edibon

Technical Teaching Equipment

Computer Controlled **Cross Flow Heat Exchanger,**
with SCADA and PID Control

TIFCC

EDIBON PATENT

Teaching Technique used

EDIBON SCADA System
and **PID CONTROL** included

② Control Interface Box

③ Data Acquisition Board

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

Computer (not included in the supply)

⑤ Cables and Accessories
⑥ Manuals

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

Different exchangers in detail

① Unit: TIFCC. Cross Flow Heat Exchanger

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.**

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

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➥Products
➥Products range
➥Units
➥9.-Thermodynamics & Thermotechnics

For more information about Key Features, click here:

INTRODUCTION

Many types of heat exchangers have been designed to transfer heat between two fluids. In one of the most common systems heat is transferred between one fluid, which flows through a set of tubes, and another fluid, which flows outside in transverse direction.

This arrangement is known as cross flow heat exchanger. The tubes may be arranged in different ways in order to increase the efficiency of the heat exchanger and reduce its size. The objective of the arrangements of all the components is to promote turbulences in the fluid around the set of tubes.

The TIFCC unit designed by EDIBON is a teaching unit used for the study of the heat transfer phenomenon by convection in a cross-flow. The student will have a series of practical exercises to put in practice the knowledge acquired theoretically.

GENERAL DESCRIPTION

The Computer Controlled Cross Flow Heat Exchanger (TIFCC) basically consists of a rectangular wind tunnel made of stainless steel, resistant to corrosion. It has a bell-shaped inlet and a central opening arranged longitudinally with two supporting elements made of stainless steel to retain the plates with the different exchangers.

The tunnel is installed over the inlet of a powerful centrifugal fan and connected to it by an elastic coupling flange. This fan aspirates air from the tunnel and expels it outside, making air flow along the tunnel. There is a variable speed drive to control the air flow through the tunnel with the fan control through the computer (PC).

The TIFCC unit includes two types of exchangers: a pinned (multi-tube) exchanger and a single tube exchanger, where the heating element is lodged, which is controlled through the computer (PC).

To perform all the practical exercises the unit has two temperature sensors to measure the air temperature in the tunnel, before and after passing through the heat exchanger, a control temperature sensor lodged in the heating element and a pressure sensor that allows the user to determine the air flow along the tunnel.
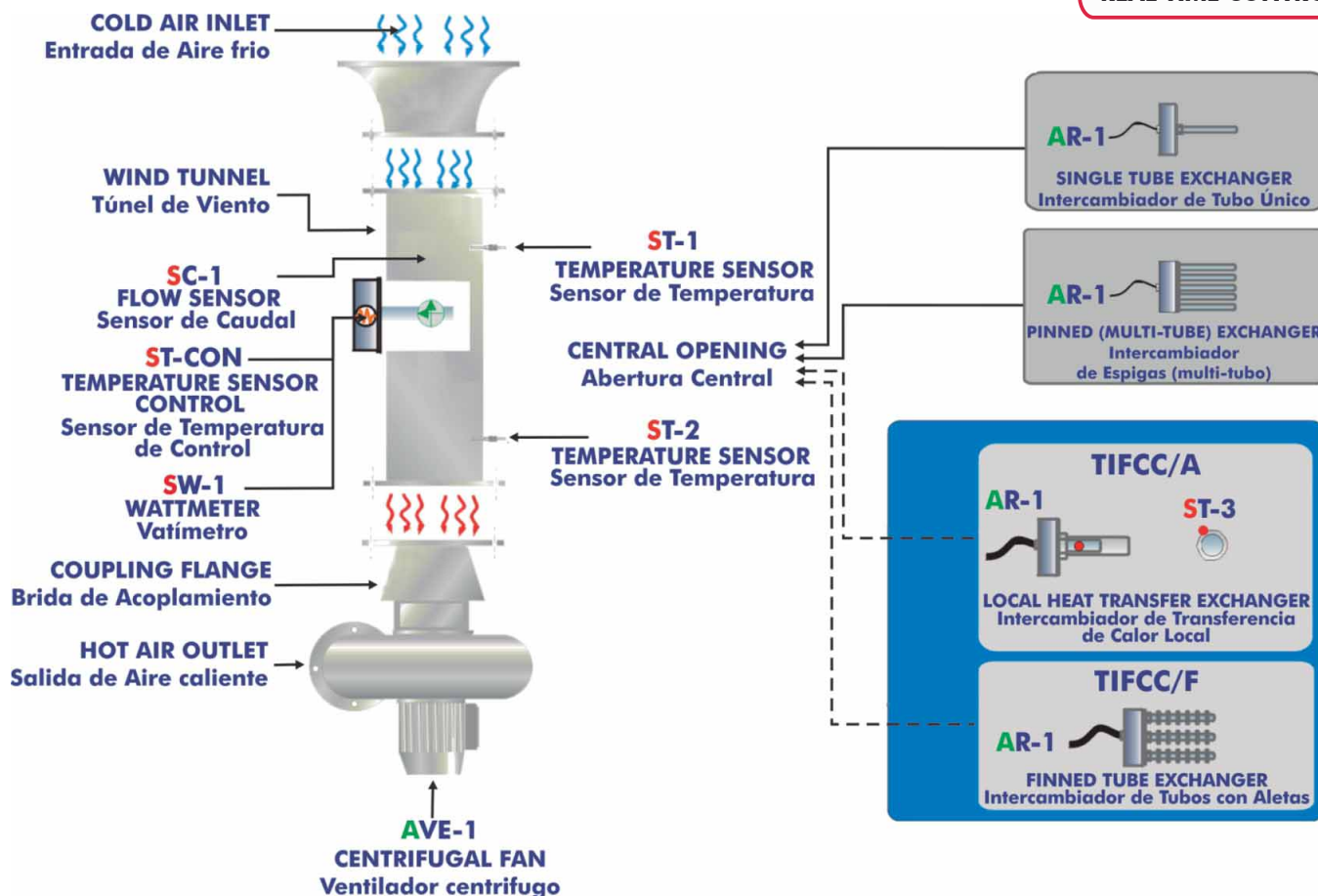
Available two optional exchangers: Local Heat Transfer Exchanger (TIFCC/A) and Finned Tube Exchanger (TIFCC/F).

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit self + 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

2 actuators and 6 sensors controlled from any computer, and working simultaneously

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

COLD AIR INLET
Entrada de Aire frio

WIND TUNNEL
Túnel de Viento

SC-1
FLOW SENSOR
Sensor de Caudal

ST-CON
TEMPERATURE SENSOR
CONTROL
Sensor de Temperatura
de Control

SW-1
WATTMETER
Vatímetro

COUPLING FLANGE
Brida de Acoplamiento

HOT AIR OUTLET
Salida de Aire caliente

AVE-1
CENTRIFUGAL FAN
Ventilador centrifugo

ST-1
TEMPERATURE SENSOR
Sensor de Temperatura

CENTRAL OPENING
Abertura Central

ST-2
TEMPERATURE SENSOR
Sensor de Temperatura

AR-1
SINGLE TUBE EXCHANGER
Intercambiador de Tubo Único

AR-1
PINNED (MULTI-TUBE) EXCHANGER
Intercambiador
de Espigas (multi-tubo)

TIFCC/A
AR-1   ST-3
LOCAL HEAT TRANSFER EXCHANGER
Intercambiador de Transferencia
de Calor Local

TIFCC/F
AR-1
FINNED TUBE EXCHANGER
Intercambiador de Tubos con Aletas

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 TIFCC. Unit:

Frame made of anodized aluminum and steel and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Stainless steel vertical tunnel of 1200 mm. long of rectangular section (65 x 170 mm.) and resistant to corrosion.

Rectangular central opening of 200 x 150 mm. in the tunnel with two supports made of stainless steel to hold the plates with the exchangers.

Elastic tunnel - fan coupling flange with clamp.

Computer controlled centrifugal fan, controlled through a variable-speed drive; operating range: 0 – 10 m/s.

Two "J" type temperature sensors.

Differential pressure sensor to know the air flow, range: 0-1 inch H_2O.

Computer controlled heating element with a diameter of 16 mm. and 80 mm. long (500W) with control thermocouple.

Wattmeter to measure the power supplied by the heating elements.

Included exchangers:

Single tube exchanger: one exchangeable plate made of Teflon with flat surface with a central bore to install the single tube heating element.

Pinned (multi-tube) exchanger: one exchangeable plate made of Teflon with 27 fixed tubes made of PVC of 16 mm. approximately of diameter arranged in an equilateral triangle. The tubes are arranged in six rows and there is a removable tube close to the center of each row. It can be replaced by the heating element to measure the effects of the rows of adjacent tubes on the heat transfer rate of the heating element.

Optional exchangers (not included in the minimum supply):

TIFCC/A. Local Heat Transfer Exchanger.

Exchangeable plate made of Teflon with a central bore of 40 mm. of diameter that allows to hold the direct transfer heating element (TDC).

Knurled and marked knob made of Teflon that allows to rotate the TDC circumferentially.

Computer controlled heating element with a diameter of 16 mm. and 70 mm. long (500W) and with control thermocouple.

"J" type thermocouple in the copper surface.

TIFCC/F. Finned Tube Exchanger.

Plate made of Teflon with 10 copper tubes with finned surface. The exchanger has four rows of finned tubes, so that the tubes are arranged in an equilateral triangle with a distance of 30 mm. between the centers. There is a removable finned tube close to the center of each row. It can be replaced by the heating element.

Computer controlled heating element with a diameter of 16 mm. and 100 mm. long (500W) with control thermocouple.

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).
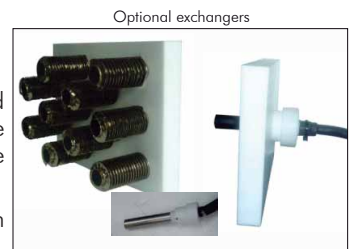
Designed and manufactured under several quality standards.

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.

Included exchangers

TIFCC. Unit

Optional exchangers

② **TIFCC/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.

TIFCC/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/0. DMA channels=6.

Analog output:

Number of **channels=2**. **Resolution=16 bits**, 1 in 65536.

Maximum output rate up to: 900 KS/s.

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

Digital Input/Output:

Number of **channels=24 inputs/outputs**. D0 or DI Sample Clock frequency: 0 to 100 MHz.

Timing: Number of **Counter/timers=4**. Resolution: Counter/timers: 32 bits.

DAB

④ **TIFCC/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.
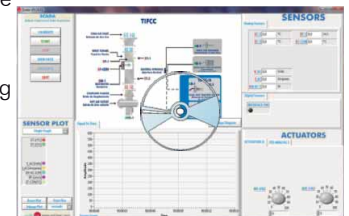
TIFCC/SOF

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: TIFCC + TIFCC/CIB + DAB + TIFCC/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.- Investigation of convective processes.

2.- Determination of heat transfer in a single tube exchanger.

3.- Determination of heat transfer in a pinned (multi-tube) exchanger.

4.- Determination of the average heat transfer in a pinned (multi-tube) exchanger.

5.- Deduction of the relationship between Nusselt, Reynolds and Prandtl numbers.

Additional practical possibilities:

6.- Sensors calibration.

Practical possibilities with the optional TIFCC/A exchanger:

7.- Determination of the existing relationship between Nusselt and Reynolds number using the direct heat transfer element.

8.- Determination of the local variation in the convective heat transfer coefficient, using the direct heat transfer element.

Practical possibilities with the optional TIFCC/F exchanger:

9.- Effect produced by the external fins in the heat transfer process.

10.- Determination of the heat transfer in a finned tube exchanger.

Other possibilities to be done with this Unit:

11.- Many students view results simultaneously.

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

12.- 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.

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

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

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

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

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

18.- Visualization of all the sensors values used in the TIFCC 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).

DIMENSIONS & WEIGHTS

TIFCC:

Unit:	-Dimensions:	900 x 450 x 2000 mm. approx. (35.43x17.71 x 78.74 inches approx.)
	-Weight:	100 Kg. approx. (220 pounds approx.).
Control Interface Box:	-Dimensions:	490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.).
	-Weight:	10 Kg. approx. (22 pounds approx.).

OPTIONAL EXCHANGERS

- TIFCC/A. Local Heat Transfer Exchanger.

- TIFCC/F. Finned Heat Exchanger.

AVAILABLE VERSIONS

Offered in this catalogue:
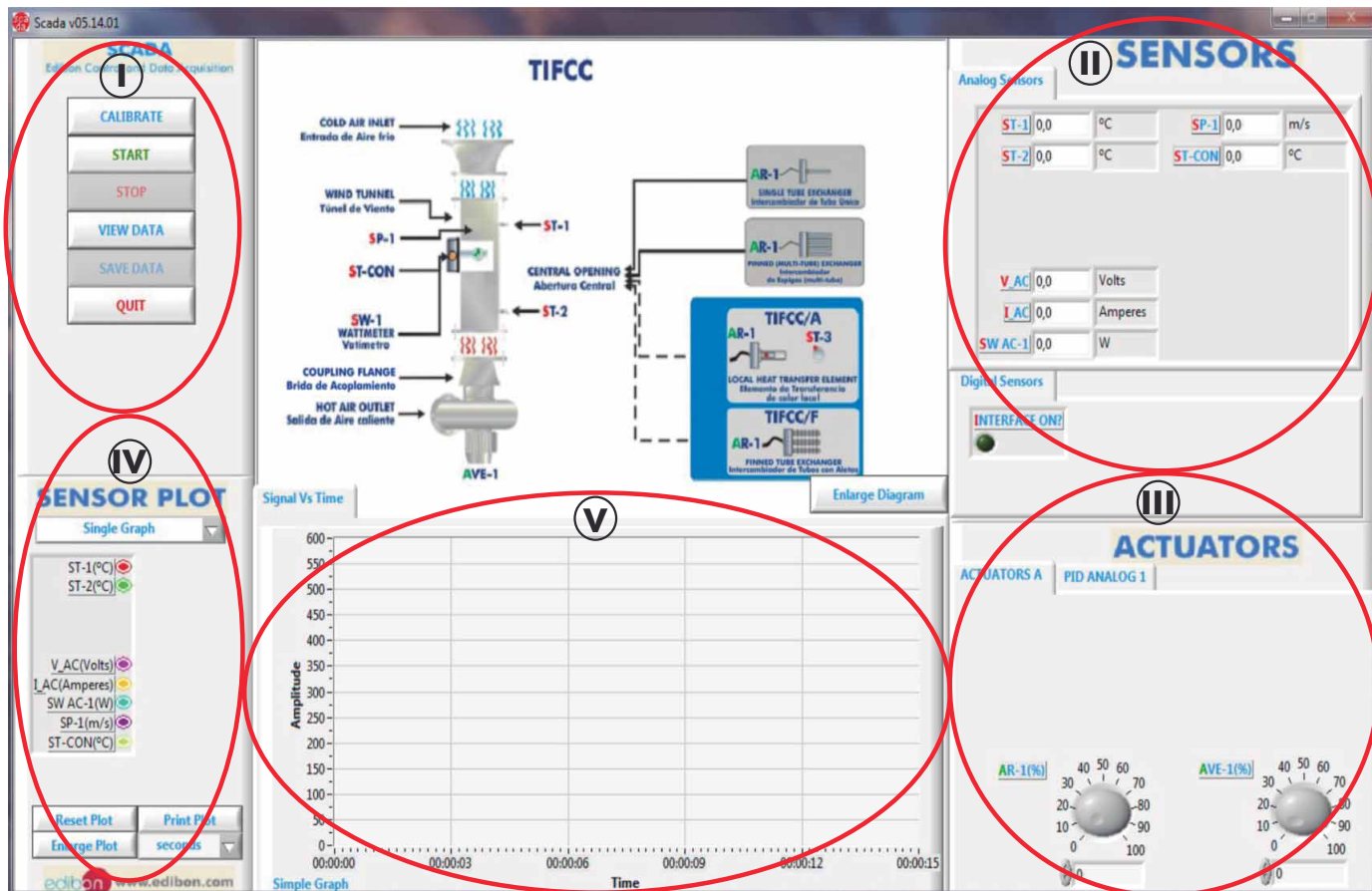
-TIFCC.   Computer Controlled Cross Flow Heat Exchanger.

Offered in other catalogues:

-TIFCB.   Cross Flow Heat Exchanger.

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 (to know the air flow).
ST-CON=Temperature sensor control. SW=Wattmeter.

Ⓘ Actuators controls. **Actuators:** AR=Heating element. AVE=Fan.

Ⓘ Channel selection and other plot parameters.

Ⓥ Real time graphics displays.

Software for Sensors Calibration
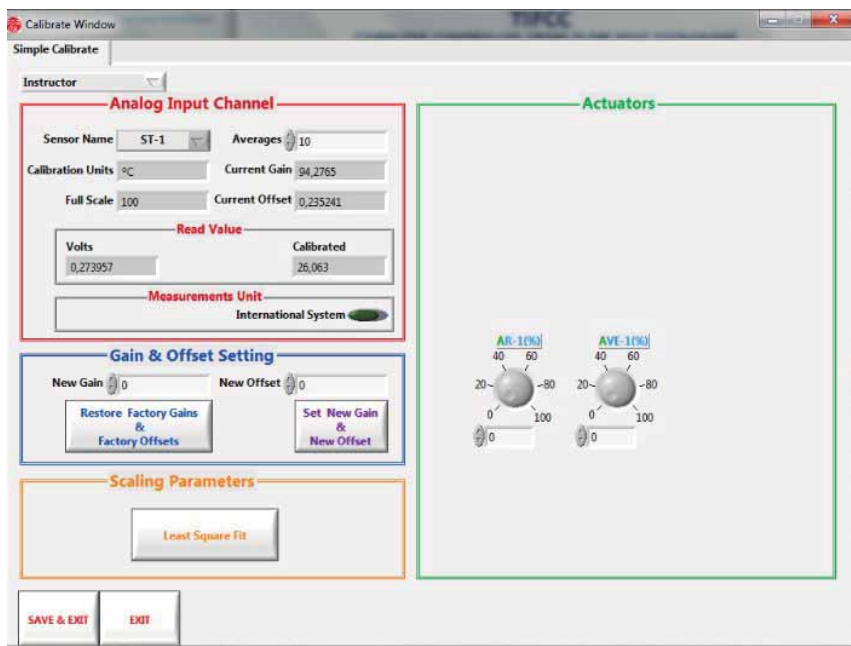
By using a free of charge code, the teacher and the students can calibrate the unit.
The teacher can recover his/her own calibration by using the EDIBON code that we give free of charge.

Selection of the exchanger used to perform the experiments. The TIFCC unit includes two types of exchangers: a pinned (multi-tube) exchanger and a single tube exchanger.
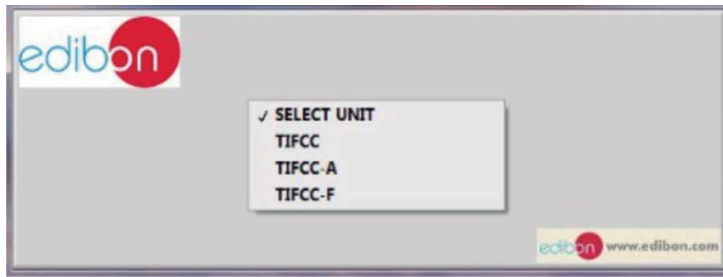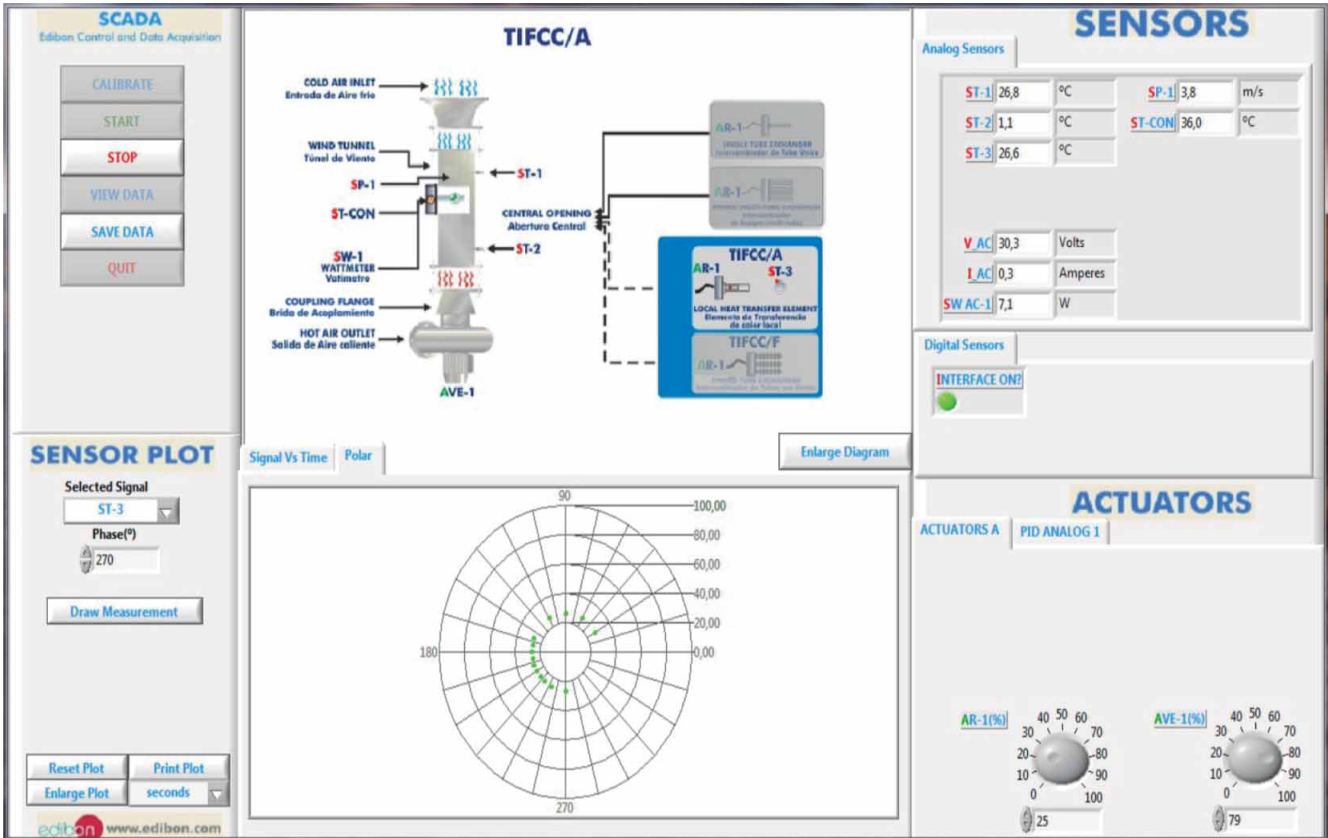

Results obtained with the pinned (multi-tube) exchanger. The software allows to control from 0-100% of the heating element power (AR-1) and the fan air flow (AVE-1).
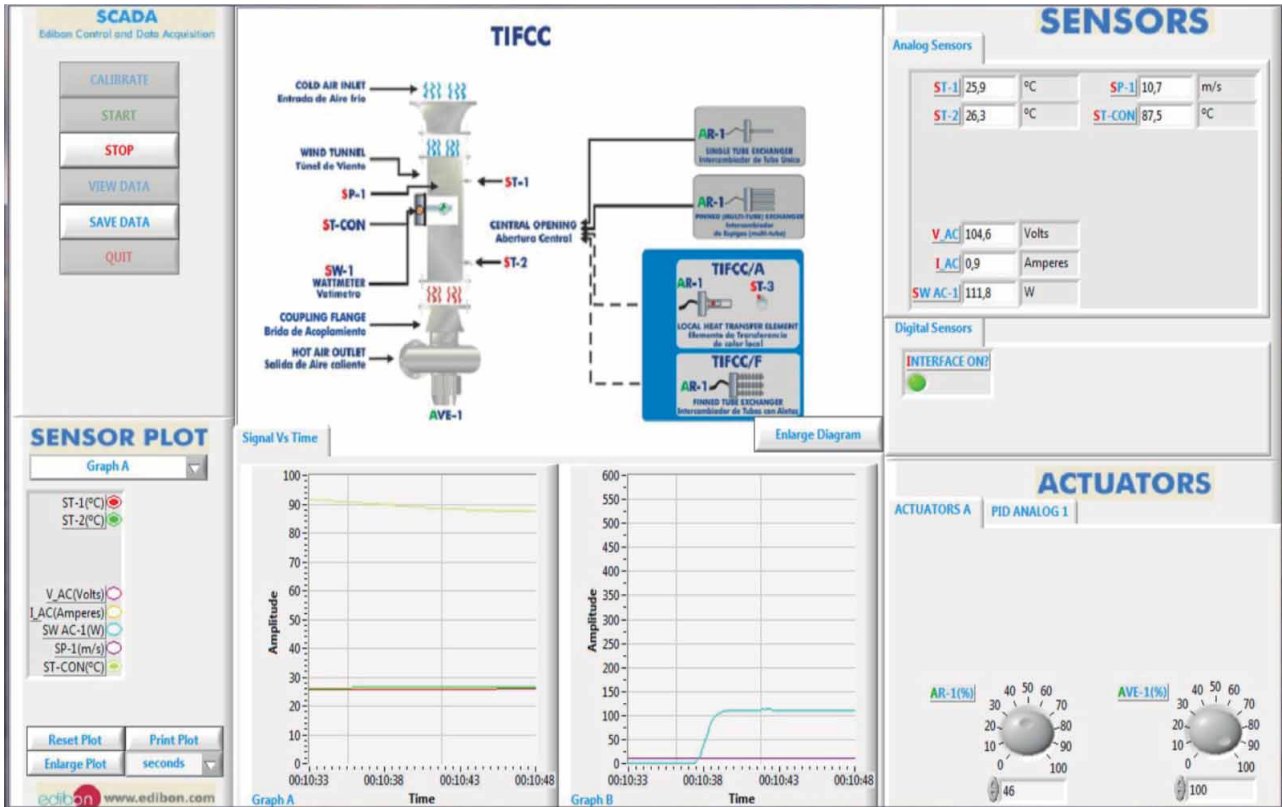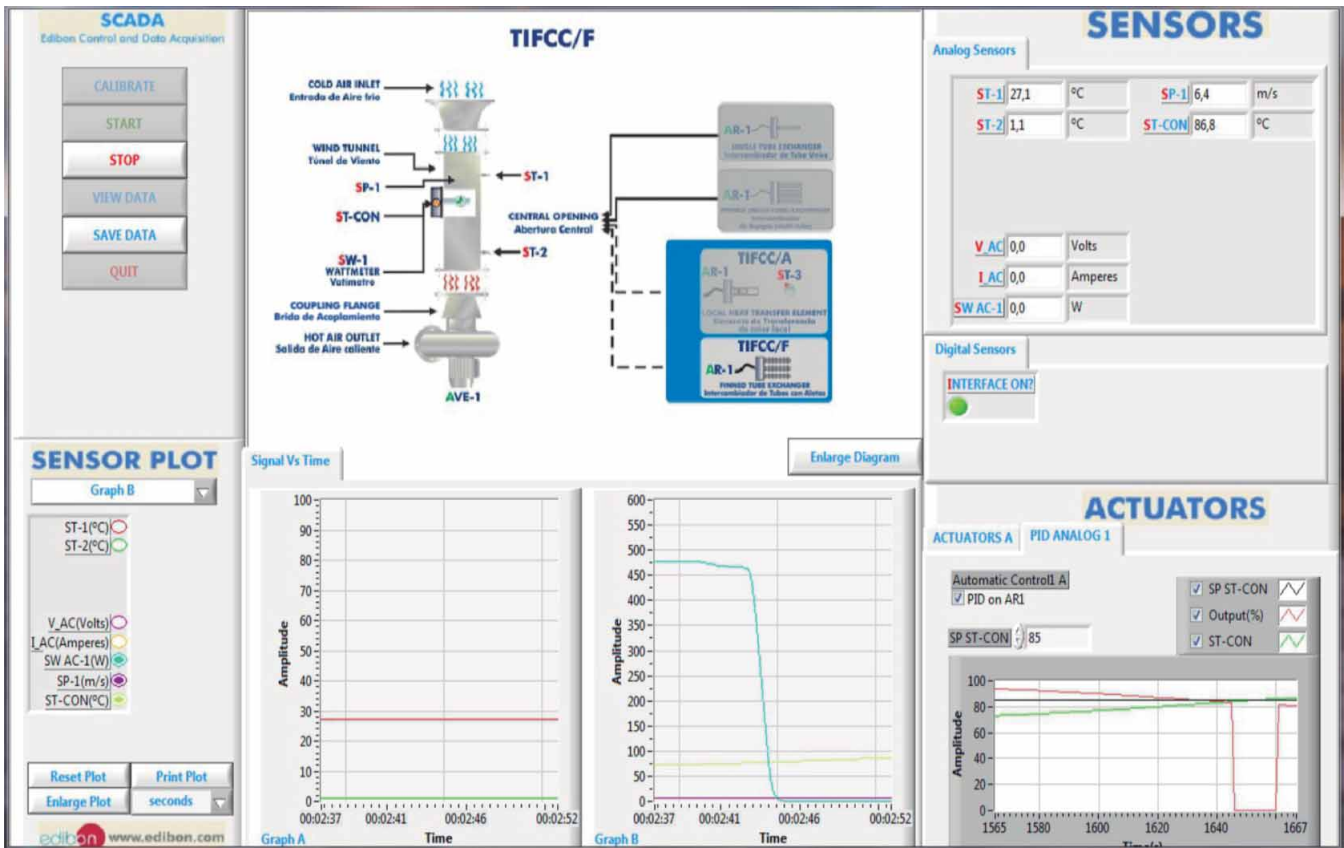

The software allows to control the heating element via a PID control with the control thermocouple, ST-CON.
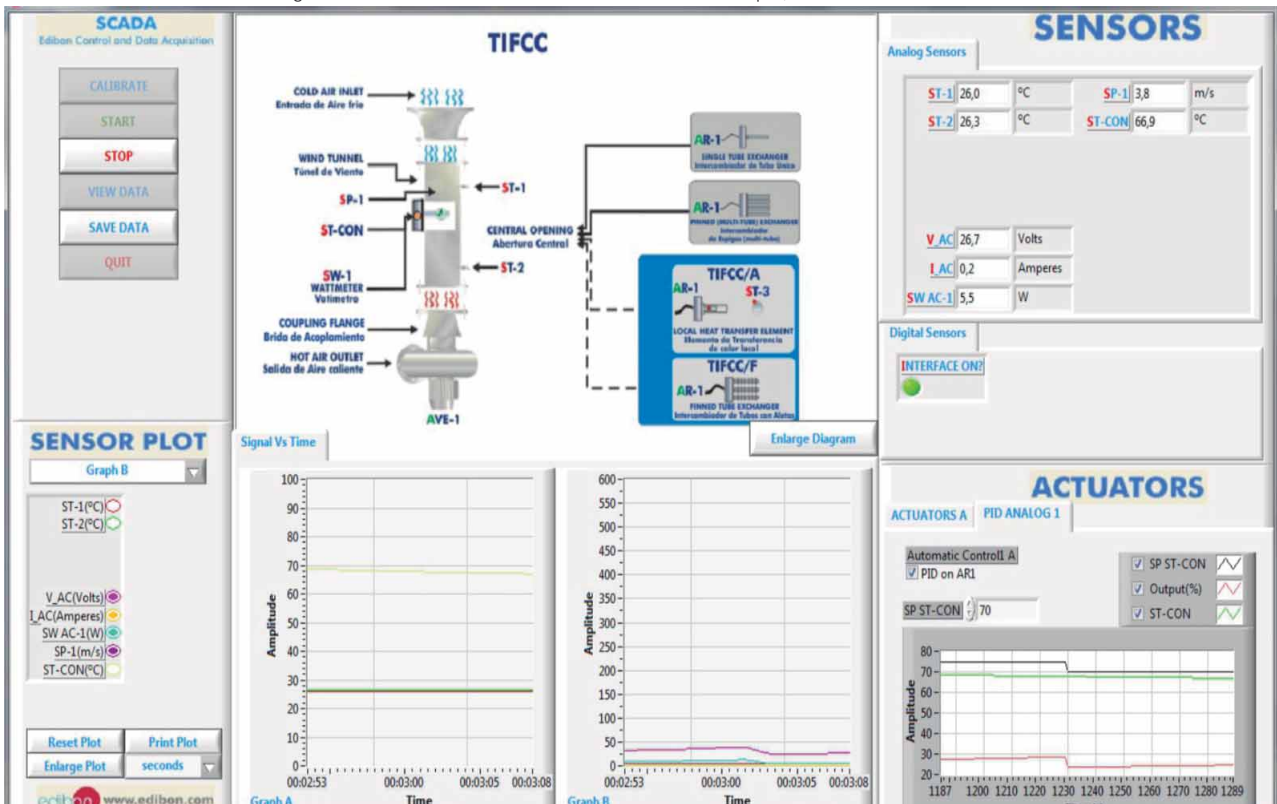
Results obtained with the optional Local Heat Transfer Exchanger (TIFCC/A).

Results obtained with the optional Finned Tube Exchanger (TIFCC/F).

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. (CAL)

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.
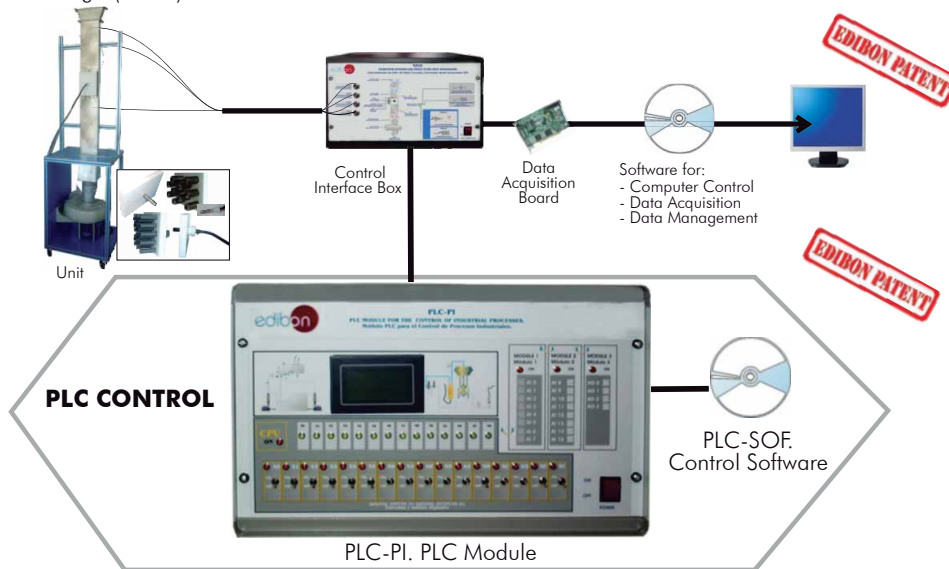 **Digital inputs/outputs and analog inputs/outputs Panasonic modules**.
  Communication RS232 wire to computer (PC).
  Dimensions: 490 x 330 x 310 mm. approx. (19.29 x 12.99 x 12.20 inches approx.). Weight: 30 Kg. approx. (66 pounds approx.).
- **TIFCC/PLC-SOF. PLC Control Software:**
  For this particular 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 Cross Flow Heat Exchanger (TIFCC).

Unit

Control Interface Box

Data Acquisition Board

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

PLC CONTROL

PLC-PI. PLC Module

PLC-SOF. Control Software

Practices to be done with PLC-PI:

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

2.- Visualization of all the sensors values used in the TIFCC unit process.

3.- Calibration of all sensors included in the TIFCC unit process.

4.- Hand on of all the actuators involved in the TIFCC 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 TIFCC 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 TIFCC unit process.

17.- Possibility of creating new process in relation with the TIFCC unit.

18.- PLC Programming exercises.

19.- Own PLC applications in accordance with teacher and student requirements.

b) <u>Technical and Vocational Education configuration</u>

⑧ TIFCC/CAI. Computer Aided Instruction Software System.

This complete software package includes two Softwares: the INS/ SOF. Classroom Management Software (Instructor Software) and the TIFCC/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 of an Instructor Software (INS/ SOF) totally integrated with the Student Software (TIFCC/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:

<u>Instructor Software</u>

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.
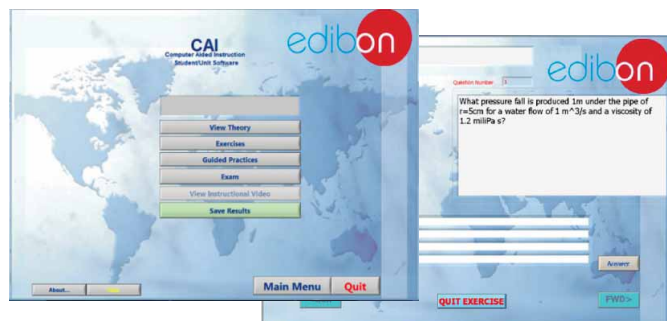
…and many other facilities.
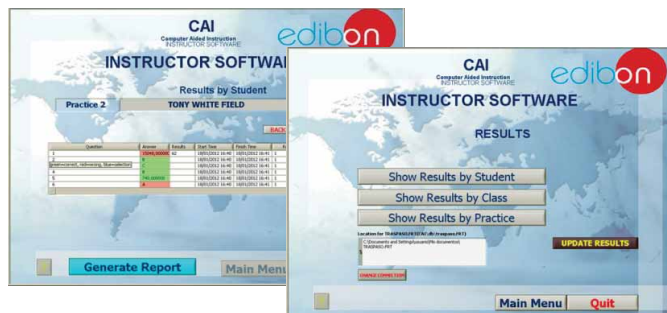
- **TIFCC/SOF. Computer Aided Instruction Software (Student Software):**

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.

<u>Student Software</u>

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

www.edibon.com/products/catalogues/en/CAI.pdf

⑨ TIFCC/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.**
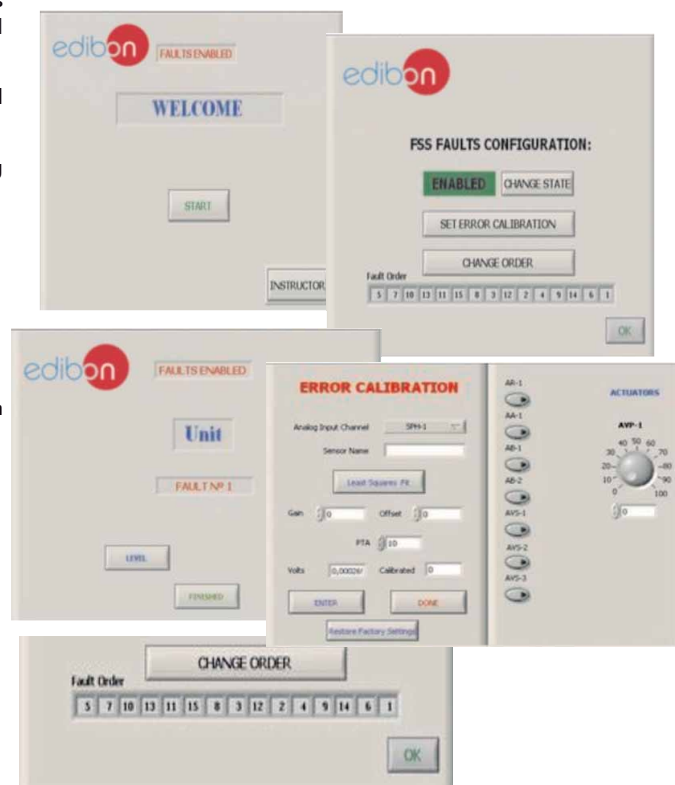
- **Response reduction of an actuator.**

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.**

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

www.edibon.com/products/catalogues/en/FSS.pdf

Example of some screens

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

⑩ TIFCC/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.
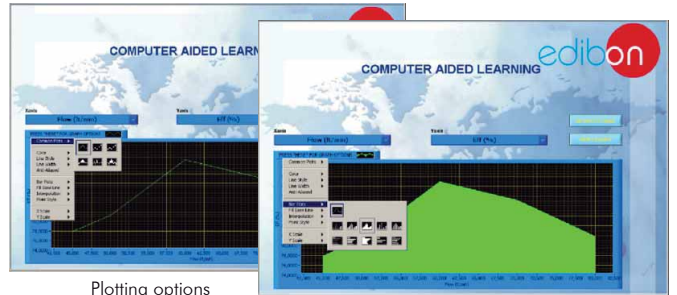
For more information see CAL catalogue. Click on the following link:
www.edibon.com/products/catalogues/en/CAL.pdf
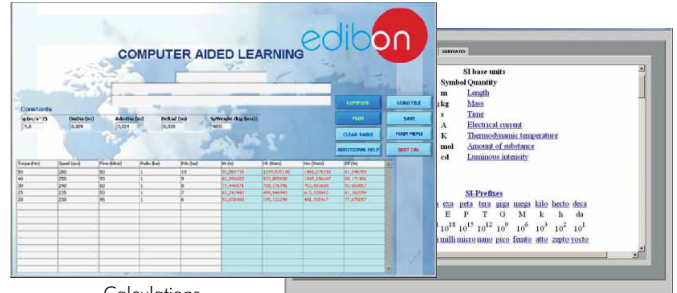
Calculations

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).
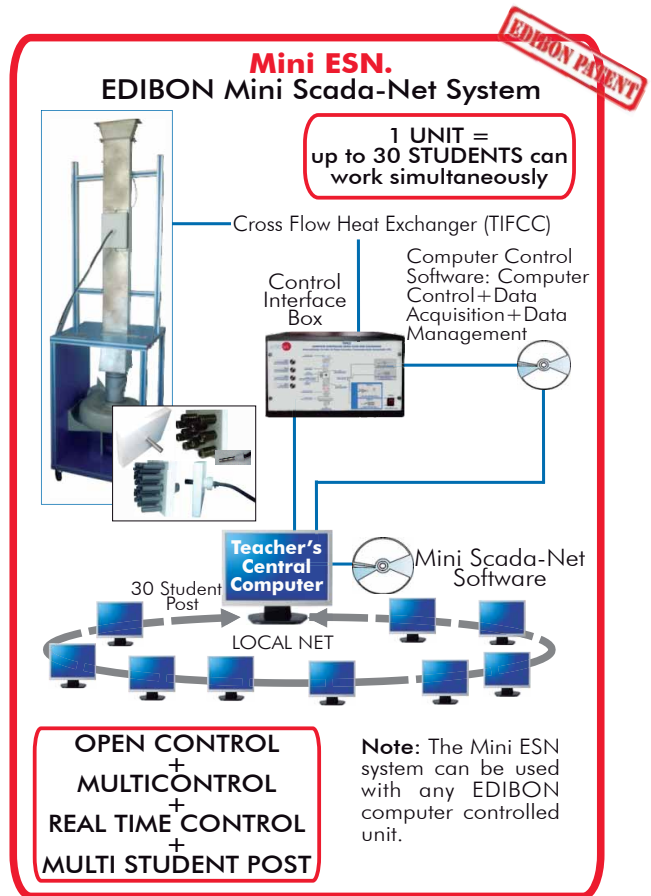
Main characteristics:

- 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

Mini ESN.
EDIBON Mini Scada-Net System

EDIBON PATENT

1 UNIT =
up to 30 STUDENTS can work simultaneously

Cross Flow Heat Exchanger (TIFCC)

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.

⑫ ESN. EDIBON Scada-Net System.

This unit can be integrated, 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/thermodynamicsthermotechnics/esn-thermodynamics/ESN-THERMODYNAMICS.pdf

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: TIFCC. Cross Flow Heat Exchanger.**

② **TIFCC/CIB. Control Interface Box.**

③ **DAB. Data Acquisition Board.**

④ **TIFCC/CCSOF. PID Computer Control + Data Acquisition + Data Management Software.**

⑤ **Cables and Accessories**, for normal operation.

⑥ **Manuals.**

* IMPORTANT: Under TIFCC 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.

  - TIFCC/PLC-SOF. PLC Control Software.

b) Technical and Vocational configuration

⑧ TIFCC/CAI. Computer Aided Instruction Software System.

⑨ TIFCC/FSS. Faults Simulation System.

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

⑩ TIFCC/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 **TIFCC. Unit:**

Frame made of anodized aluminum and steel and panels made of painted steel.

Main metallic elements made of stainless steel.

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

Stainless steel vertical tunnel of 1200 mm. long of rectangular section (65 x 170 mm.) and resistant to corrosion.

Rectangular central opening of 200 x 150 mm. in the tunnel with two supports made of stainless steel to hold the plates with the exchangers.

Elastic tunnel - fan coupling flange with clamp.

Computer controlled centrifugal fan, controlled through a variable-speed drive; operating range: 0 – 10 m/s.

Two "J" type temperature sensors.

Differential pressure sensor to know the air flow, range: 0-1 inch H_2O.

Computer controlled heating element with a diameter of 16 mm. and 80 mm. long (500W) with control thermocouple.

Wattmeter to measure the power supplied by the heating elements.

Included exchangers:

    Single tube exchanger: one exchangeable plate made of Teflon with flat surface with a central bore to install the single tube heating element.

    Pinned (multi-tube) exchanger: one exchangeable plate made of Teflon with 27 fixed tubes made of PVC of 16 mm. approximately of diameter arranged in an equilateral triangle. The tubes are arranged in six rows and there is a removable tube close to the center of each row. It can be replaced by the heating element to measure the effects of the rows of adjacent tubes on the heat transfer rate of the heating element.

Optional exchangers (not included in the minimum supply):

    TIFCC/A. Local Heat Transfer Exchanger.

        Exchangeable plate made of Teflon with a central bore of 40 mm. of diameter that allows to hold the direct transfer heating element (TDC).

        Knurled and marked knob made of Teflon that allows to rotate the TDC circumferentially.

        Computer controlled heating element with a diameter of 16 mm. and 70 mm. long (500W) and with control thermocouple.

        "J" type thermocouple in the copper surface.

    TIFCC/F. Finned Tube Exchanger.

        Plate made of Teflon with 10 copper tubes with finned surface. The exchanger has four rows of finned tubes, so that the tubes are arranged in an equilateral triangle with a distance of 30 mm. between the centers. There is a removable finned tube close to the center of each row. It can be replaced by the heating element.

        Computer controlled heating element with a diameter of 16 mm. and 100 mm. long (500W) with control thermocouple.

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.

② **TIFCC/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 **TIFCC/CCSOF. PID Computer Control +Data Acquisition+Data Management Software:**

The three softwares are part of the SCADA system.

Compatible with the industry standards.

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

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

Management, processing, comparison and storage of data.

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

Calibration system for the sensors involved in the process.

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

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

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.- Investigation of convective processes.

2.- Determination of heat transfer in a single tube exchanger.

3.- Determination of heat transfer in a pinned (multi-tube) exchanger.

4.- Determination of the average heat transfer in a pinned (multi-tube) exchanger.

5.- Deduction of the relationship between Nusselt, Reynolds and Prandtl numbers.

Additional practical possibilities:

6.- Sensors calibration.

Practical possibilities with the optional TIFCC/A exchanger:

7.- Determination of the existing relationship between Nusselt and Reynolds number using the direct heat transfer element.

8.- Determination of the local variation in the convective heat transfer coefficient, using the direct heat transfer element.

Practical possibilities with the optional TIFCC/F exchanger:

9.- Effect produced by the external fins in the heat transfer process.

10.- Determination of the heat transfer in a finned tube exchanger.

Other possibilities to be done with this Unit:

11.- Many students view results simultaneously.

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

12.- 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.

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

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

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

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

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

18.- Visualization of all the sensors values used in the TIFCC 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.

- **TIFCC/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 TIFCC unit process through the control interface box without the computer.

2.- Visualization of all the sensors values used in the TIFCC unit process.

3.- Calibration of all sensors included in the TIFCC unit process.

4.- Hand on of all the actuators involved in the TIFCC 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 TIFCC 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 TIFCC unit process.

17.- Possibility of creating new process in relation with the TIFCC unit.

18.- PLC Programming exercises.

19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

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

This complete software package consists of an Instructor Software (INS/SOF) totally integrated with the Student Software (TIFCC/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.

-TIFCC/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 **TIFCC/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 TIFCC/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

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 and PID Control integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.

Main characteristics:

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

Main advantages:

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

The system basically will consist of:

This system is used with a Computer Controlled Unit.
- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- Mini ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

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

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