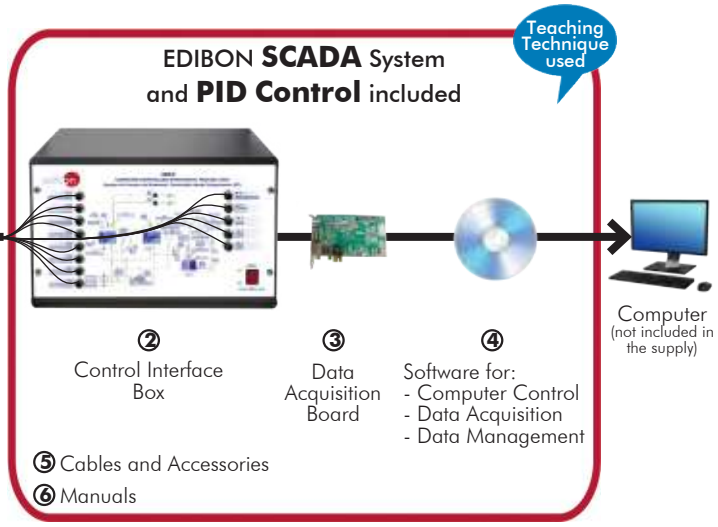
edibon

Engineering and Technical Teaching Equipment

Computer Controlled **Bioethanol Process Unit,** with SCADA and PID Control

EBEC



* Minimum supply always includes: 1 + 2 + 3 + 4 + 5 + 6
(Computer not included in the supply)

① Unit: EBEC. Computer Controlled Bioethanol Process Unit

Key features:

- **Advanced Real-Time SCADA and PID Control.**
- **Open Control + Multicontrol + Real-Time Control.**
- **Specialized EDIBON Control Software based on LabVIEW.**
- **National Instruments Data Acquisition board (250 KS/s, kilo samples per second).**
- **Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.**
- **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**
- **Capable of doing applied research, real industrial simulation, training courses, etc.**
- **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**
- **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**
- **Designed and manufactured under several quality standards.**
- **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**
- **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

LabVIEW

www.edibon.com
PRODUCTS
5.- ENERGY

For more information about Key Features, click here

ISO 9001: **Quality Management** (for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate (total safety)

Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)

"Worlddidac Quality Charter" and Platinum Member of Worlddidac

INTRODUCTION

In the past, fossil fuels were essential for transportation, relying on the abundant and less expensive petroleum supply. 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 Computer Controlled Bioethanol Process Unit, "EBEC", has been designed to perform a wide range of didactic experiments. Various processes, such as mashing, fermentation and distillation, can be studied.

GENERAL DESCRIPTION

The Computer Controlled Bioethanol Process Unit, "EBEC", 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.

EBEC detail

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 sensor measure the properties of the mixture in the tank. The pH value is adjusted by adding acid and base solutions, with an acid/base circuit system.

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 sensor measures the temperature of the mixture 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 processes can be observed and monitored. Two temperature sensors, located at the outlet of the tanks' jacket, work with the PID controller to maintain the desired temperature inside.

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.

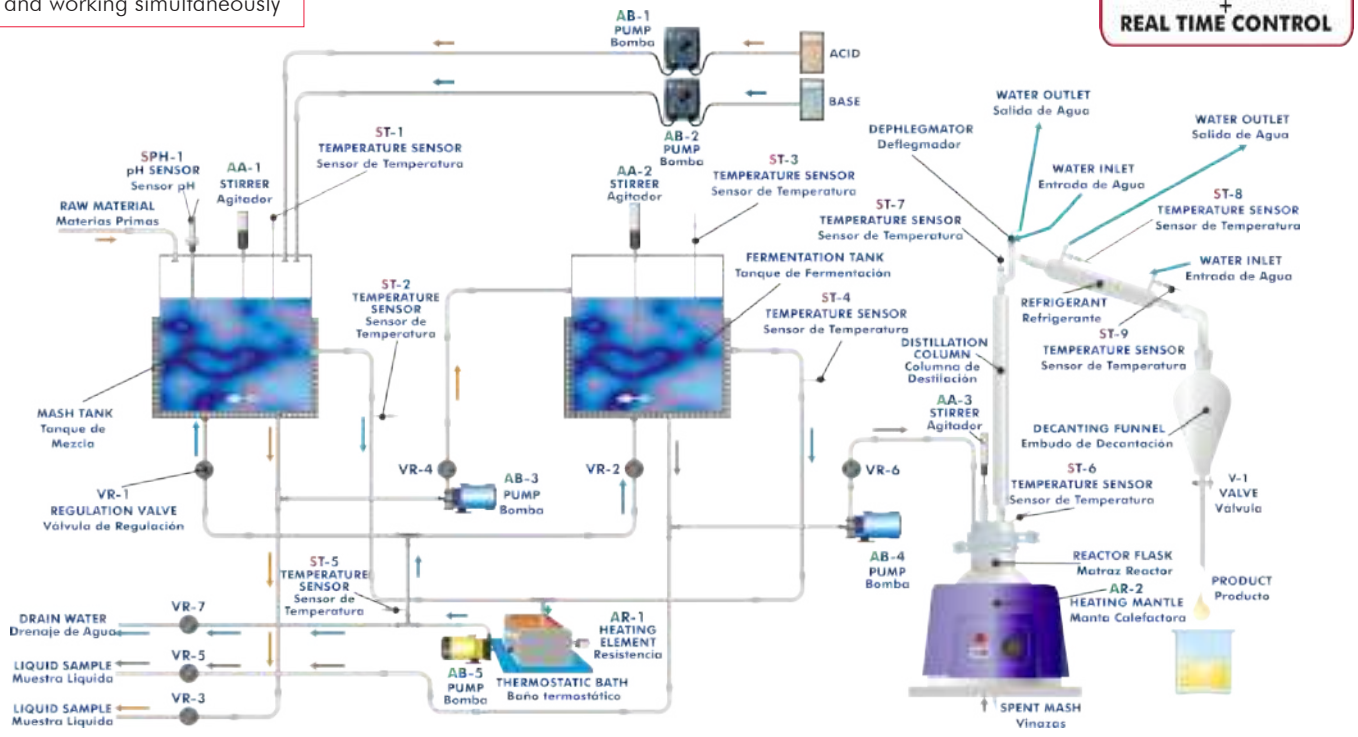
After the fermentation process, the preparation is pumped into the distillation unit. It contains a heating mantle, a stirrer, a distillation column, a cold finger (dephlegmator), a condenser and a decanting funnel. Four temperature sensors are located at different points of the distillation unit.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + a Control Interface Box + a Data Acquisition Board + Computer Control, Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

10 actuators and 10 sensors controlled from any computer and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL



With this unit there are several options and possibilities:

- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10 and 11.

Let us describe first the main items (1 to 6):

① EBEC. Unit:

Anodized aluminum frame and panels made of painted steel.

The unit includes wheels to facilitate its mobility.

Main metallic elements made of stainless steel.

Diagram in the front panel with distribution of the elements similar to the real one.

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.

Unit: EBEC

The "EBEC" unit mainly 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, computer controlled stirrer and 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, computer controlled 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:

Computer controlled heating mantle, 800 W.

Reactor flask with discharge stopcock, volume: 5 l.

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

Vigreux type distillation column.

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

Cold finger (dephlegmator).

Liebig-West condenser with interchangeable fittings.

Decantation funnel of 500 ml.

Temperature tappings placed at key points of the system.

Two computer controlled diaphragm pumps to introduce the solution into the fermentation tank and the distillation unit, range: 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.

Temperature sensor located at the hot water circulation system.

The temperature sensors located at the outlet of the jacket of the mash and fermentation tanks work with the PID controller to maintain the desired temperature inside.

pH sensor measures the pH of the mash inside the mash tank, range: 0 – 13.

Hot water circulation system, including:

Computer controlled pump.

Thermostatic bath, with computer controlled heating element.

Acid/base circuit system, including:

Two computer controlled 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.

Ball valve is used to drain water from the hot water circulation system.

The complete unit includes as well:

Advanced Real-Time SCADA and PID Control.

Open Control + Multicontrol + Real-Time Control.

Specialized EDIBON Control Software based on LabVIEW.

National Instruments Data Acquisition board (250 KS/s, kilo samples per second).

Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.

Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.

Capable of doing applied research, real industrial simulation, training courses, etc.

Remote operation and control by the user and remote control for EDIBON technical support, are always included.

Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).

Designed and manufactured under several quality standards.

Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.

This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② EBEC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output.

Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.

Single cable between the control interface box and computer.

The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.

Simultaneous visualization in the computer of all parameters involved in the process.

Calibration of all sensors involved in the process.

Real time curves representation about system responses.

Storage of all the process data and results in a file.

Graphic representation, in real time, of all the process/system responses.

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.

All the actuators and sensors values and their responses are displayed on only one screen in the computer.

EBEC/CIB

Shield and filtered signals to avoid external interferences.

Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.

Real time PID and on/off control for pumps, compressors, heating elements, control valves, etc.

Real time PID control for parameters involved in the process simultaneously.

Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).

Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.

Possibility of automatization of the actuators involved in the process.

Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

PCI Express Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI Express.

Analog input:

Number of **channels= 16** single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536.

Sampling rate up to: 250 KS/s (kilo samples per second).

Input range (V)=±10 V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.

Analog output:

Number of **channels=2**. **Resolution=16 bits**, 1 in 65536.

Maximum output rate up to: 900 KS/s.

Output range (V)=±10 V. Data transfers=DMA, interrupts, programmed I/0.

Digital Input/Output:

Number of **channels=24 inputs/outputs**. D0 or DI Sample Clock frequency: 0 to 100 MHz.

Timing: Number of **Counter/timers=4**. Resolution: Counter/timers: 32 bits.

The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

DAB

④ EBEC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software:

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Analog and digital PID control.

PID menu and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

Sampling velocity up to 250 KS/s (kilo samples per second).

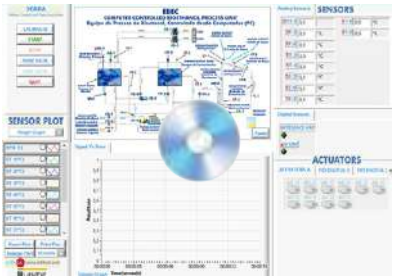
Calibration system for the sensors involved in the process.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.



EBEC/CCSOF

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

This unit is **supplied with 8 manuals**: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

∗References 1 to 6 are the main items: EBEC + EBEC/CIB + DAB + EBEC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

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.

Additional practical possibilities:

9.- Sensors calibration.

Other possibilities to be done with this Unit:

10.- Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

11.-Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

12.-The Computer Control System with SCADA and PID Control allow a real industrial simulation.

13.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.

14.-This unit can be used for doing applied research.

15.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

16.-Control of the EBEC unit process through the control interface box without the computer.

17.-Visualization of all the sensors values used in the EBEC unit process.

- By using PLC-PI additional 19 more exercises can be done.
- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Water supply and drain.
- Computer.

DIMENSIONS AND WEIGHTS

EBEC:

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.).

Control Interface Box:

-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.).

ADDITIONAL RECOMMENDED ELEMENTS (Not included)

- Hydrometer.

RECOMMENDED CONSUMABLES (Not included)

- 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.

SIMILAR UNITS AVAILABLE

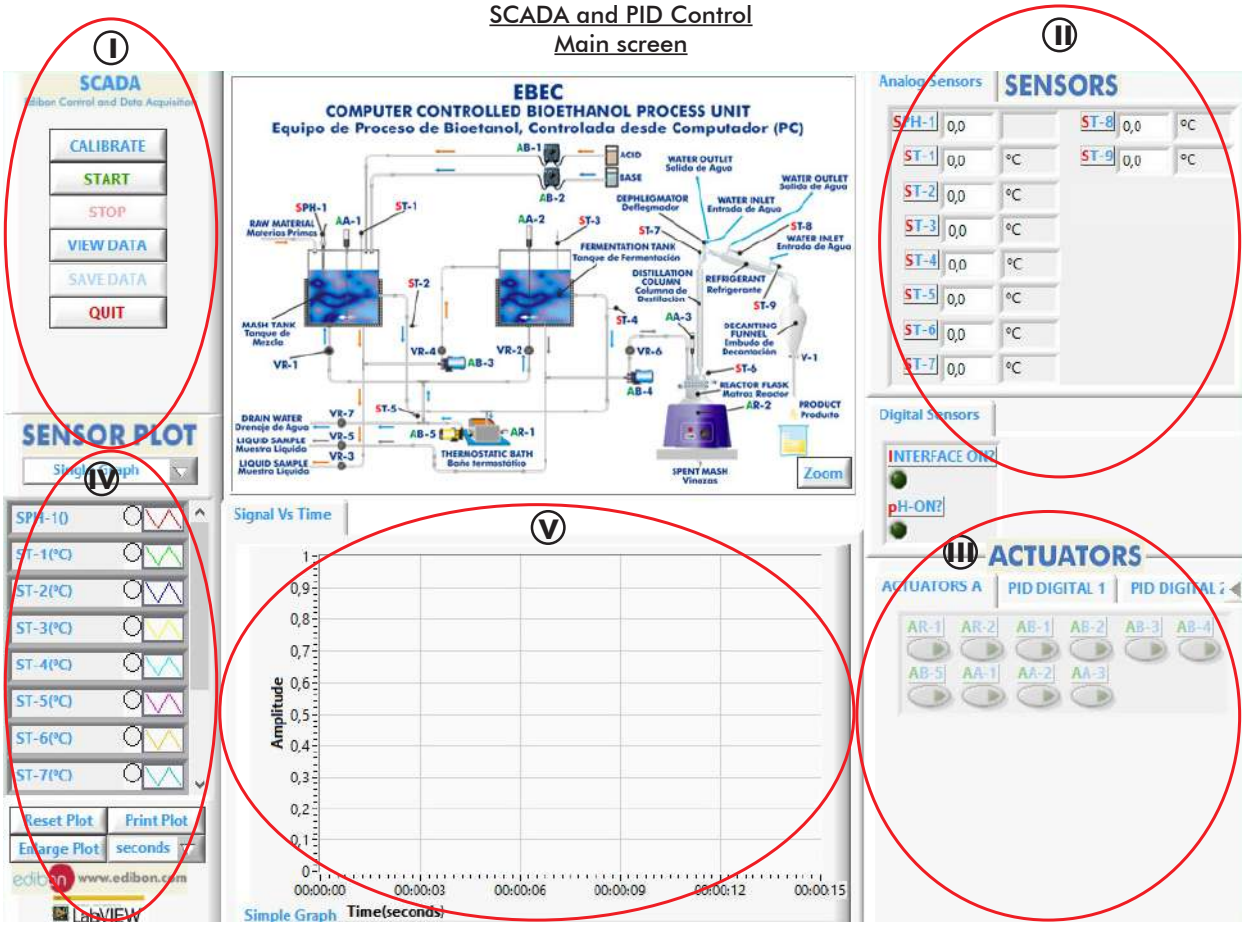
Offered in this catalog:

-EBEC. Computer Controlled Bioethanol Process Unit.

Offered in other catalog:

-EBEB. Bioethanol Process Unit.

SCADA and PID Control
Main screen



Ⅰ Main software operation possibilities.

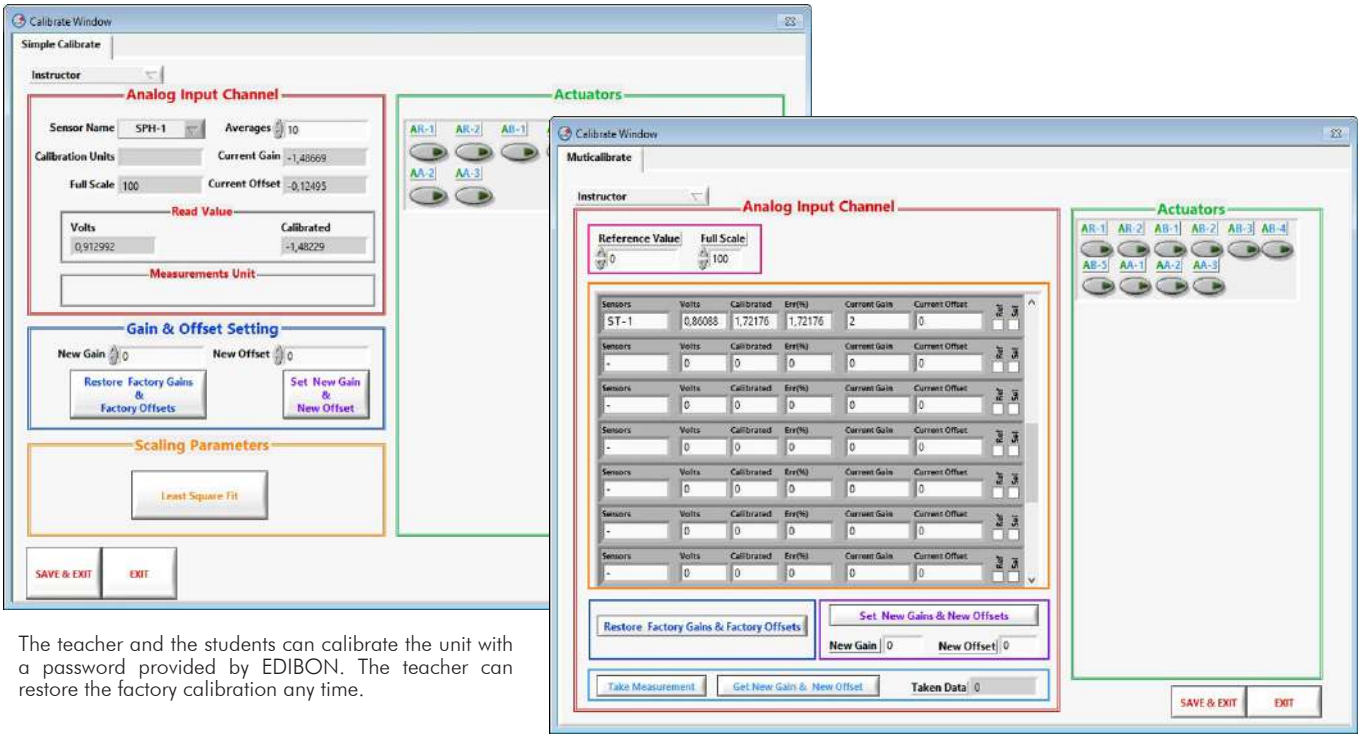
Ⅱ **Sensors displays, real time values, and extra output parameters. Sensors:** ST=Temperature sensor. SPH=pH sensor.

Ⅲ **Actuators controls. Actuators:** AR=Heating resistance. AB=Pump. AA=Stirrer.

Ⅳ Channel selection and other plot parameters.

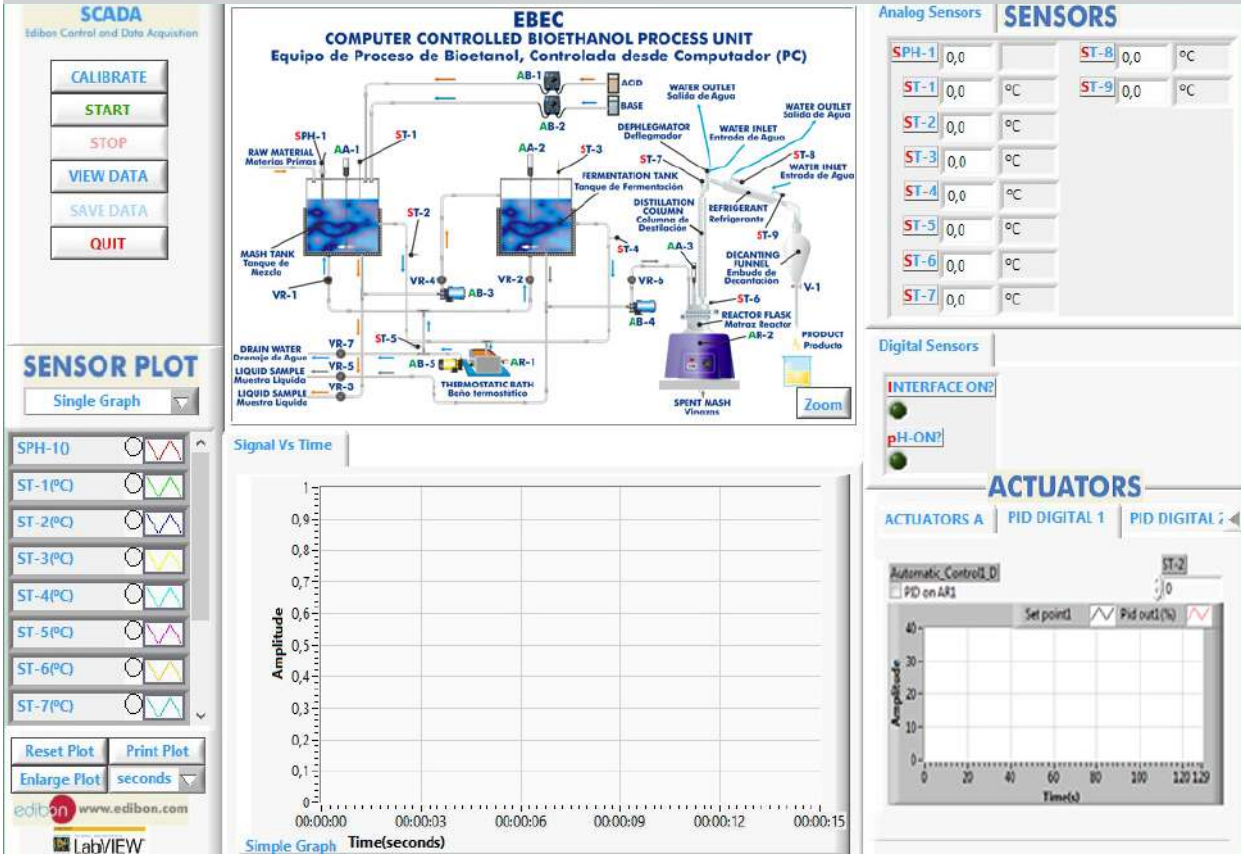
Ⅴ Real time graphics displays.

Software for Sensors Calibration
Example of screen

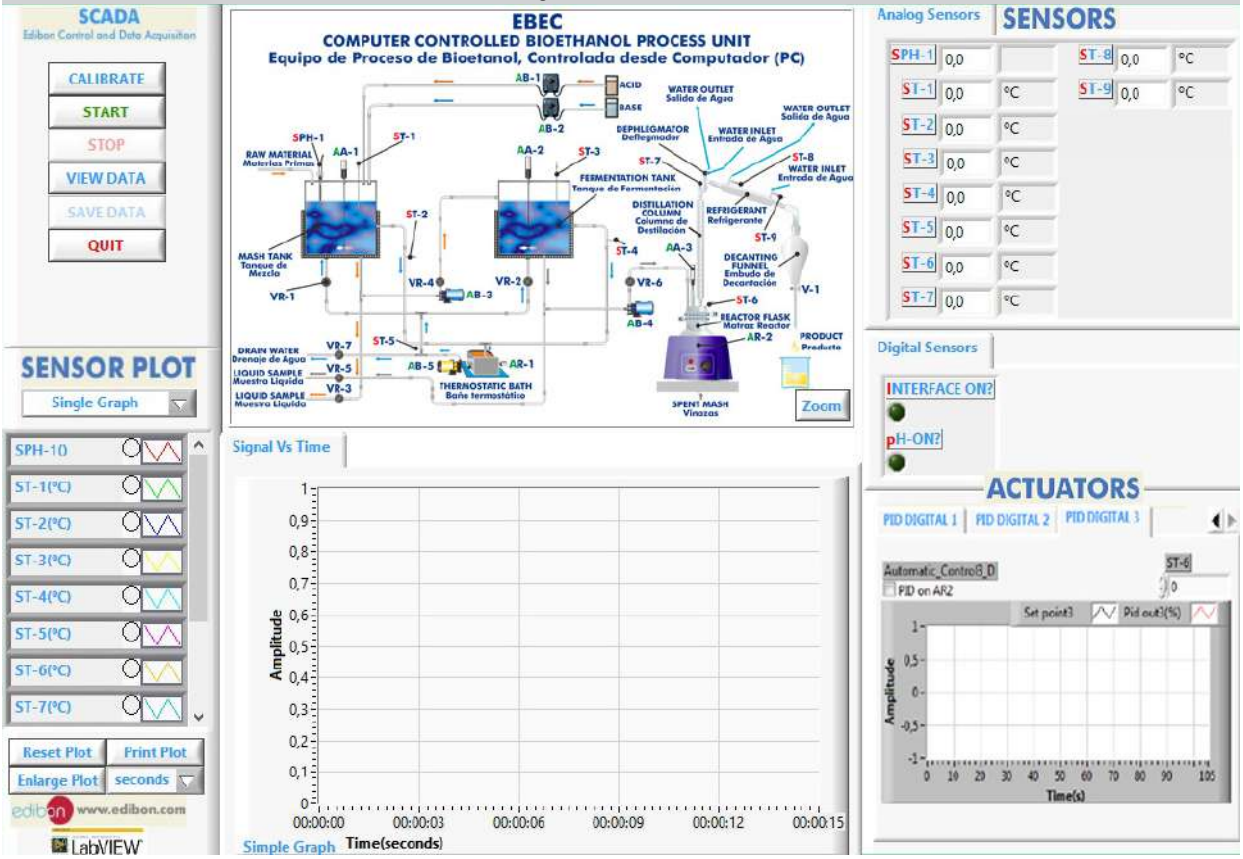


The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

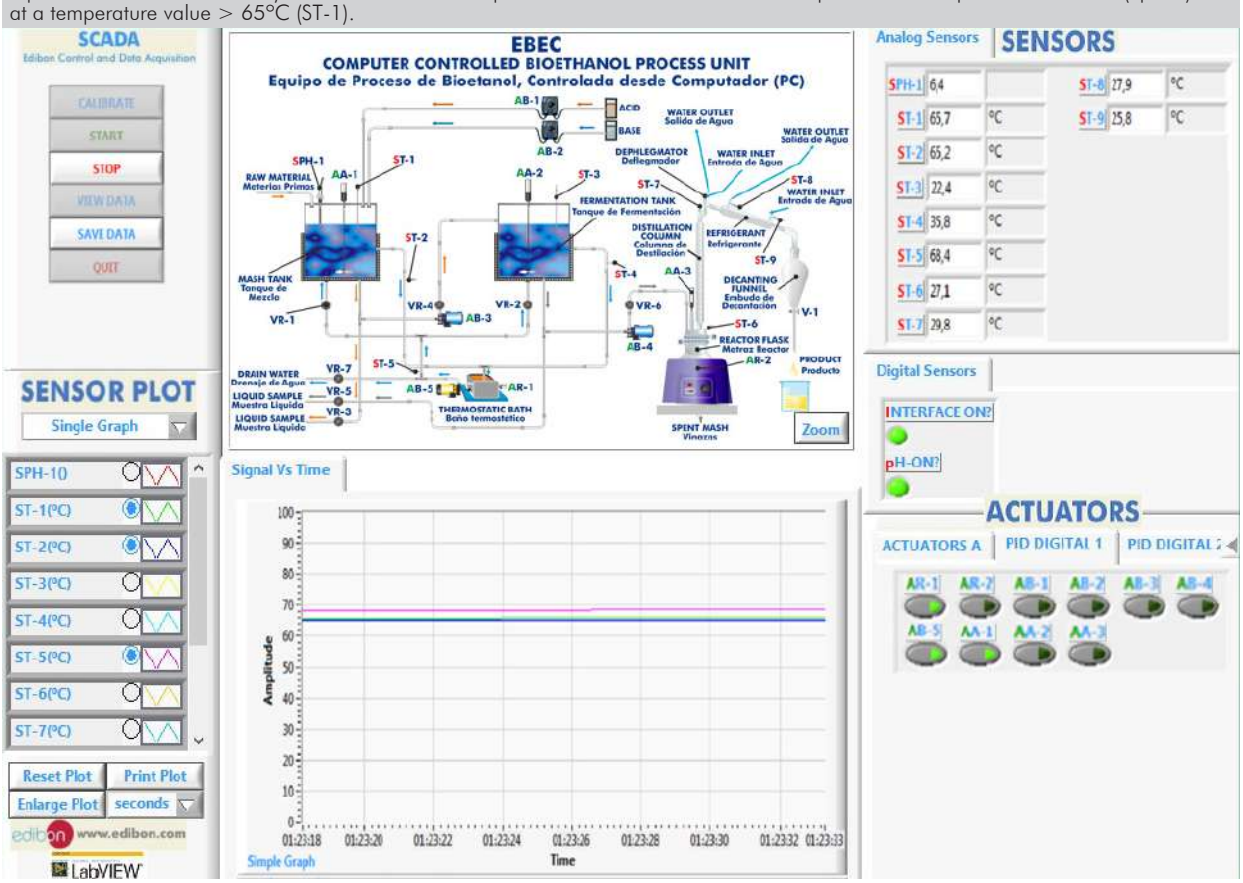
The unit works with different PID controllers to maintain a desired temperature. This screen shows the PID controller used to keep the desired temperature inside the mash tank. It includes a temperature sensor, located at the outlet of the jacket of this tank. It controls the resistor of the thermostatic bath.



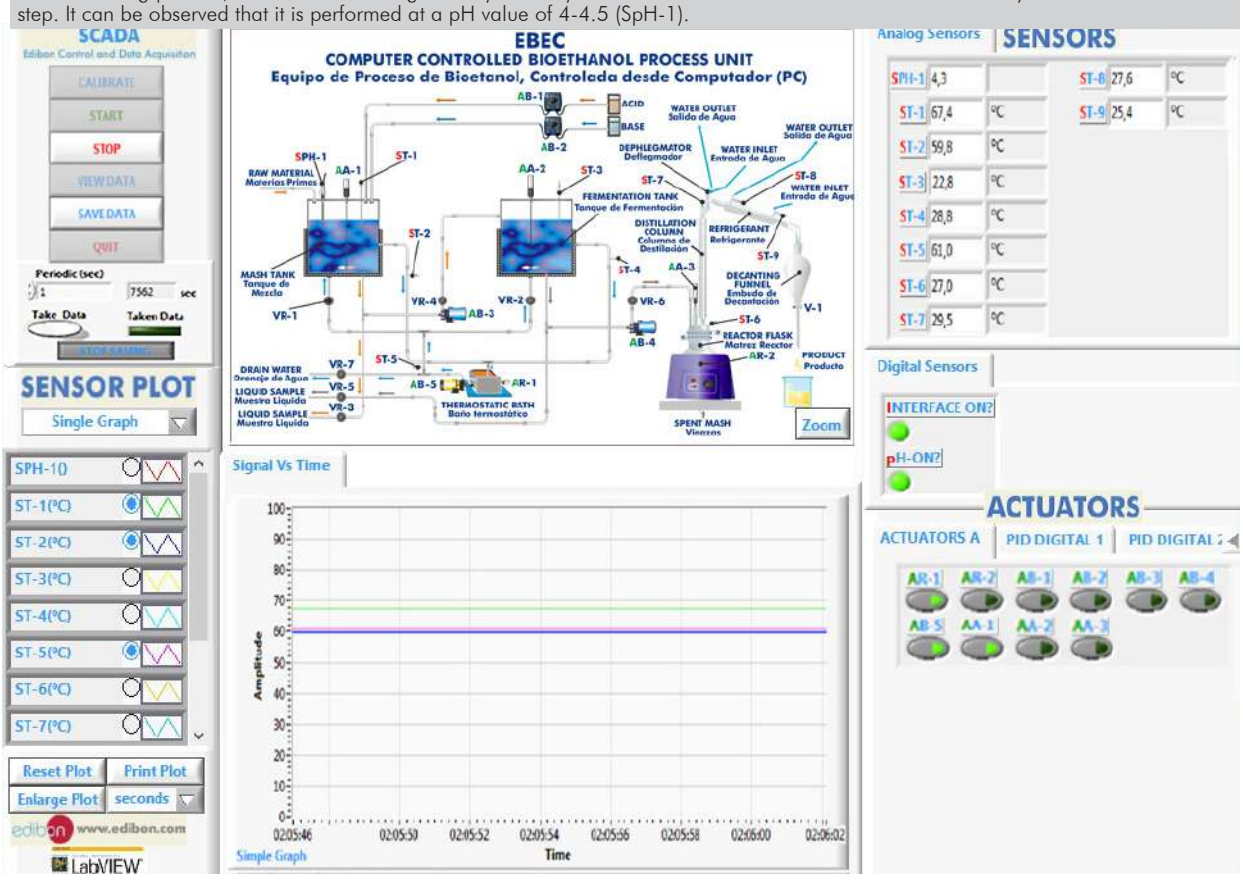
This screen shows the PID controller used to maintain the desired temperature inside the reactor flask. It includes a temperature sensor, located in this flask, which controls the resistor of the heating mantle.



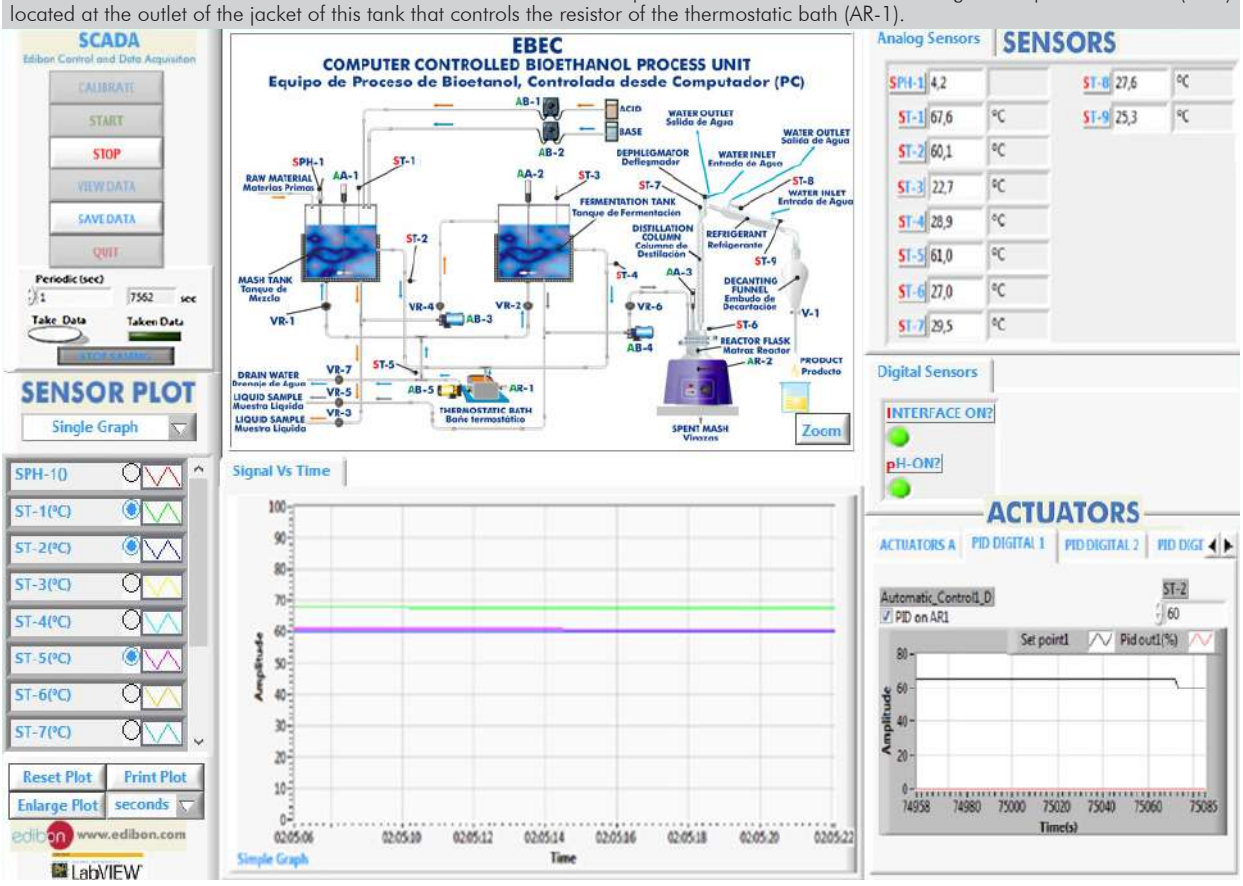
During the mashing process, the starch of the raw materials is turned into glucose. The addition of the alpha-amylase enzyme enables the liquefaction of the starch slurry. This screen shows this process. It can be observed that it is performed at a pH value of 6-6.5 (SpH-1) and at a temperature value > 65ºC (ST-1).



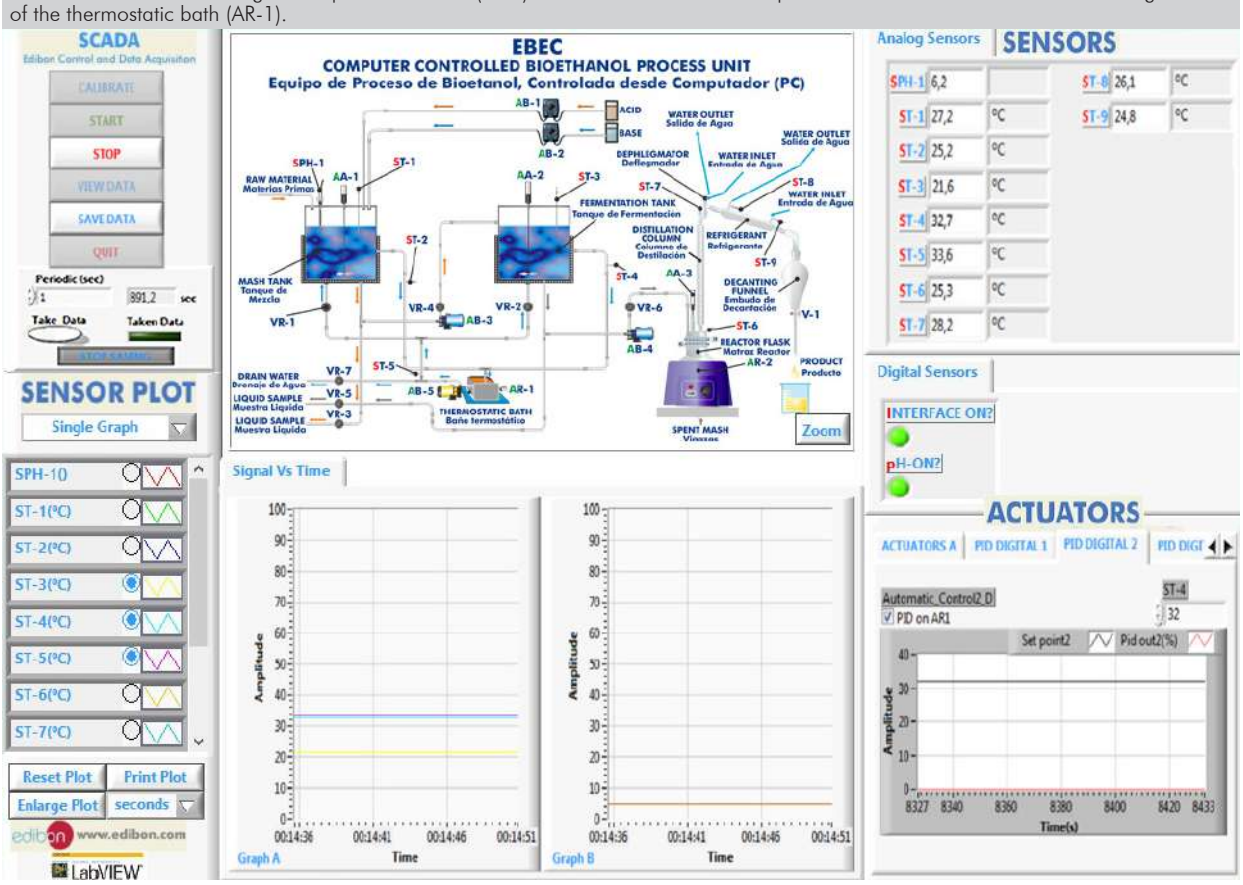
In the mashing process, the addition of the glucoamylase enzyme enables the saccharification of the starch slurry. This screen shows this step. It can be observed that it is performed at a pH value of 4-4.5 (SpH-1).



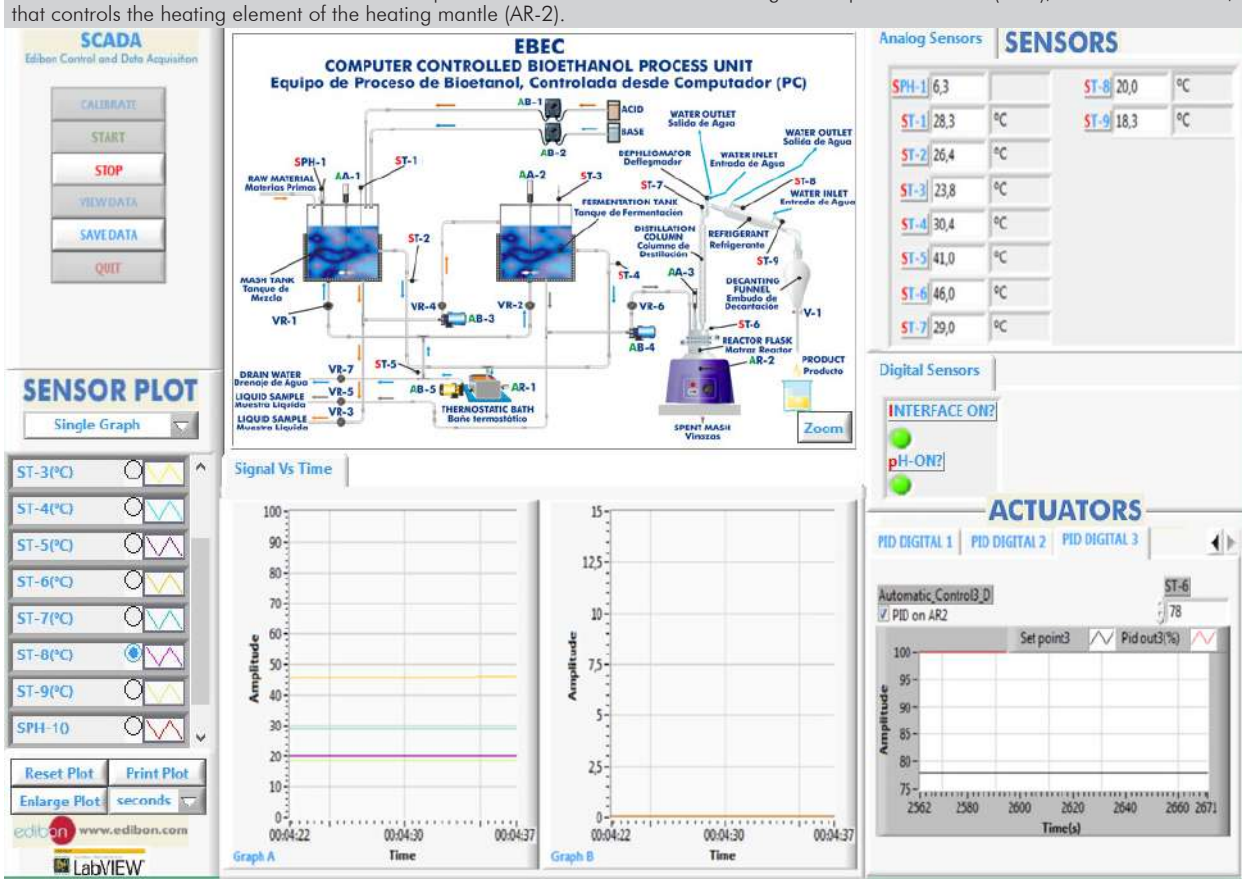
The screen shows the PID controller used to maintain the desired temperature inside the mash tank through a temperature sensor (ST-2) located at the outlet of the jacket of this tank that controls the resistor of the thermostatic bath (AR-1).



The mixture must be cooled and pumped to the fermentation tank. After the addition of yeast, the fermentation process takes place in anaerobic conditions, generating ethanol and CO_2. The screen shows the PID controller used to maintain the desired temperature inside the fermentation tank through a temperature sensor (ST-4) located at the outlet of the jacket of this tank that controls the heating element of the thermostatic bath (AR-1).



The distillation process makes use of the different volatilities of the components (ethanol and water) to separate them. This screen shows the PID controller used to maintain the desired temperature inside the reactor flask through a temperature sensor (ST-6), located in this tank, that controls the heating element of the heating mantle (AR-2).



COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 11.
All these items try to give more possibilities for:

a) Industrial configuration. (PLC)
b) Technical and Vocational Education configuration. (ICAI and FSS)
c) Multipost Expansions options. (MINI ESN and ESN)

a) Industrial configuration

⑦ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.

Circuit diagram in the module front panel.

Front panel:

Digital inputs (X) and Digital outputs (Y) block:

16 Digital inputs, activated by switches and 16 LEDs for confirmation (red).

14 Digital outputs (through SCSI connector) with 14 LEDs for message (green).

Analog inputs block:

16 Analog inputs (-10 V. to + 10 V.) (through SCSI connector).

Analog outputs block:

4 Analog outputs (-10 V. to + 10 V.) (through SCSI connector).

Touch screen:

High visibility and multiple functions. Display of a highly visible status. Recipe function. Bar graph function. Flow display function. Alarm list. Multi language function. True type fonts.

Back panel:

Power supply connector. Fuse 2A. RS-232 connector to PC. USB 2.0 connector to PC.

Inside:

Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.

Panasonic PLC:

High-speed scan of 0.32 μsec. for a basic instruction.

Program capacity of 32 Ksteps, with a sufficient comment area.

Power supply input (100 to 240 V AC).

DC input: 16 (24 V DC).

Relay output: 14.

High-speed counter.

Multi-point PID control.

Digital inputs/outputs and analog inputs/outputs Panasonic modules.

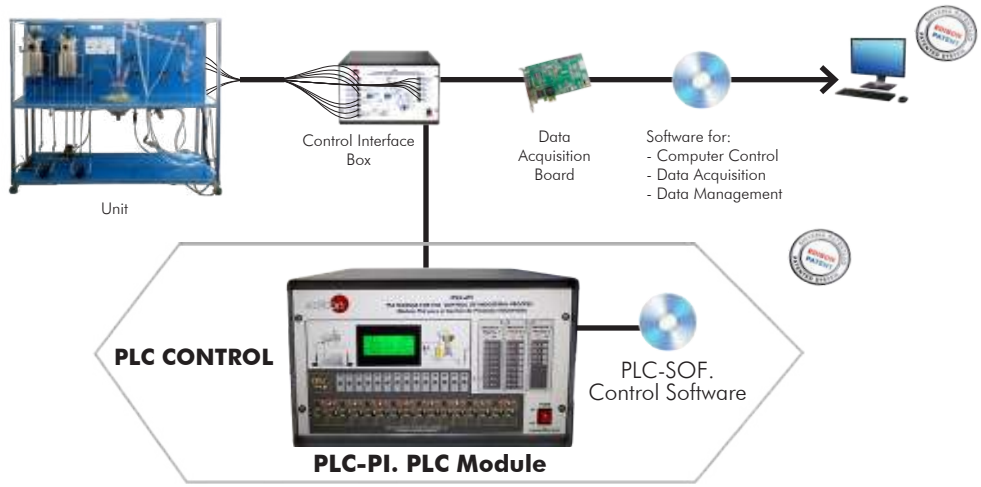
Communication RS232 wire to computer (PC).

Dimensions: 490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.). Weight: 30 Kg. approx. (66 pounds approx.).

-EBEC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

The software has been designed using Labview and it follows the unit operation procedure and linked with the Control Interface Box used in the Computer Controlled Bioethanol Process Unit (EBEC).



Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.
13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
14.-New configuration and development of new process.
15.-Hand on an established process.
16.-To visualize and see the results and to make comparisons with the particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ EBEC/ICAI. Interactive Computer Aided Instruction Software.

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

This software is optional and can be used additionally to items (1 to 6).

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- **User Data Base Management.**
- **Administration and assignment of Workgroup, Task and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation System Solver Engine.**
- **Updatable Contents.**
- **Report generation, User Progression Monitoring and Statistics.**

- ESL-SOF. EDIBON Student Labsoft (Student Software).

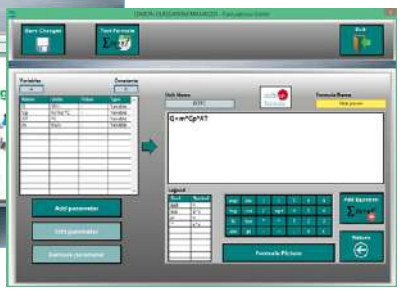
ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

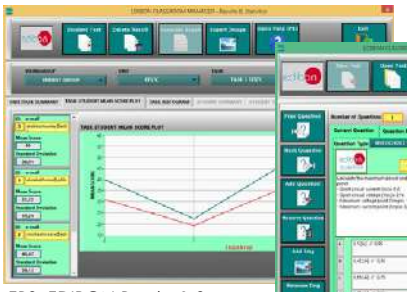
- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge and progression.**
- **Test self-correction.**
- **Calculations computing and plotting.**
- **Equation System Solver Engine.**
- **User Monitoring Learning & Printable Reports.**
- **Multimedia-Supported auxiliary resources.**

Instructor Software

ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



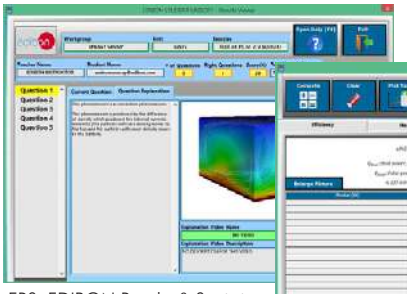
ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram

ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

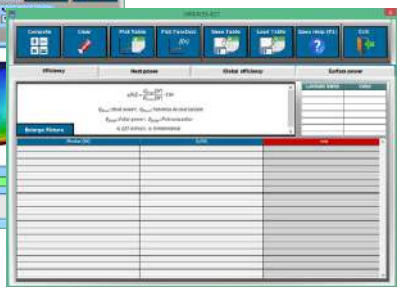
Student Software

ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen

EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

For more information see **ICAI** catalogue. Click on the following link:

www.edibon.com/en/interactive-computer-aided-instruction-software

⑨ EBEC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit. It is useful for Technical and Vocational level.

The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them. There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:

- An incorrect calibration is applied to them.

- Non-linearity.

Faults affecting the actuators:

- Actuators channels interchange at any time during the program execution.

- Response reduction of an actuator.

Faults in the controls execution:

- Inversion of the performance in ON/OFF controls.

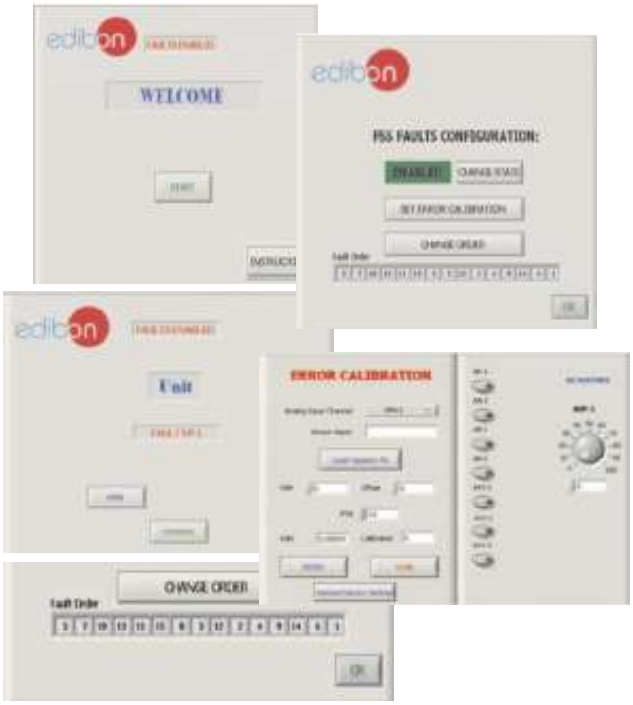
- Reduction or increase of the calculated total response.

- The action of some controls is annulled.

On/off faults:

- Several on/off faults can be included.

Example of some screens



For more information see **FSS** catalogue. Click on the following link:

www.edibon.com/en/fault-simulation-system

c) Multipost Expansions options

⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.

- Open Control + Multicontrol + Real Time Control + Multi Student Post.

- Instructor controls and explains to all students at the same time.

- Any user/student can work doing "real time" control/multicontrol and visualisation.

- Instructor can see in the computer what any user/student is doing in the unit.

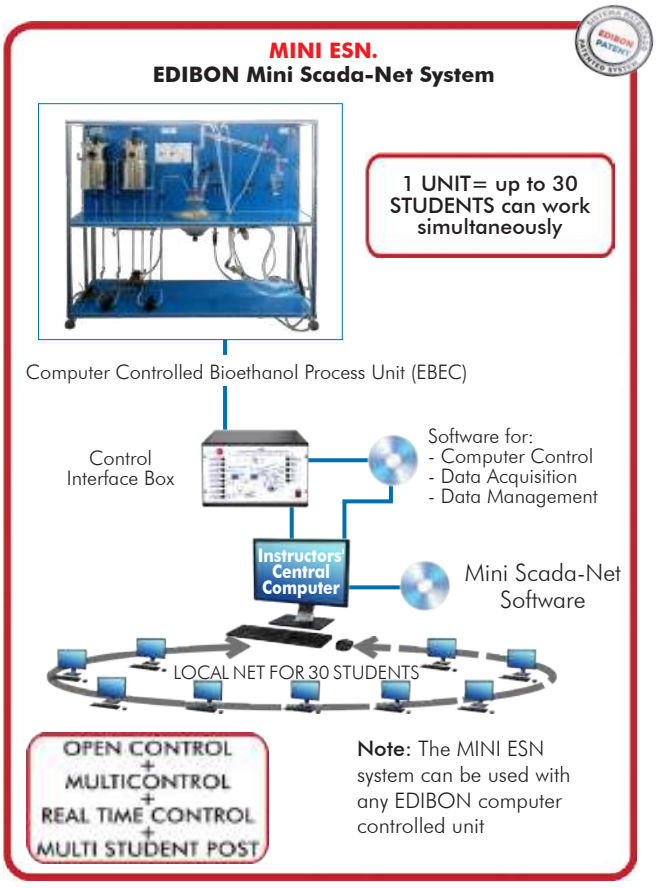
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.

- This system allows you can save time and cost.

- Future expansions with more EDIBON Units.



For more information see **MINI ESN** catalogue. Click on the following link:

www.edibon.com/en/edibon-scada-net

⑪ ESN. EDIBON Scada-Net Systems.

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

For more information see **ESN** catalogue. Click on the following link:

www.edibon.com/en/edibon-scada-net

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: EBEC. Computer Controlled Bioethanol Process Unit.**

② **EBEC/CIB. Control Interface Box.**

③ **DAB. Data Acquisition Board.**

④ **EBEC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software.**

⑤ **Cables and Accessories**, for normal operation.

⑥ **Manuals.**

*IMPORTANT: Under EBEC we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.

Optional items (supplied under specific order)

a) Industrial configuration

⑦ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

- PCL-PI. PLC Module.
- EBEC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

⑧ EBEC/ICAI. Interactive Computer Aided Instruction Software.

⑨ EBEC/FSS. Faults Simulation System.

c) Multipost Expansions options

⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑪ ESN. EDIBON Scada-Net Systems.

① EBEC. Unit:

Anodized aluminum frame and panels made of painted steel.
The unit includes wheels to facilitate its mobility.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
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 "EBEC" unit mainly 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, computer controlled stirrer, and 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, computer controlled 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:
    - Computer controlled heating mantle, 800 W.
    - Reactor flask with discharge stopcock, volume: 5 l.
    - Reactor lid, with four inlets, especially designed for this system.
    - Vigreux type distillation column.
    - Computer controlled stirring rod with stirring lock that assures a perfect insulation of the system.
    - Cold finger (dephlegmator).
    - Liebig-West condenser with interchangeable fittings.
    - Decantation funnel of 500 ml.
    - Temperature tappings placed at key points of the system.
- Two computer controlled diaphragm pumps to introduce the solution into the fermentation tank and the distillation unit, range: 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.
  - Temperature sensor located at the hot water circulation system.
  - The temperature sensors located at the outlet of the jacket of the mash and fermentation tanks work with the PID controller to maintain the desired temperature inside.
- pH sensor measures the pH of the mash inside the mash tank, range: 0 – 13.
- Hot water circulation system, including:
  - Computer controlled pump.
  - Thermostatic bath, with computer controlled heating element.
- Acid/base circuit system, including:
  - Two computer controlled 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.
  - Ball valve is used to drain water from the hot water circulation system.

The complete unit includes as well:

Advanced Real-Time SCADA and PID Control.
Open Control + Multicontrol + Real-Time Control.
Specialized EDIBON Control Software based on LabVIEW.
National Instruments Data Acquisition board (250 KS/s, kilo samples per second).
Calibration exercises, which are included, teach the user how to calibrate a sensor and the importance of checking the accuracy of the sensors before taking measurements.
Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
Capable of doing applied research, real industrial simulation, training courses, etc.
Remote operation and control by the user and remote control for EDIBON technical support, are always included.
Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
Designed and manufactured under several quality standards.
Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② EBEC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.
Control interface box with process diagram in the front panel.
The unit control elements are permanently computer controlled.
Simultaneous visualization in the computer of all parameters involved in the process.
Calibration of all sensors involved in the process.
Real time curves representation about system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
Shield and filtered signals to avoid external interferences.
Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.
Real time PID control for parameters involved in the process simultaneously.
Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).
Open control allowing modifications, at any moment and in real time, of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.
PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.
Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).
Analog output: Channels=2. Resolution=16 bits, 1 in 65536.
Digital Input/Output: Channels=24 inputs/outputs.
The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

④ EBEC/CCSOF. PID Computer Control +Data Acquisition+Data Management Software:

The three softwares are part of the SCADA system.
Compatible with the industry standards.
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.
Analog and digital PID control. PID menu and set point selection required in the whole work range.
Management, processing, comparison and storage of data.
Sampling velocity up to 250 KS/s (kilo samples per second).
Calibration system for the sensors involved in the process.
It allows the registration of the alarms state and the graphic representation in real time.
Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.
This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Exercises and Practical Possibilities to be done with the Main Items

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.

Additional practical possibilities:

9.- Sensors calibration.

Other possibilities to be done with this Unit:

10.-Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

11.-Open Control, Multicontrol and Real Time Control.

This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc, in real time.

12.-The Computer Control System with SCADA and PID Control allow a real industrial simulation.

13.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.

14.-This unit can be used for doing applied research.

15.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

16.-Control of the EBEC unit process through the control interface box without the computer.

17.-Visualization of all the sensors values used in the EBEC unit process.

- By using PLC-PI additional 19 more exercises can be done.

- Several other exercises can be done and designed by the user.

a) Industrial configuration

⑦ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

Metallic box.
Circuit diagram in the module front panel.
Digital inputs (X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.
Analog inputs block: 16 Analog inputs.
Analog outputs block: 4 Analog outputs.
Touch screen.
Panasonic PLC:
High-speed scan of 0.32 μsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.
Digital inputs/outputs and analog inputs/outputs Panasonic modules.

-EBEC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.
13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
14.-New configuration and development of new process.
15.-Hand on an established process.
16.-To visualize and see the results and to make comparisons with the particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **EBEC/ICAI. Interactive Computer Aided Instruction Software.**

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc...so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
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- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

⑨ EBEC/FSS. Faults Simulation System.

Faults Simulation System (FSS) is a Software package that simulates several faults in any EDIBON Computer Controlled Unit.
The "FAULTS" mode consists in causing several faults in the unit normal operation. The student must find them and solve them.
There are several kinds of faults that can be grouped in the following sections:

Faults affecting the sensors measurement:
- An incorrect calibration is applied to them.
- Non-linearity.

Faults affecting the actuators:
- Actuators channels interchange at any time during the program execution.
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Faults in the controls execution:
- Inversion of the performance in ON/OFF controls.
- Reduction or increase of the calculated total response.
- The action of some controls is annulled.

On/off faults:
- Several on/off faults can be included.

c) Multipost Expansions options

⑩ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.
The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control integrated in a local network.
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.
Main characteristics:
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:
- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:
This system is used with a Computer Controlled Unit.
- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

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

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REPRESENTATIVE: