edibon
Technical Teaching Equipment

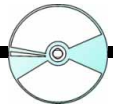
Computer Controlled
Flow Boiling Demonstration Unit
TFEC

EDIBON PATENT

Always included in the supply:

Teaching Technique used

SCADA.
EDIBON Computer Control System



Computer (not included in the supply)

② Control Interface Box

③ Data Acquisition Board

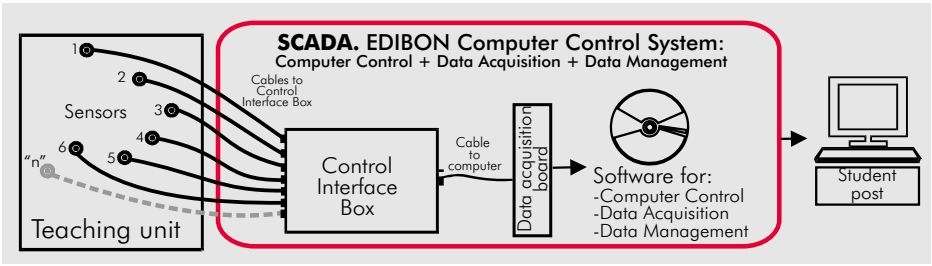
④ Software for:
- Computer Control
- Data Acquisition
- Data Management

⑤ Cables and Accessories

⑥ Manuals

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

① Unit: TFEC. Flow Boiling Demonstration Unit



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Products
Products range
Units
9.-Thermodynamics & Thermotechnics

INTRODUCTION

The flow boiling occurs in some point of the metal tubes of every vapour generation units such as vopour boilers, turbines, evaporators, etc. Usually, it occurs during the starting of these systems, until the vapour pressure is reached, causing two-phase flow: liquid and vopour. In some cases cavitation can occur.

The importance of studying the two-phase flow is due to the negative influence of this type of flow on the machines efficiency.

DESCRIPTION

The TFEC unit has as main component an experimental tube made of two glass concentric tubes. In these tubes two fluids flow crosscurrent: refrigerant, which flows by convection and in an ascendant way through the internal tube, and hot water, which flows in a descendant way through the external tube. This unit has been designed for using SES36 refrigerant gas, free of CFC´s, compatible with the Environment.

Refrigerant circuit:

The main circuit will be where the different stages of the two-phase flow will be visualised by student. This circuit is composed of:

- Internal glass concentric tube, where the refrigerant liquid flows.
- Regulation valve for the input flow to the experimental tube.
- Condensing chamber, that is complemented with an absolute pressure sensor which allows to determine the presence of air in the system, a security valve to protect it from possible over pressure. With a temperature sensor the refrigerant temperature into the tank will be visualized. Other temperature sensor shows the temperature of the saturated vapour in the condensing chamber.

Heating circuit:

Basically, this second circuit is composed of:

- External glass concentric tube, through which hot water flows to transfer the hot to the internal tube fluid.
- Thermostatic bath, with a resistance of 600W. It heats the water in the tank.
- Centrifugal pump for recirculation.

The electric power consumed by the resistance is controlled, from the computer, by PID over the bath temperature.

The heat transfer can be valued because there are two temperature sensors in the refrigerant liquid, in the input and in the output of the concentric tubes.

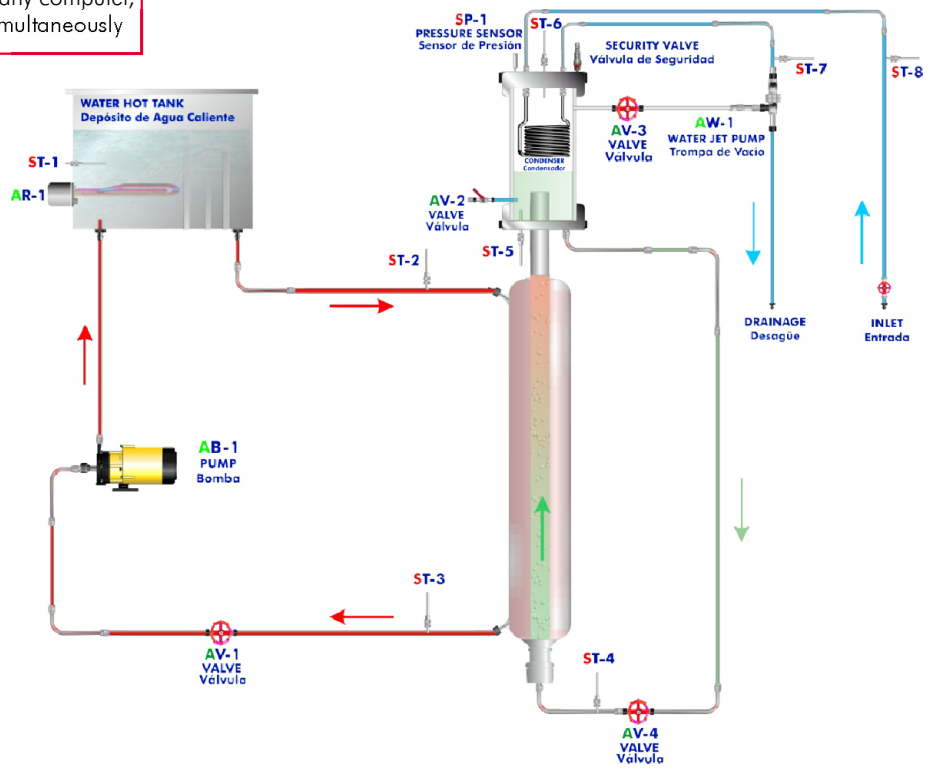
Finally the condensing chamber has a security valve. It also can be used if we want to carry out the refrigerant charge operation.

This Computer Controlled Unit, is supplied with the EDIBON Computer Control System (SCADA), including: Control Interface Box + Data Acquisition Board +Computer Control and Data Acquisition Software, for controlling the process and the parameters involved.

PROCESS DIAGRAM AND ELEMENTS ALLOCATION

2 actuators and 9 sensors controlled from any computer, and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL



Note:

SP=Pressure sensor.
ST=Temperature sensor.
AR=Heating resistance.

Items supplied as standard

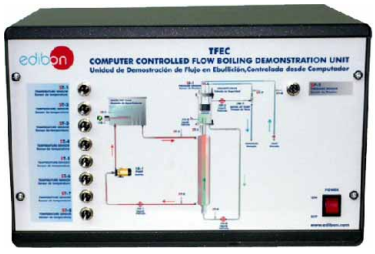
① TFEC. Unit:

Anodized aluminium structure and panels in painted steel (epoxi paint).
Main metallic elements in stainless steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
Experiment visualisation tube of 1500 mm. length composed by two glass concentric tubes.
Refrigerant control valve. It is needed for regulating the refrigerant flow during the experiment.
Condensing chamber: silicate boron of high resistance cylinder; internal diameter of 90 mm., external of 100 mm. and 300 mm. length.
Security valve, placed on the top of the condensing chamber. It is needed to avoid overpressures. It also can be used to the refrigerant charge.
Condensate coil, formed by a nickel-plated copper tube with a superficial area of 0.043 m^2.
Thermostatic bath, that heats the water that flows by the experimental tube periphery. It includes a heating resistance of 600W, computer controlled.
Centrifugal pump for hot water impulsion, computer controlled.
Water control valve. It is placed on the water conduction line and it regulates the water flow that enters in the condensate coil.
Water jet pump for extracting the air and controlling the refrigerant pressure.
8 Temperature sensors "J" type, distributed along the process to know the heat transfers occurred.
1 Absolute pressure sensor from 0 to 6.5 bar, to know the experiment pressure.
Water flow meter from 0 to 6.5 l./min.
Drain and security valve. If a high pressure in the condensing chamber is produced, the valve ats at the selected pressure.
This unit has been designed for using SES36 refrigerant gas, free of CFC´s, compatible with the Environment.
The unit incorporates wheels for mobility.

TFEC Unit

② TFEC/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.



TFEC/CIB

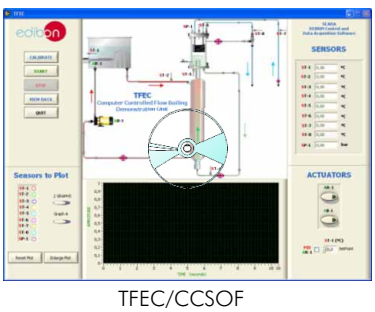
③ DAB. Data Acquisition Board:

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 KS/s** (Kilo samples per second). Input range (V)=±10V. Data transfers=DMA, interrupts, programmed I/0. Number of DMA channels=6.
Analog output: Number of **channels=2**. **Resolution=16 bits**, 1 in 65536. Maximum output rate up to: 833KS/s. 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 TFEC/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.



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

Continue...

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.

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).

PLC-PI

⑧ TFEC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

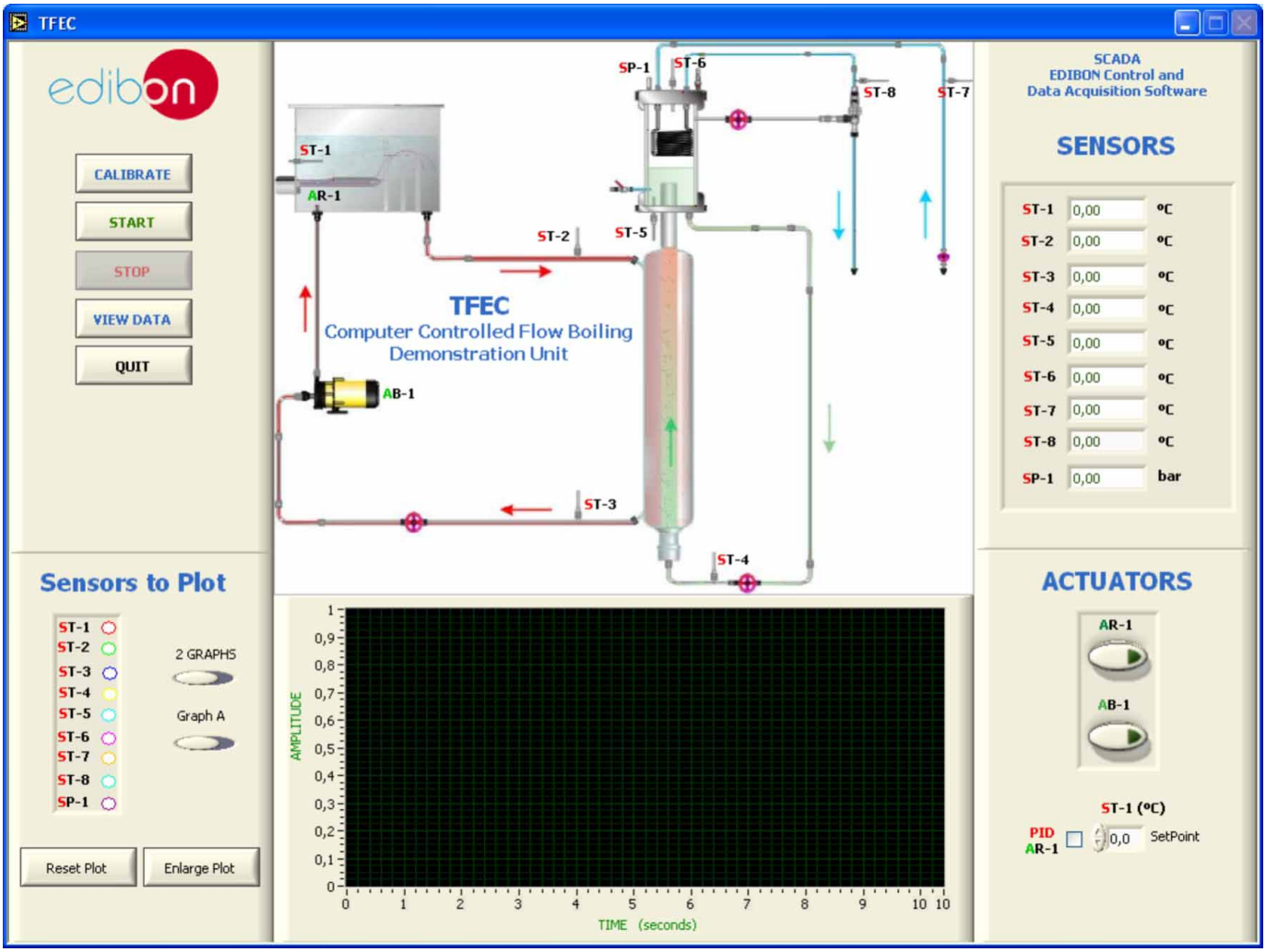
Items available on request

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

⑩ TFEC/FSS. Faults Simulation System.

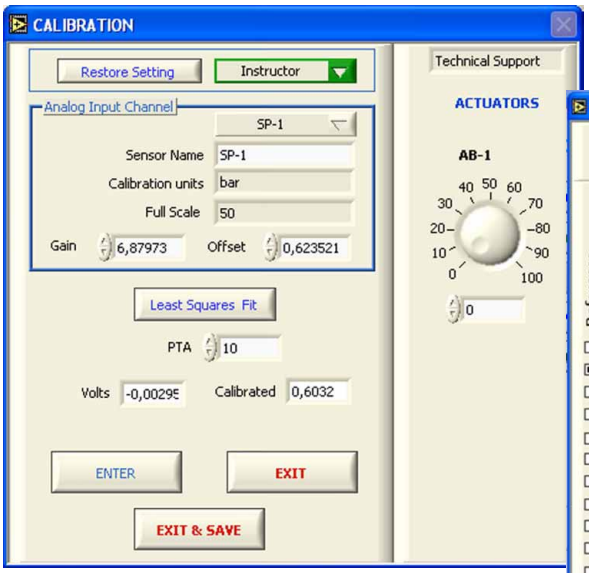
Software Main Screens

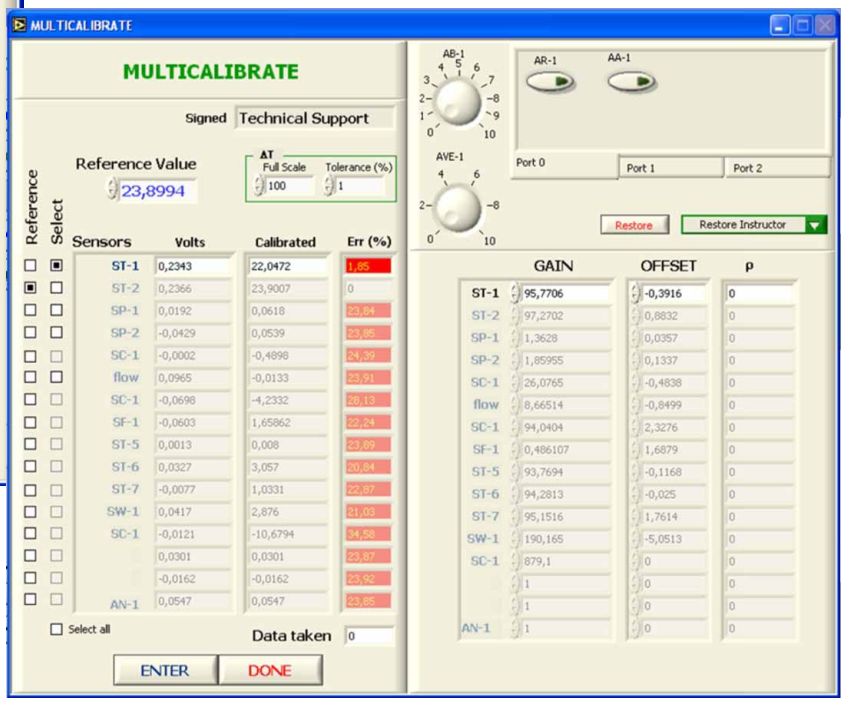
Main screen



Note: ST=Temperature sensor. SP=Pressure sensor. AR=Heating resistance. AB=Pump.

Examples of Sensors Calibration screens





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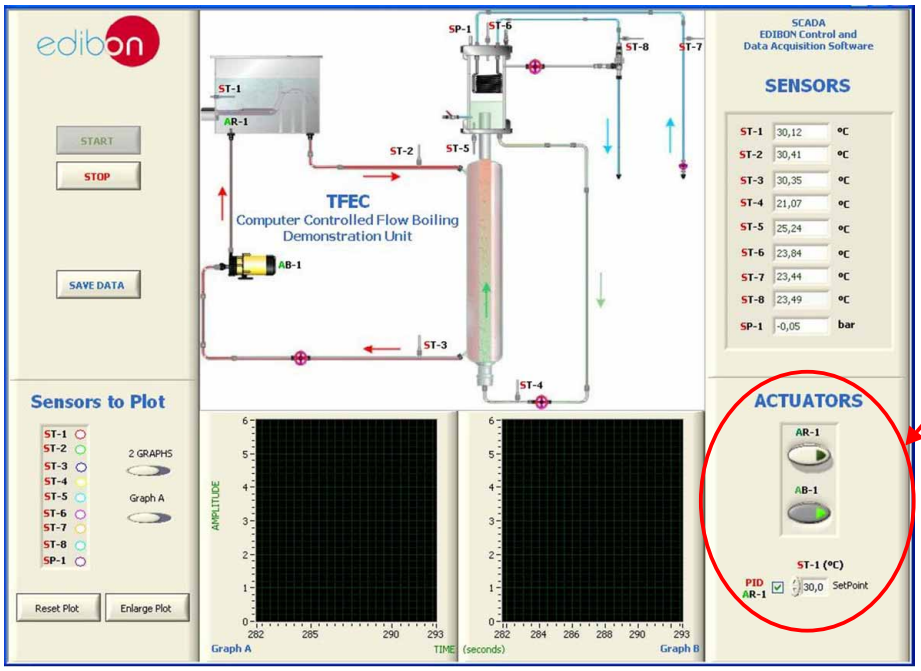
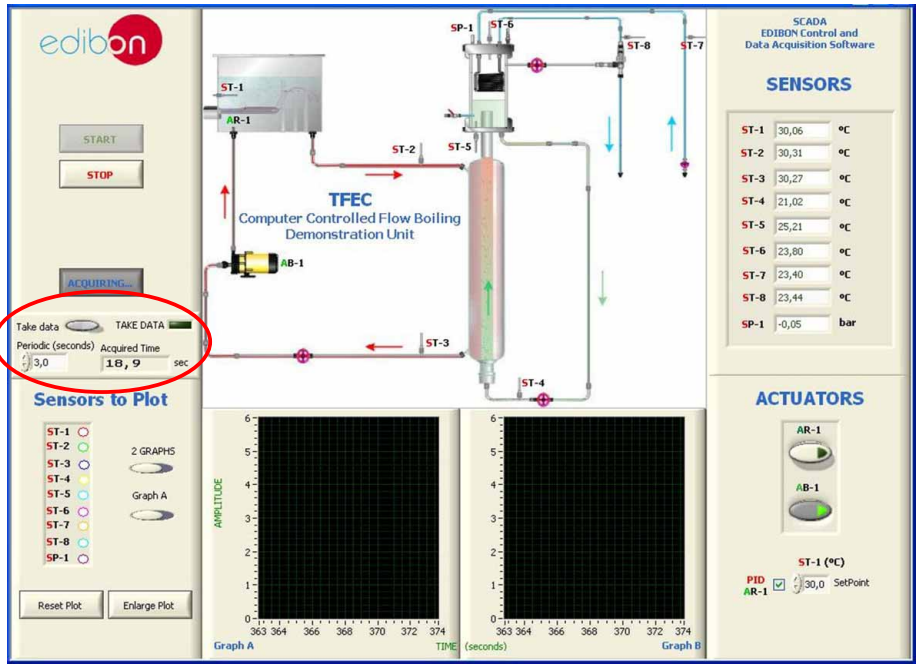


PID control over AR-1 resistance.

The student will be able to acquire the selected data in the sampling time.



Graphs screen.
The student has the possibility of enlarging the graphs for a better visualization.

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.-Observation of:
- Single-phase liquid flow.
- Sub-cooled boiling.
- Bubbly flow.
- Slug regime.
- Annular flow.
- Film boiling.
- Drop flow (mist).
- Single-phase vapour flow.

2.-Demonstration of a heating process accompanied by vapour formation within a tube, including:
- Circulation promoted by natural convection.
- Nucleation in sub-cooled and saturated liquid.
- Convective heat transfer to sub-cooled liquid.
- Slugging.
- Droplet entrainment.
- Annular flow.
- Complete dry out to superheated vapour.

3.-Demonstration of effect of air in condensers.
4.-Demonstration of two phase flow with increasing vapour content.
5.-Effect of flow rate on the evaporation process.
6.-Effect of temperature on the evaporation process.
7.-Effect of pressure on the evaporation process.
8.-Relationship between pressure and temperature.
9.-Film condensation.

Other possible practices:

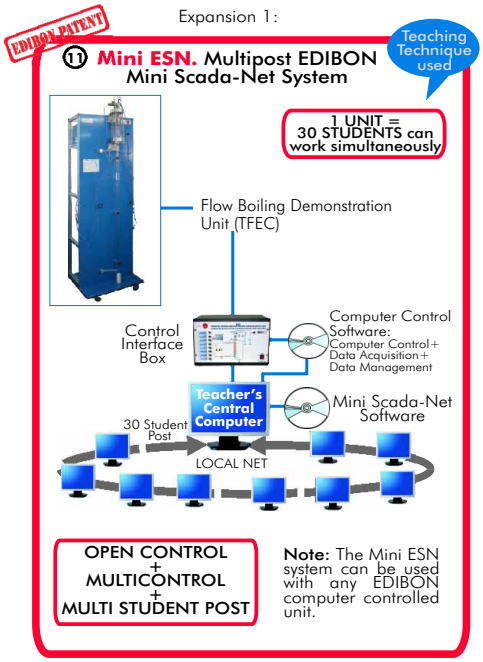
10.-Sensors calibration.

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

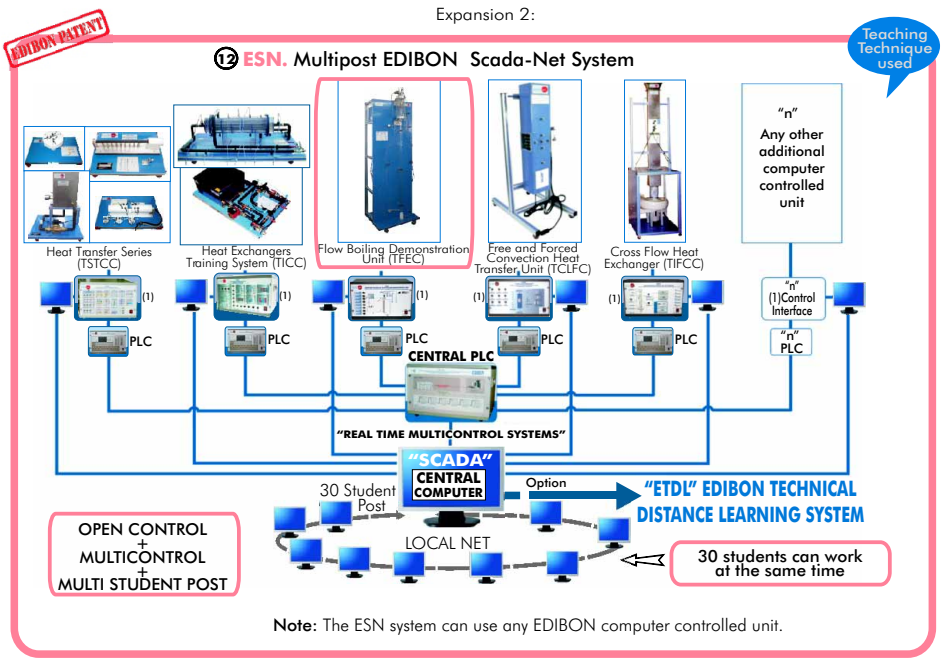
11.-Control of the TFEC unit process through the control interface box without the computer.
12.-Visualization of all the sensors values used in the TFEC unit process.
13.-Calibration of all sensors included in the TFEC unit process.
14.-Hand on of all the actuators involved in the TFEC unit process.
15.-Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
16.-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).
17.-PLC hardware general use and manipulation.
18.-PLC process application for TFEC unit.
19.-PLC structure.
20.-PLC inputs and outputs configuration.
21.-PLC configuration possibilities.
22.-PLC program languages.
23.-PLC different programming standard languages (literal structured, graphic, etc.).
24.-New configuration and development of new process.
25.-Hand on an established process.
26.-To visualize and see the results and to make comparisons with the TFEC unit process.
27.-Possibility of creating new process in relation with the TFEC unit.
28.-PLC Programming Exercises.
29.-Own PLC applications in accordance with teacher and student requirements.

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:



Expansion 2:



ORDER INFORMATION

Items supplied as standard

Minimum configuration for normal operation includes:

- ① **Unit: TFEC. Flow Boiling Demonstration Unit.**
- ② **TFEC/CIB. Control Interface Box.**
- ③ **DAB. Data Acquisition Board.**
- ④ **TFEC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
- ⑤ **Cables and Accessories**, for normal operation.
- ⑥ **Manuals.**

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

Complemenary items to the standard supply

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

- ⑦ PCL-PI.PLC Module.
- ⑧ TFEC/PLC-SOF. PLC Control Software.
- ⑨ TFEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request)
- ⑩ TFEC/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: 6 l/min., with pressure of 10 m. of height approx.
-SES36 refrigerant gas.
-Computer (PC).

DIMENSIONS & WEIGHTS

TFEC Unit:	-Dimensions: 750 x 700 x 2100 mm. approx. -Weight: 70 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.

AVAILABLE VERSIONS

Offered in this catalogue:

- TFEC. Computer Controlled **Flow Boiling Demonstration Unit.**

Offered in other catalogue:

- TFEB. **Flow Boiling Demonstration Unit.**

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

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