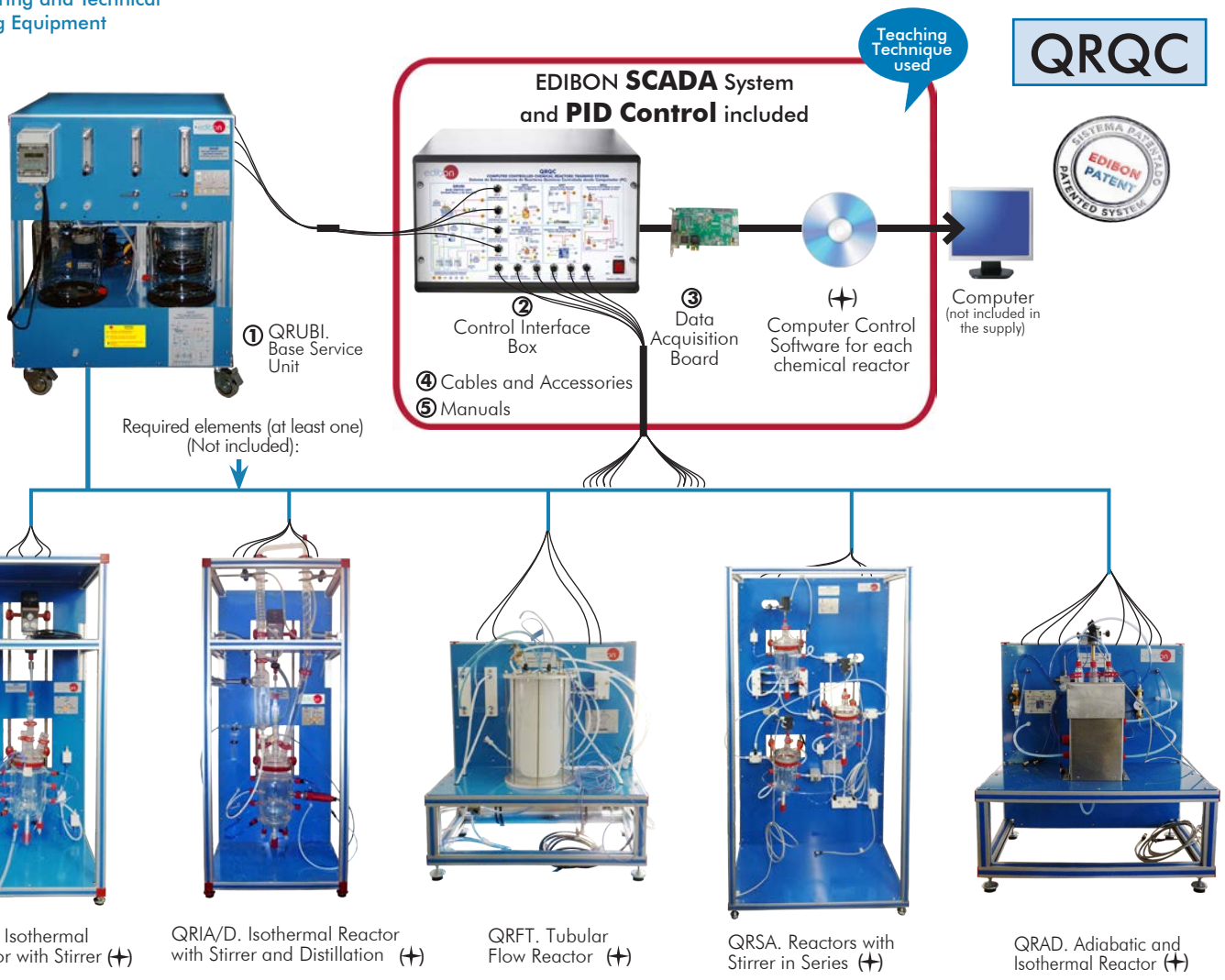
edibon

Engineering and Technical Teaching Equipment

Computer Controlled **Chemical Reactors Training System,** with SCADA and PID Control

QRQC

Teaching Technique used



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

POWERED BY NATIONAL INSTRUMENTS LabVIEW

www.edibon.com
↳PRODUCTS
↳11.-CHEMICAL ENGINEERING

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

A chemical reactor is a device where a change in composition occurs due to a chemical reaction. It is therefore any vessel where a chemical reaction occurs. In a chemical reaction, chemical bonds between atoms are broken and new bonds are formed. Two types of substances are involved in this process: those that we initially have and know as reactants and those that are obtained after the chemical reaction, called products.

Depending on the requirements different types of reactors are used.

The problem of reactor engineering is to make the most appropriate design with a methodology independent of the size and reaction being carried out, and to design to maximise the conversion and selectivity of that reaction at the lowest possible cost.

GENERAL DESCRIPTION

The Computer Controlled Chemical Reactors Training System, "QRQC", has been designed by EDIBON for the study and comparison of different types of chemical reactors.

The minimum supply consists of two main elements: the Base Service Unit, "QRUBI", and at least one of the required elements described below.

The Base Service Unit, "QRUBI", provides the necessary elements for the operation of the different reactor modules. It performs the following functions:

- Reagent supply: consisting of two glass tanks, two dosing pumps and all the necessary connections.
- Temperature control: consisting of a thermostatic bath and an impulsion pump.
- Product collection system: allows the products obtained in the reactors to be quickly and easily conveyed to the base module and deposited in the corresponding tank.
- Reaction monitoring system: this consists of a conductivity cell and a conductivity meter installed on the front panel of the base module.

Required elements (at least one) (Not included):

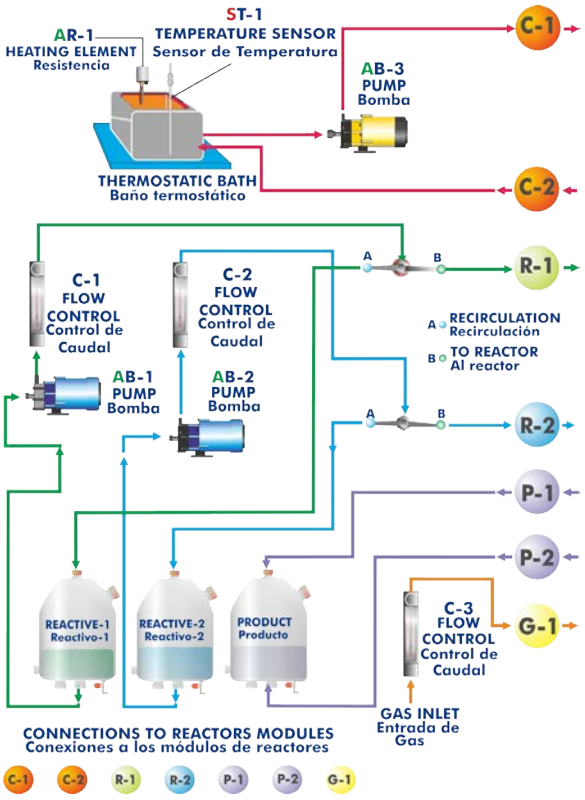
- QRIA. Isothermal Reactor with Stirrer.
- QRIA/D. Isothermal Reactor with Stirrer and Distillation.
- QRFT. Tubular Flow Reactor.
- QRSA. Reactors with Stirrer in Series.
- QRAD. Adiabatic and Isothermal Reactor.

10 actuators and 8 sensors controlled from any computer and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

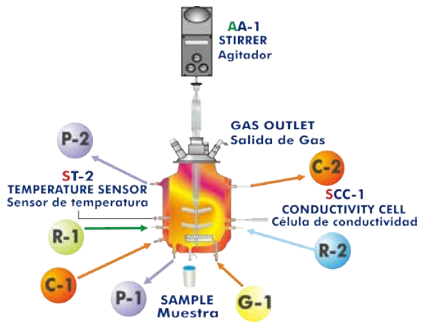
QRUBI

BASE SERVICE UNIT
Unidad Base y de Servicio



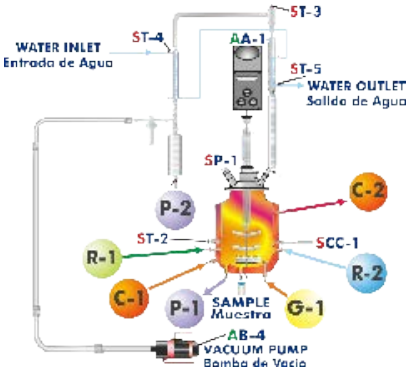
QRIA

ISOTHERMAL REACTOR WITH STIRRER
Reactor Isotermo con Agitador



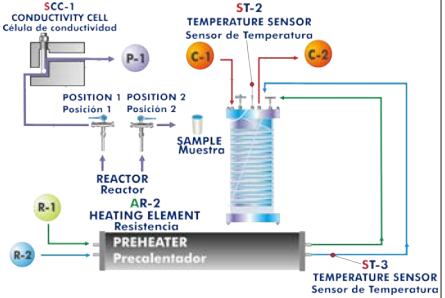
QRIA/D

ISOTHERMAL REACTOR WITH DISTILLATION
Reactor Isotermo con Destilación



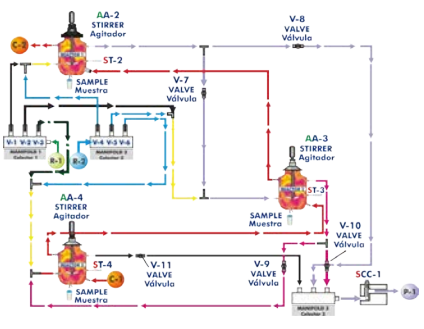
QRFT

TUBULAR FLOW REACTOR
Reactor de Flujo Tubular



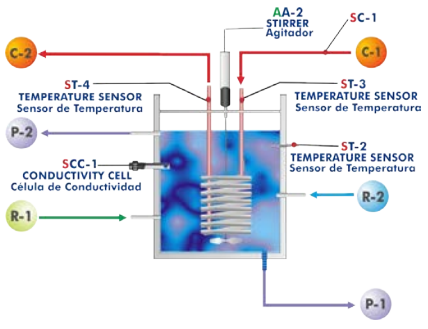
QRSA

REACTORS WITH STIRRER IN SERIES
Reactores con Agitador en Serie



QRAD

ADIABATIC AND ISOTHERMAL REACTOR
Reactor Adiabático e Isotermo



With this unit there are several options and possibilities:

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

Let us describe first the main items (1 to 5):

① QRUBI. Base Service Unit:

QRUBI

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.

This unit is common for the required elements (at least one) (Not included).

Installation and exchange system of the reactors quick and easy to handle.

It supplies all the services for the operation of each reactor.

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

The "QRUBI" unit mainly consists of:

Three tanks of 10 l made of Pyrex-glass: two of them for the reagents and the other one for the product.

Thermostatic bath of 6 l that regulates the temperature between (Tºroom + 5ºC) and 70ºC. It includes a computer controlled heating element, power: 600 W. PID control of the temperature.

Three computer controlled pumps:

Pump to impel the water from the thermostatic bath to the reactor, power: 0.37 kW, max. flow: 80 l/min – 12.8 m.w.c.

Two dosing pumps, max. flow: 7 l/h.

Temperature sensor type "J" to measure the water temperature of the thermostatic bath in a continuous way.

Conductivity cell and a conductivity meter to measure the product conductivity during the reaction, range: 30 μS/cm – 20 mS/cm. Working temperature: 0 – 100 ºC. The software includes a temperature compensation to remove the temperature effect of the conductivity measurement.

Three flow meters to measure the gas and reagents flow:

Flow meter to measure the CO_2 flow, range: 0 – 1440 Nl/h, max. pressure: 0.5 kg/cm^2.

Flow meter to measure the sodium acetate flow, range: 0.54 – 5.4 l/h.

Flow meter to measure the ethyl acetate flow, range: 0.7 – 7 l/h.

Two three-way valves to divert the reagents between the reactor and the reactive tank (bypass).

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.

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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.

Required elements (at least one) (Not included):

- QRIA. Isothermal Reactor with Stirrer.
- QRIA/D. Isothermal Reactor with Stirrer and Distillation.
- QRFT. Tubular Flow Reactor.
- QRSA. Reactors with Stirrer in Series.
- QRAD. Adiabatic and Isothermal Reactor.

② QRQC/CIB. Control Interface Box:

This control interface is common for the required elements (at least one) (Not included).

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.

QRQC/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:

Common for the required elements (at least one) (Not included).

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 Cables and Accessories, for normal operation.

⑤ Manuals:

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

Required elements (at least one) (Not included):

QRIA. Isothermal Reactor with Stirrer

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

Cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 2 l, diameter: 100 mm. It includes:

- Cover with a gas outlet and a connection for the stirrer.
- Water inlet and water outlet for the water jacket, forming a close circuit with the Base Service Unit, "QRUBI". This allows to keep the temperature inside of the reactor.
- Two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
- Two outlets for the products, which are stored in the product tank of the Base Service Unit, "QRUBI".
- Gas inlet and gas diffuser plate at the bottom of the reactor.
- Connection at the bottom of the reactor for the sample collection.
- Connection for the conductivity cell of the Base Service Unit, "QRUBI", and connection for a temperature sensor.

Temperature sensor type "J" to measure the temperature inside of the reactor.

Stirrer, computer controlled, power: 50 W, max. speed: 2000 rpm.

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

QRIA

(+) **QRIA/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).

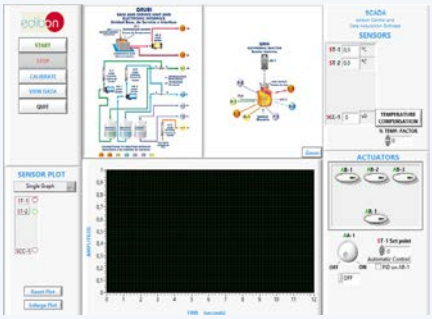
Calibration system for the sensors involved in the process.

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.



Required elements (at least one) (Not included):

QRIA/D. Isothermal Reactor with Stirrer and Distillation

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

Cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 2 l, diameter: 100 mm. It includes:

- Cover with a gas outlet and a connection for the stirrer.
- Water inlet and water outlet for the jacket, forming a close circuit with the Base Service Unit, "QRUBI". This allows to keep the temperature inside of the reactor.
- Two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
- Two outlets for the products, which are stored in the product tank of the Base Service Unit, "QRUBI".
- Gas inlet and gas diffuser plate at the bottom of the reactor.
- Connection at the bottom of the reactor for the sample collection.
- Connection for the conductivity cell of the Base Service Unit, "QRUBI", and connection for a temperature sensor.

Distillation system. It includes:

- Distillation column, length: 300 mm, diameter: 30 mm.
- Balls condenser, length: 300 mm.
- Coil condenser, length: 250 mm.
- Vacuum trap, length: 125 mm, diameter: 24 mm.
- Graduated funnel, volume: 500 ml.
- Computer controlled vacuum pump to decrease the mixture boiling temperature.

Four temperature sensors type "J":

- Sensor to measure the temperature inside of the reactor.
- Two sensors to measure the water temperature in the distillation system.
- Sensor to measure the condensed product temperature of the distillation system.

Pressure sensor to measure the pressure inside of the reactor, range: 0 – 0.34 bar.

Stirrer, computer controlled, power: 50 W, max. speed: 2000 rpm.

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

QRIA/D

(+) **QRIA/D/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.

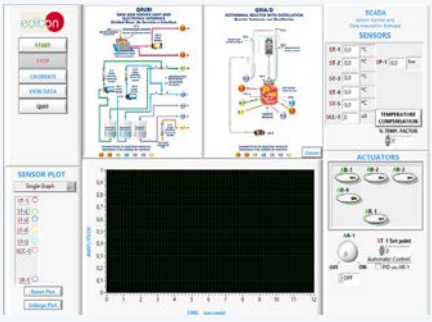
PID menu and set point selection required in the whole work range.

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.

Required elements (at least one) (Not included):

QRFT. Tubular Flow Reactor

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

Reactor with inner coil made of Teflon of 6 mm of inner diameter. Reactor coil length: 14.5 m. It includes:

- Water inlet and water outlet for the jacket, forming a close circuit with the Base Service Unit, "QRUBI". This allows to keep the temperature inside of the reactor.
- Three-way valve to divert the product between the sample collection and its analysis with the conductivity cell of the Base Service Unit, "QRUBI".
- Outlet for the products, situated at the outlet of the conductivity cell, which are stored in the product tank of the Base Service Unit, "QRUBI".

Electrical preheater for the reactives. It includes a computer controlled heating element and a thermostat (70 °C):

- Heating element power: 265 W.
- PID control of the reagents temperature.
- It includes two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".

Two temperature sensors type "J":

- Sensor to measure the jacket water temperature inside of the reactor.
- Sensor to control the reagents temperature at the electrical preheater outlet.

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

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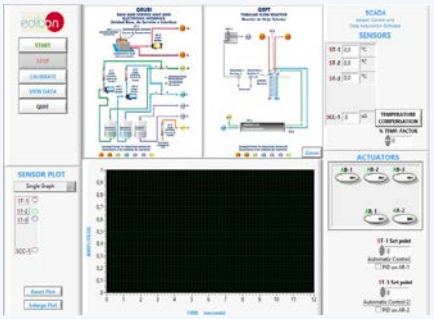
QRFT



Required elements (at least one) (Not included):

QRSA. Reactors with Stirrer in Series

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

Three cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 1 l each one, diameter: 100 mm. Each one of the reactors includes:

- Cover with a connection for the stirrer.
- Water inlet and water outlet for the jacket, forming a close circuit the three reactors with the Base Service Unit, "QRUBI". This allows to keep the temperature inside of the reactors.
- Inlets for the reagents.
- Outlet for the products. They can circulate through one, two or three reactors before being stored in the product tank of the Base Service Unit, "QRUBI".
- Connection at the bottom of the reactor for the sample collection.
- Connection for a temperature sensor.

Two collectors made of Teflon to divert the reagents between one, two and three reactors. They include one inlet (each one) for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".

Collector made of Teflon to collect the reactors products. It includes a connection for the conductivity cell of the Base Service Unit, "QRUBI" and an outlet for the products obtained in the reactors, which are stored in the product tank of the Base Service Unit, "QRUBI".

Computer controlled stirrer, max. speed: 330 rpm. (for each reactor).

Three temperature sensors type "J" to measure the temperature inside of each reactor.

Valves to circulate the reagents and products between the reactors and the outlet.

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

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Analog and digital PID control.

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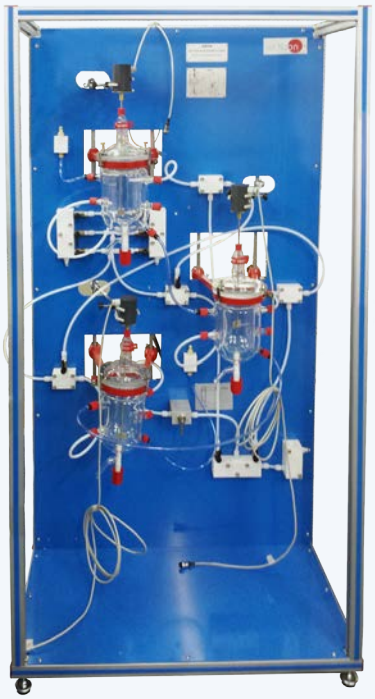
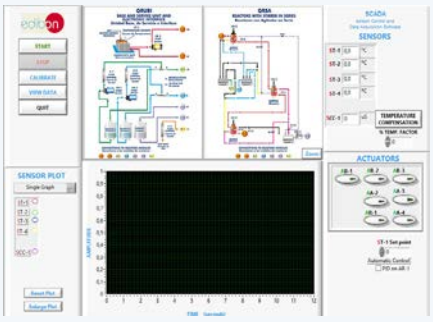


QRSA



Required elements (at least one) (Not included):

QRAD. Adiabatic and Isothermal Reactor

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Safety, easy and quick connections.

All elements of this unit are chemically resistant.

Cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 2 l , diameter: 100 mm. It includes:

- Cover with two connections for the coil and a connection for the stirrer.
- Two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
- Two outlets for the products, which are stored in the product tank of the Base Service Unit, "QRUBI".
- Connection for the conductivity cell of the Base Service Unit, "QRUBI" and connection for a temperature sensor.
- Outer jacket made of anodized aluminum. The space between the jacket and the reactor is filled with expanded polyurethane foam.
- Nickel plated copper coil, length: 2500 mm, outer diameter: 6.7 mm, inner diameter: 4.1 mm. It includes a water inlet and one water outlet, forming a close circuit with the Base Service Unit, "QRUBI". This allows to keep the temperature inside of the reactor.

Three temperature sensors type "J":

- Sensor to measure the temperature inside of the reactor.
- Sensor to measure the water temperature at the coil inlet.
- Sensor to measure the water temperature at the coil outlet.

Flow sensor to measure the water flow in the coil, range: 0.25 – 6.5 l/min.

Computer controlled stirrer, max. speed: 330 rpm.

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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.

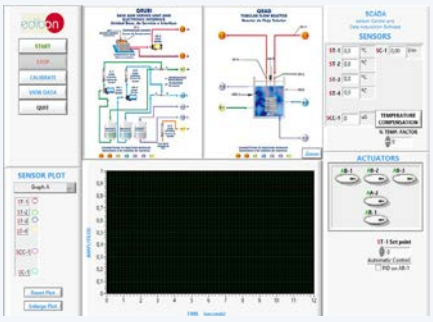
It allows the registration of the alarms state and the graphic representation in real time.

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.

QRAD



Practices to be done with the Isothermal Reactor with Stirrer (QRIA):

1.- Determining the ionic conductivities.

2.- Batch operation. Obtaining the reaction order with respect to the ethyl acetate. Method of initial rates.

3.- Batch operation. Obtaining the reaction order with respect to the sodium hydroxide. Method of initial rates.

4.- Batch operation. Calculation of the rate constant. Constant sodium hydroxide initial concentration.

5.- Batch operation. Calculation of the rate constant. Constant ethyl acetate initial concentration.

6.- Rate equation formulation.

7.- Batch operation. Variation of the kinetic constant with temperature. Arrhenius equation.

8.- Batch operation. Theoretical and experimental conversion comparison. Deviation from ideality.

9.- Batch operation. Mixture effects.

10.-Continuous operation.

11.-Continuous operation. Mixture effects.

Additional practical possibilities:

12.-Sensors calibration.

Practices to be done with Isothermal Reactor with Distillation (QRIA/D):

13.-Determination of the ionic conductivities.

14.-Batch operation. Obtaining the reaction order with respect to the ethyl acetate. Method of initial rates .

15.-Batch operation. Obtaining the reaction order with respect to the sodium hydroxide. Method of initial rates.

16.-Batch operation. Calculation of the rate constant. Constant sodium hydroxide initial concentration.

17.-Batch operation. Calculation of the rate constant. Constant ethyl acetate initial concentration.

18.-Rate equation formulation.

19.-Batch operation. Variation of the kinetic constant with temperature. Arrhenius equation.

20.-Batch operation. Theoretical and experimental conversion comparison. Deviation from ideality.

21.-Batch operation. Mixture effects.

22.-Continuous operation.

23.-Continuous operation. Mixture effects.

Additional practical possibilities:

24.-Sensors calibration.

Practices to be done with the Tubular Flow Reactor (QRFT):

25.-Determination of the ionic conductivities.

26.-Theoretical conversion of the tubular reactor.

27.-Experimental determination of the tubular reactor conversion.

28.-Dependence on the residence time.

29.-Determination of the reaction order.

30.-Dependence of the rate constant and the conversion with the temperature.

Additional practical possibilities:

31.-Sensors calibration.

Practices to be done with the Adiabatic and Isothermal Reactor (QRAD):

32.-Determination of the ionic conductivities.

33.-Batch operation. Obtaining the reaction order with respect to the ethyl acetate. Method of initial rates.

34.-Bach operation. Obtaining the reaction order with respect to the sodium hydroxide. Method of initial rates.

35.-Batch operation. Calculation of the rate constant. Constant sodium hydroxide initial concentration.

36.-Batch operation. Calculation of the rate constant. Constant ethyl acetate initial concentration.

37.-Rate equation formulation.

38.-Batch operation. Variation of the kinetic constant with temperature. Arrhenius equation.

39.-Batch operation. Theoretical and experimental conversion comparison. Deviation from ideality.

40- Batch operation. Effect of concentration on conversion.

41.-Calculation of the heat transfer coefficient of the coil.

42.-Batch operation. Mixing effects.

43.-Continuous operation.

Additional practical possibilities:

44.-Sensors calibration.

Practices to be done with the Reactors with Stirrer in Series (QRSA):

45.-Determination of the ionic conductivities.

46.-Continuous operation with only one reactor. .

47.-Continuous operation with only one reactor with mixture effects.

48.-Continuous operation with the three reactors.

Additional practical possibilities:

49.-Sensors calibration.

Other possibilities to be done with this Unit:

50.-Many students view results simultaneously.

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

51.-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.

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

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

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

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

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

57.-Visualization of all the sensors values used in the 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.

REQUIRED ELEMENTS (Not included)

Required (at least one):

- QRIA. Isothermal Reactor with Stirrer.
- QRIA/D. Isothermal Reactor with Stirrer and Distillation.
- QRFT. Tubular Flow Reactor.
- QRSA. Reactors with Stirrer in Series.
- QRAD. Adiabatic and Isothermal Reactor.

DIMENSIONS AND WEIGHTS

QRQC:

QRUBI. Base Service Unit:

-Dimensions: 700 x 700 x 1100 mm approx.
(27.56 x 27.56 x 43.30 inches approx.)

-Weight: 100 kg approx.
(220 pounds approx.)

QRIA. Unit:

-Dimensions: 500 x 500 x 1300 mm approx.
(19.68 x 19.68 x 51.18 inches approx.)

-Weight: 50 kg approx.
(110 pounds approx.)

QRIA/D. Unit:

-Dimensions: 600 x 500 x 1500 mm approx.
(23.62 x 19.68 x 59.05 inches approx.)

-Weight: 70 kg approx.
(154 pounds approx.)

QRFT. Unit:

-Dimensions: 700 x 500 x 700 mm approx.
(27.56 x 19.68 x 27.56 inches approx.)

-Weight: 20 kg approx.
(44.09 pounds approx.)

QRSA. Unit:

-Dimensions: 900 x 500 x 1800 mm approx.
(35.43 x 19.68 x 70.86 inches approx.)

-Weight: 100 kg approx.
(220 pounds approx.)

QRAD. Unit:

-Dimensions: 700 x 400 x 720 mm approx.
(27.56 x 15.74 x 28.34 inches approx.)

-Weight: 70 kg approx.
(154 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)

-Laboratory materials as: burettes, test tubes, glasses and a 1 l glass flask.

RECOMMENDED CONSUMABLES (Not included)

-Chemical reagents: ethyl acetate, sodium acetate and sodium hydroxide.

-Cylinder of carbon dioxide.

SIMILAR UNITS AVAILABLE

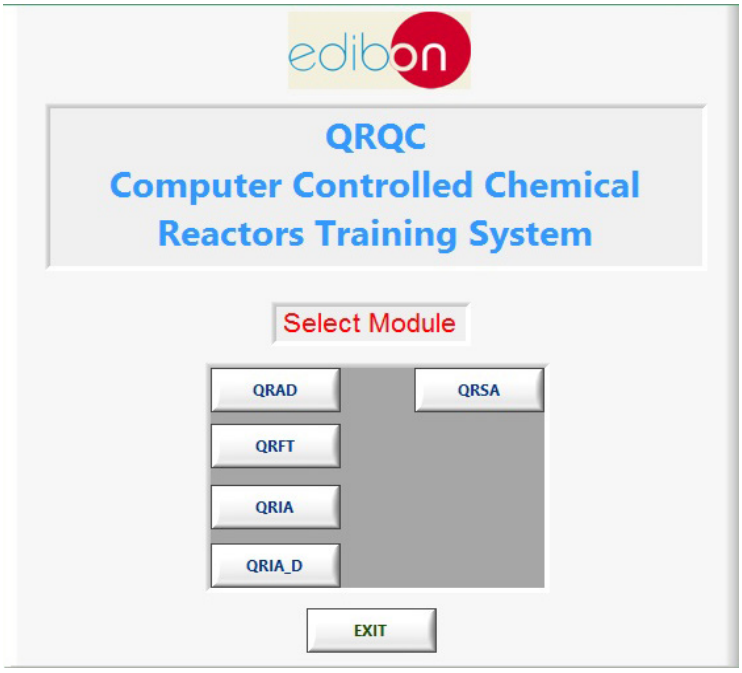
Offered in this catalog:

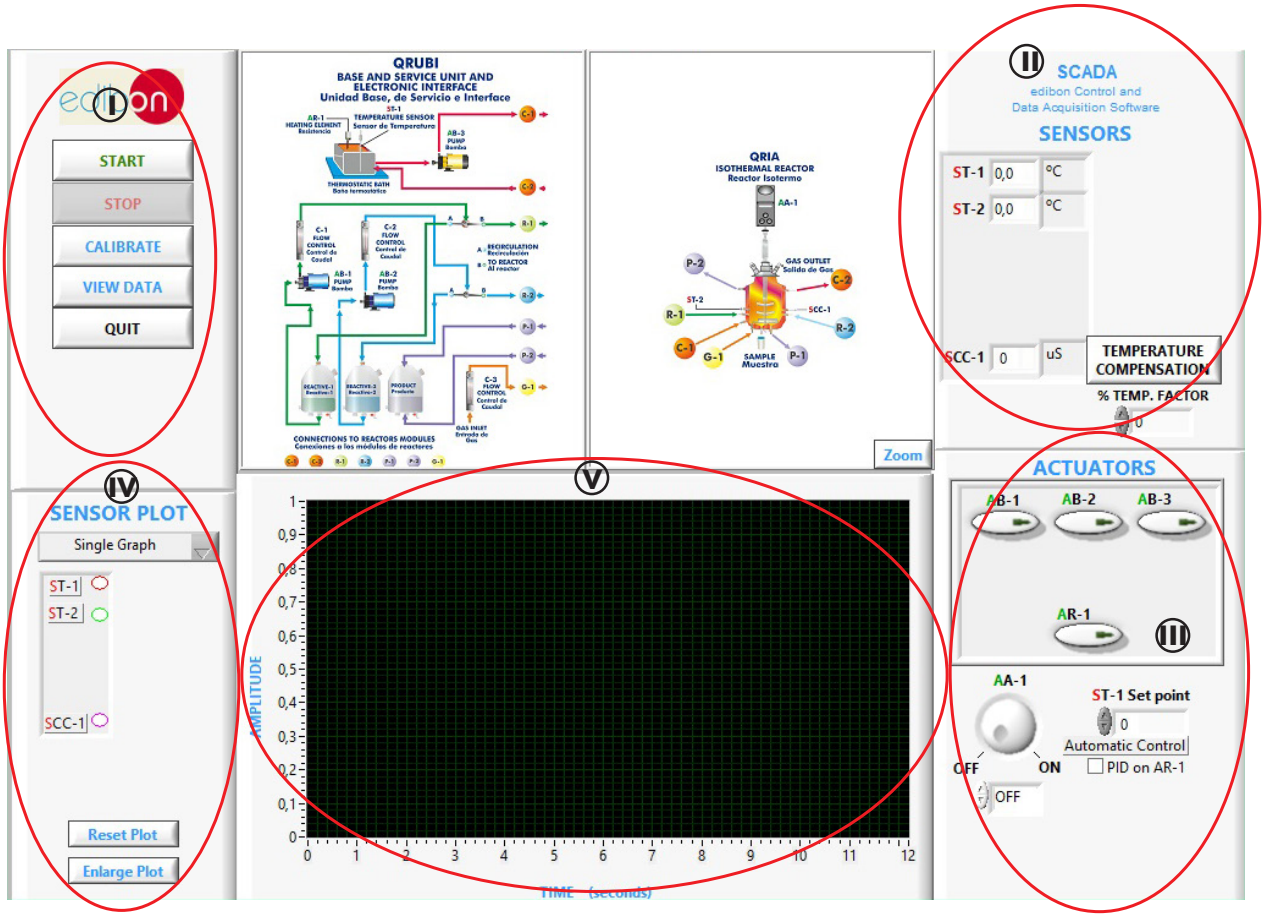
- QRQC. Computer Controlled Chemical Reactors Training System.

Offered in other catalogs:

- QR. Chemical Reactors.
- QRC. Computer Controlled Chemical Reactors.

SCADA and PID Control
Main screens





Ⅰ **Main software operation possibilities.**

Ⅱ **Sensors displays, real time values, and extra output parameters. Sensors:** ST=Temperature sensor. SCC=Conductivity cell.

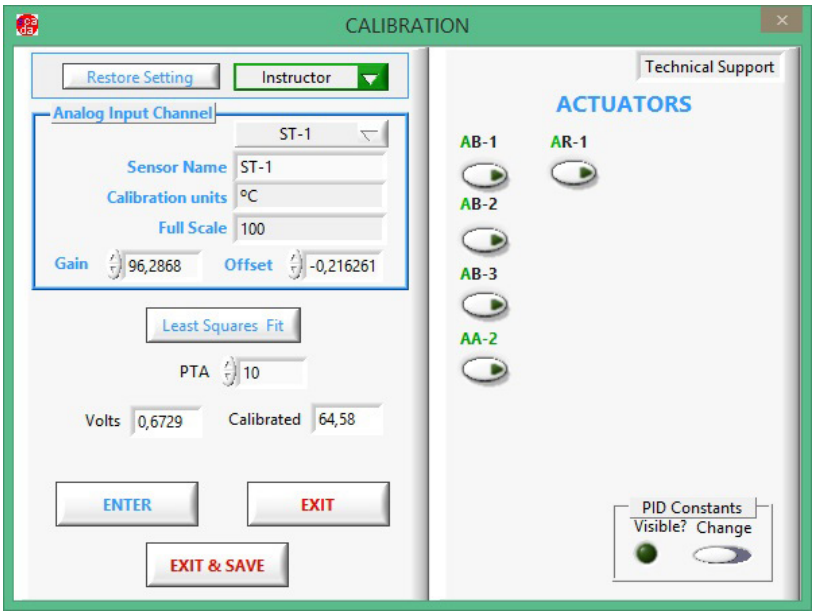
Ⅲ **Actuators controls. Actuators:** AA=Stirrer. AR=Heating element. AB=Pump.

Ⅳ Channel selection and other plot parameters.

Ⅴ Real time graphics displays.

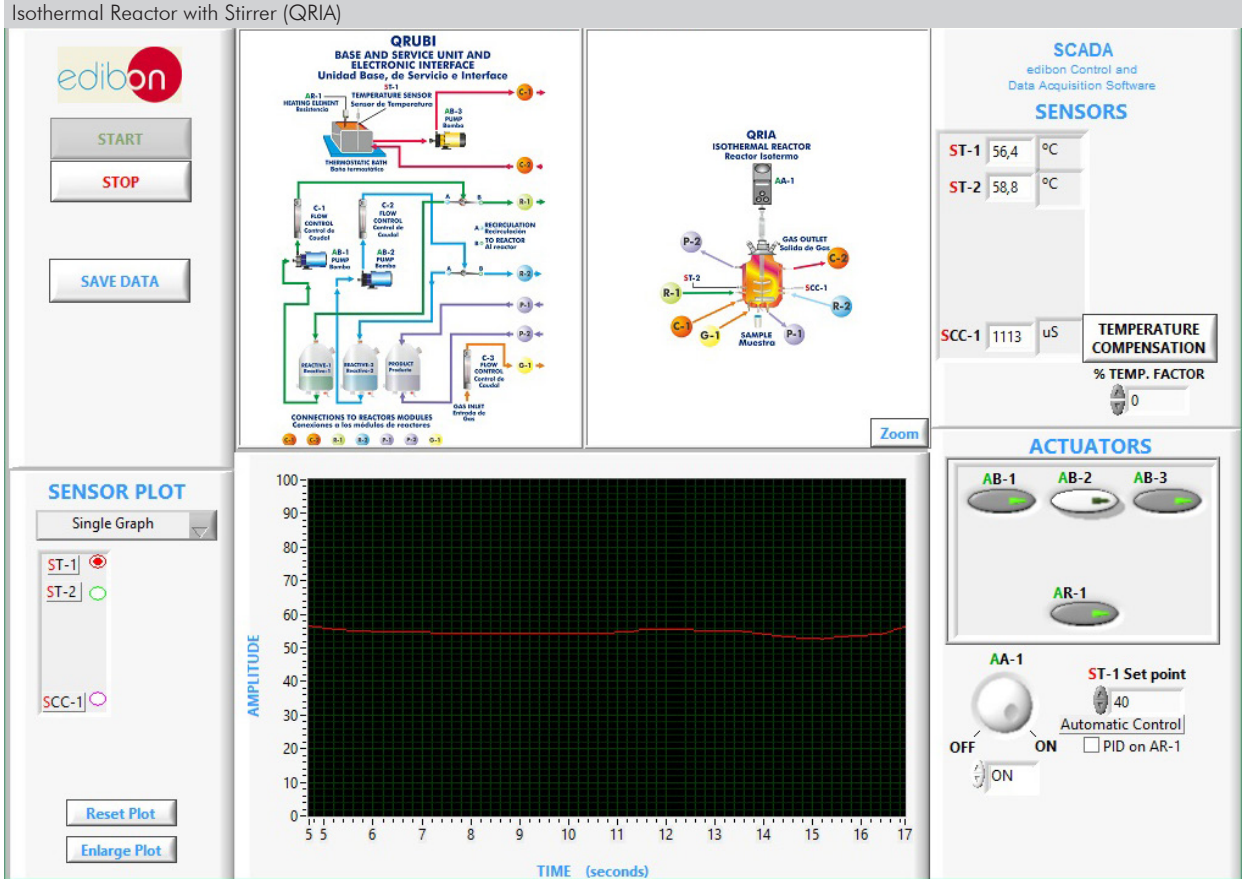
Software for Sensors Calibration

Example of screen

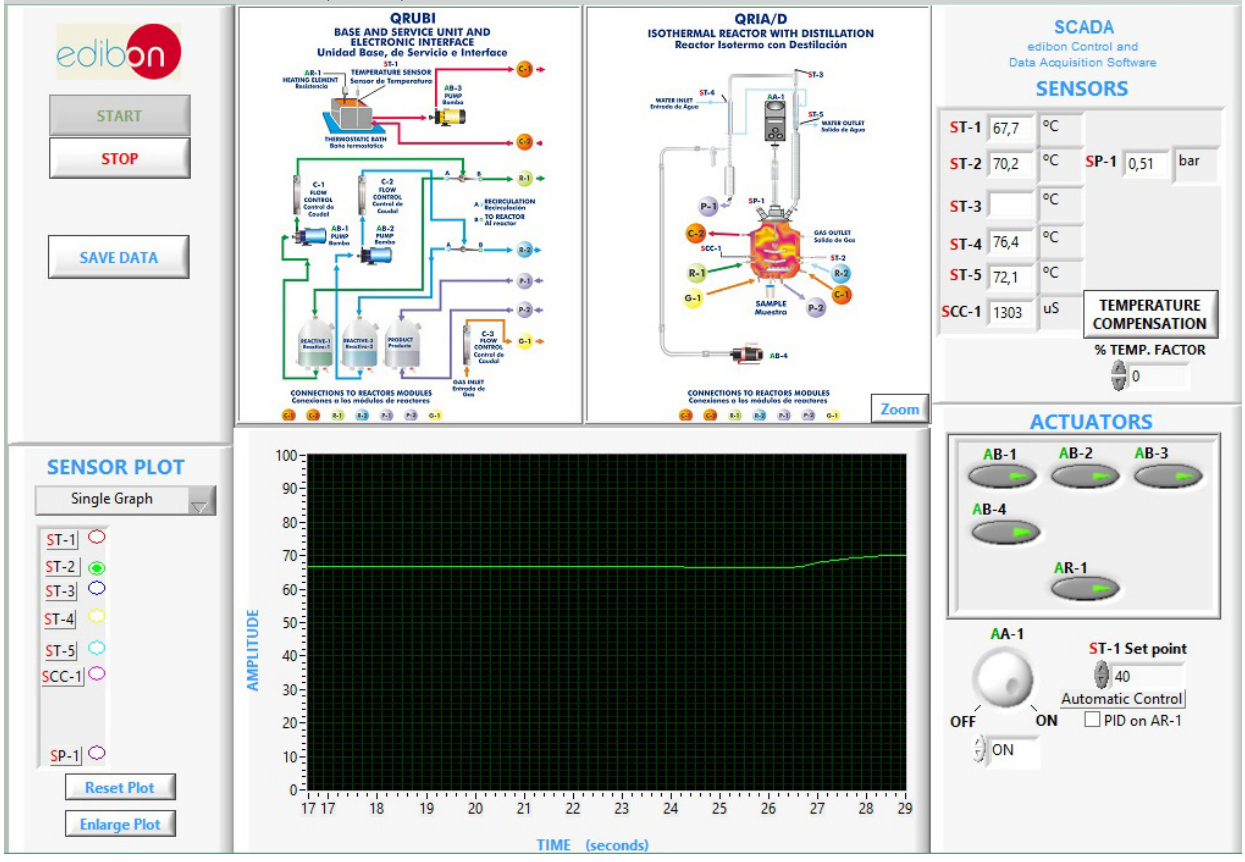


The teacher and the students can calibrate the unit with a password provided by EDIBON.
The teacher can restore the factory calibration any time.

Isothermal Reactor with Stirrer (QRIA)

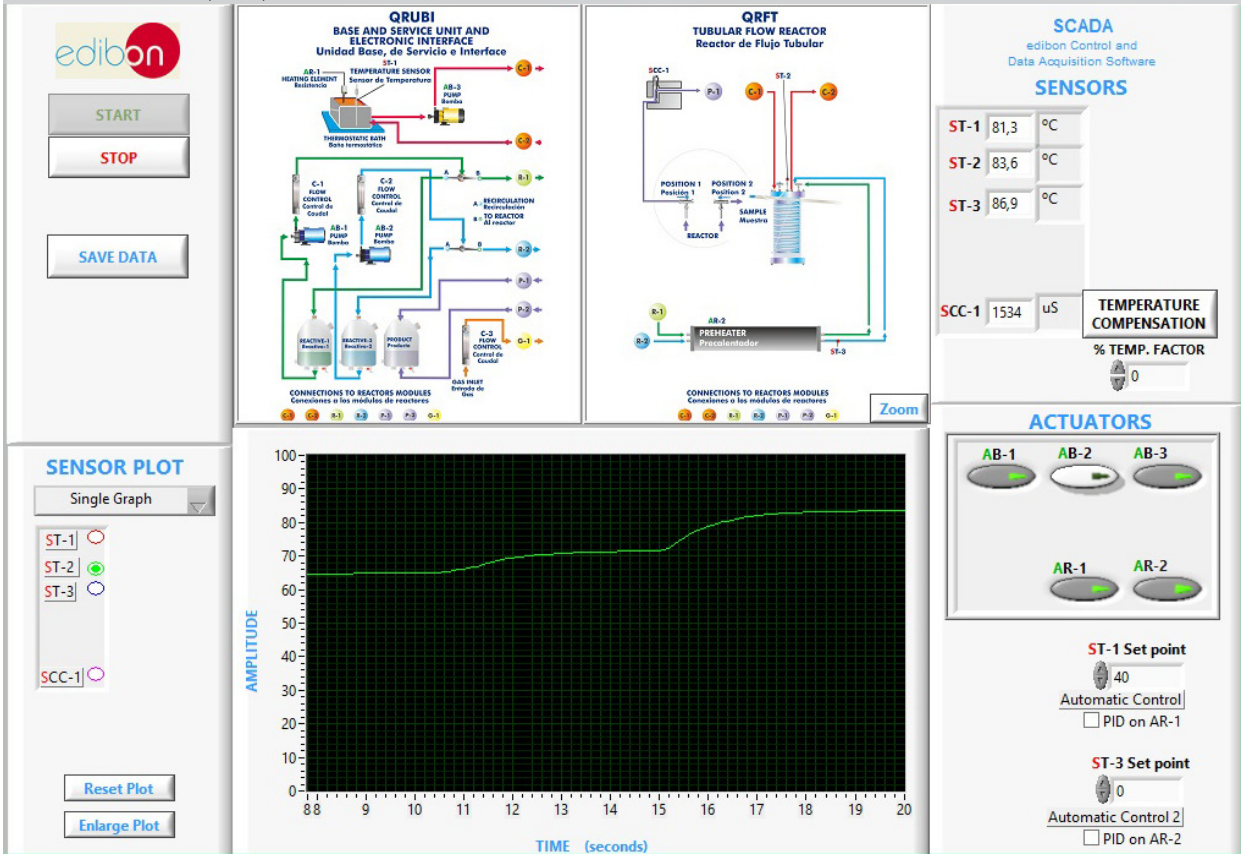


Isothermal Reactor with Distillation (QRIA/D)

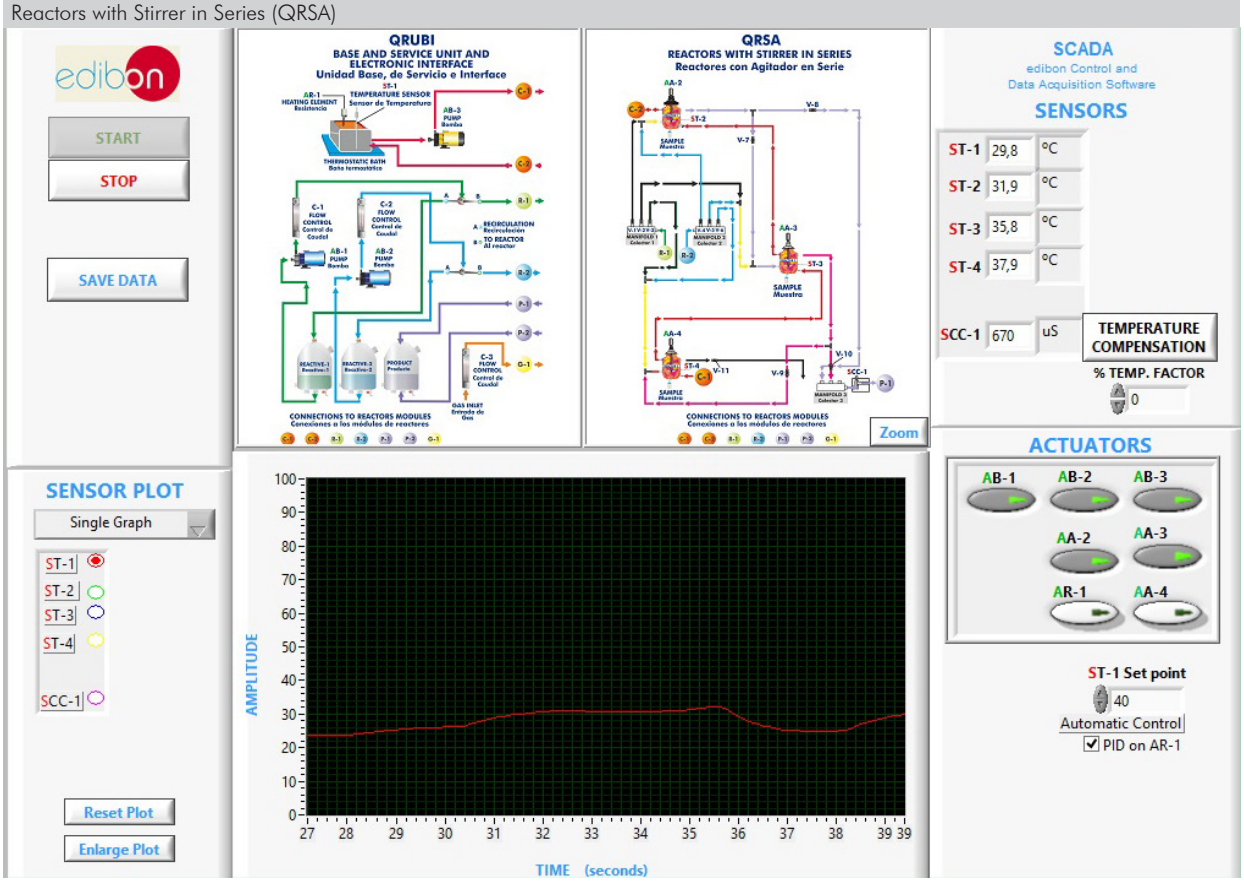


Some **real** results obtained from this Unit

Tubular Flow Reactor (QRFT)

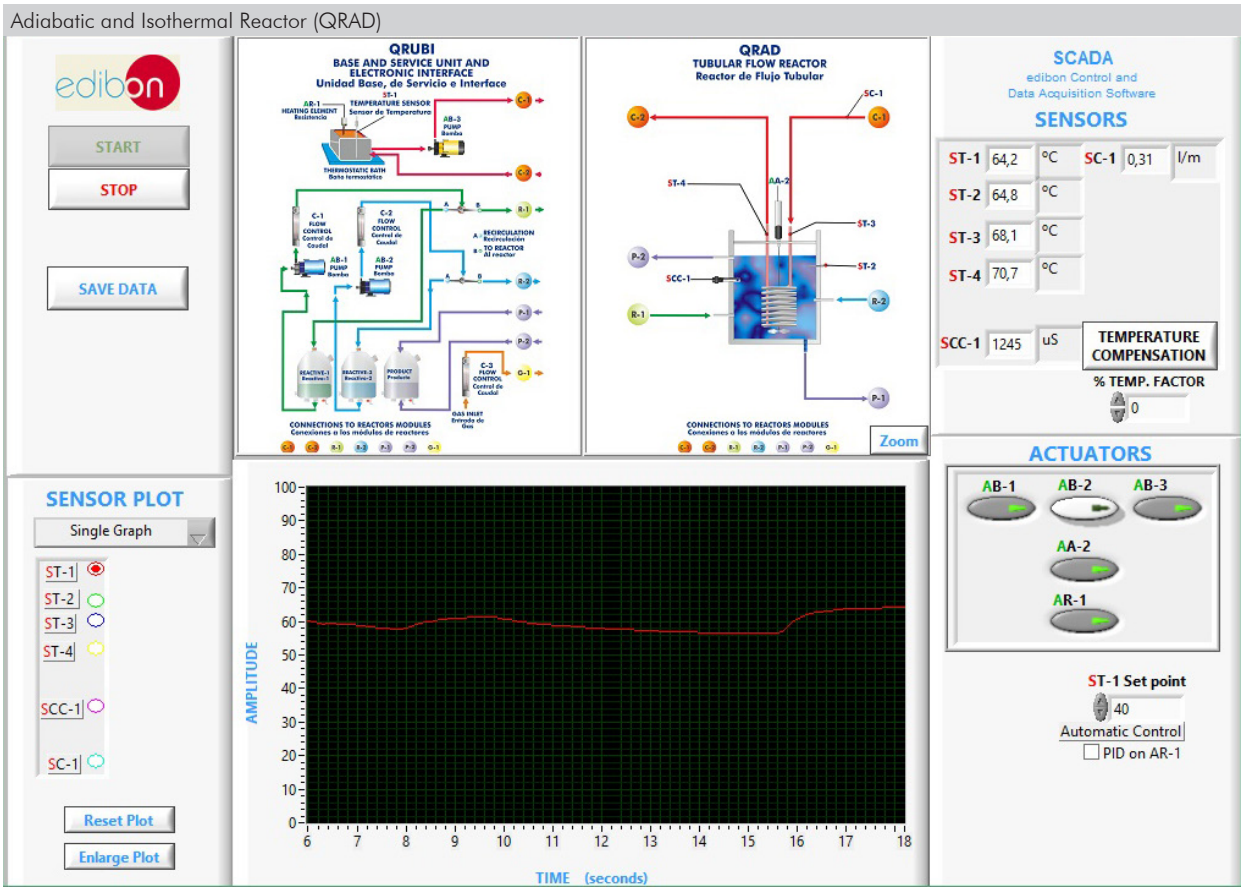


Reactors with Stirrer in Series (QRSA)



Some **real** results obtained from this Unit

Adiabatic and Isothermal Reactor (QRAD)



Additionally to the main items (1 to 5) described, we can offer, as optional, other items from 6 to 10.
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

⑥ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

This unit is common for the modules type "TI" and can work with one or several modules.

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.

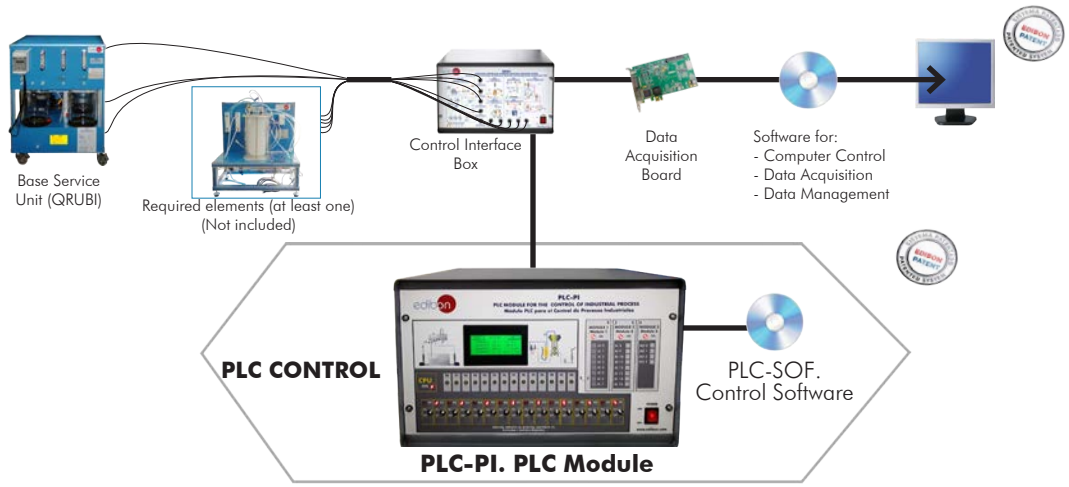
Communication RS232 wire to computer (PC).

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.).

-QRQC/PLC-SOF. PLC Control Software:

Always included with PLC supply.

Each chemical reactor has its own Software.



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

⑦ QRQC/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:

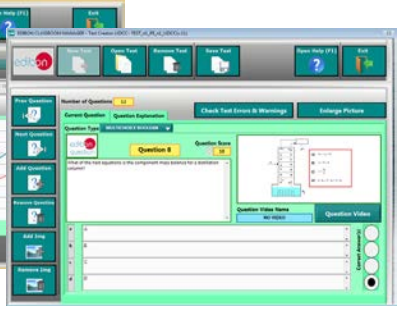
- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge 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

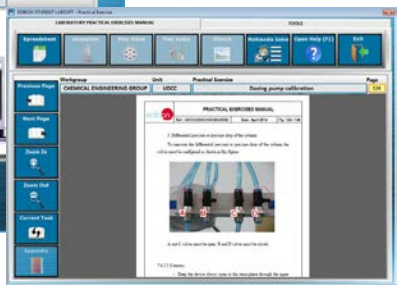
ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram



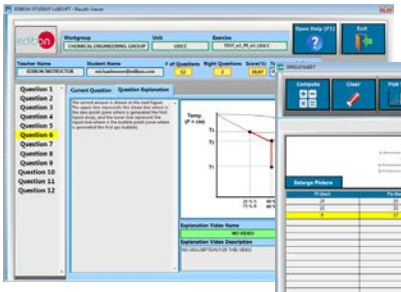
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software

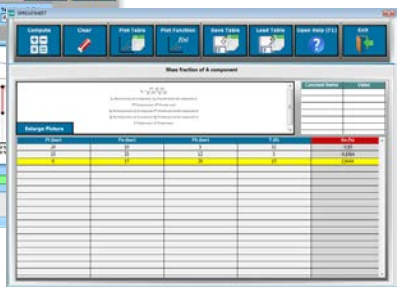
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



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:

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

⑧ QRQC/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.

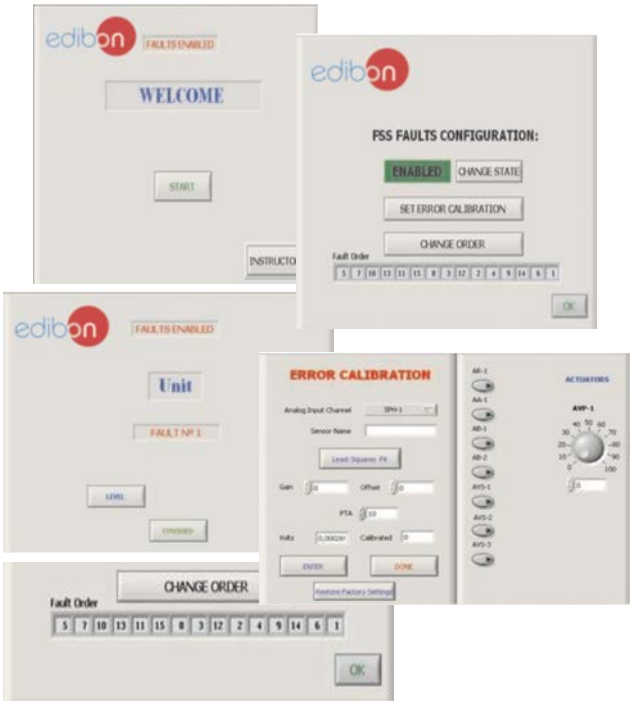
- Reduction or increase of the calculated total response.

- 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:

https://www.edibon.com/en/fault-simulation-system/catalog

c) Multipost Expansions options

⑨ 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.

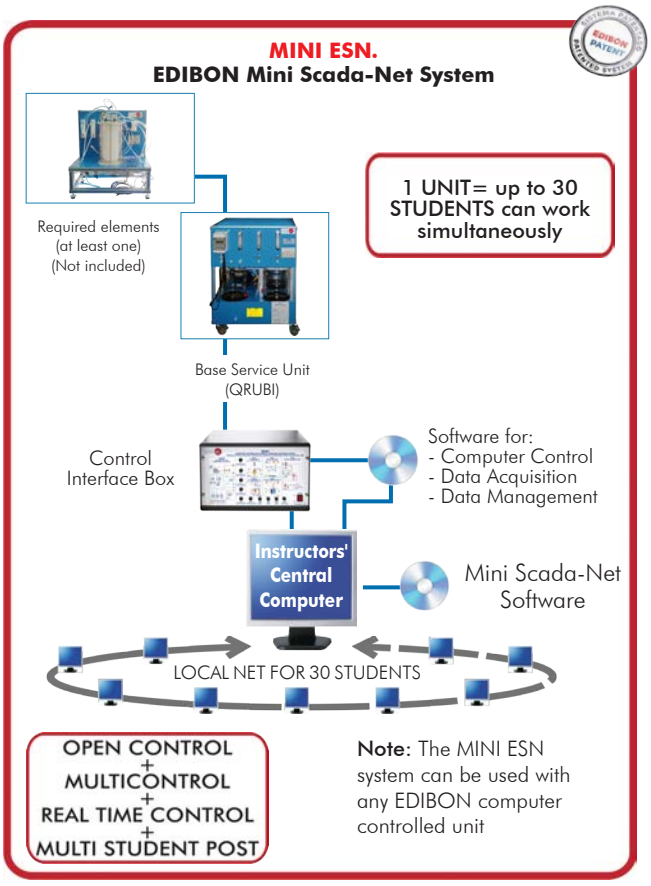
- Continuous communication between the instructor and all the users/students connected.

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:

https://www.edibon.com/en/edibon-scada-net/catalog

⑩ 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:

https://www.edibon.com/en/edibon-scada-net/catalog

Main items (always included in the supply)

Minimum supply always includes:

① **QRUBI. Base Service Unit** (Can work with the required elements (at least one) (Not included)).

② **QRQC/CIB. Control Interface Box.** (Can work with the required elements (at least one) (Not included)).

③ **DAB. Data Acquisition Board.** (Common for Required elements (at least one) (Not included)).

④ **Cables and Accessories**, for normal operation.

⑤ **Manuals.**

Required elements (at least one) to be used with the Base Service Unit "QRUBI":

QRIA. Isothermal Reactor with Stirrer. (+)

QRIA/D. Isothermal Reactor with Stirrer and Distillation. (+)

QRFT. Tubular Flow Reactor. (+)

QRSA. Reactors with Stirrer in Series. (+)

QRAD. Adiabatic and Isothermal Reactor. (+)

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

Optional items (supplied under specific order)

a) Industrial configuration

⑥ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

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

b) Technical and Vocational Education configuration

⑦ QRQC/ICAI. Interactive Computer Aided Instruction Software.

⑧ QRQC/FSS. Faults Simulation System.

c) Multipost Expansions options

⑨ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑩ ESN. EDIBON Scada-Net Systems.

① QRUBI. Base Service 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.
This unit is common for the required elements (at least one) (Not included).
Installation and exchange system of the reactors quick and easy to handle.
It supplies all the services for the operation of each reactor.
Safety, easy and quick connections.
All elements of this unit are chemically resistant.
The "QRUBI" unit mainly consists of:
- Three tanks of 10 l made of Pyrex-glass: two of them for the reagents and the other one for the product.
- Thermostatic bath of 6 l that regulates the temperature between (Tºroom + 5ºC) and 70ºC. It includes a computer controlled heating element, power: 600 W. PID control of the temperature.
- Three computer controlled pumps:
  - Pump to impel the water from the thermostatic bath to the reactor, power: 0.37 kW, max. flow: 80 l/min – 12.8 m.w.c.
  - Two dosing pumps, max. flow: 7 l/h.
- Temperature sensor type "J" to measure the water temperature of the thermostatic bath in a continuous way.
- Conductivity cell and a conductivity meter to measure the product conductivity during the reaction, range: 30 μS/cm – 20 mS/cm. Working temperature: 0 – 100 ºC. The software includes a temperature compensation to remove the temperature effect of the conductivity measurement.
- Three flow meters to measure the gas and reagents flow:
  - Flow meter to measure the CO_2 flow, range: 0 – 1440 Nl/h, max. pressure: 0.5 kg/cm^2.
  - Flow meter to measure the sodium acetate flow, range: 0.54 – 5.4 l/h.
  - Flow meter to measure the ethyl acetate flow, range: 0.7 – 7 l/h.
- Two 3-way valves to divert the reagents between the reactor and the reactive tank (bypass).

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.

Required elements (at least one) (Not included):

QRIA. Isothermal Reactor with Stirrer:

Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
Safety, easy and quick connections.
All elements of this unit are chemically resistant.
Cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 2 l, diameter: 100 mm. It includes:
- Cover with a gas outlet and a connection for the stirrer.
- Water inlet and water outlet for the water jacket, forming a close circuit with the QRUBI Base Service Unit. This allows to keep the temperature inside of the reactor.
- Two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
- Two outlets for the products, which are stored in the product tank of the Base Service Unit, "QRUBI".
- Gas inlet and gas diffuser plate at the bottom of the reactor.
- Connection at the bottom of the reactor for the sample collection.
- Connection for the conductivity cell of the Base Service Unit, "QRUBI", and connection for a temperature sensor.

Temperature sensor type "J" to measure the temperature inside of the reactor.
Stirrer, computer controlled, power: 50 W, max. speed: 2000 rpm.
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) QRIA/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.

QRIA/D. Isothermal Reactor with Stirrer and Distillation.

Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
Safety, easy and quick connections.
All elements of this unit are chemically resistant.
Cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 2 l, diameter: 100 mm. It includes:

Cover with a gas outlet and a connection for the stirrer.
Water inlet and water outlet for the jacket, forming a close circuit with the QRUBI Base Service Unit. This allows to keep the temperature inside of the reactor.
Two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
Two outlets for the products, which are stored in the product tank of the Base Service Unit, "QRUBI".
Gas inlet and gas diffuser plate at the bottom of the reactor.
Connection at the bottom of the reactor for the sample collection.
Connection for the conductivity cell of the Base Service Unit, "QRUBI", and connection for a temperature sensor.
Distillation system. It includes:
Distillation column, length: 300 mm, diameter: 30 mm.
Balls condenser, length: 300 mm.
Coil condenser, length: 250 mm.
Vacuum trap, length: 125 mm, diameter: 24 mm.
Graduated funnel, volume: 500 ml.
Computer controlled vacuum pump to decrease the mixture boiling temperature.
Four temperature sensors type "J":
Sensor to measure the temperature inside of the reactor.
Two sensors to measure the water temperature in the distillation system.
Sensor to measure the condensed product temperature of the distillation system.
Pressure sensor to measure the pressure inside of the reactor, range: 0 – 0.34 bar.
Stirrer, computer controlled, power: 50 W, max. speed: 2000 rpm.
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) QRIA/D/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.

QRFT. Tubular Flow Reactor.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
Safety, easy and quick connections.
All elements of this unit are chemically resistant.
Reactor with inner coil made of Teflon of 6 mm of inner diameter. Reactor coil length: 14.5 m. It includes:
Water inlet and water outlet for the jacket, forming a close circuit with the QRUBI Base Service Unit. This allows to keep the temperature inside of the reactor.
Three-way valve to divert the product between the sample collection and its analysis with the conductivity cell of the Base Service Unit, "QRUBI".
Outlet for the products, situated at the outlet of the conductivity cell, which are stored in the product tank of the Base Service Unit, "QRUBI".
Electrical preheater for the reactives. It includes a computer controlled heating element and a thermostat (70 °C):
Heating element power: 265 W.
PID control of the reagents temperature.
It includes two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
Two temperature sensors type "J":
Sensor to measure the jacket water temperature inside of the reactor.
Sensor to control the reagents temperature at the electrical preheater outlet.
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) QRFT/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.

QRSA. Reactors with Stirrer in Series.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
Safety, easy and quick connections.
All elements of this unit are chemically resistant.
Three cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 1 l each one, diameter: 100 mm. Each one of the reactors includes:
Cover with a connection for the stirrer.
Water inlet and water outlet for the jacket, forming a close circuit the three reactors with the QRUBI Base Service Unit. This allows to keep the temperature inside of the reactors.
Inlets for the reagents.
Outlet for the products. They can circulate through one, two or three reactors before being stored in the product tank of the QRUBI Base Service Unit.
Connection at the bottom of the reactor for the sample collection.

Connection for a temperature sensor.
Two collectors made of Teflon to divert the reagents between one, two and three reactors. They include one inlet (each one) for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
Collector made of Teflon to collect the reactors products. It includes a connection for the conductivity cell of the Base Service Unit, "QRUBI" and an outlet for the products obtained in the reactors, which are stored in the product tank of the Base Service Unit, "QRUBI".
Computer controlled stirrer, max. speed: 330 rpm. (for each reactor).
Three temperature sensors type "J" to measure the temperature inside of each reactor.
Valves to circulate the reagents and products between the reactors and the outlet.
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) QRSA/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.

QRAD. Adiabatic and Isothermal Reactor.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
Safety, easy and quick connections.
All elements of this unit are chemically resistant.
Cylindrical reactor made of Pyrex-glass with water jacket, max. capacity: 2 l , diameter: 100 mm. It includes:
Cover with two connections for the coil and a connection for the stirrer.
Two inlets for the reagents of the reactive tanks of the Base Service Unit, "QRUBI".
Two outlets for the products, which are stored in the product tank of the Base Service Unit, "QRUBI".
Connection for the conductivity cell of the Base Service Unit, "QRUBI" and connection for a temperature sensor.
Outer jacket made of anodized aluminum. The space between the jacket and the reactor is filled with expanded polyurethane foam.
Nickel plated copper coil, length: 2500 mm, outer diameter: 6.7 mm, inner diameter: 4.1 mm. It includes a water inlet and one water outlet, forming a close circuit with the Base Service Unit, "QRUBI". This allows to keep the temperature inside of the reactor.
Three temperature sensors type "J":
Sensor to measure the temperature inside of the reactor.
Sensor to measure the water temperature at the coil inlet.
Sensor to measure the water temperature at the coil outlet.
Flow sensor to measure the water flow in the coil, range: 0.25 – 6.5 l/min.
Computer controlled stirrer, max. speed: 330 rpm.
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) QRAD/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.

② **QRQC/CIB. Control Interface Box:**
This control interface is common for the required elements (at least one) (Not included).
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:**
Common for the required elements (at least one) (Not included).
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 **Cables and Accessories**, for normal operation.

⑤ **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

Practices to be done with the Isothermal Reactor with Stirrer (QRIA):
1.- Determining the ionic conductivities.
2.- Batch operation. Obtaining the reaction order with respect to the ethyl acetate. Method of initial rates.
3.- Batch operation. Obtaining the reaction order with respect to the sodium hydroxide. Method of initial rates.
4.- Batch operation. Calculation of the rate constant. Constant sodium hydroxide initial concentration.
5.- Batch operation. Calculation of the rate constant. Constant ethyl acetate initial concentration.
6.- Rate equation formulation.
7.- Batch operation. Variation of the kinetic constant with temperature. Arrhenius equation.
8.- Batch operation. Theoretical and experimental conversion comparison. Deviation from ideality.
9.- Batch operation. Mixture effects.
10.-Continuous operation.
11.-Continuous operation. Mixture effects.
Additional practical possibilities:
12.-Sensors calibration.

Practices to be done with Isothermal Reactor with Distillation (QRIA/D):
13.-Determination of the ionic conductivities.
14.-Batch operation. Obtaining the reaction order with respect to the ethyl acetate. Method of initial rates .
15.-Batch operation. Obtaining the reaction order with respect to the sodium hydroxide. Method of initial rates.
16.-Batch operation. Calculation of the rate constant. Constant sodium hydroxide initial concentration.
17.-Batch operation. Calculation of the rate constant. Constant ethyl acetate initial concentration.
18.-Rate equation formulation.
19.-Batch operation. Variation of the kinetic constant with temperature. Arrhenius equation.
20.-Batch operation. Theoretical and experimental conversion comparison. Deviation from ideality.
21.-Batch operation. Mixture effects.
22.-Continuous operation.
23.-Continuous operation. Mixture effects.
Additional practical possibilities:
24.-Sensors calibration.

Practices to be done with the Tubular Flow Reactor (QRFT):
25.-Determination of the ionic conductivities.
26.-Theoretical conversion of the tubular reactor.
27.-Experimental determination of the tubular reactor conversion.
28.-Dependence on the residence time.
29.-Determination of the reaction order.
30.-Dependence of the rate constant and the conversion with the temperature.
Additional practical possibilities:
31.-Sensors calibration.

Practices to be done with the Adiabatic and Isothermal Reactor (QRAD):
32.-Determination of the ionic conductivities.
33.-Batch operation. Obtaining the reaction order with respect to the ethyl acetate. Method of initial rates.
34.-Bach operation. Obtaining the reaction order with respect to the sodium hydroxide. Method of initial rates.
35.-Batch operation. Calculation of the rate constant. Constant sodium hydroxide initial concentration.
36.-Batch operation. Calculation of the rate constant. Constant ethyl acetate initial concentration.
37.-Rate equation formulation.
38.-Batch operation. Variation of the kinetic constant with temperature. Arrhenius equation.
39.-Batch operation. Theoretical and experimental conversion comparison. Deviation from ideality.
40- Batch operation. Effect of concentration on conversion.
41.-Calculation of the heat transfer coefficient of the coil.
42.-Batch operation. Mixing effects.
43.-Continuous operation.
Additional practical possibilities:
44.-Sensors calibration.

Practices to be done with the Reactors with Stirrer in Series (QRSA):
45.-Determination of the ionic conductivities.
46.-Continuous operation with only one reactor. .
47.-Continuous operation with only one reactor with mixture effects.
48.-Continuous operation with the three reactors.
Additional practical possibilities:
49.-Sensors calibration.

Other possibilities to be done with this Unit:
50.-Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
51.-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.
52.-The Computer Control System with SCADA and PID Control allow a real industrial simulation.
53.-This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
54.-This unit can be used for doing applied research.
55.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
56.-Control of the unit process through the control interface box without the computer.
57.-Visualization of all the sensors values used in the 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

⑥ **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.

-QRQC/PLC-SOF. PLC Control Software:

Always included with PLC supply. Each chemical reactor has its own Software.

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

⑦ **QRQC/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.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

⑧ QRQC/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.
- 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) Multipost Expansions options

⑨ 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: