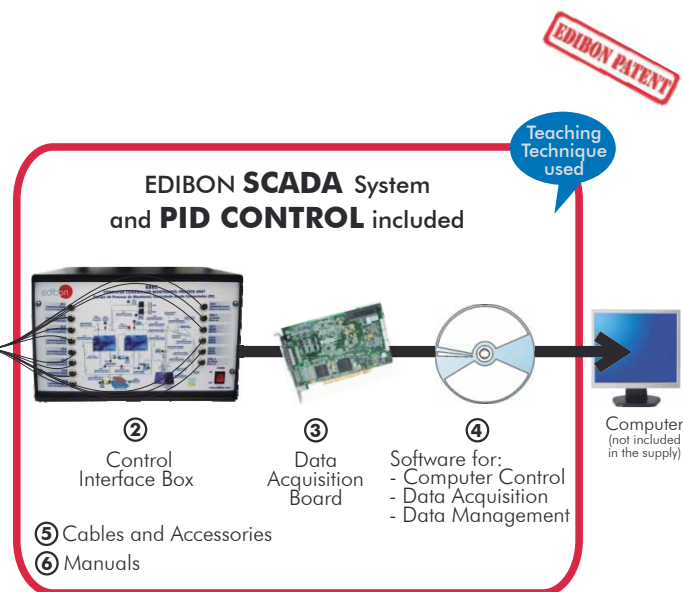


① Unit: EBEC. Bioethanol Process Unit



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

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 CAL software helps the user perform calculations and comprehend the results.**
- **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**

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Products
Products range
Units
5.-Energy

For more information about Key Features, click here:



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)



**Worldidac Quality Charter
Certificate**
(Worldidac Member)

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 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.

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 temperature sensor and a CO_2 sensor 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 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.

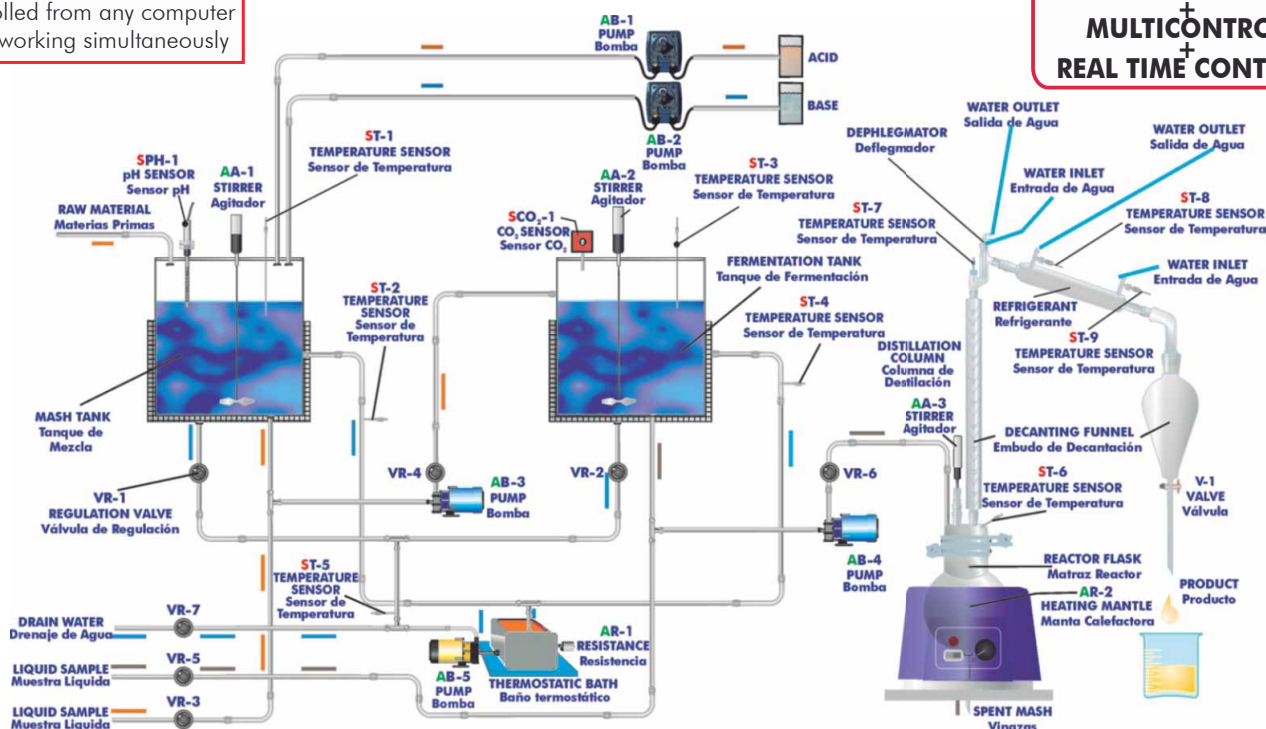
After the fermentation process, the preparation is pumped into the distillation unit. It contains a heating mantle, a stirrer, a distillation column, a cold finger (dephlegmator), a condenser and a decanting funnel. Four temperature sensors are located at different points of the distillation unit.

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

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

10 actuators and 11 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, 11 and 12.

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

① EBEC. Unit:

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 (computer controlled), 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, stirrer (computer controlled), 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 (computer controlled), 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 (computer controlled) 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 tapings placed at key points of the system.

Two diaphragm pumps (computer controlled) 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.

One 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.

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

A CO₂ infrared detector measures the CO₂ concentration generated during the process at the fermentation tank, measurement range: from 0 to 20%.

A hot water circulation system, including:

Pump (computer controlled).

Thermostatic bath, with computer controlled heating element.

An acid/base circuit system, including:

Two peristaltic pumps (computer controlled) 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 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 CAL software helps the user perform calculations and comprehend the results.

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.



EBEC. Unit

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.

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, resistances, 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.



EBEC/CIB

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

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

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/O. DMA channels=6.

Analog output:

Number of channels=2. Resolution= 16 bits, 1 in 65536. Maximum output rate up to: 833 KS/s.

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

Digital Input/Output:

Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency: 0 to 1 MHz.

Timing: Number of Counter/timers=2. Resolution: Counter/timers: 32 bits.



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).

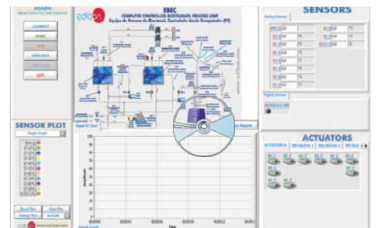
Calibration system for the sensors involved in the process.

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 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, derivate 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 and 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, 220 V./50 Hz. or 110 V./60 Hz.
- Water supply.
- Hydrometers.
- Computer (PC).

RECOMMENDED REAGENTS

- 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

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.).

AVAILABLE VERSIONS

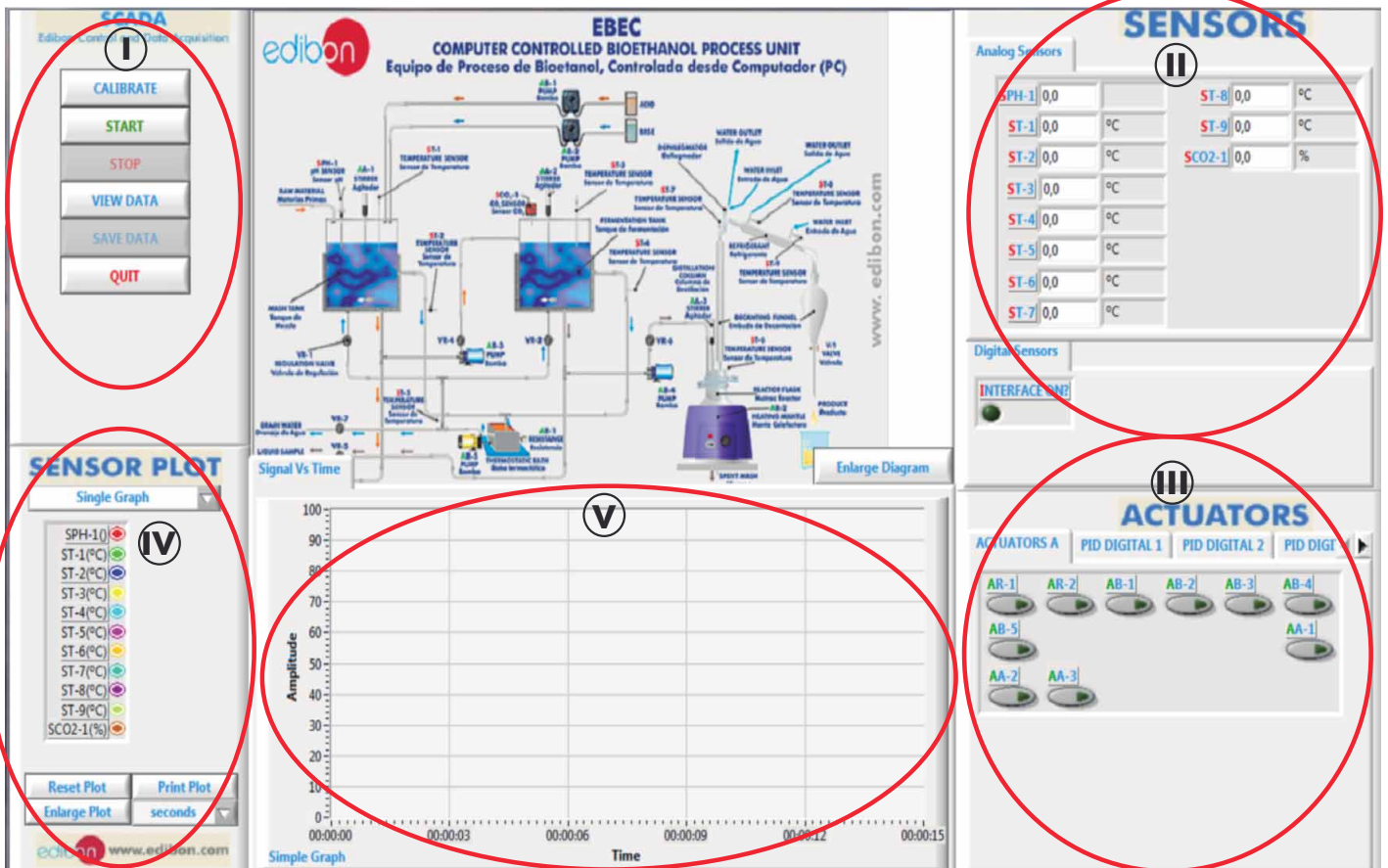
Offered in this catalogue:

- EBEC. Computer Controlled Bioethanol Process Unit.

Offered in other catalogue:

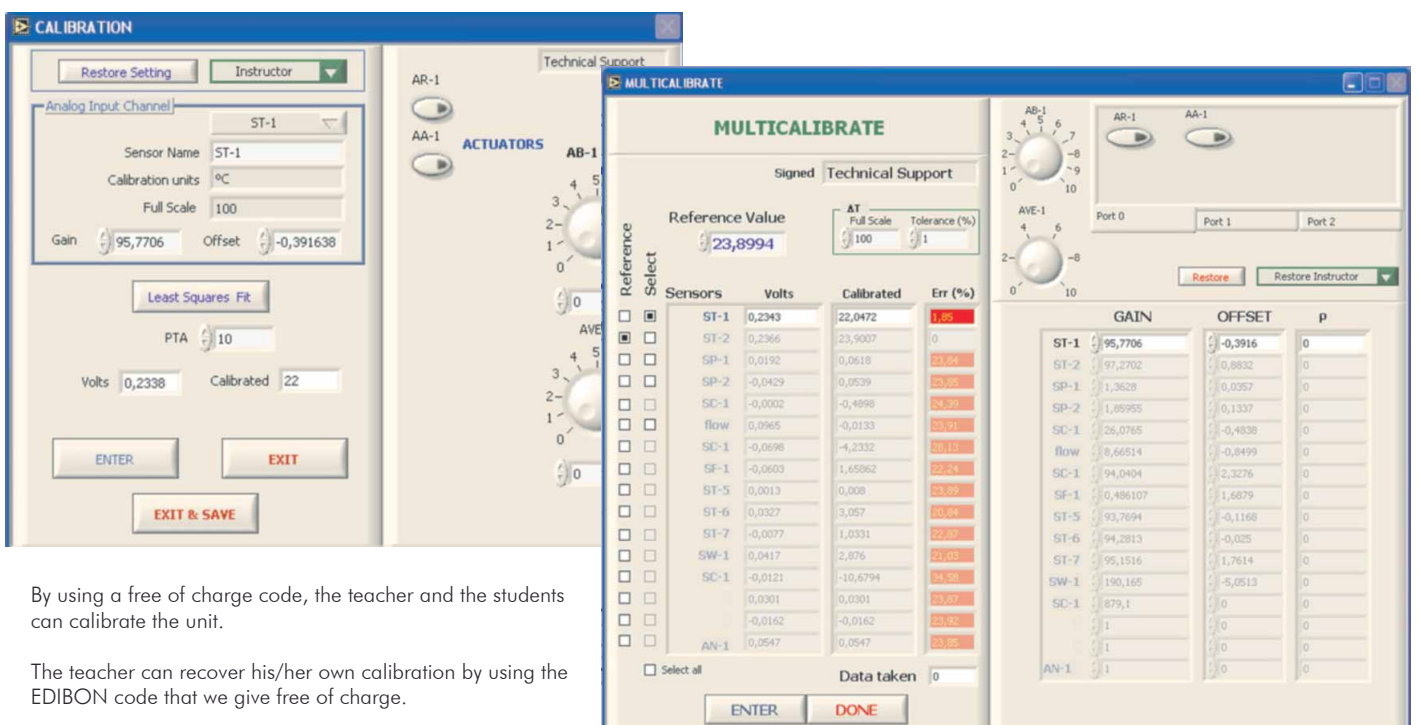
- EBEB. Bioethanol Process Unit.

SCADA Main screen



- (I) Main Controls operation possibilities.
- (II) Sensors displays, real time values, and extra output parameters. Sensors: ST= Temperature sensor. SPH= pH sensor. SCO₂: CO₂ sensor.
- (III) Actuators controls. Actuators: AR=Heating resistance. AB=Pump. AA= Stirrer.
- (IV) Channel selection and other plot parameters.
- (V) Real time graphics displays.

Example of Software for Sensors Calibration

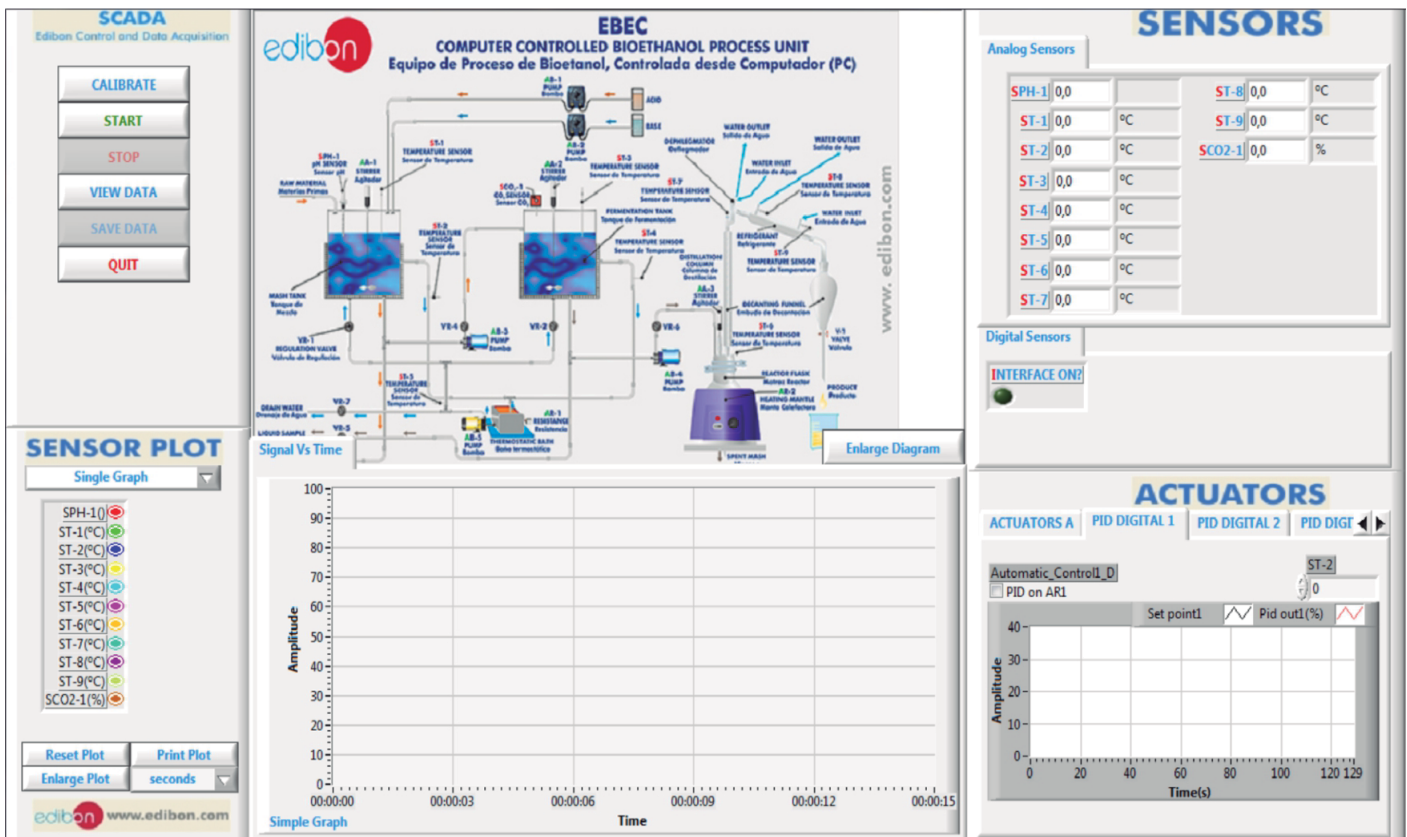


By using a free of charge code, the teacher and the students can calibrate the unit.

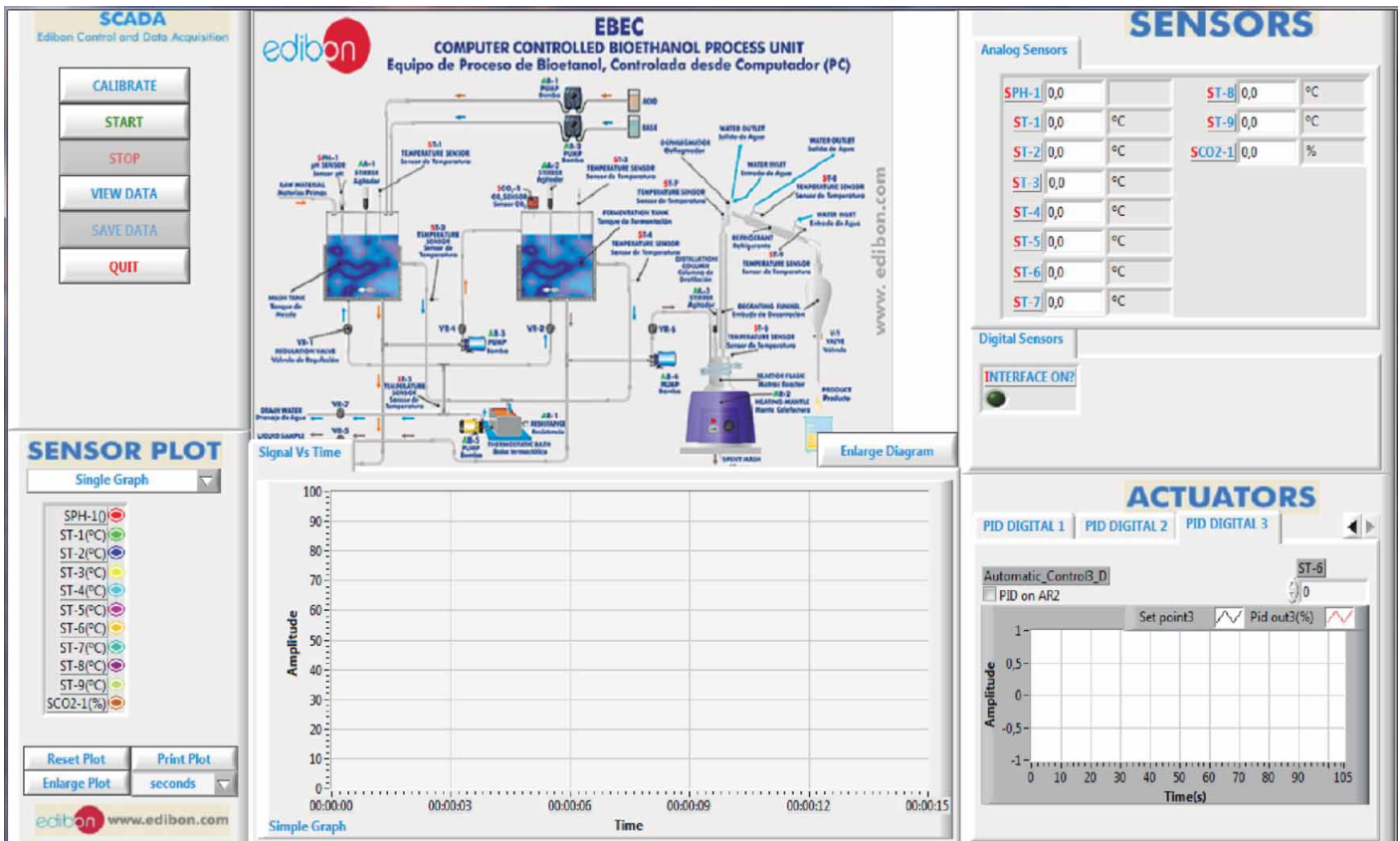
The teacher can recover his/her own calibration by using the EDIBON code that we give free of charge.

SOME TYPICAL RESULTS

The Computer Controlled Bioethanol Process Unit (EBEC) has been designed to study and control the bioethanol production process on a laboratory scale. 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.

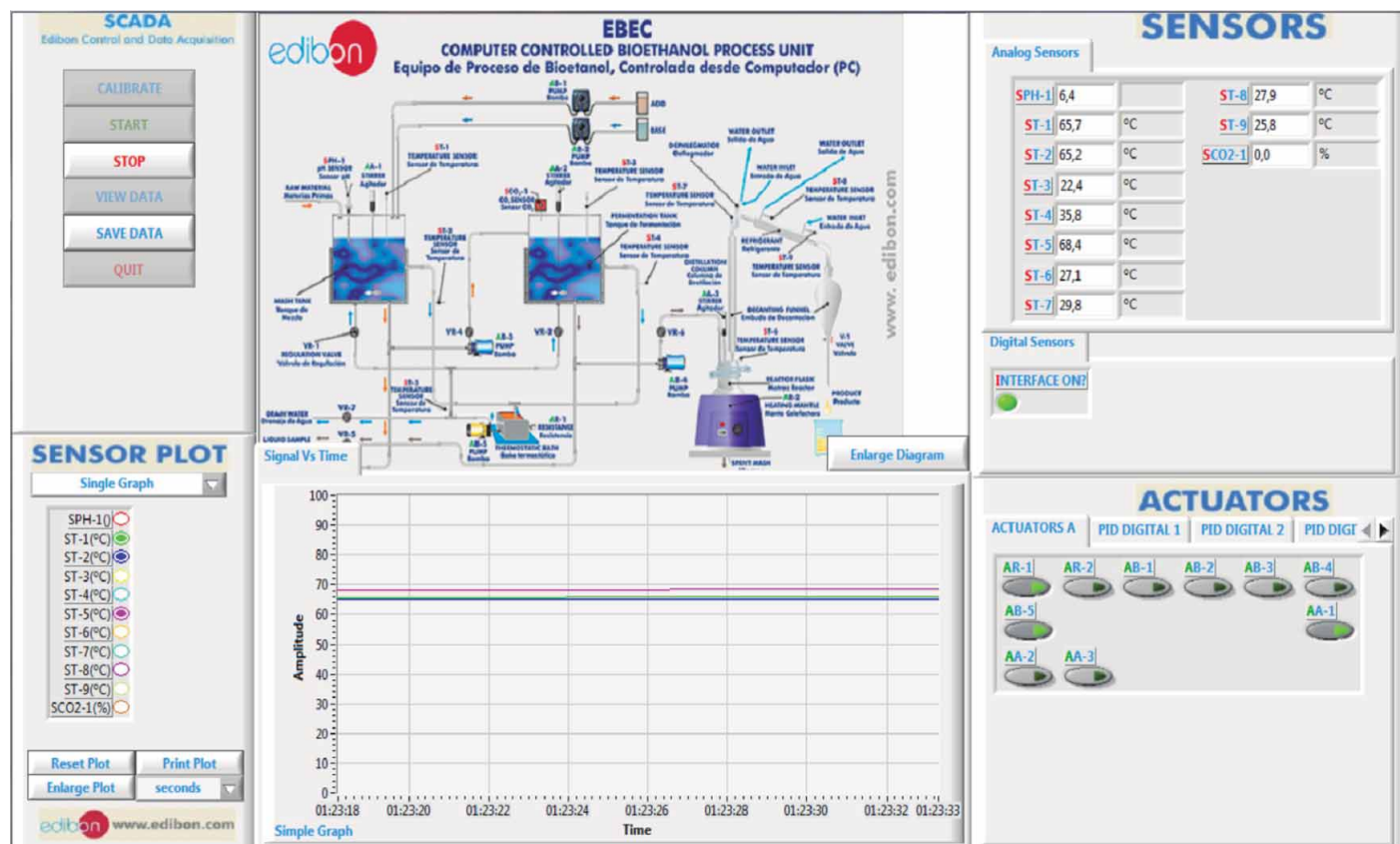


This screen shows the PID controller used to maintain the desired temperature inside the reactor flask. It includes a temperature sensor, located in this flask, which controls the resistor of the heating mantle.

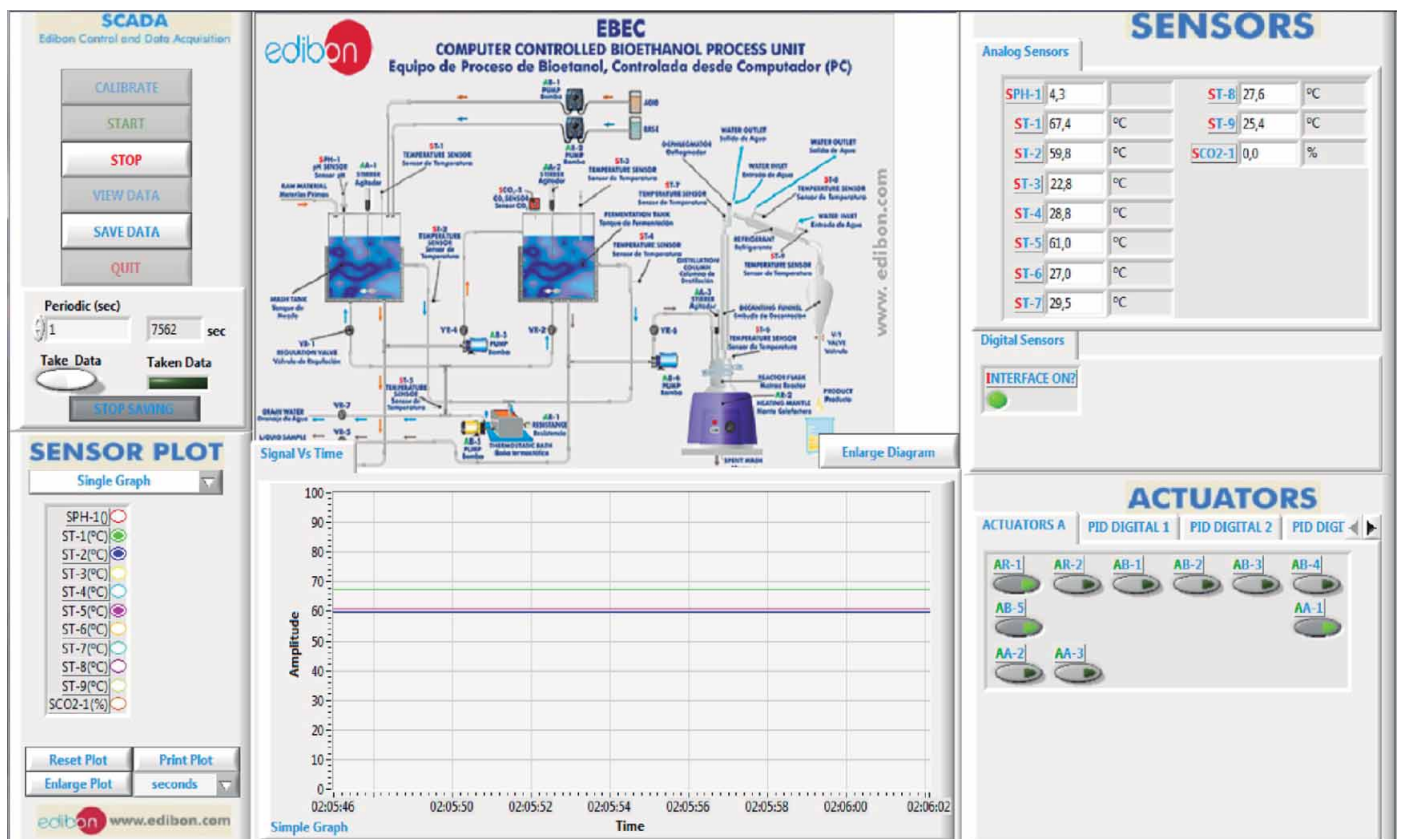


Some typical results

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 $> 65^{\circ}\text{C}$ (ST-1).

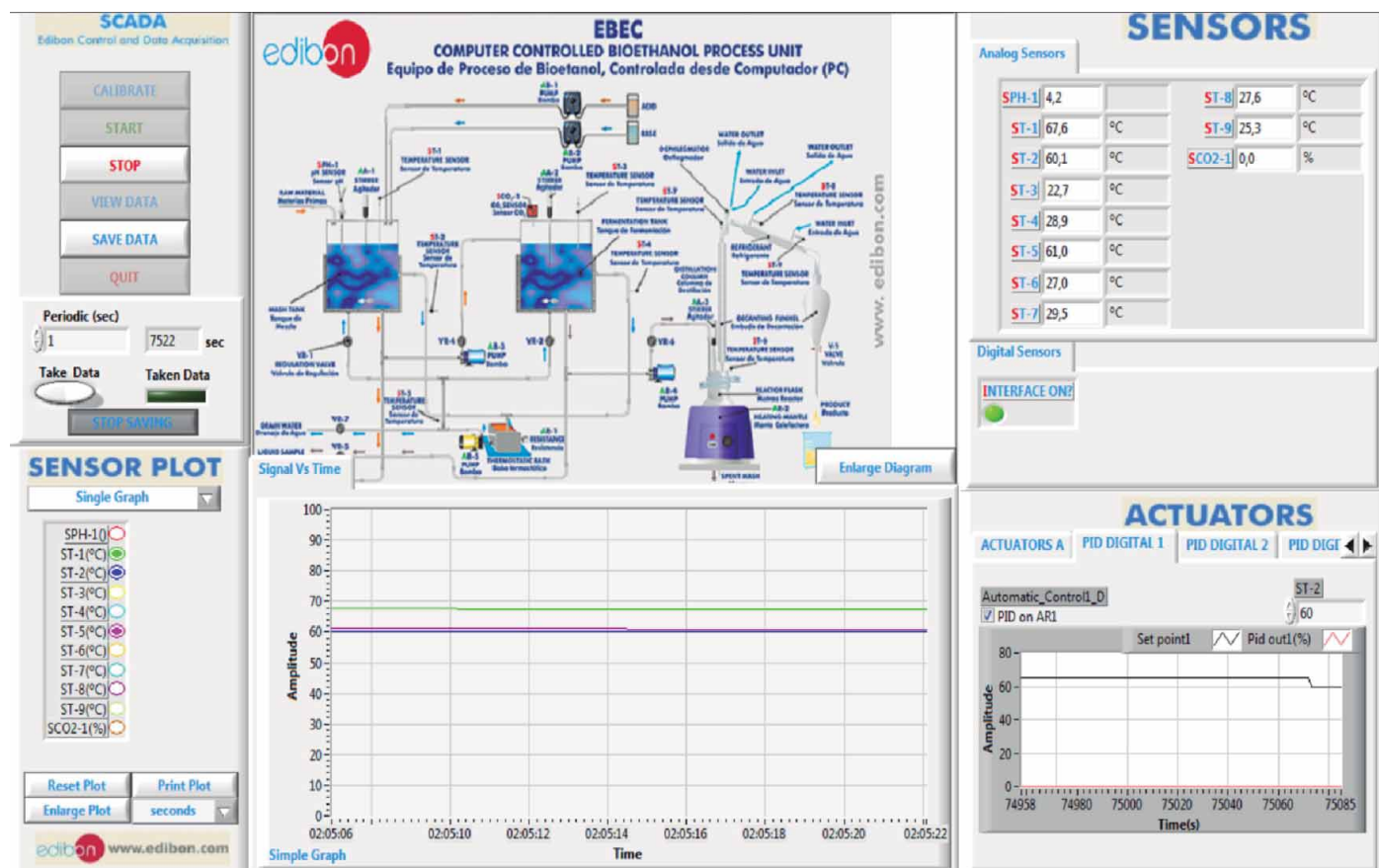


In the mashing process, the addition of the glucoamylase enzyme enables the saccharification of the starch slurry. This screen shows this step. It can be observed that it is performed at a pH value of 4-4.5 (SPH-1).

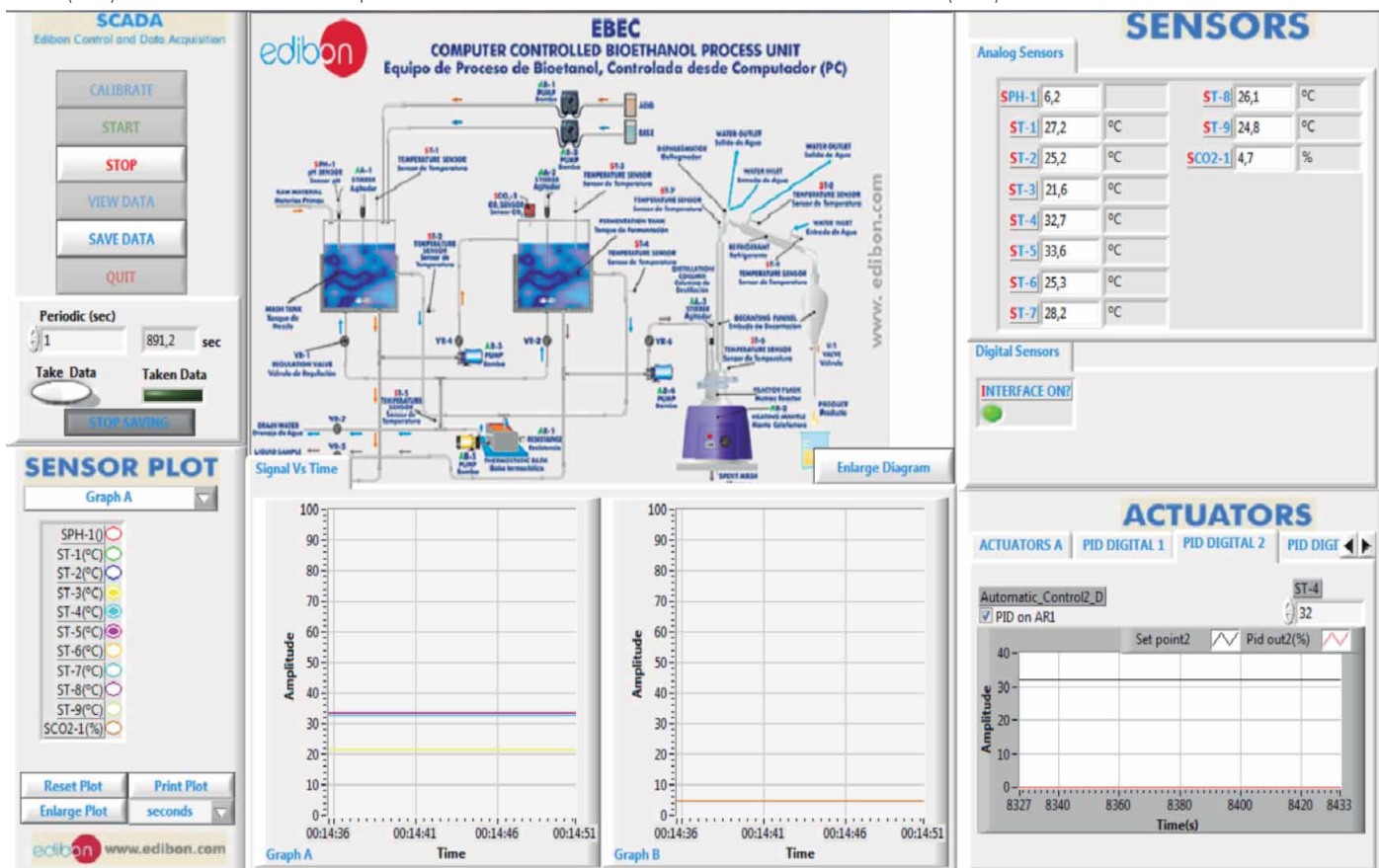


Some typical results

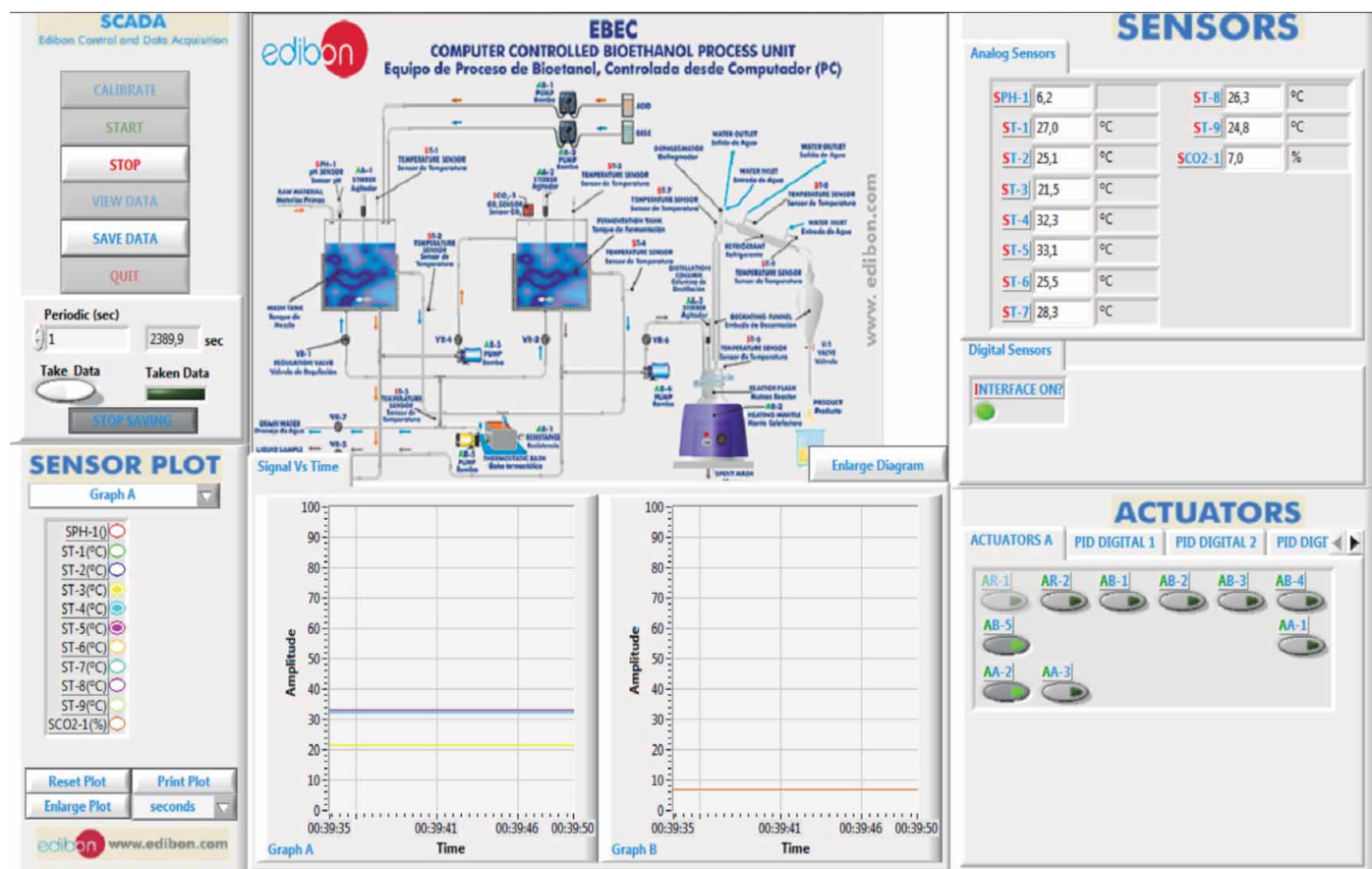
The screen shows the PID controller used to maintain the desired temperature inside the mash tank through a temperature sensor (ST-2) located at the outlet of the jacket of this tank that controls the resistor of the thermostatic bath (AR-1).



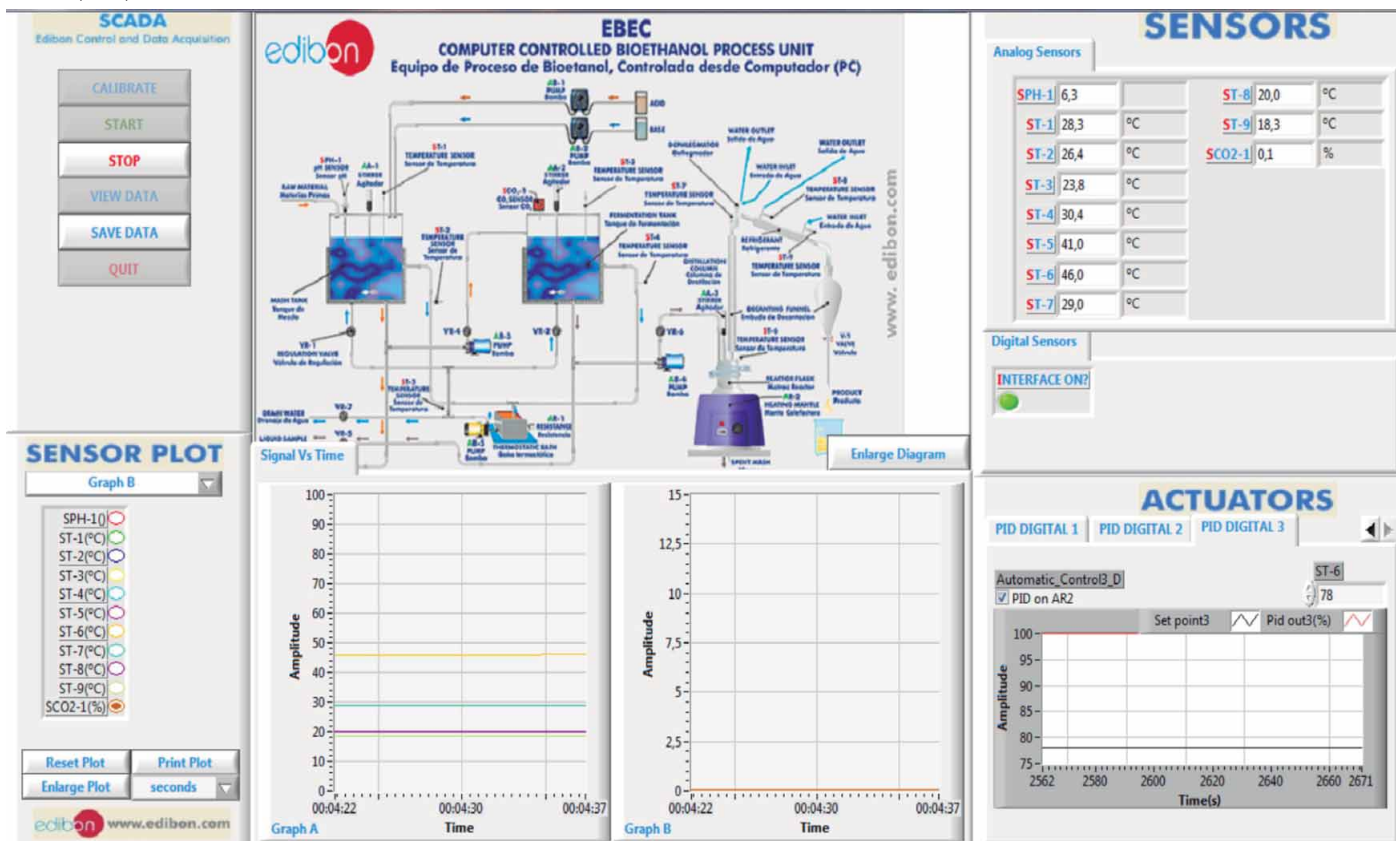
The mixture must be cooled and pumped into the fermentation tank. After the addition of yeast, the fermentation process takes place in anaerobic conditions, generating ethanol and CO_2 . The screen shows the PID controller used to maintain the desired temperature inside the fermentation tank through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



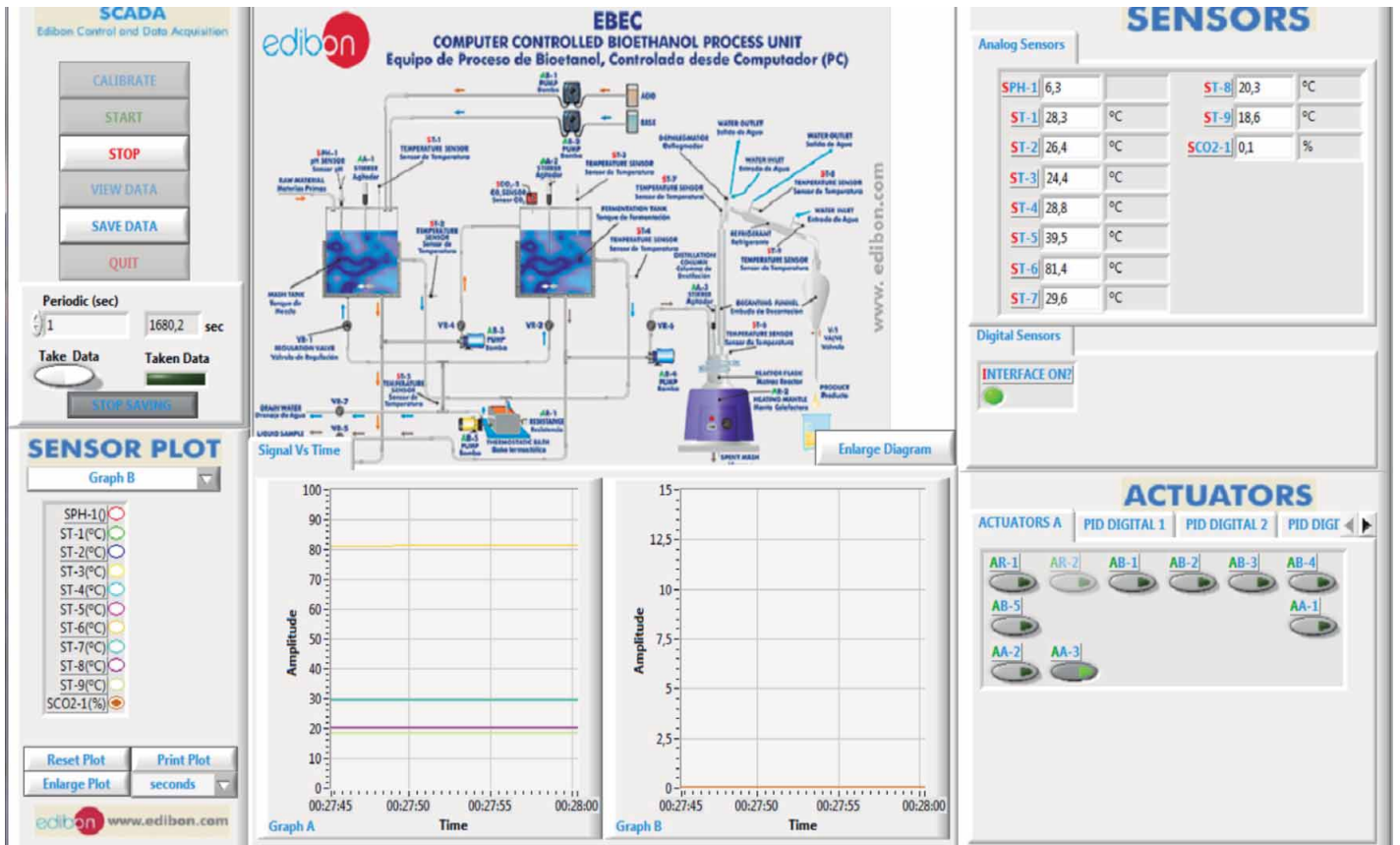
CO₂ is produced during the fermentation process. It is indicated by the value of the CO₂ sensor (SCO₂-1). This screen shows the CO₂ production at this stage. Moreover, CO₂ produced during this process can be seen at the fermentation airlock of the tank.



The distillation process utilizes 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 resistor of the heating mantle (AR-2).



This screen shows the value of the different temperature sensors (ST-6, ST-7, ST-8 and ST-9) during the distillation process.



Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 12.

All these items try to give more possibilities for:

- a) Industrial configuration. (PLC)
- b) Technical and Vocational Education configuration. (CAI and FSS)
- c) Higher Education and/or Technical and Vocational Education configuration. (CAL)
- d) 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 μ sec. 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.

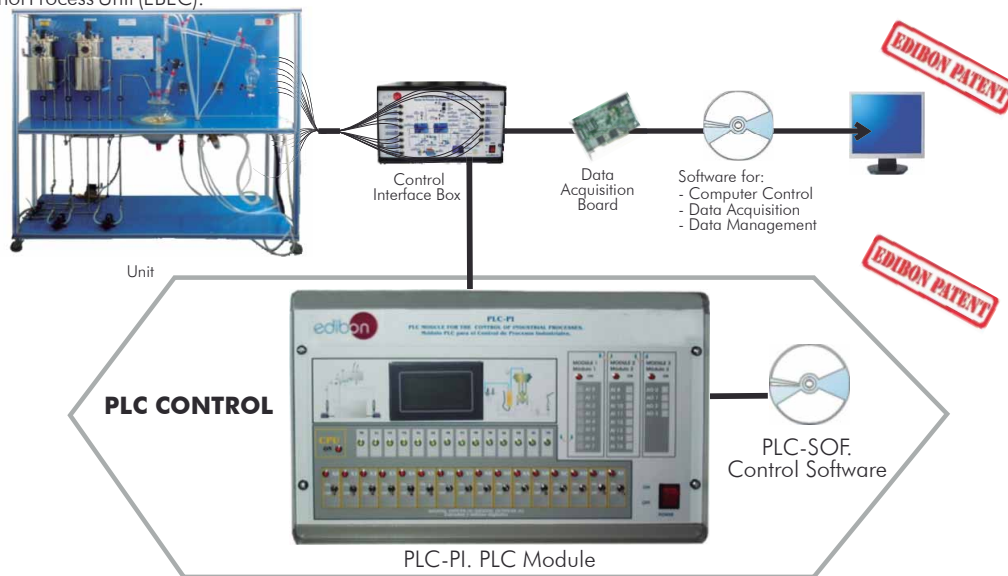
Communication RS232 wire to computer (PC).

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 EBEC unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the EBEC unit process.
- 3.- Calibration of all sensors included in the EBEC unit process.
- 4.- Hand on of all the actuators involved in the EBEC unit process.
- 5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
- 6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
- 7.- PLC hardware general use and manipulation.
- 8.- PLC process application for EBEC unit.
- 9.- PLC structure.
- 10.- PLC inputs and outputs configuration.
- 11.- PLC configuration possibilities.
- 12.- PLC programming languages.
- 13.- PLC different programming standard languages.
- 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 EBEC unit process.
- 17.- Possibility of creating new process in relation with the EBEC unit.
- 18.- PLC Programming exercises.
- 19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑧ **EBEC/CAI. Computer Aided Instruction Software System.**

This complete package included two Softwares: the INS/ SOF. Classroom Management Software (Instructor Software) and the EBEC/SOF. Computer Aided Instruction Software (Student Software).

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

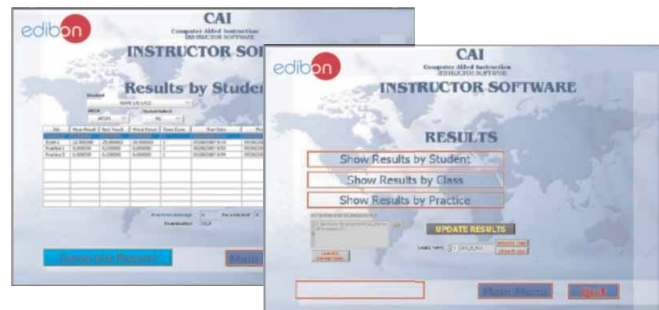
This complete package consists on an Instructor Software (INS/SOF) totally integrated with the Student Software (EBEC/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students. These, on the other hand, get a virtual instructor who helps them to deal with all the information on the subject of study.

- INS/SOF. Classroom Management Software (Instructor Software):

The Instructor can:

- Organize Students by Classes and Groups.
- Create easily new entries or delete them.
- Create data bases with student information.
- Analyze results and make statistical comparisons.
- Print reports.
- Develop own examinations.
- Detect student's progress and difficulties.
- ...and many other facilities.

Instructor Software



- EBEC/SOF. Computer Aided Instruction Software (Student Software):

It explains how to use the unit, run the experiments and what to do at any moment.

This Software contains:

- Theory.
- Exercises.
- Guided Practices.
- Exams.

Student Software



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

www.edibon.com/products/catalogues/en/CAI.pdf

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 on 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.

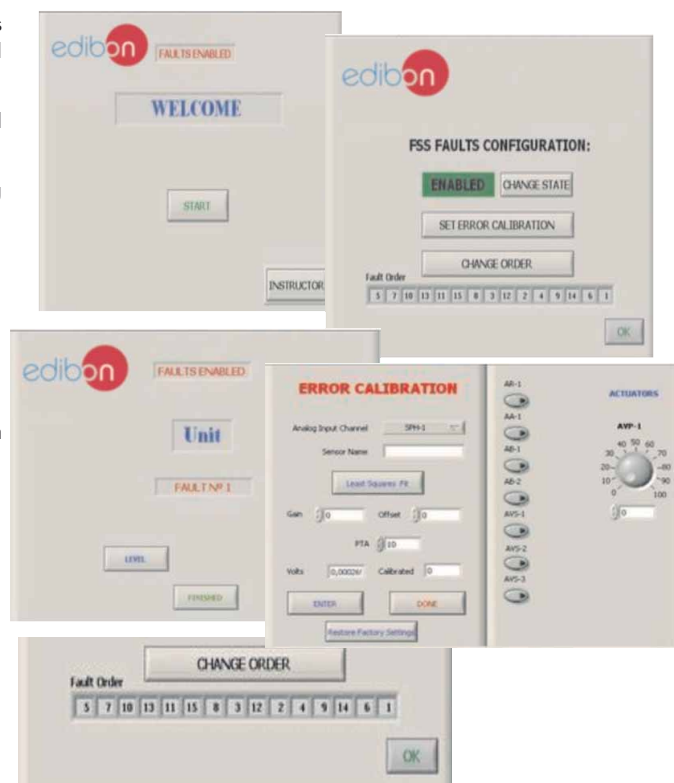
Faults in the controls execution:

- 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/products/catalogues/en/FSS.pdf

c) Higher Education and/or Technical and Vocational Education configuration**10 EBEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).**

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use, specifically developed by EDIBON. It is very useful for Higher Education level.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

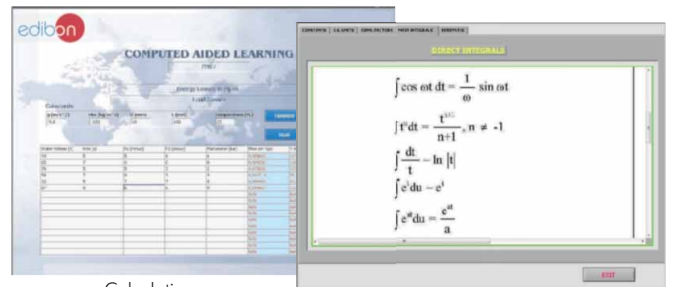
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

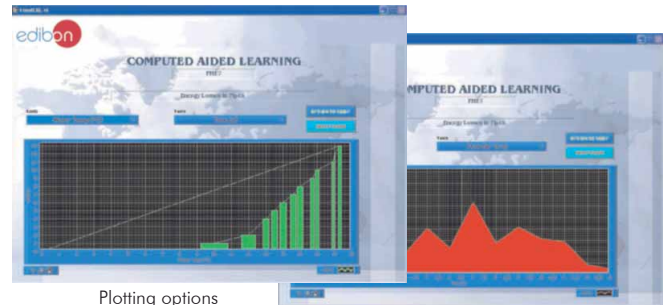
For more information see CAL catalogue. Click on the following link:

www.edibon.com/products/catalogues/en/CAL.pdf



Calculations

Information of constant values, unit conversion factors and integral and derivative tables



Plotting options

d) Multipost Expansions options**11 Mini ESN. EDIBON Mini Scada-Net System.**

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 on 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:

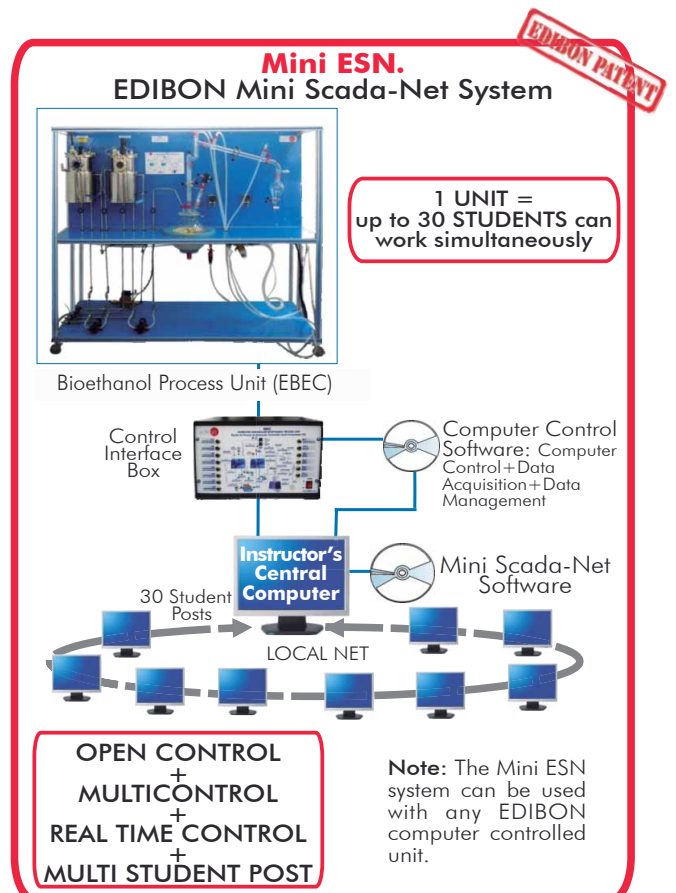
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student 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/products/catalogues/en/Mini-ESN.pdf

**12 ESN. EDIBON Scada-Net System.**

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

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

www.edibon.com/products/catalogues/en/units/energy/esn-alternativeenergies/ESN-ALTERNATIVE_ENERGIES.pdf

Main items (always included in the supply)

Minimum supply always includes:

- ① **Unit: EBEC. 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 configuration

- ⑧ **EBEC/CAL. Computer Aided Instruction Software System.**
- ⑨ **EBEC/FSS. Faults Simulation System.**

c) Higher Education and/or Technical and Vocational Education configuration

- ⑩ **EBEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).**

d) Multipost Expansions options

- ⑪ **Mini ESN. EDIBON Mini Scada-Net System.**
- ⑫ **ESN. EDIBON Scada-Net System.**

① EBEC. Unit:

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 (computer controlled) 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, stirrer (computer controlled) 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 (computer controlled), 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 (computer controlled) 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 tapings placed at key points of the system.

Two diaphragm pumps (computer controlled) 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.

One 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.

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

A CO₂ infrared detector measures the CO₂ concentration generated during the process at the fermentation tank, measurement range: from 0 to 20%.

A hot water circulation system, including:

Pump (computer controlled).

Thermostatic bath, with computer controlled heating element.

An acid/base circuit system, including:

Two peristaltic pumps (computer controlled) 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 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 CAL software helps the user perform calculations and comprehend the results.

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 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.

④ EBEC/CSOF. 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 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, derivate 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 and 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 μ sec. 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 EBEC unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the EBEC unit process.
- 3.- Calibration of all sensors included in the EBEC unit process.
- 4.- Hand on of all the actuators involved in the EBEC unit process.
- 5.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
- 6.- Simulation of outside actions, in the cases hardware elements do not exist. (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
- 7.- PLC hardware general use and manipulation.
- 8.- PLC process application for EBEC unit.
- 9.- PLC structure.
- 10.- PLC inputs and outputs configuration.
- 11.- PLC configuration possibilities.
- 12.- PLC programming languages.
- 13.- PLC different programming standard languages.
- 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 EBEC unit process.
- 17.- Possibility of creating new process in relation with the EBEC unit.
- 18.- PLC Programming exercises.
- 19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration**⑧ EBEC/CAI. Computer Aided Instruction Software System.**

This complete package consists on an Instructor Software (INS/ SOF) totally integrated with the Student Software (EBEC/SOF).

-INS/SOF. Classroom Management Software (Instructor Software):

The Instructor can:

- Organize Students by Classes and Groups.
- Create easily new entries or delete them.
- Create data bases with student information.
- Analyze results and make statistical comparisons.
- Print reports.
- Develop own examinations.
- Detect student's progress and difficulties.

-EBEC/SOF. Computer Aided Instruction Software (Student Software):

It explains how to use the unit, run the experiments and what to do at any moment.

This Software contains:

- Theory.
- Exercises.
- Guided Practices.
- Exams.

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 on 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.

c) Higher Education and/or Technical and Vocational Education configuration

⑩ **EBEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).**

This Computer Aided Learning Software (CAL) is a Windows based software, simple and very easy to use.

CAL is a class assistant that helps in making the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL will perform the calculations.

CAL computes the value of all the variables involved.

It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

Different plotting displays.

It has a wide range of information, such as constant values, unit conversion factors and integral and derivative tables.

d) Multipost Expansions options

⑪ **Mini ESN. EDIBON Mini Scada-Net System.**

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Main characteristics:

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- 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 improvements of the product.



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