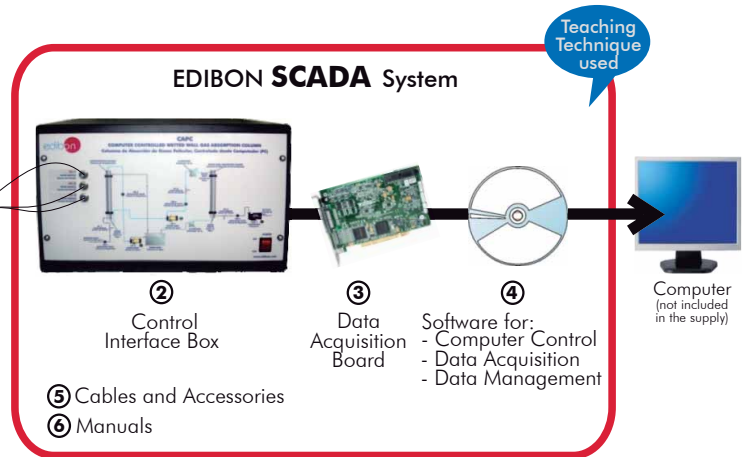


EDIBON PATENT



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

① Unit: CAPC. Wetted Wall Gas Absorption Column

Key features:

- ▶ **Advanced Real-Time SCADA.**
- ▶ **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**

www.edibon.com
Products
Products range
Units
11.-Chemical Engineering

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)



Worlddidac Quality Charter
Certificate
(Worlddidac Member)

GENERAL DESCRIPTION

Wetted wall gas absorption columns can be used to determine the mass transfer coefficients between gases and liquids, essential in the design of absorption towers. This factor is the most important one to calculate the size of such towers, since they serve as a basis from which correlations have been developed for packed towers.

A wet film absorption column (or wetted wall gas) consists, essentially, in a vertical tube through which a liquid descends, meanwhile a gas ascends through it. The gas, when contacting the liquid, is partially spread in it by means of the mass transfer. This process is normally used to study the mass transfer between two components in two different phases due to the fact that there is an interfacial film between such phases in the wet film column, unlike other processes. It will be assumed that such superficial area corresponds to the inner surface of such tube, so that the liquid can be in the shape of a thin laminar film.

The Computer Controlled Wetted Wall Gas Absorption Column (CAPC) allows to determine the liquid mass transfer coefficient and study the existing relation between the mass transfer coefficient of the liquid film and the mass flow of water. The obtained results can be compared with the theoretical predictions.

The studied absorption process corresponds to the oxygen-deoxygenated water system, where the oxygen comes from the air and the deoxygenated air is obtained through a desorption column, where a water current comes into contact with a nitrogen current.

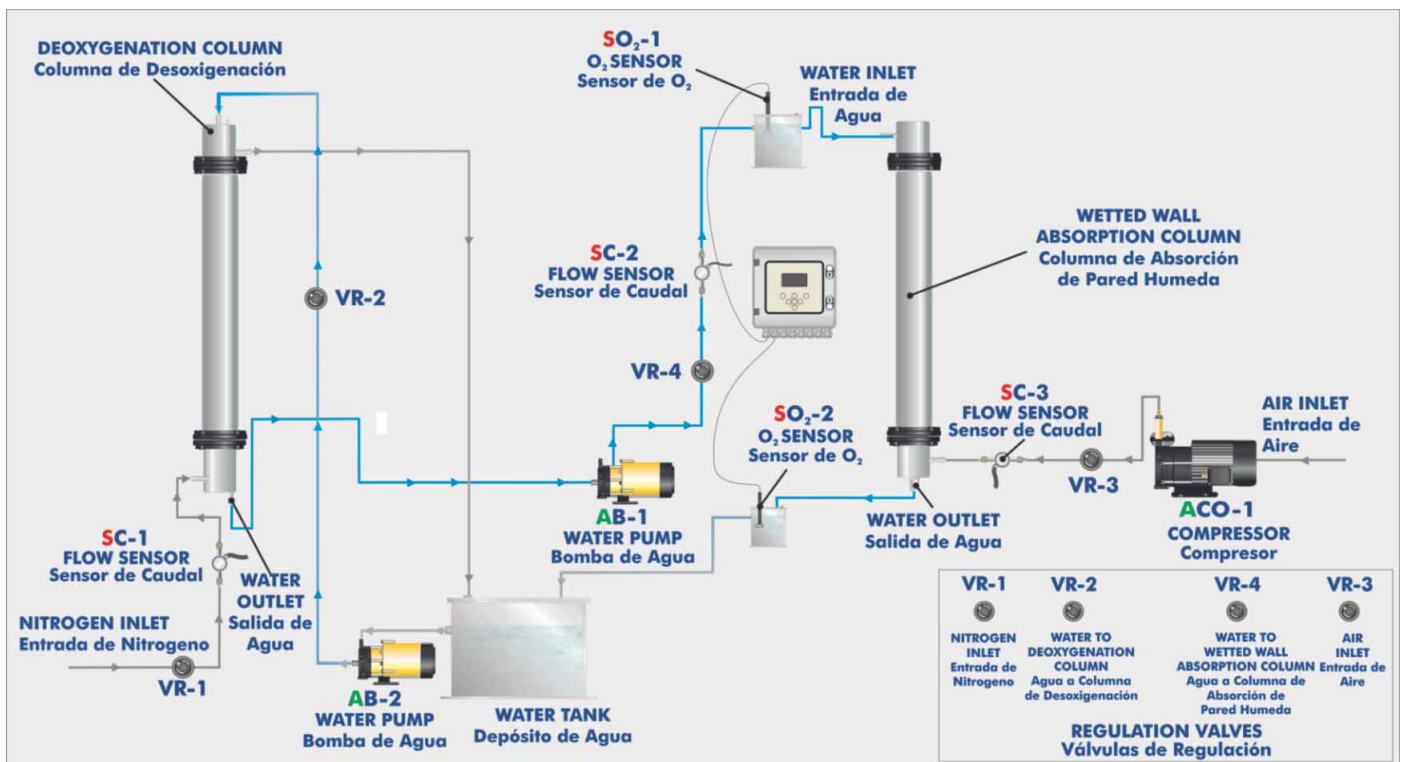
This is a controlled liquid film absorption example; so that the liquid film mass transfer coefficient can be determined for different water flows.

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

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

3 actuators and 5 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 CAPC. Unit:

Anodized aluminium structure and panels in painted steel.

Main metallic elements in stainless steel.

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

Wetted walls absorption column, consisting of a glass cylindrical tube of 900 mm. long and 32 mm. of inner diameter. It has two overflows (one at the upper side and another at the lower side) connected in series to two membrane electrodes which allow the measurement of the oxygen dissolved in the water.

Desorption column, consisting of a glass cylindrical tube of 1400 mm. long and 26 mm. of inner diameter.

Water tank with a capacity of 40 l.

Two supply centrifugal pumps, computer controlled, for the wetted wall absorption column and for the desorption column respectively. Characteristics: maximum flow supplied: 37 l./min, maximum pressure: 2 bar.

Air compressor, computer controlled, that provides a maximum flow of 6 m³/h.

Air flow sensor, range: 0-5 l./min.

Nitrogen flow sensor, range: 0-5 l./min.

Water flow sensor, range: 0.05-1.6 l./min.

An O₂ measuring device that allows to determine the concentration and saturation of such gas in the water currents belonging to the inlet and outlet of the wetted wall absorption column. Such device consists of a modular unit that allows the simultaneous display of the measured parameters and their transmission and two membrane electrodes for the measuring of dissolved oxygen. The characteristics of the oxygen meter are:

Saturation, range: 0...500%, resolution: 0.1%, accuracy: ≤ 0.2%.

Concentration, range: 0...50ppm, resolution: 0.01, accuracy: ≤ 0.1%.

Temperature, range: 0...50°C, resolution: 0.1, accuracy ≤ 0.5°C.

Two sample takings for the inlet and outlet water, respectively, of the absorption column, for the study of the oxygen contained in the water flows.

The gas supplied to the desorption column comes from a cylinder of compressed nitrogen with pressure regulator (not included in the unit supply).

The unit includes wheels for its mobility.

The complete unit includes as well:

Advanced Real-Time SCADA.

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.



CAPC. Unit

② **CAPC/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 computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.

Real time computer control for pumps, compressors, resistances, control valves, etc.

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

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.



CAPC/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 **CAPC/CCSOF. 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.

Management, processing, comparison and storage of data.

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

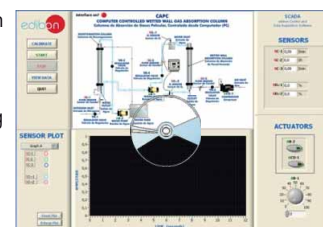
Calibration system for the sensors involved in the process.

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.



CAPC/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: CAPC + CAPC/CIB + DAB + CAPC/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.-Absorption process study.
- 2.-Calculation of liquid film mass transfer coefficients.
- 3.-Study of the variation of the coefficient depending on mass flow rate.
- 4.-Variation of oxygen flow rate to determine power law relationship.
- 5.- Effect of water flow rate.
- 6.- Effect of oxygen flow rate.

Additional practical possibilities:

- 7.-Sensors calibration.

Other possibilities to be done with this Unit:

- 8.-Many students view results simultaneously.

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

- 9.-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.

- 10.-The Computer Control System with SCADA allows a real industrial simulation.

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

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

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

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

- 15.-Visualization of all the sensors values used in the CAPC 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, 220V./50Hz or 110V./60Hz.
- Computer (PC).
- Supply of nitrogen through a compressed nitrogen cylinder with pressure regulator. (Not supplied with the unit).

DIMENSIONS & WEIGHTS

CAPC:

Unit: -Dimensions:1000 x 500 x 2000 mm. approx.
(39.37 x 19.68 x 78.74 inches approx.)

-Weight: 200 Kg. approx.
(441 pounds approx.)

Control Interface Box:-Dimensions:490 x 330 x 310 mm. approx.
(19.29 x 13 x 12.20 inches approx.)

-Weight: 10 Kg. approx.
(22 pounds approx.)

SCADA
Main screen

The SCADA main screen is divided into several functional areas:

- Top Left (I):** Main software operation possibilities including buttons for CALIBRATE, START, STOP, VIEW DATA, and QUIT.
- Top Center (II):** A detailed schematic diagram of the CAPC (COMPUTER CONTROLLED WETTED WALL GAS ABSORPTION COLUMN) system, showing components like the deoxygenation column, water tank, pumps, valves, and sensors.
- Top Right (III):** Sensors display showing real-time values for SC-1, SC-2, SC-3, SO-1, and SO-2.
- Bottom Left (IV):** Sensor Plot area with a graph showing amplitude over time, and options to reset or enlarge the plot.
- Bottom Center (V):** A large real-time graphics display area.
- Bottom Right:** Actuators controls, including visual indicators for AB-2 and ACO-1, and a rotary knob for AB-1.

- (I) Main software operation possibilities.
- (II) Sensors displays, real time values, and extra output parameters. Sensors: SC=Flow sensor. SO₂=Oxygen sensor.
- (III) Actuators controls. Actuators: AB=Pump. ACO=Compressor.
- (IV) Channel selection and other plot parameters.
- (V) Real time graphics displays.

Software for Sensors Calibration

The calibration software consists of two main windows:

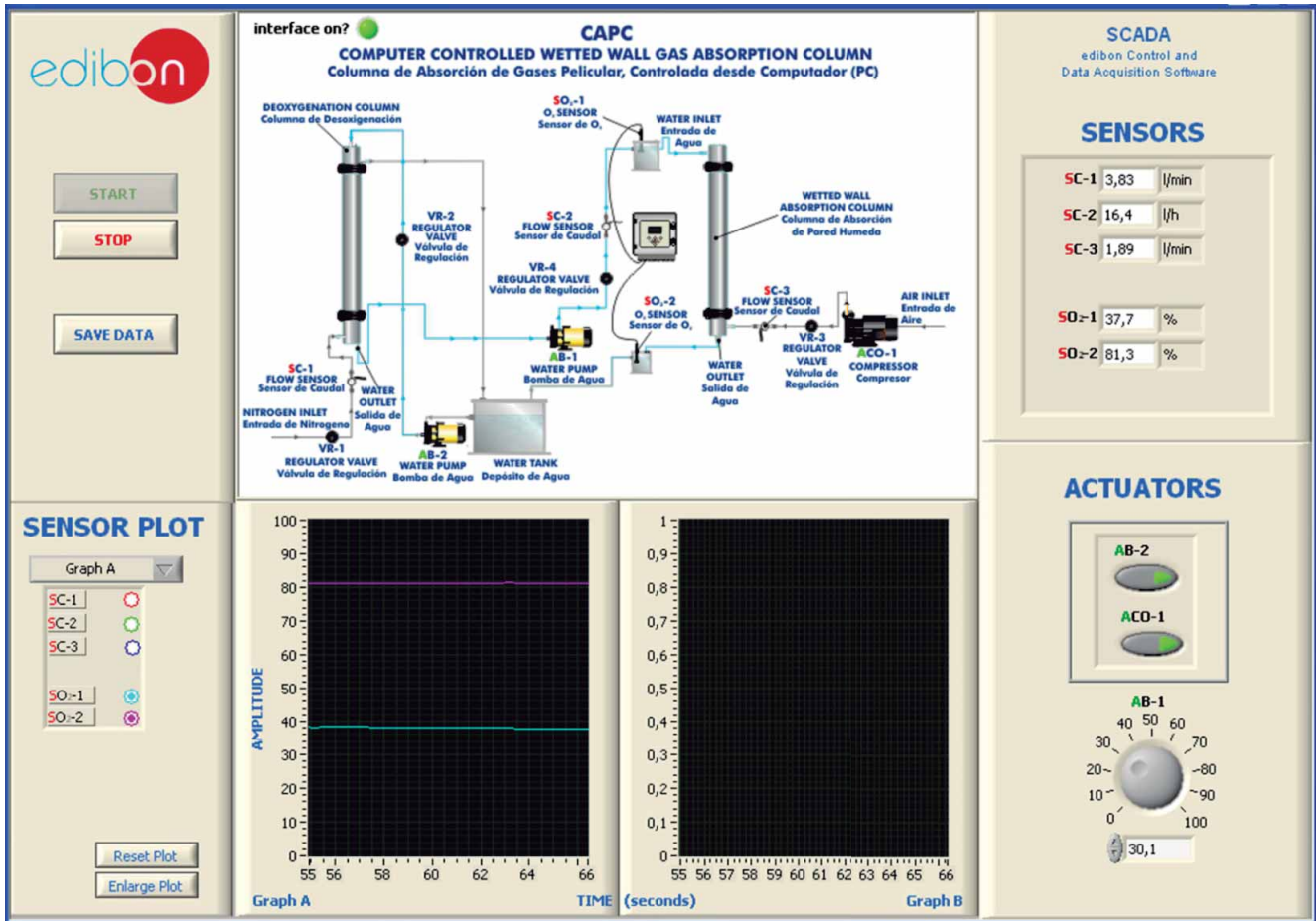
- CALIBRATION:** Used for single-point calibration. It shows the selected sensor (ST-8), units (°C), full scale (150), gain (95,4198), and offset (1,67443). It includes a Least Squares Fit button and a table of calibration data.
- MULTICALIBRATE:** Used for multi-point calibration. It displays a list of sensors with their reference values, measured volts, calibrated values, and error percentages. A table below shows the resulting gain, offset, and p values for each sensor.

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

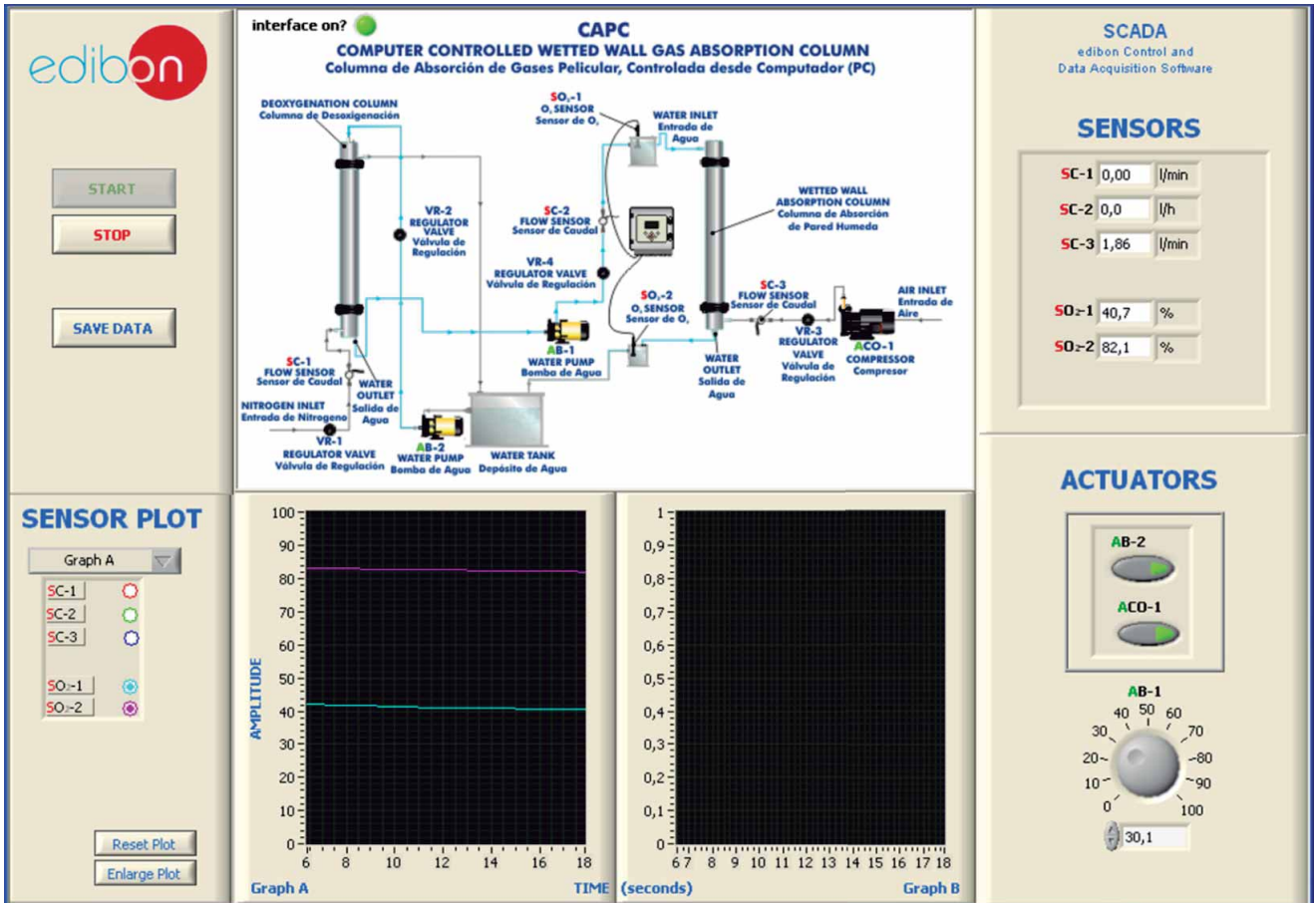
The teacher can recover his/her own calibration by using the EDIBON code that we give free of charge.

SOME TYPICAL RESULTS

Real time representation of sensors during the unit operation. We can observe in the screen the unit operation, that allows in the first stage the obtaining of deoxygenated water in the deoxygenation column when having a nitrogen flow (flow sensor SC-1) in countercurrent with a water current. In the second stage consists on the absorption process of the oxygen-deoxygenated water system, in which a flow of deoxygenated water (flow sensor SC-2) gets in contact with an air flow (flow sensor SC-3) in a wetted wall absorption column.

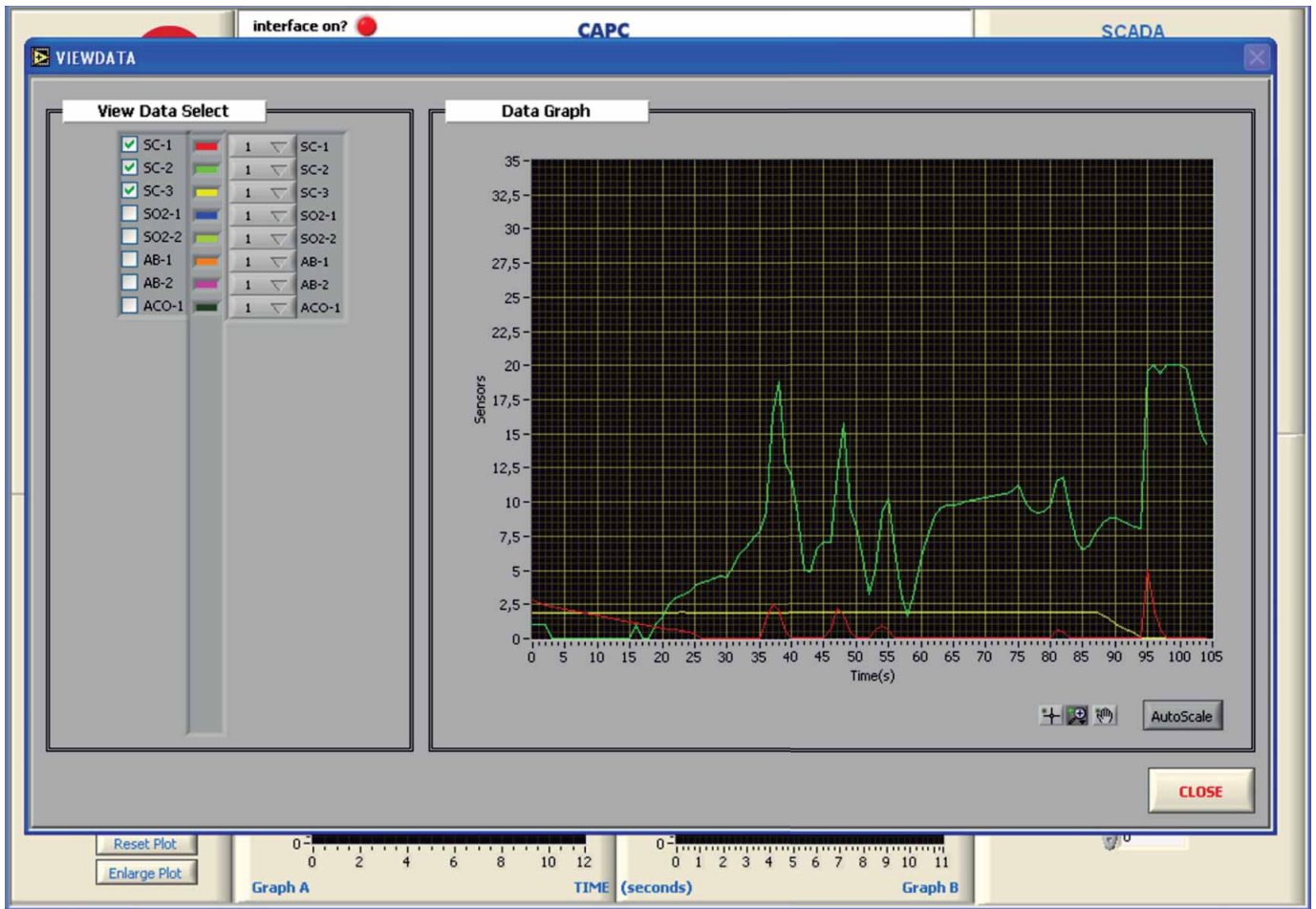


The unit operation is observed in the screen. It can be appreciated a decrease in the content of oxygen of the deoxygenated water, with regard to the running water, at the deoxygenation column outlet (O_2 sensor, SO_2-1). Once the deoxygenated water passes through the wetted wall gas absorption column the content in oxygen rises (O_2 sensor, SO_2-2).



Some typical results

Graph representing the measurement of the nitrogen flow (SC-1 sensor), the water deoxygenated flow (SC-2) and the air flow (SC-3) sensors during the unit operation.



COMPLETE TECHNICAL SPECIFICATIONS (for optional items)

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

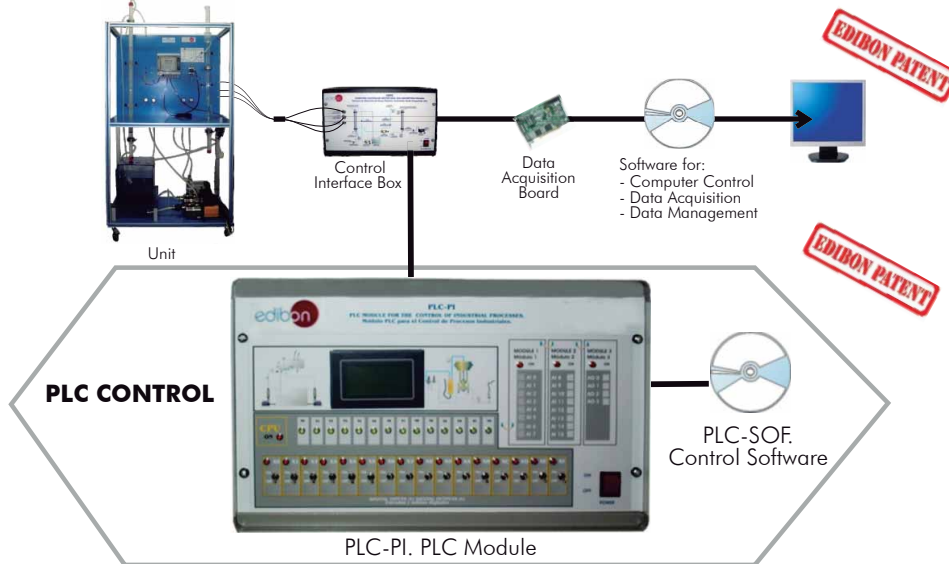
Communication RS232 wire to computer (PC).

Dimensions: 490 x 330 x 310 mm. approx. (19.29 x 13 x 12.20 inches approx.). Weight: 30 Kg. approx. (66 pounds approx.).

-CAPC/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 Wetted Wall Gas Absorption Column (CAPC).



Practices to be done with PLC-PI:

- 1.- Control of the CAPC unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the CAPC unit process.
- 3.- Calibration of all sensors included in the CAPC unit process.
- 4.- Hand on of all the actuators involved in the CAPC 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 CAPC 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 CAPC unit process.
- 17.- Possibility of creating new process in relation with the CAPC unit.
- 18.- PLC Programming exercises.
- 19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

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

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

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

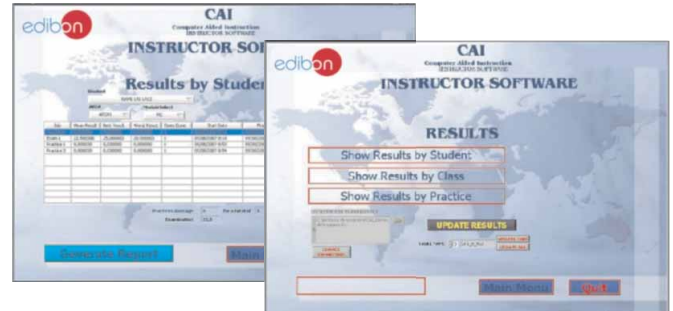
This complete package consists on an Instructor Software (INS/SOF) totally integrated with the Student Software (CAPC/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students. These, on the other hand, get a virtual instructor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



- CAPC/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 **CAPC/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.

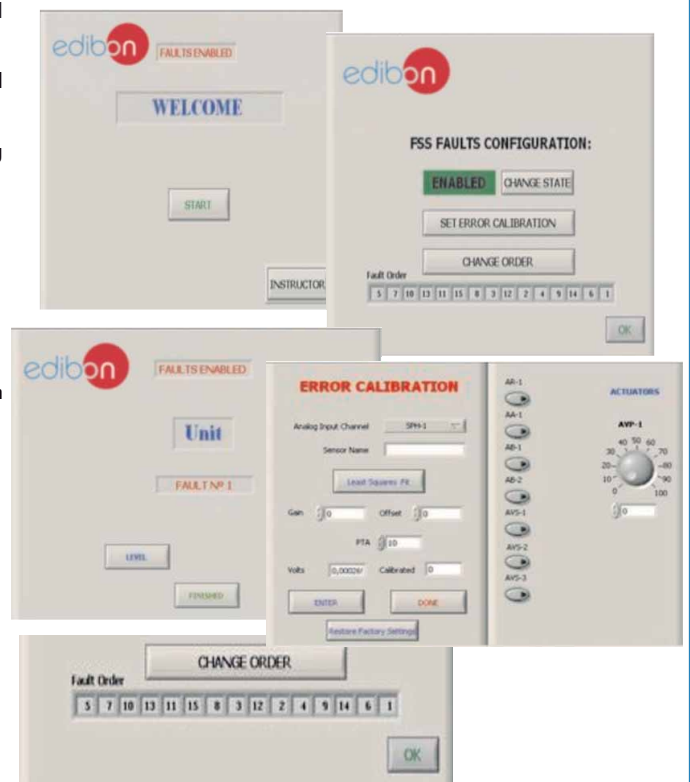
Faults in the controls execution:

- 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 **CAPC/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.

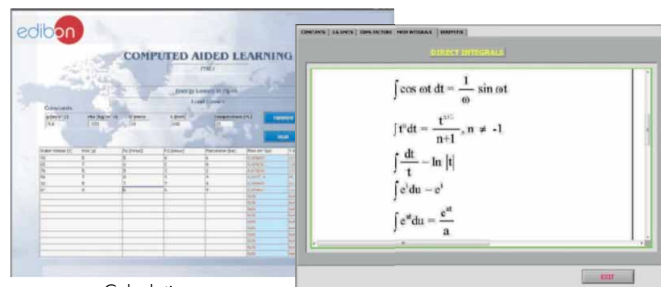
It allows to plot and print the results. Between the plotting options, any variable can be represented against any other.

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 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:

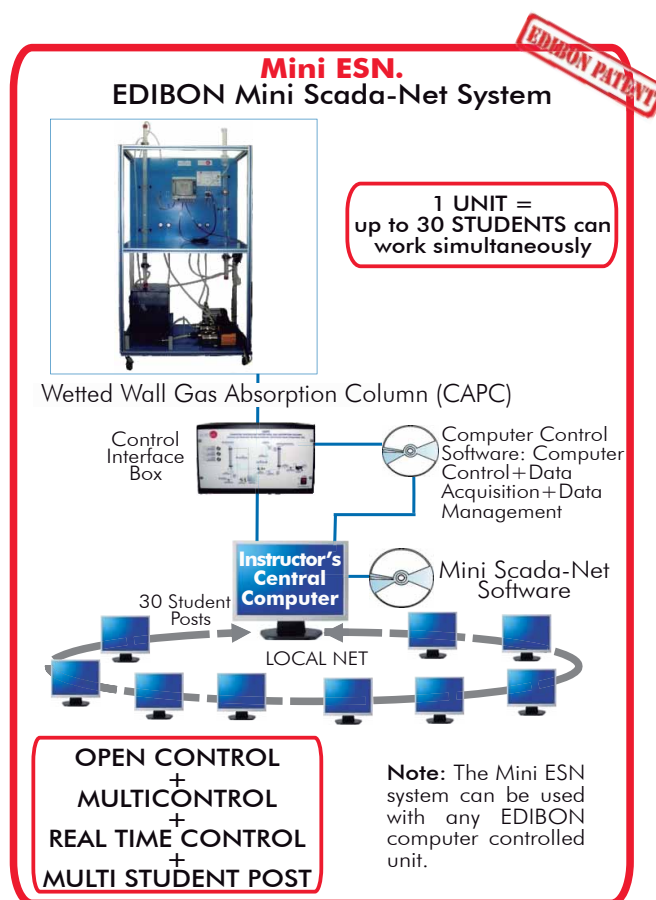
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work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

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

- ① **Unit: CAPC. Wetted Wall Gas Absorption Column.**
- ② **CAPC/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **CAPC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

* **IMPORTANT:** Under CAPC 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.
 - CAPC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

- ⑧ CAPC/CAI. Computer Aided Instruction Software System.
- ⑨ CAPC/FSS. Faults Simulation System.

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

- ⑩ CAPC/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 CAPC. Unit:

Anodized aluminium structure and panels in painted steel.

Main metallic elements in stainless steel.

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

Wetted walls absorption column, consisting of a glass cylindrical tube of 900 mm. long and 32 mm. of inner diameter. It has two overflows (one at the upper side and another at the lower side) connected in series to two membrane electrodes which allow the measurement of the oxygen dissolved in the water.

Desorption column, consisting of a glass cylindrical tube of 1400 mm. long and 26 mm. of inner diameter.

Water tank with a capacity of 40 l.

Two supply centrifugal pumps, computer controlled, for the wetted wall absorption column and for the desorption column respectively. Characteristics: maximum flow supplied: 37 l./min, maximum pressure: 2 bar.

Air compressor, computer controlled, that provides a maximum flow of 6 m³/h.

Air flow sensor, range: 0-5 l./min.

Nitrogen flow sensor, range: 0-5 l./min.

Water flow sensor, range: 0.05-1.6 l./min.

An O₂ measuring device that allows to determine the concentration and saturation of such gas in the water currents belonging to the inlet and outlet of the wetted wall absorption column. Such device consists of a modular unit that allows the simultaneous display of the measured parameters and their transmission and two membrane electrodes for the measuring of dissolved oxygen. The characteristics of the oxygen meter are:

Saturation, range: 0...500%, resolution: 0.1%, accuracy: ≤0.2%.

Concentration, range: 0...50ppm, resolution: 0.01, accuracy: ≤0.1%.

Temperature, range: 0...50°C, resolution: 0.1, accuracy ≤0.5°C.

Two sample takings for the inlet and outlet water, respectively, of the absorption column, for the study of the oxygen contained in the water flows.

The gas supplied to the desorption column comes from a cylinder of compressed nitrogen with pressure regulator (not included in the unit supply).

The unit includes wheels for its mobility.

The complete unit includes as well:

Advanced Real-Time SCADA.

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 CAPC/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 computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.

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

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 CAPC/CCSOF. 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.

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.- Absorption process study.
 - 2.- Calculation of liquid film mass transfer coefficients.
 - 3.- Study of the variation of the coefficient depending on mass flow rate.
 - 4.- Variation of oxygen flow rate to determine power law relationship.
 - 5.- Effect of water flow rate.
 - 6.- Effect of oxygen flow rate.
- Additional practical possibilities:
- 7.- Sensors calibration.
- Other possibilities to be done with this Unit:
- 8.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
 - 9.- 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.
 - 10.- The Computer Control System with SCADA allows a real industrial simulation.
 - 11.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
 - 12.- This unit can be used for doing applied research.
 - 13.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
 - 14.- Control of the CAPC unit process through the control interface box without the computer.
 - 15.- Visualization of all the sensors values used in the CAPC unit process.
- By using PLC-PI additional 19 more exercises can be done.
 - Several other exercises can be done and designed by the user.

a) Industrial configuration

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

-PLC-PI. PLC Module:

Metallic box.
 Circuit diagram in the module front panel.
 Digital inputs(X) and Digital outputs (Y) block: 16 Digital inputs. 14 Digital outputs.
 Analog inputs block: 16 Analog inputs.
 Analog outputs block: 4 Analog outputs.
 Touch screen.
 Panasonic PLC:

High-speed scan of 0.32 µsec. Program capacity of 32 Ksteps. High-speed counter. Multi-point PID control.
 Digital inputs/outputs and analog inputs/outputs Panasonic modules.

-CAPC/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 CAPC unit process through the control interface box without the computer.
- 2.- Visualization of all the sensors values used in the CAPC unit process.
- 3.- Calibration of all the sensors included in the CAPC unit process.
- 4.- Hand on of all the actuators involved in the CAPC 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 CAPC 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 CAPC unit process.
- 17.- Possibility of creating new process in relation with the CAPC unit.
- 18.- PLC Programming exercises.
- 19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

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

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

-CAPC/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 **CAPC/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 **CAPC/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.**

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 on the adaptation of any EDIBON Computer Controlled Unit with SCADA 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, 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 improvements of the product.



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