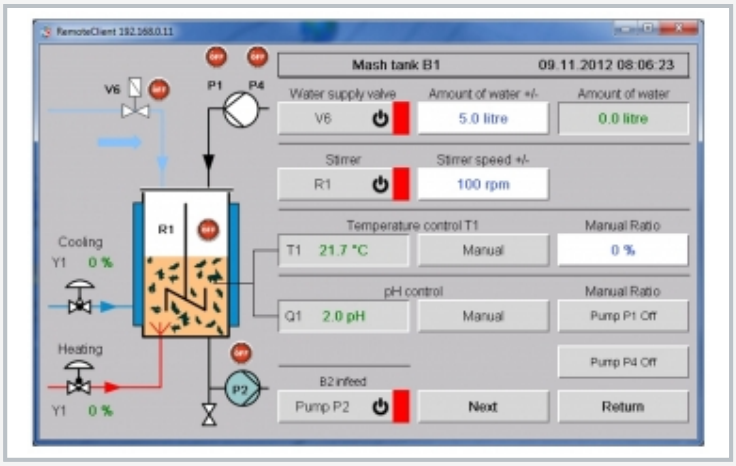


1 cooling water control valve, 2 acid/caustic tanks, 3 acid/caustic pumps, 4 distillation unit, 5 product tank, 6 spent mash tank (mobile), 7 switch cabinet, 8 condenser, 9 fermentation tank, 10 mash tank, 11 steam pressure control valve



1 heating steam, 2 cooling water, 3 heating water, 4 mash tank, 5 fermentation tank, 6 distillation unit, 7 spent mash tank, 8 product tank, 9 condenser, 10 dephlegmator, 11 acid/caustic pumps and tanks; P pressure, T temperature, A water quantity, Q pH value



Screenshot of the touch screen for the PLC control unit

Specification

[1] batch conversion of starch-based raw materials into ethanol
[2] open mash tank with water-jacket cooling, steam injection and stirrer
[3] closed fermentation tank with stirrer and water-jacket cooling/heating
[4] distillation unit with 3 bubble cap trays, dephlegmator, condenser and stirrer
[5] 2 pumps for delivering the mash
[6] pH value control in the mash tank with acid and caustic delivered by metering pumps
[7] adjustment of the amount of injected heating steam, the cooling water flow rates and the head temperature by means of PID controllers
[8] system control using a PLC; operated by touch screen
[9] GUNT software for data acquisition via USB under Windows Vista or Windows 7

Technical data

Mash tank: 40L
Fermentation tank: 50L
Product tank: 10L
Spent mash: 30L
Distillation unit
- column: DxH: 220x1200mm
- sump capacity: 45L
- sump heater: 0...7500W

2 air-operated diaphragm pumps
- drive pressure: 2bar
- max. flow rate: 15L/min
- max. head: 20m
- max. solid lump size: 4mm

2 metering pumps (acid and caustic)
- max. flow rate: each 2,1L/h

Measuring ranges
- temperature: 10x 0...150°C
- water quantity mash tank: 0...20L
- pH value: 2...10
- pressure heating steam: 0...10bar

400V, 50Hz, 3 phases
230V, 60Hz, 3 phases
LxWxH: 3500x1200x2000mm
Weight: approx. 500kg

Required for operation

compressed air (1,5...6bar), cooling water (min. 400L/h), steam (10kg/h, min. 3bar), heating water (min. 400L/h, 40°C)
PC with Windows recommended

Scope of delivery

experimental plant, 1 set of enzymes etc., 1 areometer, 1 set of accessories, 1 GUNT software CD + USB cable, 1 set of instructional material

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Optional accessories

083.71501	CE 715.01	Electrical Steam Generator 10kW