

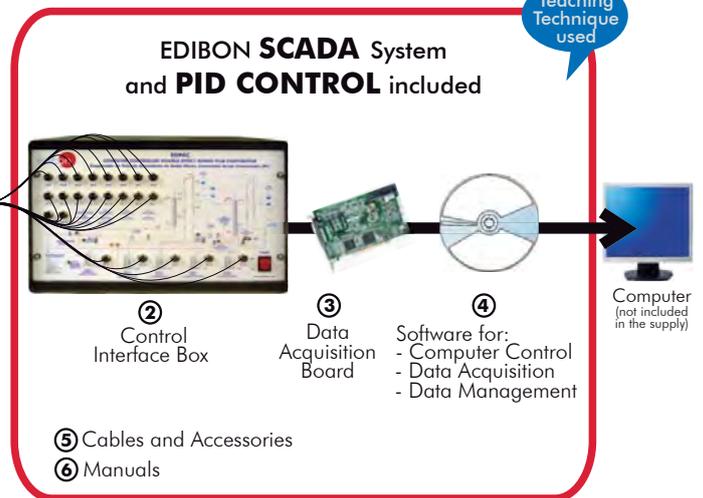


① Unit: EDPAC. Double Effect Rising Film Evaporator

Key features:

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

For more information about Key Features, click here:



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

**OPEN CONTROL  
+  
MULTICONTROL  
+  
REAL TIME CONTROL**

[www.edibon.com](http://www.edibon.com)  
Products  
Products range  
Units  
11.-Chemical Engineering



**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)

## INTRODUCTION

The objective of the evaporation is to concentrate a solution containing a non-volatile solute and a volatile solvent. In most evaporation processes the solvent is water. Evaporation means vaporizing part of the solvent to obtain a concentrate solution of thick liquor.

Rising or falling film evaporators are very useful if the product to be concentrated breaks down easily when subjected to high temperatures for a long period of time, since these evaporators work at a lower temperature. These evaporators can be used to concentrate, for example, juices, milk and dairy products, etc.

The multiple effect method is used to improve the global thermal economy of the process without increasing the capacity of the plant.

## GENERAL DESCRIPTION

The "EDPAC" unit, designed by EDIBON, allows to observe and control a serial, parallel or double effect evaporation process.

The unit consists of two evaporators with a single glass tube, allowing the student to observe all the processes that take place in the unit.

The solution to be concentrated enters the evaporator and, as it flows along the tube, it is progressively evaporated since an annular flow or rising film flow is generated internally, keeping that film thanks to the friction induced by the vapour nucleus, which moves at high speed with regard to the liquid film. The supply enters the rising tube in liquid state for a short distance, receiving heat from the steam.

Steam introduced in the first evaporator can be introduced again in the second evaporator (serial operation mode) or either two different steam flows can be introduced (parallel operation mode).

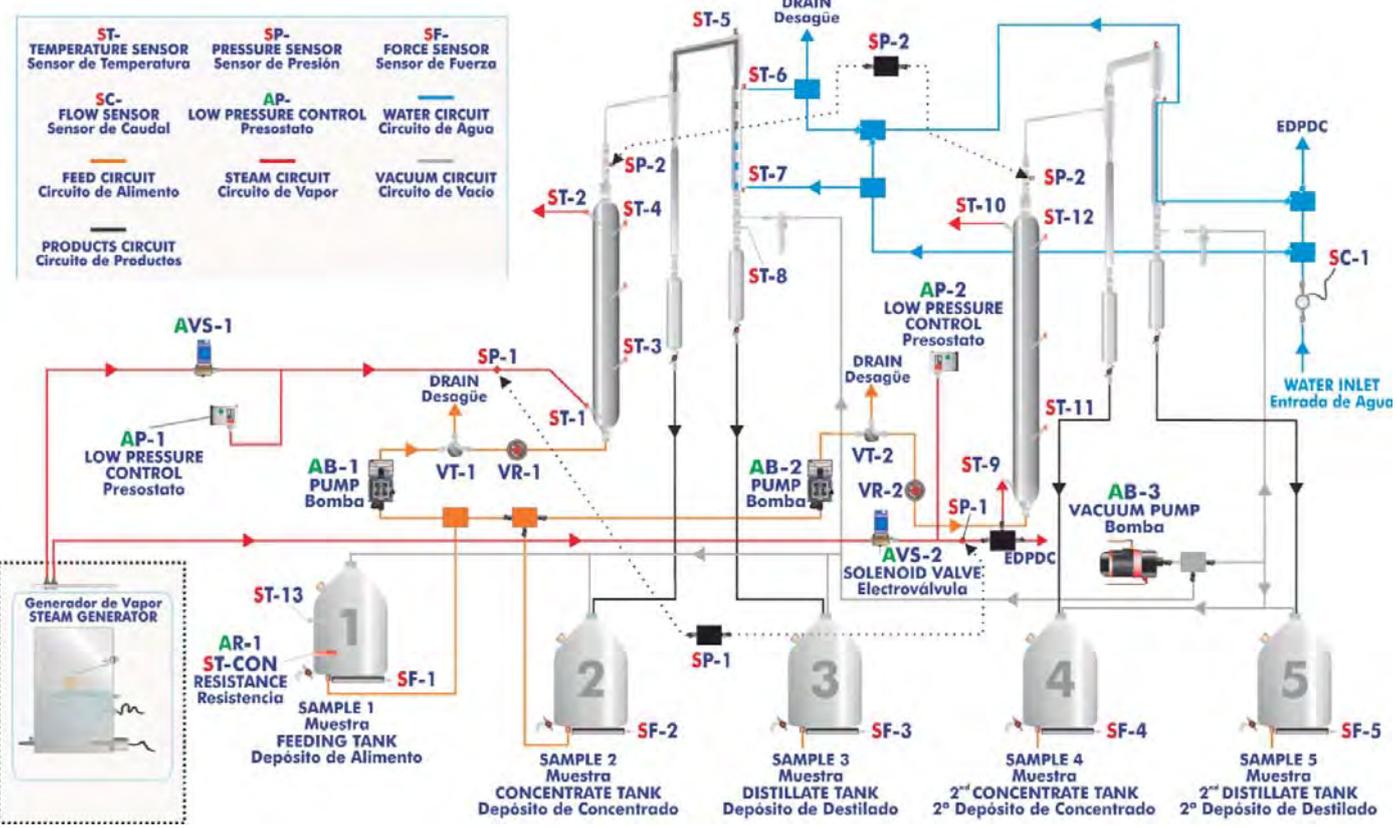
The unit also allows the steam generated in the first evaporator to be introduced as heating medium in the second evaporator and the concentrated product obtained can be used as supply for the second column. Thus, one of the main premises of a double effect evaporator, which is the economy of the heat employed, can be evaluated.

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

## PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION

7 actuators and 21 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 EDPAC. Unit:**

Anodized aluminum structure and panels in painted steel.

Main metallic elements in stainless steel.

Three diagrams with the arrangement of the elements in the front panel with the three possible configurations.

2 Evaporation double jacket columns, with a heating area of 0.122 m<sup>2</sup>, 30 mm of inner diameter, 60 mm of outer diameter and length of 1300 mm.

2 Membrane dosing pumps, computer controlled, with maximum flow of 15 l./h. with flow control.

Simple effect vacuum pump, computer controlled, with maximum flow of 3 m<sup>3</sup>/h and maximum vacuum of 150 microns.

Five 10 l. tanks (for feeding, concentrated and evaporated).

Four 500 ml graduated vessels for storage of concentrated and evaporated product.

Immersion heating element, computer controlled, range: 300W.

Included a safety temperature sensor with internal temperature controller.

Automatic temperature control (PID Control).

2 Coil coolants with length of 400 mm.

2 High safety pressure cut out for pressure control in the columns.

13 Temperature sensors, "J" type.

1 Flow sensor, range: 0.2 to 6.5 l./min.

2 Pressure sensors of 0 to 2 bar.

5 Force sensors, one in each one of the five tanks (for feeding, concentrated and evaporated), for measuring the amount of fed or collected substance.

2 Solenoid valves, computer controlled.

The unit allows to work with several configurations:

- a) Double-effect: the steam generated in the first stage of the evaporation is introduced in the second column.
- b) Steam from the first column's jacket can be used to heat the second column.
- c) Columns receive steam from the generator in an independent way.

This unit incorporates wheels for its mobility.

The complete unit includes as well:

**Advanced Real-Time SCADA and PID Control.**

**Open Control + Multicontrol + Real-Time Control.**

**Specialized EDIBON Control Software based on Labview.**

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

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

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

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

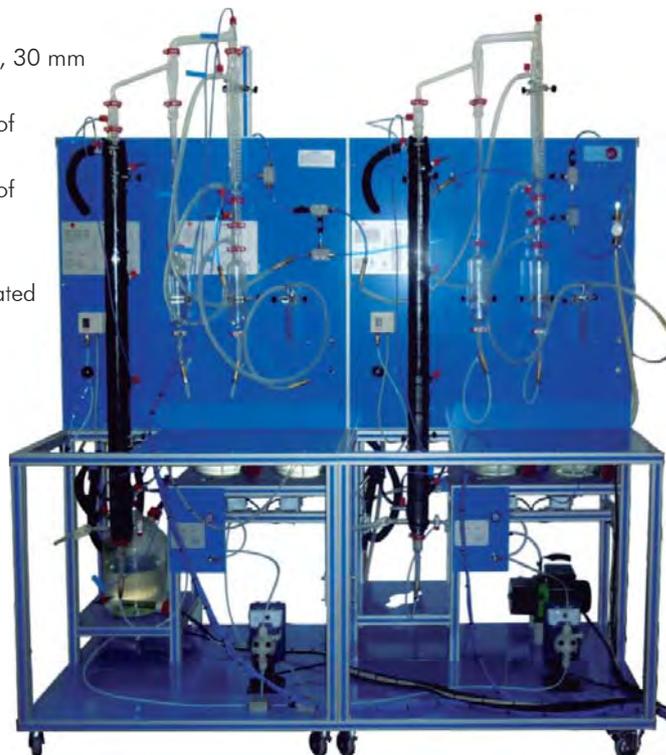
**Remote operation and control by the user and remote control for EDIBON technical support, are always included.**

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

**Designed and manufactured under several quality standards.**

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

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



EDPAC. Unit

Optional accessory (not included in the minimum supply): (See section "Optional accessory" in page 6).

- EDPDC. Computer Controlled Double Effect Falling Film Evaporator (for adding to EDPAC).

② **EDPAC/CIB. Control Interface Box:**

The Control Interface Box is part of the SCADA system.

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

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer.

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

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

**Calibration of all sensors involved in the process.**

**Real time curves representation about system responses.**

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

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

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

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

**Shield and filtered signals to avoid external interferences.**

**Real time PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process.** Real time PID and on/off control for pumps, compressors, resistances, control valves, etc. **Real time PID control for parameters involved in the process simultaneously.** Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).

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

Possibility of automatization of the actuators involved in the process.

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



EDPAC/CIB

③ **DAB. Data Acquisition Board:**

The Data Acquisition board is part of the SCADA system.

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

**Analog input:**

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

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

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

**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.



DAB

④ **EDPAC/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 on the computer 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).**

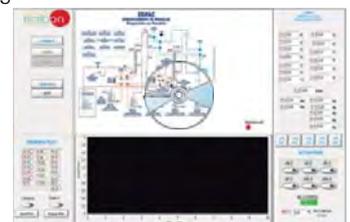
**Calibration system for the sensors involved in the process.**

**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.**



EDPAC/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: EDPAC + EDPAC/CIB + DAB + EDPAC/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.-Heating efficiency calculation.
- 2.-Sugared solution concentration.
- 3.-Evaporation velocity determination.
- 4.-Study of the evaporation velocity in function of the working conditions.
- 5.-Study of the relation between condensed and evaporated product.
- 6.-Study of the mass balance of the solute.
- 7.-Study of the mass balance of the solvent.
- 8.-Energy balance of the evaporation unit.
- 9.-Energy balance of the tubular refrigerator.
- 10.- Heat transfer global coefficient determination.
- 11.- Heat transfer coefficient determination of a tubular refrigerator.
- 12.- Study of the mass balance of the solute in one column.
- 13.- Fruit juices and vegetable extracts concentration.
- 14.- Concentrated milk obtaining.
- 15.- Efficiency determination of the steam used in the process.
- 16.- Steam generator efficiency determination.
- 17.- Investigation of effect of varying process parameters such as: vacuum, flow rate, temperature, recycle rate.

Additional practical possibilities:

- 18.- Temperature sensors calibration.
- 19.- Force sensors calibration.
- 20.- Pressure sensors calibration.
- 21.- Feed pumps calibration.

Other possibilities to be done with this Unit:

- 22.- Many students view results simultaneously.  
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
- 23.- 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.
- 24.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
- 25.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
- 26.- This unit can be used for doing applied research.
- 27.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
- 28.- Control of the EDPAC unit process through the control interface box without the computer.
- 29.- Visualization of all the sensors values used in the EDPAC 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 with ground, 220V/50Hz or 110V/60Hz.
- Water supply and drainage.
- Computer (PC).

### REQUIRED ACCESSORIES

- EDIBON Steam Generator ( TGV-6kW ), power: 6 kW., (three phase power supply is required), or similar steam generator.
- Stopwatch.

### DIMENSIONS & WEIGHTS

EDPAC:

- |                        |   |
|------------------------|---|
| Unit:                  | -Dimensions: 2300 x 1000 x 2300 mm. approx.<br>(90.55 x 39.37 x 90.55 inches approx.) |
|                        | -Weight: 200 Kg. approx.<br>(441 pounds approx.).                                     |
| Control-Interface Box: | -Dimensions: 490 x 330 x 310 mm. approx.<br>(19.29 x 12.99 x 12.20 inches approx.).   |
|                        | -Weight: 10 Kg. approx.<br>(22 pounds approx.).                                       |

### AVAILABLE VERSIONS

Offered in this catalogue:

- EDPAC. Computer Controlled Double Effect Rising Film Evaporator.

Offered in other catalogues:

- EDPAB. Double Effect Rising Film Evaporator.
- EPAC. Computer Controlled Rising Film Evaporator.
- EPAB. Rising Film Evaporator.

## Optional accessory

### EDPDC. Computer Controlled Double Effect Falling Film Evaporator (for adding to EDPAC)

Basically, it consists of the following elements:

- Falling film evaporation column with jacket for the steam and temperature takings. It has a heating area of  $0.122 \text{ m}^2$ , 30 mm of inner diameter, 60 mm of outer diameter and length of 1300 mm.
- Cyclone to favor the separation of the most volatile component from the least volatile component.
- Graduated vessel of 500 ml to collect the concentrated product, located under the cyclone.
- Liebig-Wet refrigerant to condense the distilled product (useful length of 400 mm).
- 500 ml graduated vessel to collect the evaporated.

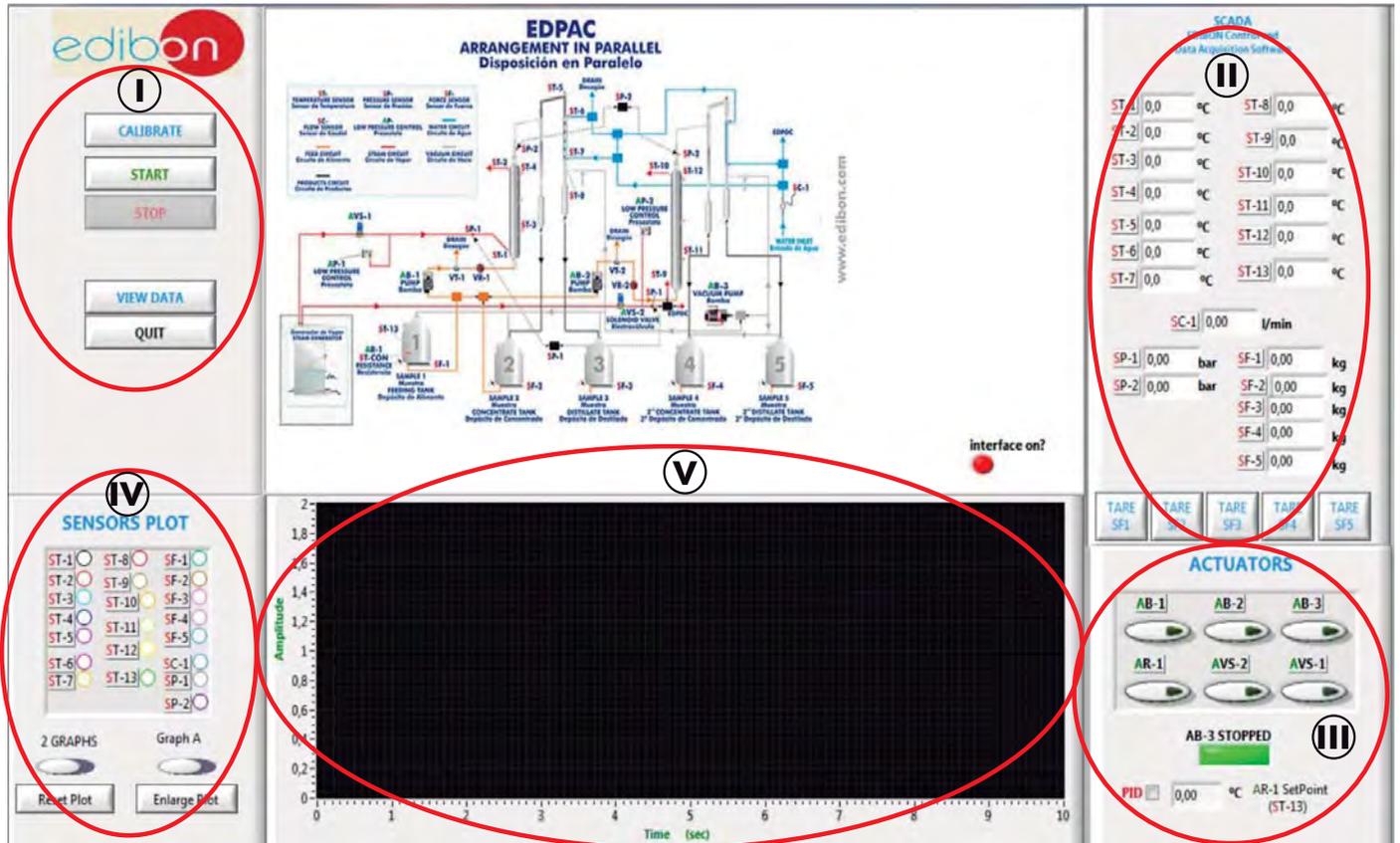
The operation with the falling film column is by replacing the second rising film column for the falling film column. For it, the falling film equipment is connected to the corresponding takings: supply, steam, water, vacuum, and sensors which come from the second rising film column. The corresponding circulation valves for the falling film column are opened and the corresponding valves to the rising film column are closed.

The temperature sensors are removed from the second rising film column and are placed at the falling film column.



SCADA and PID Control

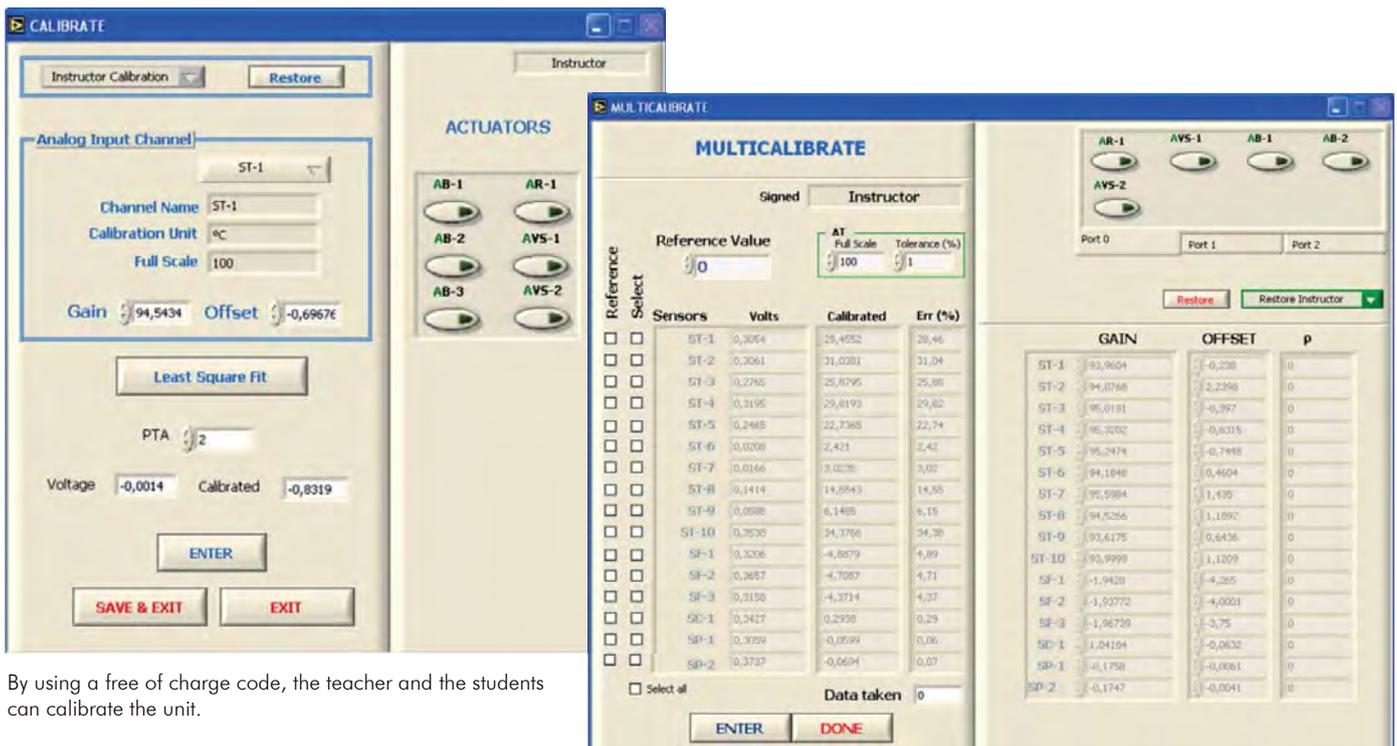
Main screen



- Ⓘ Main software operation possibilities.
- Ⓚ Sensors displays, real time values, and extra output parameters. Sensors: ST=Temperature sensor. SP=Pressure sensor. SF=Force sensor. SC=Flow sensor.
- Ⓛ Actuators controls. Actuators: AB=Pump. AR=Heating element. AVS=Solenoid Valve.
- Ⓜ Channel selection and other plot parameters.
- Ⓨ Real time graphics displays.

Software for Sensors Calibration

Examples of screens



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.

An initial screen allows to select the operation mode, either with the EDPAC unit in series, parallel or double effect or with the optional accessory EDPDC.



Arrangement in parallel: the steam generator introduces steam in both columns separately.

**SCADA**  
EDIBON Control and Data Acquisition Software

ST-1	84,7	°C	ST-8	36,9	°C
ST-2	55,5	°C	ST-9	21,3	°C
ST-3	87,8	°C	ST-10	19,3	°C
ST-4	67,4	°C	ST-11	20,5	°C
ST-5	43,0	°C	ST-12	18,1	°C
ST-6	23,2	°C	ST-13	50,0	°C
ST-7	24,4	°C			

SC-1 1,33 U/min

SP-1	-0,00	bar	SF-1	-0,03	kg
SP-2	-0,01	bar	SF-2	-0,00	kg
			SF-3	-0,01	kg
			SF-4	9,19	kg
			SF-5	10,17	kg

**SENSORS PLOT**

Graph A: Amplitude vs Time (sec) showing multiple horizontal lines for different sensors.

Graph B: Amplitude vs Time (sec) showing a single horizontal line.

**ACTUATORS**

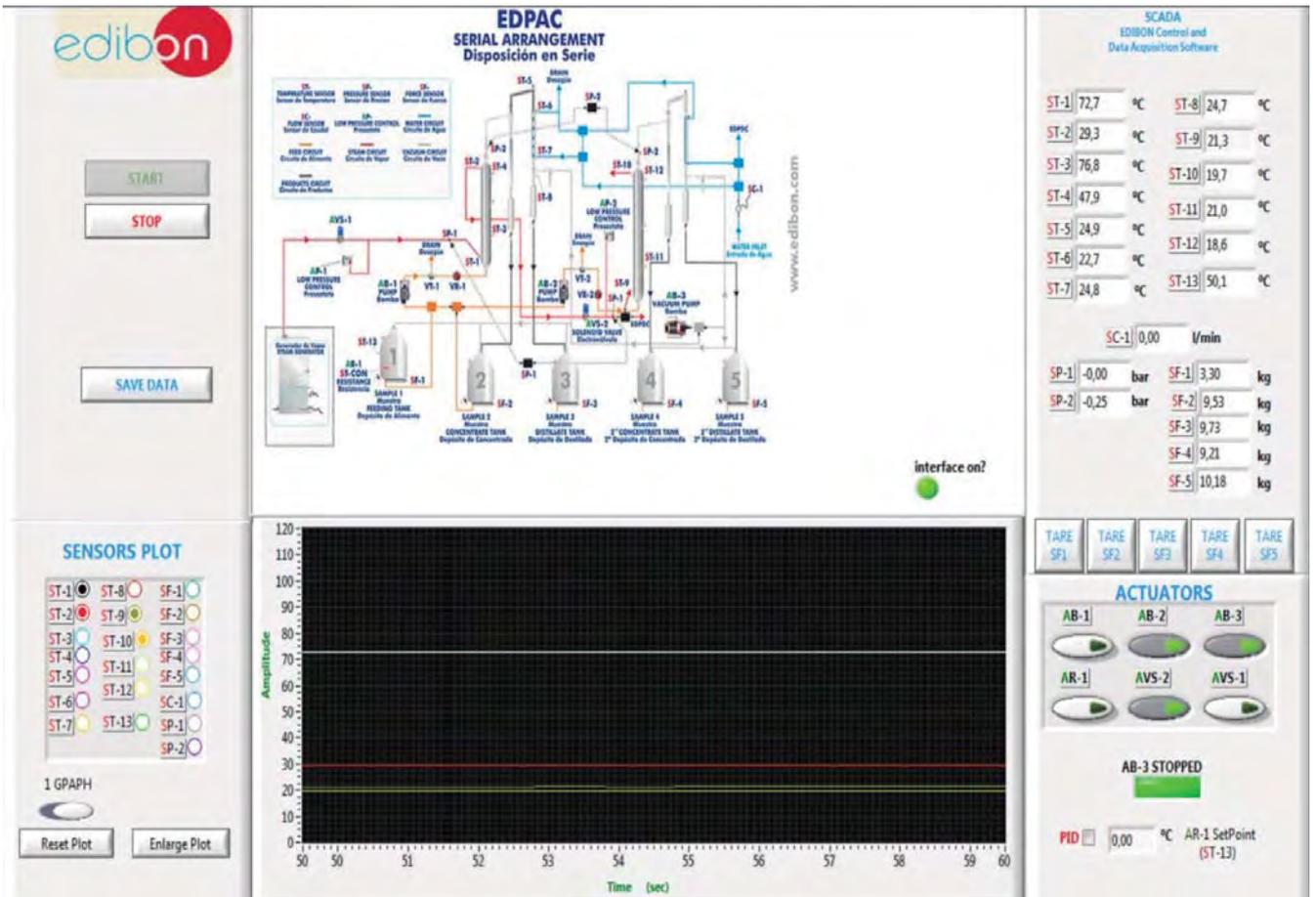
AB-1, AB-2, AB-3 (status indicators)

AR-1, AVS-2, AVS-1 (status indicators)

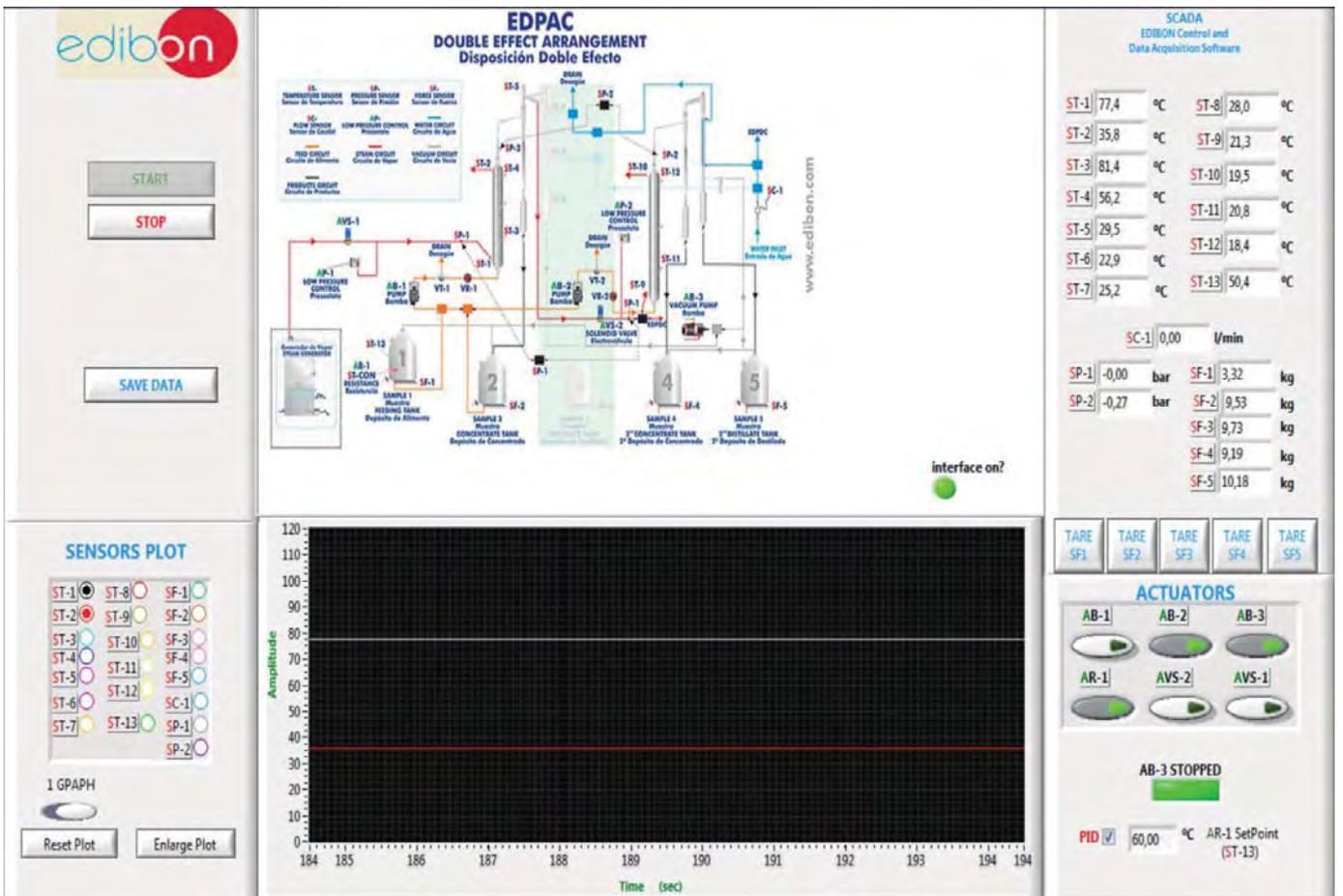
AB-3 STOPPED

PID 0,00 °C AR-1 SetPoint (ST-13)

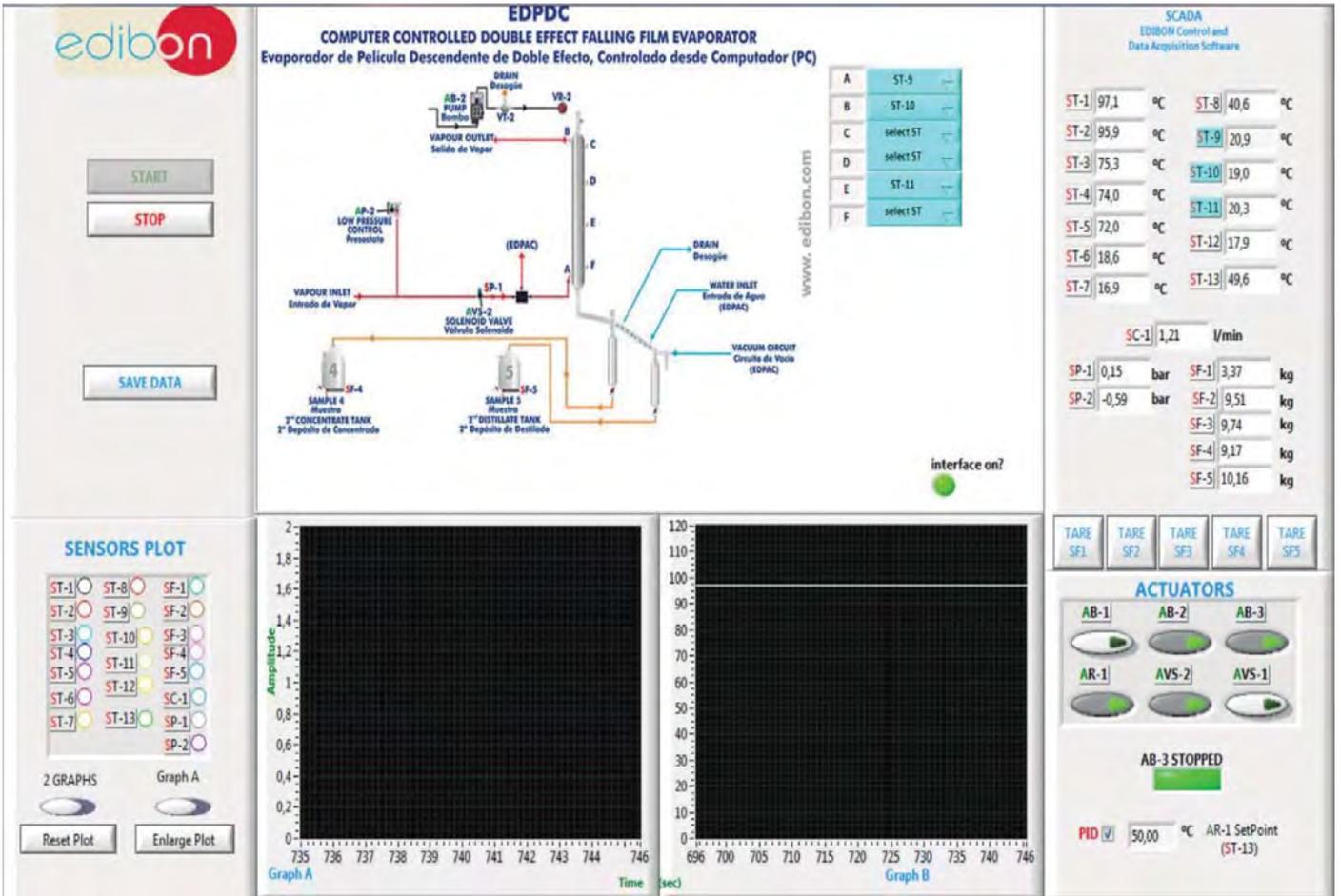
Arrangement in series: the steam generator introduces steam in the jacket of the first column and at its outlet it enters the jacket of the second column.



Double-effect arrangement: the steam generated in the first column is used to heat, being it introduced in the jacket of the second column. The screen below allows to observe how a PID control for the heating element is done, fixing the temperature of the food to be introduced in the column to 60°C.



The optional accessory EDPDC must be connected to the corresponding intakes of the EDPAC unit. The sensors are extracted from the EDPAC unit in function of the measurements under study. The software allows to select the sensors under operation for an easy reading and plotting.



## 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.**

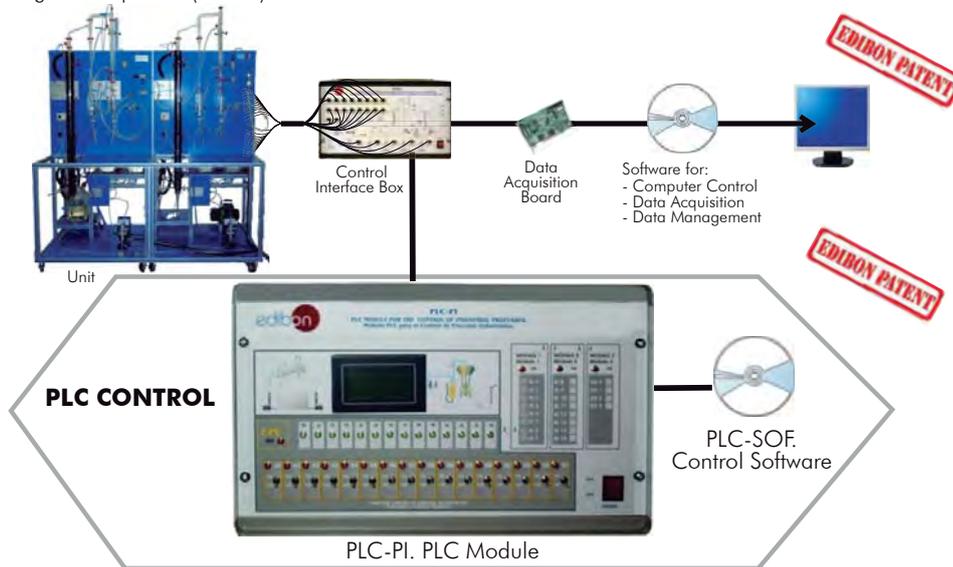
Communication RS232 wire to computer (PC).

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

##### **-EDPAC/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 Double Effect Rising Film Evaporator (EDPAC).



#### **Practices to be done with PLC-PI:**

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

b) Technical and Vocational Education configuration

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

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

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

This complete software package consists on an Instructor Software (INS/ SOF) totally integrated with the Student Software (EDPAC/SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- 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.
- Generate and print reports.
- Detect student's progress and difficulties.
- ...and many other facilities.

**Instructor Software**



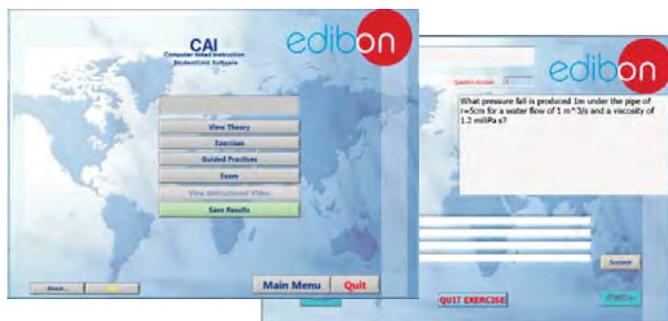
- EDPAC/SOF. Computer Aided Instruction Software (Student Software):

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](http://www.edibon.com/products/catalogues/en/CAI.pdf)

⑨ **EDPAC/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](http://www.edibon.com/products/catalogues/en/FSS.pdf)

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

⑩ **EDPAC/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 doing the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL computes the value of all the variables involved and performs the calculations.

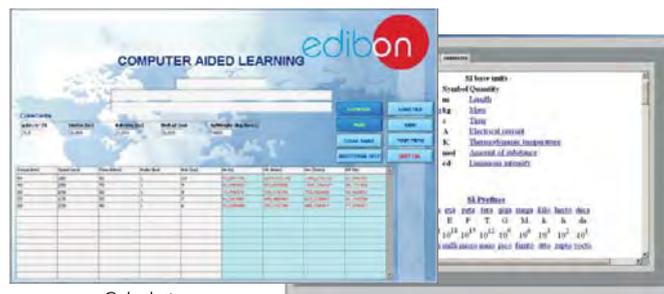
It allows to plot and print the results. Within the plotting options, any variable can be represented against any other.

Different plotting displays.

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

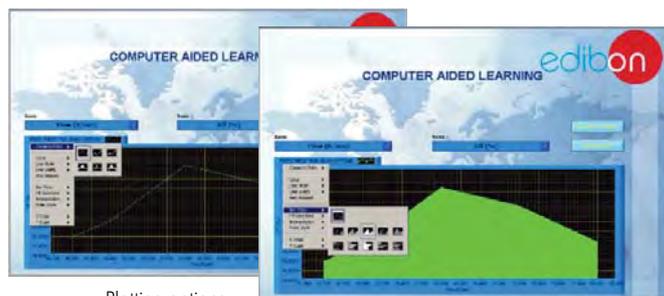
For more information see CAL catalogue. Click on the following link:

[www.edibon.com/products/catalogues/en/CAL.pdf](http://www.edibon.com/products/catalogues/en/CAL.pdf)



Calculations

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



Plotting options

d) Multipost Expansions options

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

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

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

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

Main characteristics:

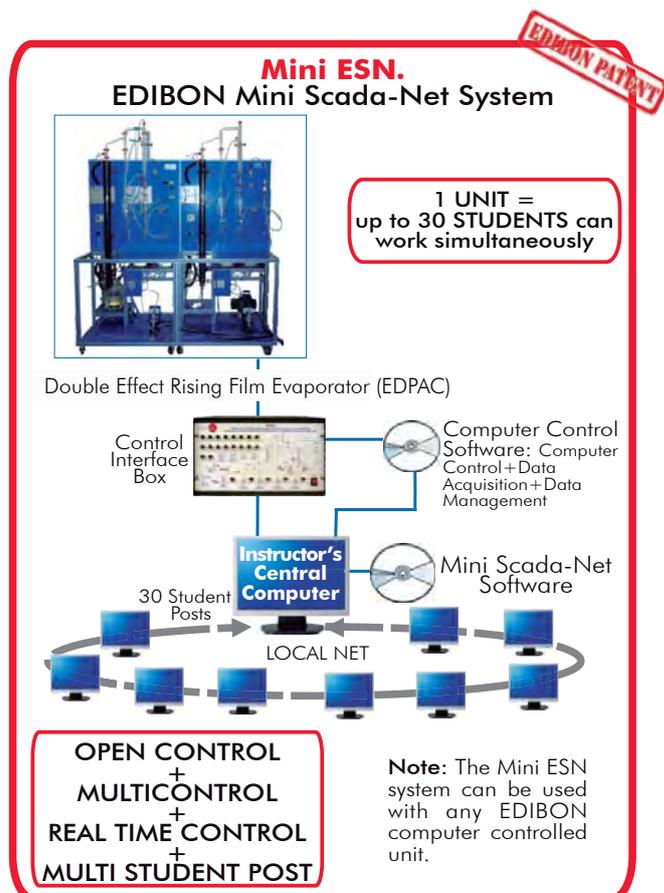
- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA and PID Control, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

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

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

[www.edibon.com/products/catalogues/en/Mini-ESN.pdf](http://www.edibon.com/products/catalogues/en/Mini-ESN.pdf)



⑫ **ESN. EDIBON Scada-Net System.**

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

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

[www.edibon.com/products/catalogues/en/units/chemicalengineering/esn-chemicalengineering/ESN-CHEMICAL\\_ENGINEERING.pdf](http://www.edibon.com/products/catalogues/en/units/chemicalengineering/esn-chemicalengineering/ESN-CHEMICAL_ENGINEERING.pdf)

**Main items** (always included in the supply)

Minimum supply always includes:

- ① Unit: EDPAC. Double Effect Rising Film Evaporator.
- ② EDPAC/CIB. Control Interface Box.
- ③ DAB. Data Acquisition Board.
- ④ EDPAC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software.
- ⑤ Cables and Accessories, for normal operation.
- ⑥ Manuals.

\* IMPORTANT: Under EDPAC 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.
  - EDPAC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

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

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

- ⑩ EDPAC/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 EDPAC. Unit:**

- Anodized aluminum structure and panels in painted steel.
  - Main metallic elements in stainless steel.
  - Three diagrams with the arrangement of the elements in the front panel with the three possible configurations.
  - 2 Evaporation double jacket columns, with a heating area of 0.122 m<sup>2</sup>, 30 mm of inner diameter, 60 mm of outer diameter and length of 1300 mm.
  - 2 Membrane dosing pumps, computer controlled, with maximum flow of 15 l./h. with flow control.
  - Simple effect vacuum pump, computer controlled, with maximum flow of 3 m<sup>3</sup>/h and maximum vacuum of 150 microns.
  - Five 10 l. tanks (for feeding, concentrated and evaporated).
  - Four 500 ml graduated vessels for storage of concentrated and evaporated product.
  - Immersion heating element, computer controlled, range: 300W.
  - Included a safety temperature sensor with internal temperature controller.
  - Automatic temperature control (PID Control).
  - 2 Coil coolants with length of 400 mm.
  - 2 High safety pressure cut out for pressure control in the columns.
  - 13 Temperature sensors, "J" type.
  - 1 Flow sensor, range: 0.2 to 6.5 l./min.
  - 2 Pressure sensors of 0 to 2 bar.
  - 5 Force sensors, one in each one of the five tanks (for feeding, concentrated and evaporated), for measuring the amount fed or collected substance.
  - 2 Solenoid valves, computer controlled.
- The unit allows to work with several configurations:
- a) Double-effect: the steam generated in the first stage of the evaporation is introduced in the second column.
  - b) Steam from the first column's jacket can be used to heat the second column.
  - c) Columns receive steam from the generator in an independent way.

This unit incorporates wheels for its mobility.

The complete unit includes as well:

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

Optional accessory (not included in the minimum supply):

- EDPDC. Computer Controlled Double Effect Falling Film Evaporator (for adding to EDPAC).

**② EDPAC/CIB. Control Interface Box:**

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

**③ DAB. Data Acquisition Board:**

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

**④ EDPAC/CSOF. PID Computer Control + Data Acquisition + Data Management Software:**

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

**⑤ Cables and Accessories**, for normal operation.**⑥ Manuals:** This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

**Exercises and Practical Possibilities to be done with Main Items**

- 1.- Heating efficiency calculation.
- 2.- Sugared solution concentration.
- 3.- Evaporation velocity determination.
- 4.- Study of the evaporation velocity in function of the working conditions.
- 5.- Study of the relation between condensed and evaporated product.
- 6.- Study of the mass balance of the solute.
- 7.- Study of the mass balance of the solvent.
- 8.- Energy balance of the evaporation unit.
- 9.- Energy balance of the tubular refrigerator.
- 10.- Heat transfer global coefficient determination.
- 11.- Heat transfer coefficient determination of a tubular refrigerator.
- 12.- Study of the mass balance of the solute in one column.
- 13.- Fruit juices and vegetable extracts concentration.
- 14.- Concentrated milk obtaining.
- 15.- Efficiency determination of the steam used in the process.
- 16.- Steam generator efficiency determination.
- 17.- Investigation of effect of varying process parameters such as: vacuum, flow rate, temperature, recycle rate.

Additional practical possibilities:

- 18.- Temperature sensors calibration.
- 19.- Force sensors calibration.
- 20.- Pressure sensors calibration.
- 21.- Feed pumps calibration.

Other possibilities to be done with this Unit:

- 22.- Many students view results simultaneously.

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

- 23.- 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.

- 24.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
- 25.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
- 26.- This unit can be used for doing applied research.
- 27.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
- 28.- Control of the EDPAC unit process through the control interface box without the computer.
- 29.- Visualization of all the sensors values used in the EDPAC 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.

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

b) Technical and Vocational Education configuration

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

This complete software package consists on an Instructor Software (INS/ SOF) totally integrated with the Student Software (EDPAC/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.
- Generate and print reports.
- Detect student's progress and difficulties.

-EDPAC/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 **EDPAC/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 **EDPAC/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 doing the necessary calculations to extract the right conclusions from data obtained during the experimental practices.

CAL computes the value of all the variables involved and performs the calculations.

It allows to plot and print the results. Within 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

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- 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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