Computer Controlled **Continuous and Batch Filtration Unit**

TFUC

Technical Teaching Equipment

Always included in the supply:

EDIBON PATENT

Teaching Technique used

SCADA. EDIBON Computer Control System

② Control Interface Box
⑤ Cables and Accessories
⑥ Manuals

③ Data Acquisition Board

④ Software for:
- Computer Control
- Data Acquisition
- Data Management

Computer (not included in the supply)

① Unit TFUC. Continuous and Batch Filtration Unit

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↳Products
  ↳Products range
    ↳Units
      ↳9.-Thermodynamics & Thermotechnics and
      11.-Chemical Engineering

DESCRIPTION

The TFUC unit demonstrates the principles of continuous and batch filtration.

This filtration unit lets the study of the filtration process for two different filters. On one side a vertical plates filter, composed of sheets of nylon, 5 microns in diameter, allowing us to filter the $CaCO_3$ suspension of known concentration. In addition, a filter cartridge, more suitable for continuous filtration of material in a larger size, will filter and "clean" water with small pieces of paper sample.
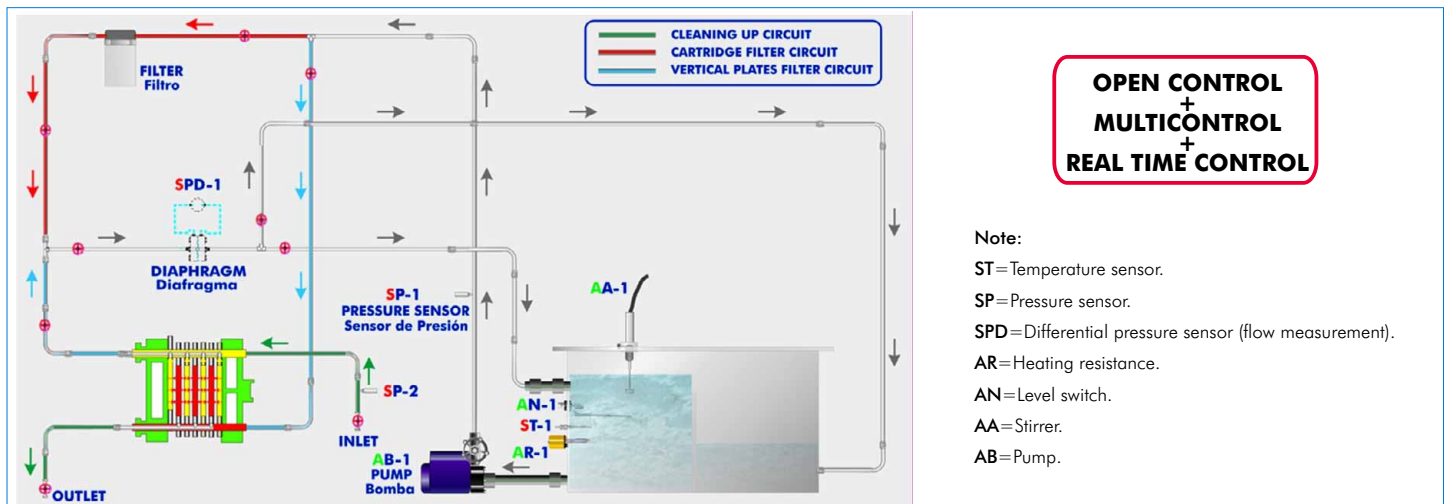
To carry out the experiments, the mixture is taken from a tank through a centrifugal pump, which sends it to one of the filters depending on the position of the valves. A motor-driven stirrer will make more homogeneous the sample inside the tank.

Along the way, the mixture goes through one pressure sensor and differential pressure sensor, which will help us to determine the flow through the circuit. The initial temperature of the sample can be controlled by a resistance and a temperature sensor, which will give the temperature value at any time.

Process control is done from the computer (PC) by using the EDIBON Computer Control System (SCADA). The software will allow the automatic control (PID) of the variables involved in the process, which will make easier the work.

There are two ways of working with the unit: the product (filtered) can be resent to the initial tank to be refiltered again or it can be sent to the "product tank" to analyse the result after just one passing through the filters. Depending on the conditions you want to work, depending on what you want to study, we will work in one or another way. To change the way to work, just turn the valves after the flow sensor.

PROCESS DIAGRAM AND ELEMENTS ALLOCATION

CLEANING UP CIRCUIT
CARTRIDGE FILTER CIRCUIT
VERTICAL PLATES FILTER CIRCUIT

FILTER
Filtro

SPD-1

DIAPHRAGM
Diafragma

SP-1
PRESSURE SENSOR
Sensor de Presión

SP-2

INLET

AB-1
PUMP
Bomba

OUTLET

AA-1

AN-1
ST-1
AR-1

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

Note:
ST=Temperature sensor.
SP=Pressure sensor.
SPD=Differential pressure sensor (flow measurement).
AR=Heating resistance.
AN=Level switch.
AA=Stirrer.
AB=Pump.

Items supplied as stardard

① TFUC. Unit:

This filtration unit demonstrates the principles of continuous and batch filtration.

Bench-top unit with anodized aluminium structure and panels in painted steel (epoxy paint).

Main metallic elements in stainless steel.

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

Double tank (capacity: 9 litres), connecting to a centrifugal pump which feeds a slurry to one of the filters depending on the position of the valves.

Centrifugal pump, computer controlled (max. 4 bar). A PID control enables constant flow rate. A PID control enables constant pressure operation by controlling the speed of the pump (from computer).

Heating resistance, computer controlled. Range: 300 W.

Level switch in the tank.

Vertical plates filter, composed of 4 sheets of nylon, 5 microns diameter, allowing us to filter the $CaCO_3$ suspension of known concentration.

Filter cartridge will filter and "clean" water with small pieces of paper sample.

Stirrer, computer controlled.

2 Temperature sensors, " J " type , range: 0-60°C.

2 Pressure sensors, range: 0-4.5 bar.

1 Differential pressure sensor, for flow measurement (0-6 l/min.).

Water and calcium carbonate are the recommended working materials for reasons of safety and ease to use.
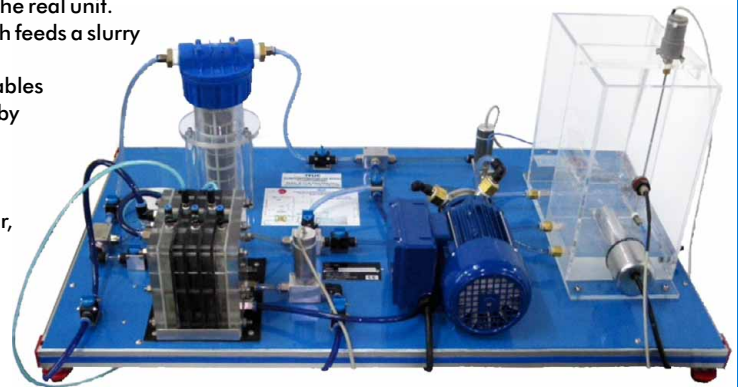
TFUC. Unit

② TFUC/CIB. Control Interface Box:

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.

Simultaneously 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 placed in only one computer screen.

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 time and in a 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, other electronic in control interface and the third one in the control software.

TFUC/CIB

③ DAB. Data Acquisition Board:

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 KSPS (Kilo samples per second).

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

Analog output: Number of **channels=2**. **Resolution=16 bits**, 1 in 65536. Max. output rate up to: 833 KSPS.

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

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

Timing: **Counter/timers=2**. Resolution: Counter/timers: 32 bits.

DAB

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

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 simultaneously way.

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

Analog and digital PID control. Menu for PID and set point selection required in the whole work range.

Management, processing, comparison and storage of data.

Sampling velocity up to 250,000 data per second guaranteed.

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 to 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 at different work levels.

This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.
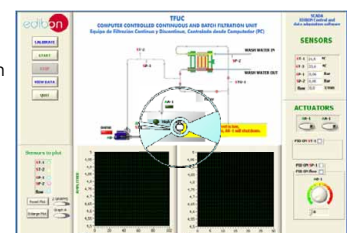
TFUC/CCSOF

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: TFUC + TFUC/CIB + DAB + TFUC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply, enabling a normal operation.**

Complementary items to the standard supply

PLC. Industrial Control using PLC (7 and 8):

⑦ PLC-PI. PLC Module:
Circuit diagram in the 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 (-10V. to + 10V.)(through SCSI connector).
   Analog outputs block:
      4 Analog outputs (-10V. to + 10V) (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.
      Free input AC voltage(100 to 240 V AC).
      DC input: 16 (24 V DC).
      Relay output: 14 (250 V A AC/2 A).
      High-speed counter.
      Multi-point PID control.
      Digital inputs/outputs and analog inputs/outputs Panasonic modules.
   Communication RS232 wire, to computer (PC).
⑧ TFUC/PLC-SOF. PLC Control Software:
   For this particular unit, always included with PLC supply.

PLC-PI

Items available on request

⑨ TFUC/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

⑩ TFUC/FSS. Faults Simulation System.

Software Main Screens

Main screen

TFUC
COMPUTER CONTROLLED CONTINUOUS AND BATCH FILTRATION UNIT
Equipo de Filtración Continua y Discontinua, Controlado desde Computador (PC)

SCADA
EDIBON Control and
data adquisition software

CALIBRATE
START
STOP
VIEW DATA
QUIT

WASH WATER IN
WASH WATER OUT

ST-2
SP-1
SP-2
STU-1

Filter

AA-1
AN-1
ST-1
High Level
AR-1

pump
AB-1

Tank level is low,
for security reasons, AR-1 will shutdown.

SENSORS

ST-1	21,5	°C
ST-2	23,6	°C
SP-1	0,06	Bar
SP-2	0,05	Bar
flow	0,0	l/min

ACTUATORS

AR-1   AA-1

PID ON ST-1 ☐

PID ON SP-1 ☐
PID ON flow ☐
AB-1

0

Sensors to plot

ST-1 ○
ST-2 ○
SP-1 ○
SP-2 ○
flow ○

Reset Plot   2 GRAPHS
Enlarge Plot   Graph A

AMPLITUDE

Graph A
Graph B

TIME (seconds)

Note: ST=Temperature sensor.   SP=Pressure sensor.   AR=Heating resistance.   AA=Stirrer.   AB=Pump.   AN=Level switch.

Examples of Sensors Calibration screens

CALIBRATION

Restore Setting   Instructor
Analog Input Channel
ST-1
Sensor Name   ST-1
Calibration units   °C
Full Scale   100
Gain   95,7706   Offset   -0,391638

Least Squares Fit
PTA   10
Volts   0,2338   Calibrated   22

ENTER   EXIT

EXIT & SAVE

Technical Support

AR-1
AA-1   ACTUATORS

MULTICALIBRATE

Signed   Technical Support

Reference Value   23,8994

AT
Full Scale   100   Tolerance (%)   1

Reference	Select	Sensors	Volts	Calibrated	Err (%)
☐	☑	ST-1	0,2343	22,0472	1,85
☑	☐	ST-2	0,2366	23,9007	0
☐	☐	SP-1	0,0192	0,0618	23,84
☐	☐	SP-2	-0,0429	0,0539	23,85
☐	☐	SC-1	-0,0002	-0,4898	24,39
☐	☐	flow	0,0965	-0,0133	23,91
☐	☐	SC-1	-0,0698	-4,2332	38,13
☐	☐	SF-1	-0,0603	1,65862	22,24
☐	☐	ST-5	0,0013	0,008	23,89
☐	☐	ST-6	0,0327	3,057	80,84
☐	☐	ST-7	-0,0077	1,0331	22,87
☐	☐	SW-1	0,0417	2,876	21,03
☐	☐	SC-1	-0,0121	-10,6794	84,58
☐	☐		0,0301	0,0301	23,87
☐	☐		-0,0162	-0,0162	23,92
☐	☐	AN-1	0,0547	0,0547	23,85

☐ Select all

Data taken   0

ENTER   DONE

AB-1
AR-1   AA-1

AVE-1

Port 0   Port 1   Port 2

Restore   Restore Instructor

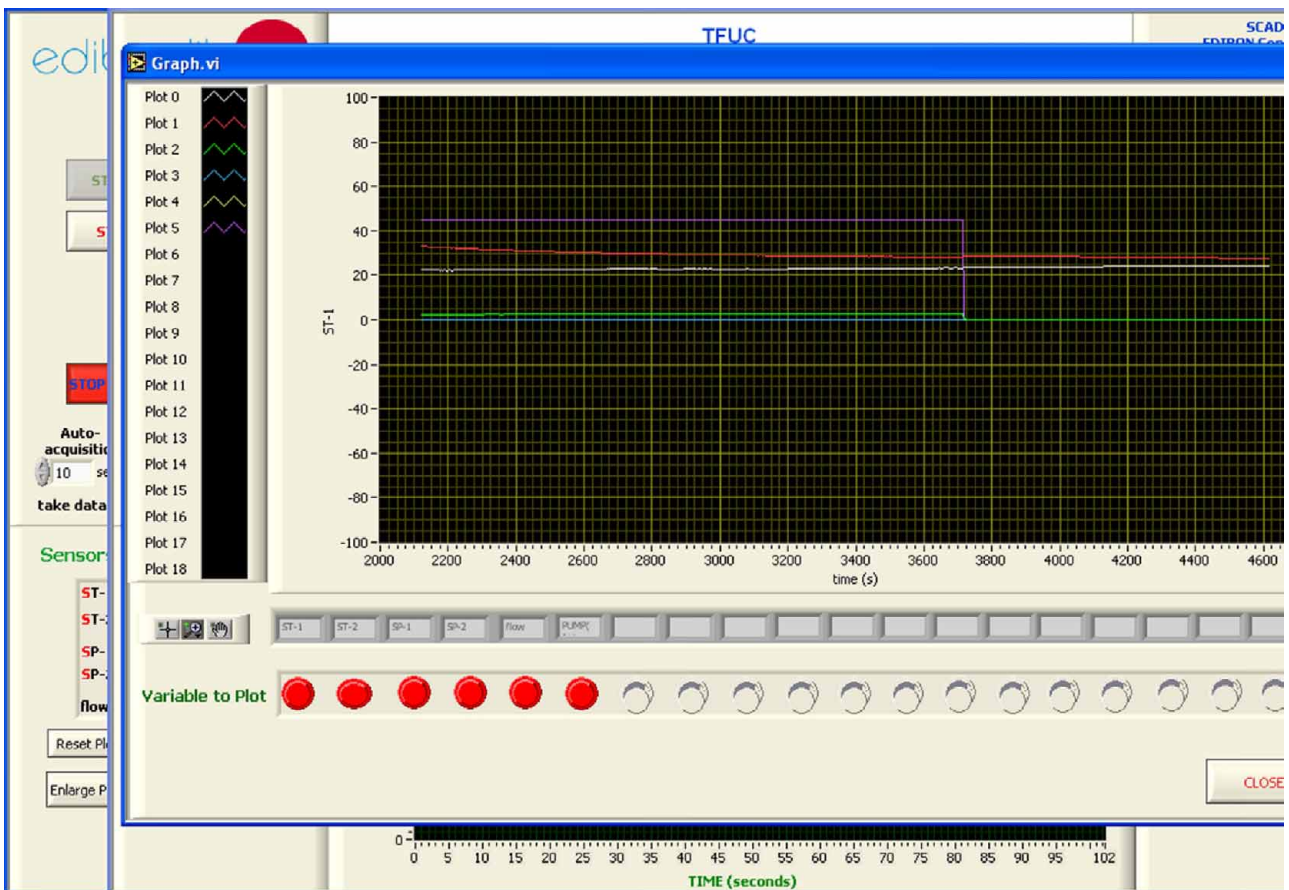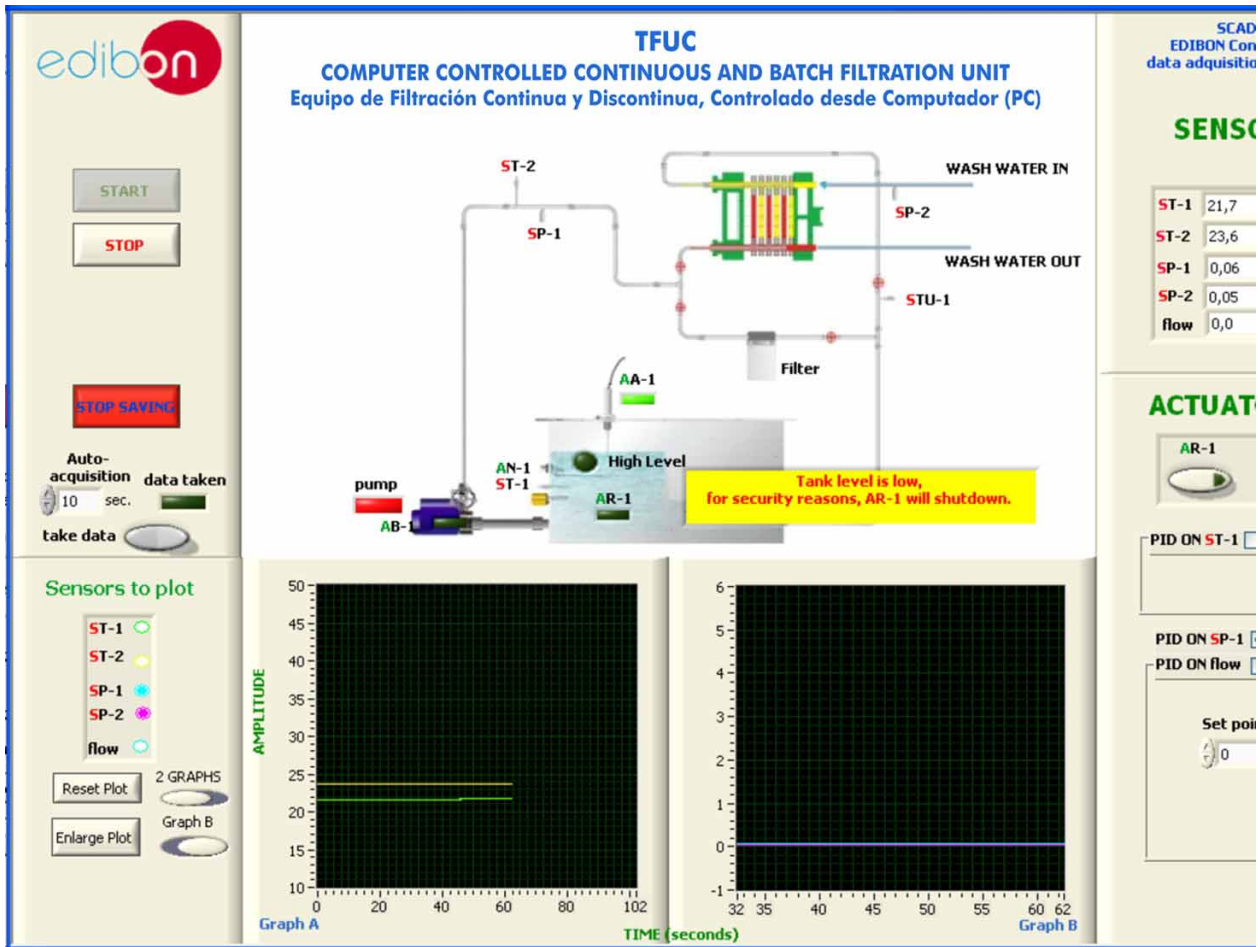|	GAIN	OFFSET	ρ
ST-1	95,7706	-0,3916	0
ST-2	97,2702	0,8832	0
SP-1	1,3628	0,0357	0
SP-2	1,85955	0,1337	0
SC-1	26,0765	-0,4838	0
flow	8,66514	-0,8499	0
SC-1	94,0404	2,3276	0
SF-1	0,486107	1,6879	0
ST-5	93,7694	-0,1168	0
ST-6	94,2813	-0,025	0
ST-7	95,1516	1,7614	0
SW-1	190,165	-5,0513	0
SC-1	879,1		0
	1	0	0
	1	0	0
AN-1	1	0	0

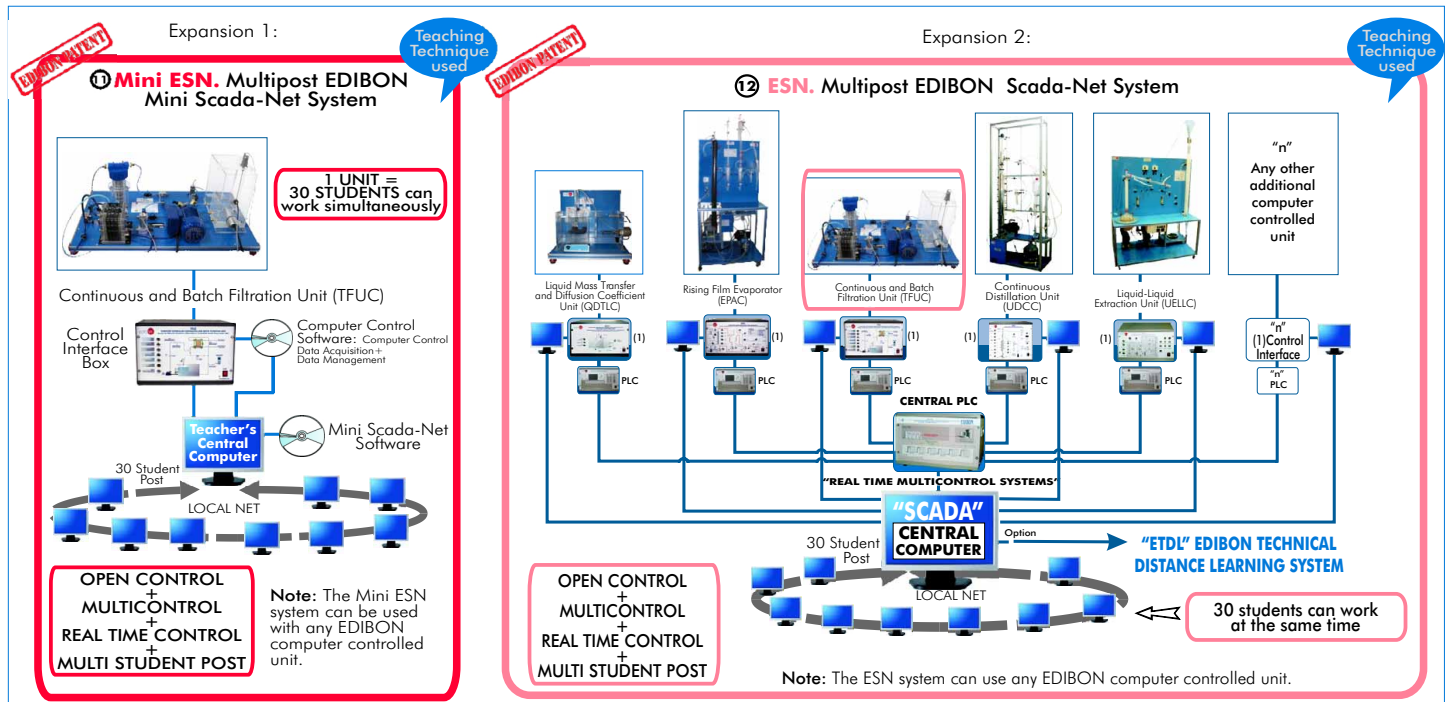Some typical exercises results
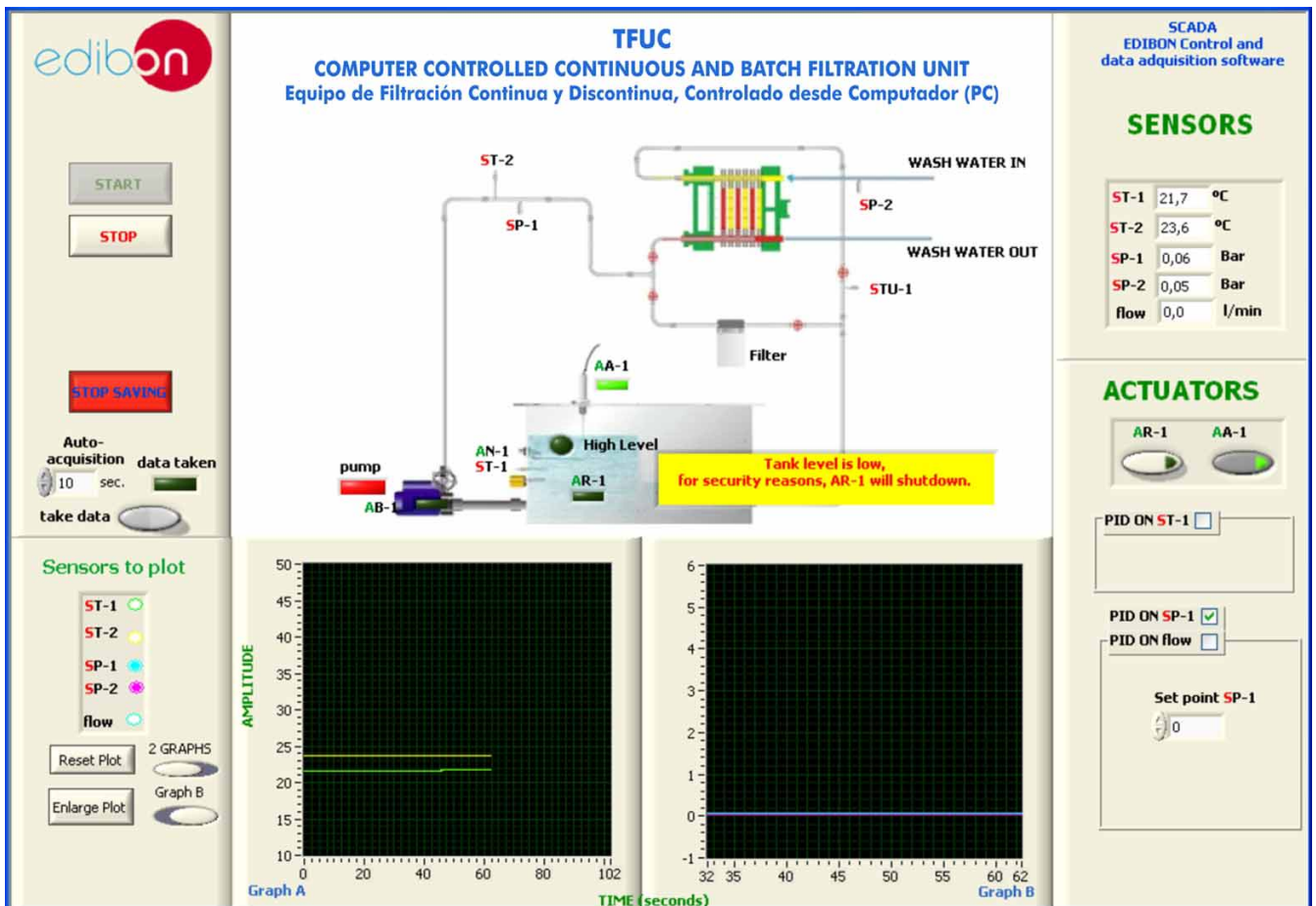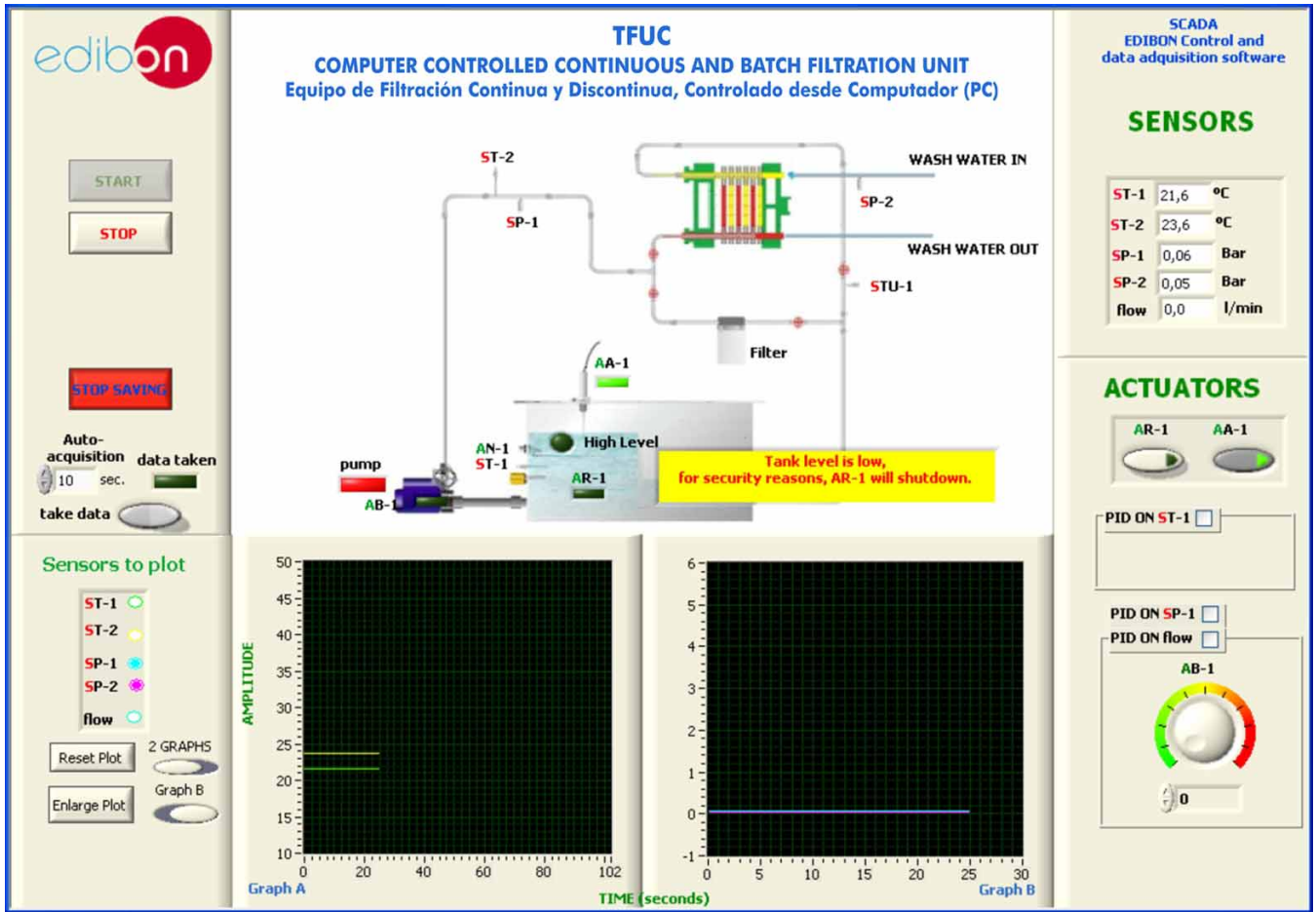
Some typical exercises results

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Understanding the principles of continuous and batch filtration using both constant pressure and constant flow operating modes (vertical plates and cartridge filters).
2.- Study of the filter plate at a constant pressure.
3.- Study of the filter plate at a constant flow.
4.- Study of the filter cartridge at constant pressure.
5.- Study of the filter cartridge at constant flow.
6.- Demonstrating filtration through membrane technology.
7.- Mass balancing.
8.- Precoat and body aid filtration.
9.- Demonstration of precoat filtration.
10.- Optimisation of filtration performance using body aid.
11.- Demonstration of Darcy's Law.
12.- Effect of body aid on medium and cake resistances.
13.- Determination of medium and cake resistances.
14.- Filter cake washing and dewatering.
15.- Study of commercial aspects of filtration and optimisation of filtration operations.

Other possible practices:

16.- Sensors calibration.

Practices to be done by PLC Module (PLC-PI)+PLC Control Software:

17.- Control of the TFUC unit process through the control interface box without computer.
18.- Visualization of all the sensors values used in TFUC unit process.

19.- Calibration of all sensors included in TFUC unit process.
20.- Hand on of all the actuators involved in the TFUC unit process.
21.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
22.- Simulation of outside actions, in the cases do not exist hardware elements (Example: test of complementary tanks, complementary industrial environment to the process to be studied, etc).
23.- PLC hardware general use and manipulation.
24.- PLC process application for the TFUC unit.
25.- PLC structure.
26.- PLC inputs and outputs configuration.
27.- PLC configuration possibilities.
28.- PLC program languages.
29.- PLC different programming standard languages (literal structured, graphic, etc.).
30.- New configuration and development of new process.
31.- Hand on an established process.
32.- To visualize and see the results and to make comparisons with the TFUC unit process.
33.- Possibility of creating new process in relation with the TFUC unit.
34.- PLC Programming Exercises.
35.- Own PLC applications in accordance with teacher and student requirements.

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:

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

1 UNIT = 30 STUDENTS can work simultaneously

Continuous and Batch Filtration Unit (TFUC)

Control Interface Box

Computer Control Software: Computer Control + Data Acquisition + Data Management

Teacher's Central Computer

Mini Scada-Net Software

30 Student Post

LOCAL NET

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL
+
MULTI STUDENT POST

Note: The Mini ESN system can be used with any EDIBON computer controlled unit.

Expansion 2:

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

Liquid Mass Transfer and Diffusion Coefficient Unit (QDTLC)

Rising Film Evaporator (EPAC)

Continuous and Batch Filtration Unit (TFUC)

Continuous Distillation Unit (UDCC)

Liquid-Liquid Extraction Unit (UELLC)

"n" Any other additional computer controlled unit

(1) PLC

CENTRAL PLC

"REAL TIME MULTICONTROL SYSTEMS"

"SCADA" CENTRAL COMPUTER

Option

"ETDL" EDIBON TECHNICAL DISTANCE LEARNING SYSTEM

30 Student Post

LOCAL NET

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL
+
MULTI STUDENT POST

30 students can work at the same time

Note: The ESN system can use any EDIBON computer controlled unit.

ORDER INFORMATION

Items supplied as standard

Minimum configuration for normal operation includes:

① Unit: TFUC. Continuous and Batch Filtration Unit.
② TFUC/CIB. Control Interface Box.
③ DAB. Data Acquisition Board.
④ TFUC/SOF. Computer Control + Data Acquisition + Data Management Software.
⑤ Cables and Accessories, for normal operation.
⑥ Manuals.

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

Complementary items to the standard supply

PLC. Industrial Control Using PLC (7 and 8):

⑦ PCL-PI. PLC Module.
⑧ TFUC/PLC-SOF. PLC Control Software.
⑨ TFUC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
⑩ TFUC/FSS. Faults Simulation System. (Available on request).

Expansions

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

REQUIRED SERVICES

- Electrical supply: single-phase, 220V/50Hz or 110V/60Hz.
- Water supply.
- Computer (PC).

OPTIONAL ACCESORIES

- Turbidity meter.

DIMENSIONS & WEIGHTS

TFUC. Unit :   -Dimensions: 750 x 750 x 400 mm. approx.

                        -Weight: 30 Kg. approx.

Control Interface Box: -Dimensions: 490 x 330 x 310 mm. approx.

                        -Weight: 10 Kg. approx.

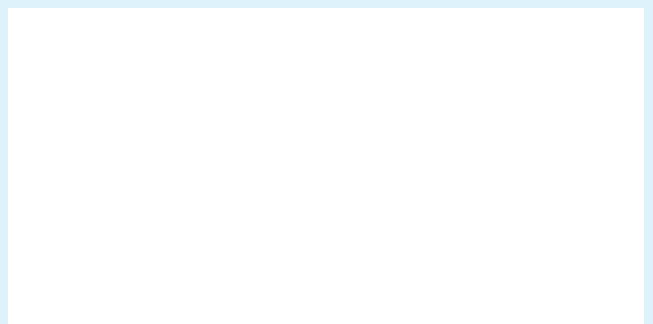PLC Module (PLC-PI): -Dimensions: 490 x 330 x 310 mm. approx.

                        -Weight: 30 Kg. approx.

✱ Specifications subject to change without previous notice, due to the convenience of improvements of the product.
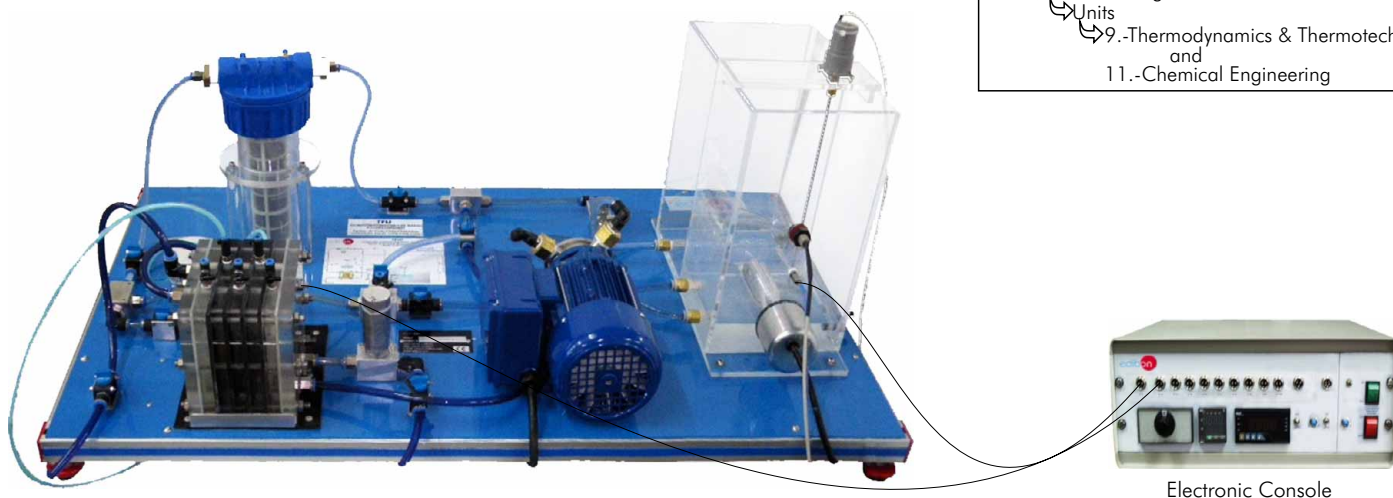
REPRESENTATIVE:

Continuous and Batch Filtration Unit

TFUB

Technical Teaching Equipment

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and
11.-Chemical Engineering

Electronic Console

DESCRIPTION

The TFUB unit demonstrates the principles of continuous and batch filtration.

This filtration unit lets the study of the filtration process for two different filters. On one side a vertical plates filter, composed of sheets of nylon, 5 microns in diameter, allowing us to filter the $CaCO_3$ suspension of known concentration. In addition, a filter cartridge, more suitable for continuous filtration of material in a larger size, will filter and "clean" water with small pieces of paper sample.

To carry out the experiments, the mixture is taken from a tank through a centrifugal pump, which sends it to one of the filters depending on the position of the valves. A motor-driven stirrer will make more homogeneous the sample inside the tank.

Along the way, the mixture goes through a manometer and a flow meter, which will help us to determine the flow through the circuit. The initial temperature of the sample can be controlled by a resistance and a temperature sensor, which will give the temperature value at any time.

There are two ways of working with the unit: the product (filtered) can be resent to the initial tank to be refiltered again or it can be sent to the "product tank" to analyse the result after just one passing through the filters. Depending on the conditions you want to work, depending on what you want to study, we will work in one or another way. To change the way to work, just turn the valves after the flow meter.

SPECIFICATIONS

This filtration unit demonstrates the principles of continuous and batch filtration.

Bench-top unit with anodized aluminium structure and panels in painted steel (epoxy paint).

Main metallic elements in stainless steel.

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

Double tank (capacity: 9 litres), connecting to a centrifugal pump which feeds a slurry to one of the filters depending on the position of the valves.

Centrifugal pump (max. 4 bar).

Heating resistance. Range: 300 W.

Level switch in the tank.

Vertical plates filter, composed of 4 sheets of nylon, 5 microns diameter, allowing us to filter the $CaCO_3$ suspension of known concentration.

Filter cartridge will filter and "clean" water with small pieces of paper sample.

Stirrer.

2 Temperature sensors, " J " type , range: 0-60°C.

Manometers.

Flow meter.

Water and calcium carbonate are the recommended working materials for reasons of safety and ease to use.

Electronic Console:

   Metallic box.

   Connections for the temperature sensors. Selector for the temperature sensors. Digital display for the temperature sensors.

   Heating resistance regulator.

   Pump regulator.

   Stirrer switch.

Cables and Accessories, for normal operation.

Manuals: This unit is supplied with following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

<u>Some Practical Possibilities of the Unit:</u>

1.- Understanding the principles of continuous and batch filtration using both constant pressure and constant flow operating modes (vertical plates and cartridge filters).

2.- Study of the filter plate at a constant pressure.

3.- Study of the filter plate at a constant flow.

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13.- Determination of medium and cake resistances.

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REQUIRED SERVICES

-Electrical supply: single-phase, 220V./50Hz or 110V./60Hz.
-Water supply.

OPTIONAL ACCESORIES

- Turbidity meter.

DIMENSIONS & WEIGHTS

TFUB:

Unit: -Dimensions: 750 x 750 x 400 mm. approx.

-Weight: 30 Kg. approx.

Electronic Console: -Dimensions: 490 x 330 x 310 mm. approx.

-Weight: 12 Kg. approx.

✷ Specifications subject to change without previous notice, due to the convenience of improvements of the product.

edibon
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