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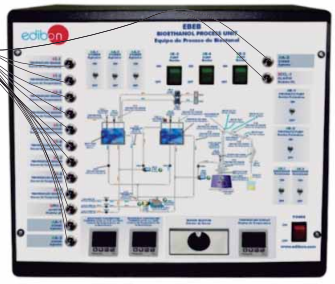
Technical Teaching Equipment

Bioethanol Process Unit

EBEB



Electronic console

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INTRODUCTION

In the past, fossil fuels were used essentially for transportation, relying on the abundant and less expensive petroleum supply by then. But in last few decades, due to the increasingly expensive petroleum supply, there has been considerable interest in the development of fuels generated from renewable resources, that is to say, biofuels.

The term biofuel is attributed to any alternative fuel that derives from organic material, such as energy crops (corn, sugar, sorghum and fruits among others), crop residues or waste biomass.

Among all biofuels, ethanol has been trusted as an alternate fuel for the future, being already produced on a great scale worldwide. In this sense, bioethanol is expected to be one of the dominating renewable biofuels in the transport sector within the coming years.

The Bioethanol Process Unit (EBEB) has been designed to perform a wide range of didactic experiments. Various processes, such as mashing, fermentation and distillation, can be studied.

ISO 9000: Quality Management
(for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate
(total safety)

Certificates ISO 14000 and
ECO-Management and Audit Scheme
(environmental management)

Worlddidac Quality Charter Certificate
(Worlddidac Member)

GENERAL DESCRIPTION

The Bioethanol Process Unit (EBEB) has been designed to study and control the bioethanol production process on a laboratory scale. This unit allows to monitor and examine all the important processes, from liquefaction and saccharification of the raw materials to the conversion of sugar into ethanol and distillation.

The unit consists of three main components: a mash tank, a fermentation tank and a distillation unit.

All vessels, valves and other accessories in contact with the process materials (except the distillation unit) are made of stainless steel. The distillation unit is made of borosilicate glass. Sight glasses are made of Neoceram glass.

The mash tank includes an inlet at its upper cover for filling water, starch and enzymes. Its base is slightly inclined towards a port for draining the solution or pumping it into the fermentation tank. During the mashing process the starch of the raw materials is turned into glucose. The addition of the alpha-amylase enzyme enables the liquefaction of the starch slurry. Subsequently, saccharification starts by adding the glucoamylase enzyme. A temperature sensor and a pH meter measure the properties of the mixture in the tank. The pH value is adjusted by adding acid and base.

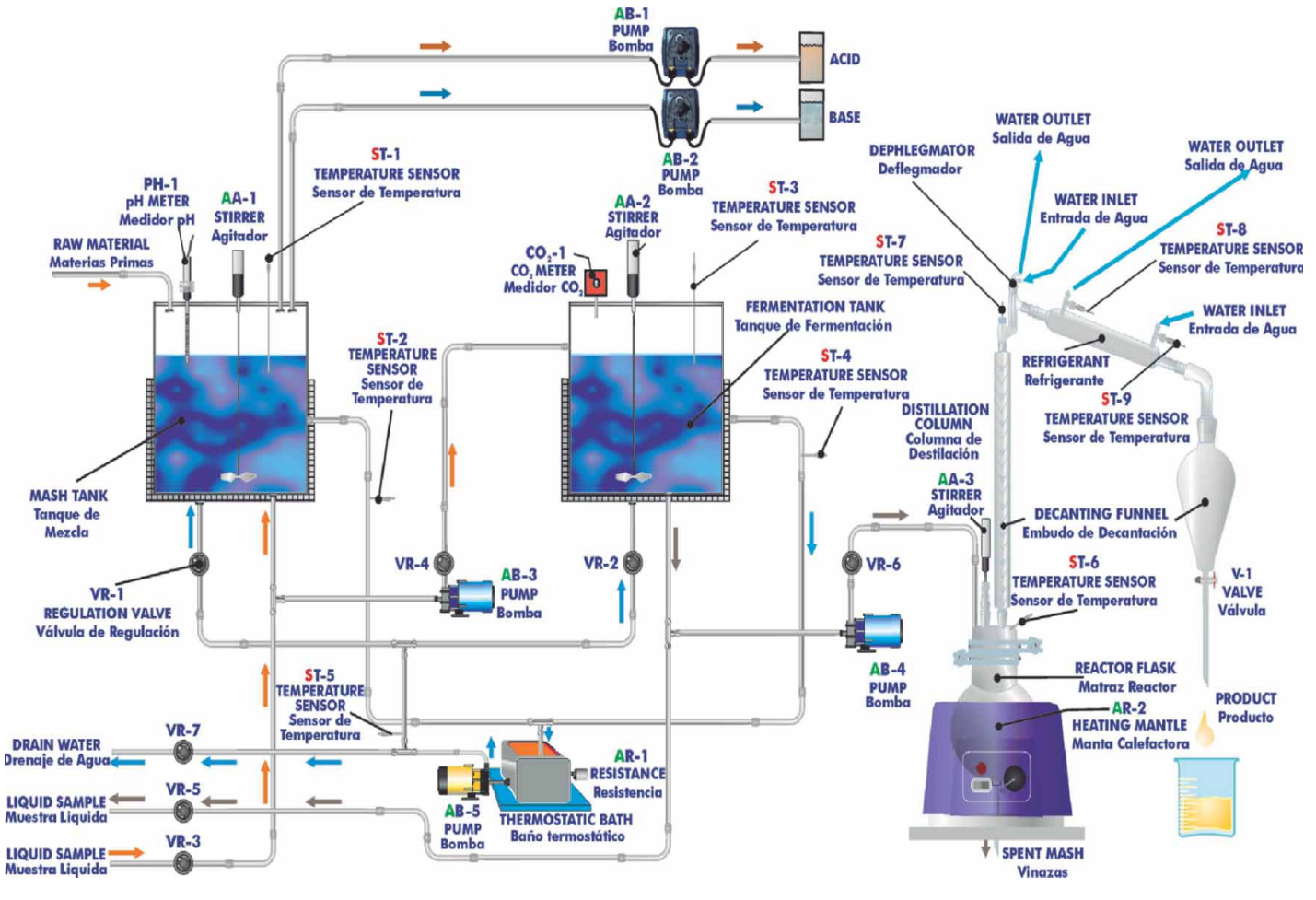
After saccharification the mash is pumped into the fermentation tank. The fermentation tank base is inclined slightly towards a port for draining the solution or pumping it into the distillation unit. The fermentation process takes place after adding yeast, producing ethanol and CO_2. A temperature sensor and a CO_2 meter measure the properties of the mixture and the concentration of CO_2 in the tank.

Both tanks are heated indirectly with hot water through a jacket and stirred constantly. Besides, they are equipped with a sight glass so that the process can be observed and monitored. Two temperature sensors are located at the outlet of the tanks' jacket.

The mash tank and the fermentation tank are thermally controlled by hot water, which is heated by a system consisting of a thermostatic bath and a pump. An additional temperature sensor is located in the thermostatic bath.

After the fermentation process, the preparation is pumped into the distillation unit. It contains a heating mantle, a stirrer, a distillation column, a cold finger (dephlegmator), a condenser and a decanting funnel. Four temperature sensors are located at different points of the distillation unit.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



SPECIFICATIONS

Anodized aluminum structure and panels in painted steel. Main metallic elements in stainless steel.

Diagram at the front panel with a distribution similar to the elements in the real unit.

All the vessels, valves and other accessories in contact with process materials (except the distillation unit) are made of stainless steel. The distillation unit is made of borosilicate glass. Sight glasses are made of Neoceram glass.

The unit consists of:

Mash tank:

Cylindrical vessel made of stainless steel, with an inlet at the upper cover to load the water, raw material and starch, jacket for process heating, stirrer and a sight glass made of Neoceram.

The base of the vessel is inclined slightly towards a port for draining the solution or pumping it into the fermentation tank.

Volume: 5 l.

Fermentation tank:

Cylindrical vessel made of stainless steel with a jacket for process heating, stirrer and a sight glass made of Neoceram.

The vessel has a base inclined slightly towards a port for draining the solution or pumping it into the distillation unit.

Volume: 5 l.

Distillation unit:

Different elements made of borosilicate glass of high thermal and mechanical resistance, as well as perfect chemical inertia. It includes:

A heating mantle, 800 W.

Reactor flask of 5 l. , with discharge stopcock.

Reactor lid, with 4 inlets, especially designed for this system.

Vigreux type distillation column.

Stirring rod with stirring lock that assures a perfect insulation of the system.

A cold finger (dephlegmator).

Liebig-West condenser with interchangeable fittings.

Decantation funnel of 500ml.

Temperature tappings placed at key points of the system.

Two diaphragm pump to introduce the solution into the fermentation tank and the distillation unit, range: 0-3.8 l./min.

Nine "J" type temperature sensors:

Two temperature sensors located at the mash tank to measure the temperature of the mash inside the tank and the temperature at the outlet of the tank's jacket. Two temperature sensors located at the fermentation tank to measure the temperature of the preparation inside the tank and the temperature at the outlet of the tank's jacket. Four temperature sensors located at different points of the distillation unit. One temperature sensor located at the hot water circulation system.

A pH meter measures the pH of the mash inside the mash tank.

A CO_2 meter measures the CO_2 concentration generated during the process at the fermentation tank.

A hot water circulation system, including:

Pump.

Thermostatic bath.

An acid/base circuit system, including:

Two peristaltic pumps to introduce an acid or base solution into the mash tank, max. flow: 0-13 ml/min.

Two vessels to contain the acid and base solutions, volume: 1 l.

Seven valves:

Two needle valves are used to divert the hot water between the jacket of the mash tank and the jacket of the fermentation tank. Two ball valves and two needle valves are used to drain the solution from the mash and fermentation tank or pump it into the fermentation tank and distillation unit. One ball valve is used to drain the water for hot water circulation system.

Electronic console:

Metallic box.

Temperature sensor connectors. Digital display for the temperature sensors. Selector for the temperature sensors.

A pH meter connector. Digital display for pH meter.

A CO_2 meter connector. Digital display for CO_2 meter.

3 Connectors for the stirrers. 3 Switches for the stirrers (one for the mash tank, other for the fermentation tank and another for the distillation unit).

5 Switches for the pumps (two for the peristaltic pumps, two for the diaphragm pumps and one for the pump of hot water circulation system).

2 Switches for the heating resistances (one for the thermostatic bath and another for the heating mantle).

Cables and Accessories, for normal operation.

Manuals: This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Familiarization with the individual steps required for bioethanol production.

2.- Familiarization with the plant components required for bioethanol production.

3.- Study of the effect of temperature on bioethanol purity.

4.- Study of the effect of pH on bioethanol yield.

5.- Study of the effect of mashing time on bioethanol yield.

6.- Study of the effect of fermentation time on bioethanol yield.

7.- Study of the use of different raw materials to produce bioethanol.

8.- Study of the effect of adding different types of yeast to the fermentation.

REQUIRED SERVICES

- Electrical supply: single phase, 220 V./50 Hz. or 110 V./60 Hz.
- Water supply.
- Hydrometers.

RECOMMENDED ACCESSORIES

- Starch of the raw material.
- Alpha-amylase for the liquefaction process.
- Gluco-amylase for the saccharification process.
- Yeast for the fermentation process.
- H_2SO_4 / HCl to prepare of acid solution.
- NaOH to prepare of base solution.

DIMENSIONS & WEIGHTS

EBEB:

Unit:	-Dimensions:	2000 x 650 x 1800 mm. approx. (78.74 x 25.59 x 70.86 inches approx.).
	-Weight:	200 Kg. approx. (441 pounds approx.).
Electric console:	-Dimensions:	490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.).
	-Weight:	10 Kg. approx. (22 pounds approx.).

AVAILABLE VERSIONS

Offered in this catalogue:

-EBEB. Bioethanol Process Unit.

Offered in other catalogue:

-EBEC. Computer Controlled Bioethanol Process Unit.

✱Specifications subject to change without previous notice, due to the convenience of improvements of the product.

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Issue: ED01/13
Date: July/2013

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