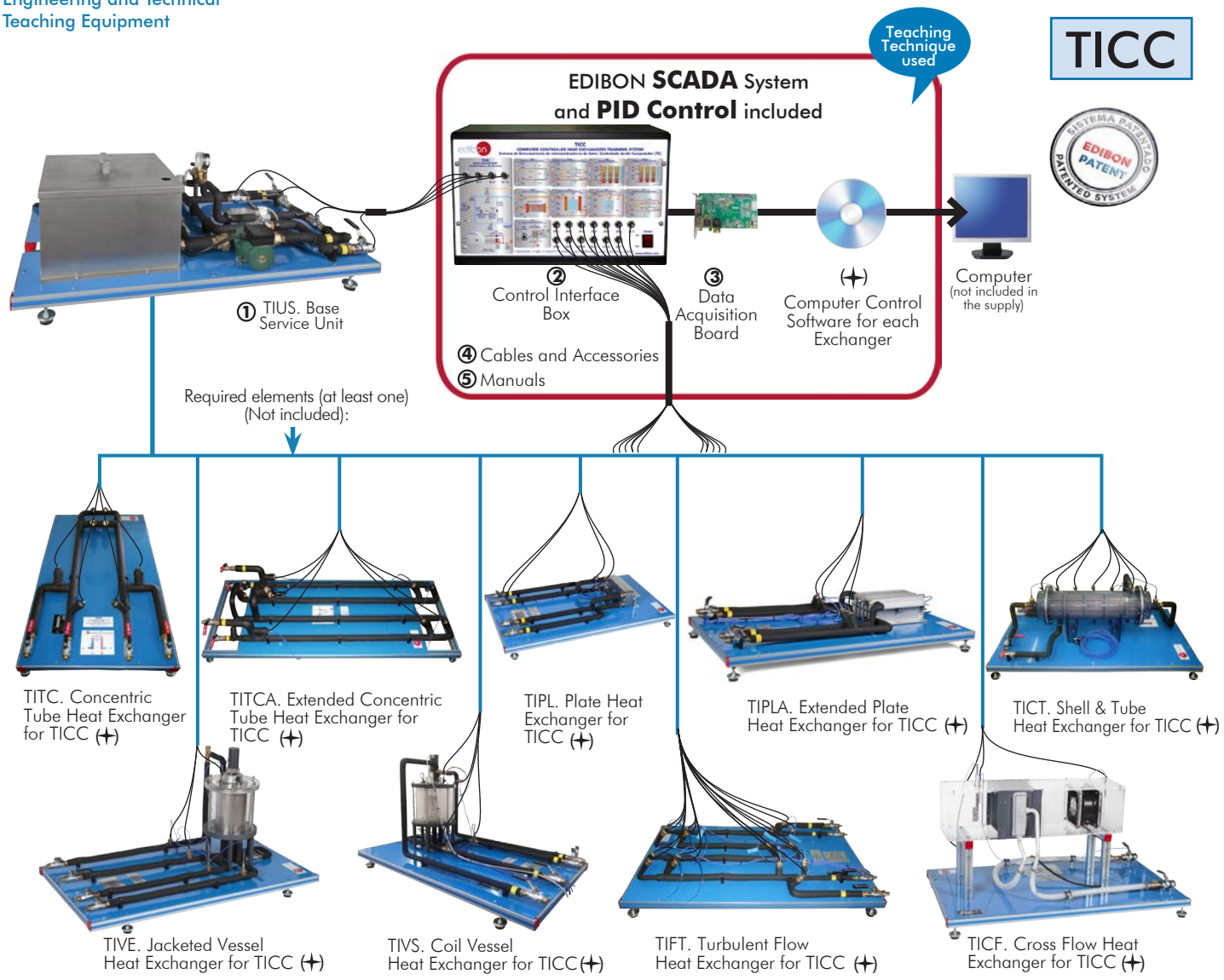
Engineering and Technical Teaching Equipment

Computer Controlled **Heat Exchangers Training System,** with SCADA and PID Control

TICC

Teaching Technique used



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 ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**
- **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

POWERED BY NATIONAL INSTRUMENTS LabVIEW

www.edibon.com
PRODUCTS
9.- THERMODYNAMICS & THERMOTECHNICS

For more information about Key Features, click here

ISO 9001: **Quality Management** (for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate (total safety)

Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)

"Worlddidac Quality Charter" and Platinum Member of Worlddidac

INTRODUCTION

The heat exchange process between two fluids at different temperature and separated by a solid wall is performed in devices named heat exchangers.

Heat exchangers are widely used in refrigeration, air conditioning, heating, energy generation, chemical processing, etc. They have many applications in engineering and, as a consequence, there are many models adapted to each application to obtain an efficient heat transfer.

GENERAL DESCRIPTION

The Computer Controlled Heat Exchangers Training System, "TICC", has been designed by EDIBON to study and compare different types of small-scale heat exchangers working with parallel or counterflow arrangements.

The minimum supply consists of two main elements: the Base Service Unit, "TIUS", and at least one of the required elements described below.

The Base Service Unit, "TIUS", has the following functions:

- Heating water in a computer controlled thermostatic bath.
- Pumping the hot water.
- Regulation and measurement of the cold water and hot water flows.
- Measurement of the inlet and outlet temperatures of the cold water and the hot water.
- Measurement of the pressure drop in the exchanger.

Required elements (at least one) (Not included):

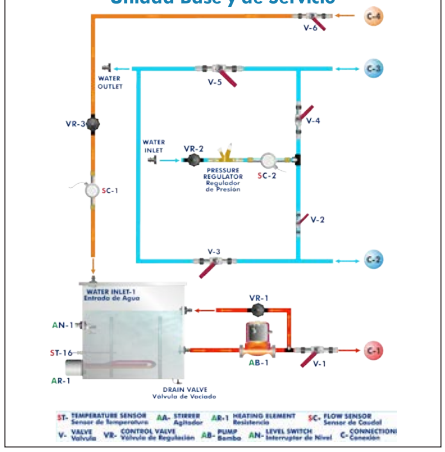
- TITC. Concentric Tube Heat Exchanger for TICC: It has been designed to study the heat transfer between hot water flowing through an internal tube and cold water flowing through the annular area between the internal and the external tubes.
- TITCA. Extended Concentric Tube Heat Exchanger for TICC: It has been designed to study the heat transfer between hot water flowing through an internal tube and cold water flowing through the annular area between the internal and the external tubes.
- TIPL. Plate Heat Exchanger for TICC: It has been designed to study the heat transfer between hot water and cold water flowing through alternate channels formed between parallel plates.
- TIPLA. Extended Plate Heat Exchanger for TICC: It has been designed to study the heat transfer between hot water and cold water flowing through alternate channels formed between parallel plates.
- TICT. Shell & Tube Heat Exchanger for TICC: It consists of a series of tubes inside the heat exchanger where hot water flows. The cooling water flows through the space between the inner tubes and the shell.
- TIVE. Jacketed Vessel Heat Exchanger for TICC: Allows the study of heat transfer between hot water flowing through a jacket and the cold water contained in a vessel.
- TIVS. Coil Vessel Heat Exchanger for TICC: Allows the study of heat transfer between hot water flowing through a coil and cold water contained in the vessel.
- TIFT. Turbulent Flow Heat Exchanger for TICC: Let us study the heat transfer between hot water that circulates through an internal tube and cold water that flows through the annular zone between the internal and the external tube.
- TICF. Cross Flow Heat Exchanger for TICC: Designed to study heat transfer between two fluids in cross flow configuration. Hot water flow coming from the base unit enters and leaves a radiator perpendicular to an air current, which is generated by a fan.

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.

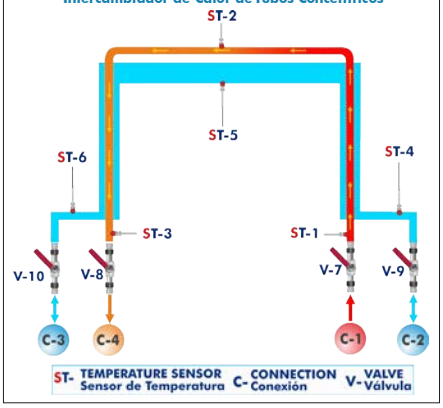
5 actuators and 16 sensors controlled from any computer, and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL

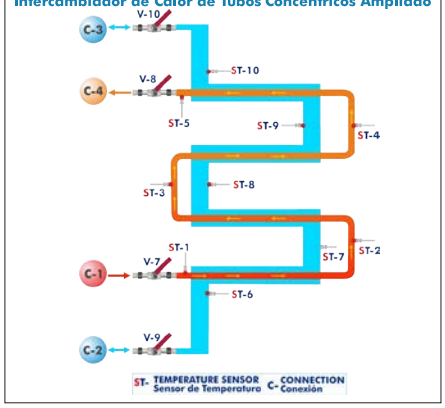
TIUS
BASE SERVICE UNIT
Unidad Base y de Servicio



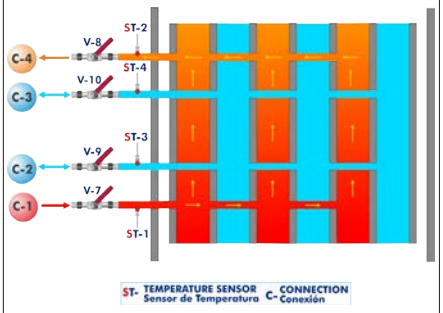
TITC
CONCENTRIC TUBE HEAT EXCHANGER
Intercambiador de Calor de Tubos Concéntricos



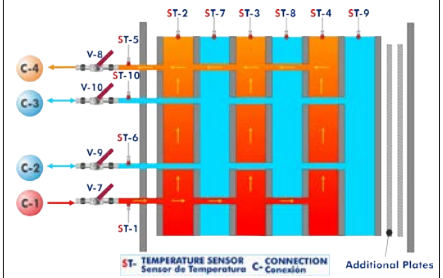
TITCA
EXTENDED CONCENTRIC TUBE HEAT EXCHANGER
Intercambiador de Calor de Tubos Concéntricos Ampliado



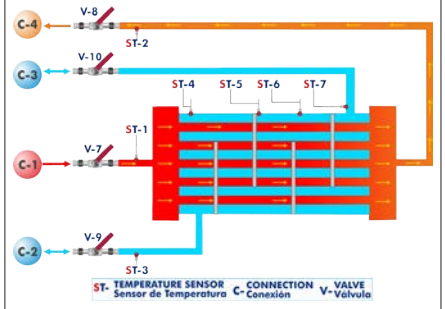
TIPL
PLATE HEAT EXCHANGER
Intercambiador de Calor de Placas



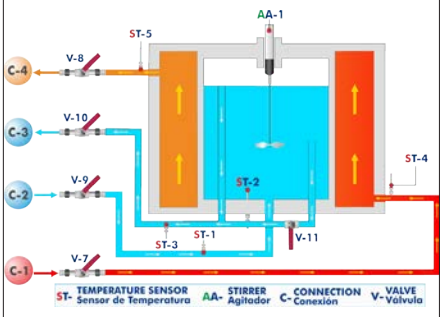
TIPLA
EXTENDED PLATE HEAT EXCHANGER
Intercambiador de Calor de Placas Ampliado



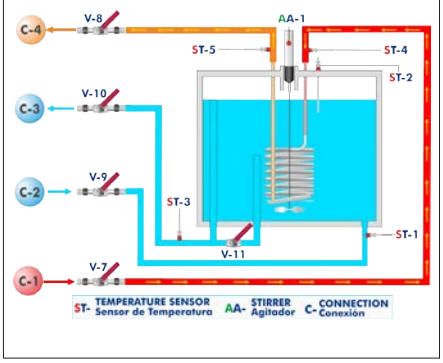
TICT
SHELL & TUBE HEAT EXCHANGER
Intercambiador de Calor de Carcasa y Tubo



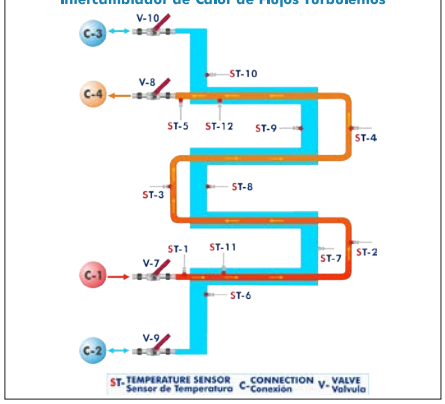
TIVE
JACKETED VESSEL HEAT EXCHANGER
Intercambiador de Calor de Vasija Encamisada



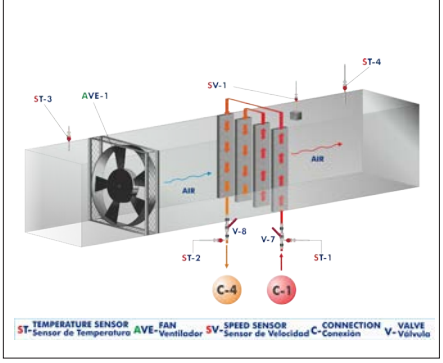
TIVS
COIL VESSEL HEAT EXCHANGER
Intercambiador de Calor de Vasija con Serpentín



TIFT
TURBULENT FLOW HEAT EXCHANGER
Intercambiador de Calor de Flujos Turbulentos



TICF
CROSS FLOW HEAT EXCHANGER
Intercambiador de Calor de Flujos Cruzados



With this unit there are several options and possibilities:

- Main items: 1, 2, 3, 4 and 5.
- Optional items: 6, 7, 8, 9 and 10.

Let us describe first the main items (1 to 5):

① TIUS. Base Service Unit:

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This unit is common for the required elements (at least one) (Not included).

This unit performs the following tasks:

Heating the water.

Pumping of hot water.

Change in the direction of cold water flows.

Cold and hot water measures.

TIUS

Stainless steel tank (30 l), equipped with:

Electric heating element (3000 W) with thermostat (70 °C), to heat the water, computer controlled. PID temperature control.

Temperature sensor ("J" type) to measure the water temperature.

Level switch to control the water level in the tank.

Stainless steel cover to avoid the contact with hot water. In this cover there is a hole that allows us to visualize the water level and also to stuff the tank.

Draining water valve.

Centrifugal pump with speed control from computer, range: 0 – 3 l/min.

Two flow sensors, one for hot water and the other for cold water, range: 0.25 – 6.5 l/min.

Control valves for the cold and hot water.

Four ball valves that, depending on how we manipulate them, give us co-current or counter-current flux in the exchanger.

Two ball valves to control and drain the hot water of the base unit.

Pressure regulator to avoid the introduction of too much pressure in the exchangers, tared at 0.6 bar.

Four flexible tubes to connect with the different exchangers.

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 ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.

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.

Required elements (at least one) (Not included):

- TITC. Concentric Tube Heat Exchanger for TICC.
- TITCA. Extended Concentric Tube Heat Exchanger for TICC.
- TIPL. Plate Heat Exchanger for TICC.
- TIPLA. Extended Plate Heat Exchanger for TICC.
- TICT. Shell & Tube Heat Exchanger for TICC.
- TIVE. Jacketed Vessel Heat Exchanger for TICC.
- TIVS. Coil Vessel Heat Exchanger for TICC.
- TIFT. Turbulent Flow Heat Exchanger for TICC.
- TICF. Cross Flow Heat Exchanger for TICC.

② TICC/CIB. Control Interface Box:

This control interface is common for the required elements (at least one) (Not included).

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.

TICC/CIB

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, heating elements, 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.

③ DAB. Data Acquisition Board:

Common for the required elements (at least one) (Not included).

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.

The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

DAB

④ Cables and Accessories, for normal operation.

⑤ Manuals:

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

Required elements (at least one) (Not included):

TITC. Concentric Tube Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Concentric Tube Heat Exchanger for TICC allows the study of heat transfer between hot water flowing through an internal tube and cold water flowing in the ring area lying between the internal and the external tubes.

This exchanger allows measuring hot and cold water temperatures at different points of the exchanger.

The exchanger is formed by two concentric copper tubes with hot water circulating through the interior tube and cold water circulating in the ring space.

This exchanger has two equal sections of 500 mm each one, where heat transfer takes place.

Exchange length: L = 2 x 0.5 = 1 m.

Internal tube:

- Internal diameter: $D_{int} = 16 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 18 \cdot 10^{-3}$ m.
- Thickness = 10 m^{-3}.
- Heat transfer internal area: $A_h = 0.0503$ m^2.
- Heat transfer external area: $A_c = 0.0565$ m^2.

External tube:

- Internal diameter: $D_{int} = 26 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 28 \cdot 10^{-3}$ m.
- Thickness = 10^{-3} m.

Six temperature sensors ("J" type):

- Three temperature sensors for measuring cold water temperature:
  - Cold water inlet.
  - Cold water mid-position.
  - Cold water outlet.
- Three temperature sensors for measuring hot water temperature:
  - Hot water inlet.
  - Hot water mid-position.
  - Hot water outlet.

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) **TITC/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 in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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.

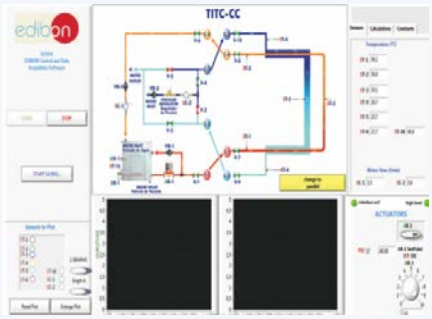
It allows the registration of the alarms state and the graphic representation in real time.

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.

TITC



Required elements (at least one) (Not included):

TITCA. Extended Concentric Tube Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Extended Concentric Tube Heat Exchanger for TICC allows the study of heat transfer between hot water flowing through an internal tube and cold water flowing in the ring area lying between the internal and the external tubes.

This exchanger allows measuring hot and cold water temperatures at different points of the exchanger.

"TITCA" is a more sophisticated unit than "TITC", with four longer tube sections, giving four times the overall heat transfer area and three interim temperature measurement points (temperature sensors) in each fluid stream.

This exchanger has sufficient heat transfer area for demonstrating the typical counter-current flow conditions where the outlet of the heated stream is hotter than the outlet of the cooled stream.

The exchanger is formed by two concentric copper tubes with hot water circulating through the interior tube and cold water circulating in the ring space.

This exchanger has four equal sections of 1000 mm each one, where heat transfer takes place.

Exchange length: L=4x1=4 m.

Internal tube:

- Internal diameter: $D_{int} = 16 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 18 \cdot 10^{-3}$ m.
- Thickness = 10^{-3} m.
- Heat transfer internal area: $A_h = 0.0503$ m^2.
- Heat transfer external area: $A_c = 0.0565$ m^2.

External tube:

- Internal diameter: $D_{int} = 26 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 28 \cdot 10^{-3}$ m.
- Thickness = 10^{-3} m.

Ten temperature sensors ("J" type):

- Five temperature sensors for measuring cold water temperature:
  - Cold water inlet.
  - Cold water at different interim positions (3).
  - Cold water outlet.
- Five temperature sensors for measuring hot water temperature:
  - Hot water inlet.
  - Hot water at different interim positions (3).
  - Hot water outlet.

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) **TITCA/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 in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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.

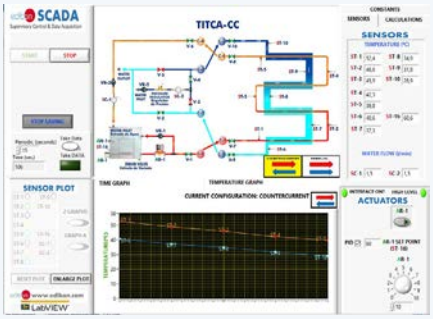
It allows the registration of the alarms state and the graphic representation in real time.

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.

TITCA



Required elements (at least one) (Not included):

TIPL. Plate Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Plate Heat Exchanger for TICC allows the study of heat transfer between hot and cold water through alternate channels formed between parallel plates.

The exchanger allows measuring cold and hot temperatures at the inlet and outlet of the exchanger.

Formed by corrugated stainless steel plates. It can be dismantled to observe its structure.

Four ports or connections of hot and cold water input and output.

Maximum flow: 12 m^3/h.

Maximum work pressure: 10 bar.

Maximum work temperature: 100 °C.

Minimum work temperature: 0 °C.

Maximum number of plates: 20.

Internal circuit capacity: 0.176 l.

External circuit capacity: 0.22 l.

Area: 0.32 m^2.

TIPL

Four temperature sensors ("J" type):

- Two temperature sensors for measuring cold water temperature (inlet and outlet).
- Two temperature sensors for measuring hot water temperature (inlet and outlet).

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) **TIPL/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 in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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.

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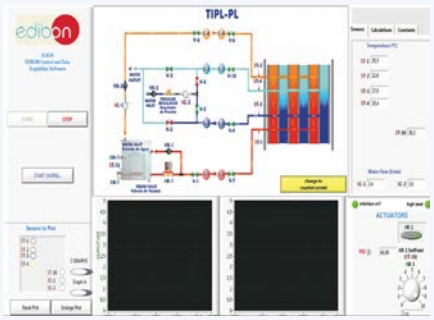


Required elements (at least one) (Not included):

TIPLA. Extended Plate Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Extended Plate Heat Exchanger for TICC allows the study of heat transfer between hot and cold water through alternate channels formed between parallel plates.

The exchanger allows measuring cold and hot temperatures at different points of the exchanger.

Formed by corrugated stainless steel plates. It can be dismantled to observe its structure.

TIPLA

Four ports or connections of hot and cold water input and output.

Maximum flow: 12 m^3/h.

Maximum work pressure: 10 bar.

Maximum work temperature: 100 °C.

Minimum work temperature: 0 °C.

Maximum number of plates: 20.

Internal circuit capacity: 0.176 l.

External circuit capacity: 0.22 l.

Area: 0.32 m^2.

Ten temperature sensors ("J" type):

- Five temperature sensors for measuring cold water temperature (inlet, outlet and interim positions).
- Five temperature sensors for measuring hot water temperature (inlet, outlet and interim positions).

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+)**TIPLA/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 in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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).

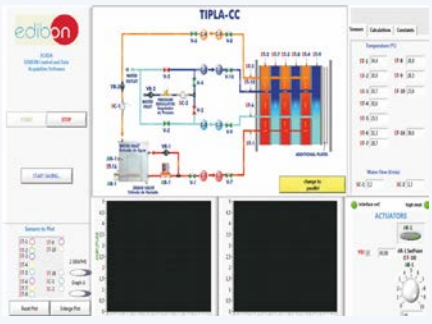
Calibration system for the sensors involved in the process.

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.



Required elements (at least one) (Not included):

TICT. Shell & Tube Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Shell & Tube Heat Exchanger for TICC consists on a group of tubes inside the heat exchanger. The hot water flows through the internal tubes and the cooling water circulates through the space between the internal tubes and the shell.

There are traverse baffles placed in the shell to guide the cold water to maximize the heat transfer.

Formed by tubes of stainless steel with hot water circulating in the interior.

Four segmented baffles located transversaly in the shell.

Exchange length of the shell and each tube: L = 0.5 m.

TICT

Internal tube (21 tubes):

- Internal diameter: $D_{int} = 8 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 10 \cdot 10^{-3}$ m.
- Thickness = 10^{-3} m.
- Internal heat transfer area: $A_h = 0.0126$ m^2.
- External heat transfer area: $A_c = 0.0157$ m^2.

Shell:

- Internal diameter: $D_{int,c} = 0.148$ m.
- External diameter: $D_{ext,c} = 0.160$ m.
- Thickness = $6 \cdot 10^{-3}$ m.

Seven temperature sensors ("J" type), for measuring cold and hot water temperatures at different points of the exchanger.

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) **TICT/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 in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

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

Analog and digital PID control.

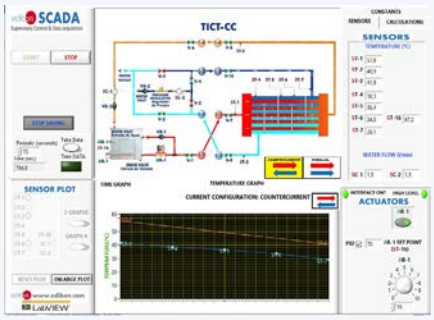
PID menu and set point selection required in the whole work range.

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.

Required elements (at least one) (Not included):

TIVE. Jacketed Vessel Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Jacketed Vessel Heat Exchanger for TICC allows the study of heat transfer between hot water flowing through a jacket and the cold water contained in a vessel.

It can work in continuous supply or in a batch process (heating of a constant mass of water contained in a vessel).

The exchanger allows measuring temperatures at the inlet and outlet of the exchanger in cold as well as in hot water.

TIVE

Inner tank:

- Made of stainless steel.
- Volume: 3.20 l.

Two overflows of different length that allow the exit of the water in the vessel through its upper part allowing two work volumes to be adjusted.

Jacket surrounds the vessel through where hot water flows:

- Made of stainless steel.
- Jacket volume: 5.90 l.

Electric stirrer.

Five temperature sensors ("J" type):

- Three temperature sensors for measuring cold water temperature.
- Two temperature sensors for measuring hot water temperature.

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) **TIVE/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 in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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).

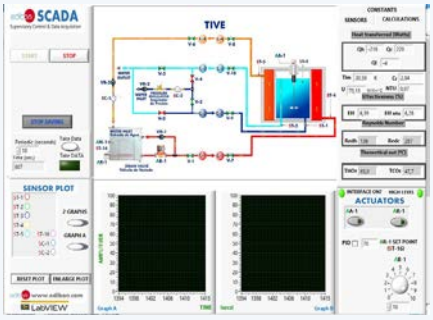
Calibration system for the sensors involved in the process.

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.



Required elements (at least one) (Not included):

TIVS. Coil Vessel Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Coil Vessel Exchanger for TICC allows the study of heat transfer between hot water flowing through a coil and cold water contained in the vessel.

It can work in continuous supply or in a batch process.

Formed by a methacrylate vessel, volume: 6 l.

Two overflows let the output of water from the vessel in the upper part allowing two work volumes to be adjusted.

Copper coil where the water circulates:

D_{int}= 4.35 mm.

D_{ext}= 6.35 mm.

Total length of the tube that forms the coil: 1.5 m.

Electric stirrer.

Five temperature sensors ("J" type):

Three temperature sensors for measuring cold water temperature.

Two temperature sensors for measuring hot water temperature.

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

TIVS

(+) **TIVS/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 in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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).

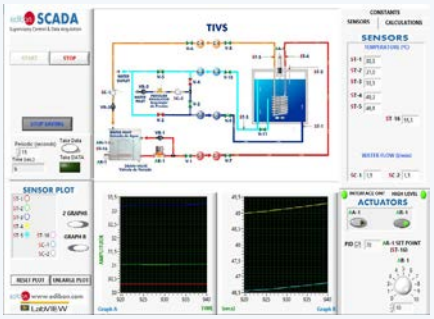
Calibration system for the sensors involved in the process.

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.



Required elements (at least one) (Not included):

TIFT. Turbulent Flow Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

This Turbulent Flow Heat Exchanger for TICC let us study the heat transfer between hot water that circulates through an internal tube and cold water that flows through the annular zone between the internal and the external tube. This exchanger let us measure cold water and hot water temperatures at different points of the exchanger.

Formed by two copper concentric tubes with hot water circulating through the internal tube and cold water circulating through the annular space.

The exchanger has 4 equal sections of 500 mm each one, where the heat transfer takes place.

Exchange length: L = 4 x 0.5 = 2 m.

Internal tube:

- Internal diameter: $D_{int} = 8 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 10 \cdot 10^{-3}$ m.
- Thickness = 10^{-3} m.
- Internal heat transfer area: Ah= 0.0377 m^2.
- External heat transfer area: Ac= 0.0471 m^2.

External tube:

- Internal diameter: $D_{int,c} = 13 \cdot 10^{-3}$ m.
- External diameter: $D_{ext,c} = 15 \cdot 10^{-3}$ m.

Thickness = 10^{-3} m.

TIFT

Twelve temperature sensors: ("J" type):

- Cold water temperature sensor at the exchanger inlet or outlet.
- Hot water sensor at the exchanger inlet.
- Cold water sensor between the first and second stretch of the exchanger.
- Hot water sensor between the first and second stretch of the exchanger.
- Cold water sensor between the second and third stretch of the exchanger.
- Hot water sensor between the second and third stretch of the exchanger.
- Cold water sensor between the third and fourth stretch of the exchanger.
- Hot water sensor between the third and fourth stretch of the exchanger.
- Cold water temperature sensor at the exchanger inlet or outlet.
- Hot water sensor at the exchanger outlet.
- Temperature sensor of the exterior surface of the interior tube at the exchanger inlet.
- Temperature sensor of the exterior surface of the interior tube at the exchanger outlet.

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

Computer Control Software:

(+) **TIFT/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 in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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).

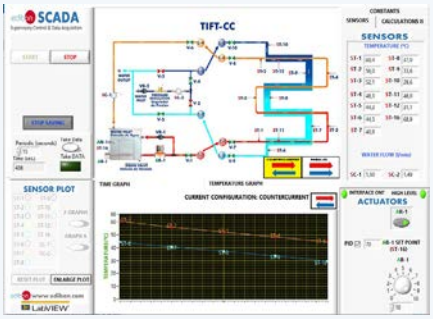
Calibration system for the sensors involved in the process.

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.



Required elements (at least one) (Not included):

TICF. Cross Flow Heat Exchanger for TICC

Bench-top unit.

Anodized aluminum frame and panels made of painted steel.

Main metallic elements made of stainless steel.

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

The Cross Flow Heat Exchanger for TICC is designed to study heat transfer between two fluids in cross flow configuration.

Hot water flow coming from the base unit enters and leaves a radiator perpendicular to an air current, which is generated by a fan.

The heat exchanger allows to measure water and air temperatures at the inlet and outlet of the exchanger.

Poly methyl methacrylate (PMMA) rectangular duct of 800 x 200 x 200 mm.

Radiator located across the air duct.

The fins of the radiator are made of aluminum and have a heat transfer area of 35000 mm^2.

Axial fan with speed control from computer (PC). It provides a maximum air velocity of 3 m/s.

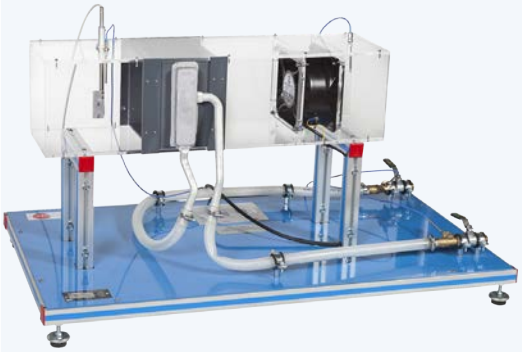
Four "J" type temperature sensors to measure input and output water and air temperatures.

Velocity sensor to measure air velocity, range: 0 – 4 m/s.

Two ball valves.

Easy connection to the Base Service Unit, "TIUS".

This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.



TICF

(+) **TICF/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 in screen.

Compatible with the industry standards.

Registration and visualization of all process variables in an automatic and simultaneous way.

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

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).

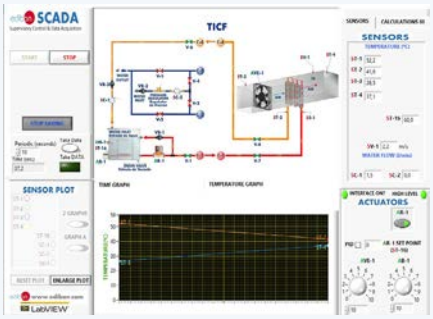
Calibration system for the sensors involved in the process.

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.



Practices to be done with the Concentric Tube Heat Exchanger for TICC (TITC):

1.- Global energy balance in the heat exchanger and the study of losses.
2.- Exchanger effectiveness determination. NTU Method.
3.- Study of the heat transfer under counter-current and co-current flow conditions.
4.- Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

5.- Sensors calibration.
6.- Study of the hysteresis of the flow sensor.

Practices to be done with the Extended Concentric Tube Heat Exchanger for TICC (TITCA):

7.- Global energy balance in the heat exchanger and the study of losses.
8.- Exchanger effectiveness determination. NTU Method.
9.- Study of the heat transfer under counter-current and co-current flow conditions.
10.- Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

11.- Sensors calibration.
12.- Study of the hysteresis of the flow sensor.

Practices to be done with the Plate Heat Exchanger for TICC (TIPL):

13.- Global energy balance in the heat exchanger and the study of losses.
14.- Exchanger effectiveness determination. NTU Method.
15.- Study of the heat transfer under counter-current and co-current flow conditions.
16.- Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

17.- Sensors calibration.
18.- Study of the hysteresis of the flow sensor.

Practices to be done with the Extended Plate Heat Exchanger for TICC (TIPLA):

19.- Global energy balance in the heat exchanger and the study of losses.
20.- Exchanger effectiveness determination. NTU Method.
21.- Study of the heat transfer under counter-current and co-current flow conditions.
22.- Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

23.- Sensors calibration.
24.- Study of the hysteresis of the flow sensor.

Practices to be done with the Shell & Tube Heat Exchanger for TICC (TICT):

25.- Global energy balance in the heat exchanger and the study of losses.
26.- Exchanger effectiveness determination. NTU Method.
27.- Study of the heat transfer under counter-current and co-current flow conditions.
28.- Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

29.- Sensors calibration.
30.- Study of the hysteresis of the flow sensor.

Practices to be done with the Jacketed Vessel Heat Exchanger for TICC (TIVE):

31.- Global balance of energy in the heat exchanger and losses study.
32.- Determination of the exchanger effectiveness. NTU Method.
33.- Influence of the flow on the heat transfer. Calculation of the number of Reynolds.
34.- Influence of the vessel stirring on the heat transfer when operating in batches.
35.- Influence of the vessel's water volume on the heat transfer when operating in batches.

Additional practical possibilities:

36.- Sensors calibration.
37.- Study of the hysteresis of the flow sensor.

Practices to be done with the Coil Vessel Heat Exchanger for TICC (TIVS):

38.- Global balance of energy in the heat exchanger and the study of losses.
39.- Determination of the exchanger effectiveness. NTU Method.
40.- Influence of the flow on the heating transfer. Calculation of Reynolds number.
41.- Influence of the stirring vessel on the heat transfer with operation in batches.
42.- Influence of the water volume in the vessel on the heat transfer with operation in batches.

Additional practical possibilities:

43.- Sensors calibration.
44.- Study of the hysteresis of the flow sensor.

Practices to be done with the Turbulent Flow Heat Exchanger for TICC (TIFT):

45.- Global energy balance in the heat exchanger and loss study.
46.- Determination of the exchanger effectiveness. NTU Method.
47.- Study of the heat transfer in counter-current and co-current flow conditions.
48.- Flow influence on heat transfer. Reynolds number calculation.
49.- Obtaining of the correlation that relates Nusselt number with Reynolds number and Prandtl number.
50.- Obtaining of the heat transfer coefficients by convection.

Additional practical possibilities:

51.- Sensors calibration.
52.- Study of the hysteresis in the flow sensors.

Practices to be done with the Cross Flow Heat Exchanger for TICC (TICF):

53.- Introduction to the concept of psychometric properties.
54.- Effect of temperature differential on the heat transfer coefficient.
55.- Familiarization with cross flow heat exchanger.
56.- Overall energy balance in the heat exchanger and study of losses.
57.- Determination of the exchanger effectiveness (NTU method).
58.- Influence of air and water flow on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

59.- Sensors calibration.
60.- Study of the hysteresis in the flow sensors.

Other possibilities to be done with this System:

61.- Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
62.- 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.
63.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
64.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
65.- This unit can be used for doing applied research.
66.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
67.- Control of the unit process through the control interface box without the computer.
68.- Visualization of all the sensors values used in the 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 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Water supply (0 to 6 l/min approx) and drain.
- Computer.

REQUIRED ELEMENTS (Not included)

Required (at least one):

- TITC. Concentric Tube Heat Exchanger for TICC.
- TITCA. Extended Concentric Tube Heat Exchanger for TICC.
- TIPL. Plate Heat Exchanger for TICC.
- TIPLA. Extended Plate Heat Exchanger for TICC.
- TICT. Shell & Tube Heat Exchanger for TICC.
- TIVE. Jacketed Vessel Heat Exchanger for TICC.
- TIVS. Coil Vessel Heat Exchanger for TICC.
- TIFT. Turbulent Flow Heat Exchanger for TICC.
- TICF. Cross Flow Heat Exchanger for TICC.

DIMENSIONS AND WEIGHTS

TICC:

TIUS. Base Service Unit:
-Dimensions: 1100 x 630 x 500 mm approx.
(43.30 x 24.80 x 19.68 inches approx.)
-Weight: 50 kg approx.
(110.2 pounds approx.)

TITC. Unit:
-Dimensions: 1100 x 630 x 320 mm approx.
(43.30 x 24.80 x 12.60 inches approx.)
-Weight: 20 kg approx.
(44.09 pounds approx.)

TITCA. Unit:
-Dimensions: 1500 x 700 x 320 mm approx.
(59.05 x 27.55 x 12.60 inches approx.)
-Weight: 30 kg approx.
(66.13 pounds approx.)

TIPL. Unit:
-Dimensions: 1100 x 630 x 320 mm approx.
(43.30 x 24.80 x 12.60 inches approx.)
-Weight: 20 kg approx.
(44.09 pounds approx.)

TIPLA. Unit:
-Dimensions: 1200 x 700 x 320 mm approx.
(47.24 x 27.55 x 12.60 inches approx.)
-Weight: 25 kg approx.
(55.11 pounds approx.)

TICT. Unit:
-Dimensions: 1100 x 630 x 400 mm approx.
(43.30 x 24.80 x 15.74 inches approx.)
-Weight: 30 kg approx.
(66.13 pounds approx.)

TIVE. Unit:
-Dimensions: 1100 x 630 x 700 mm approx.
(43.30 x 24.80 x 27.55 inches approx.)
-Weight: 35 kg approx.
(77.16 pounds approx.)

TIVS. Unit:
-Dimensions: 1100 x 630 x 700 mm approx.
(43.30 x 24.80 x 27.55 inches approx.)
-Weight: 30 kg approx.
(66.13 pounds approx.)

TIFT. Unit:
-Dimensions: 1100 x 630 x 350 mm approx.
(43.30 x 24.80 x 13.78 inches approx.)
-Weight: 20 kg approx.
(44.09 pounds approx.)

TICF. Unit:
-Dimensions: 1100 x 630 x 600 mm approx.
(43.30 x 24.80 x 22.62 inches approx.)
-Weight: 20 kg approx.
(44.09 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.)

SIMILAR UNITS AVAILABLE

Offered in this catalog:

- TICC. Computer Controlled Heat Exchangers Training System.

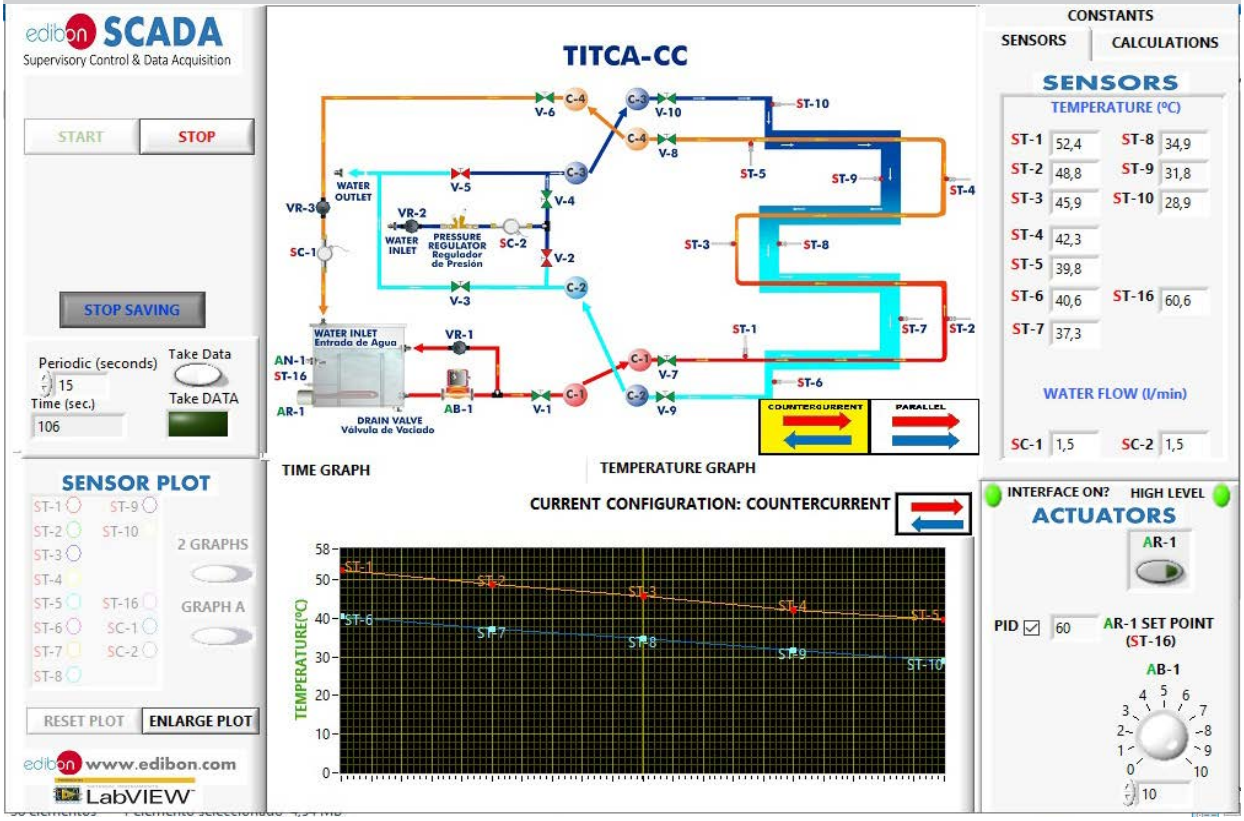
Offered in other catalogs:

- TICC/SS. Computer Controlled Heat Exchangers Basic Unit.
- TICB. Heat Exchangers Training System.

SCADA and PID Control
Main screens

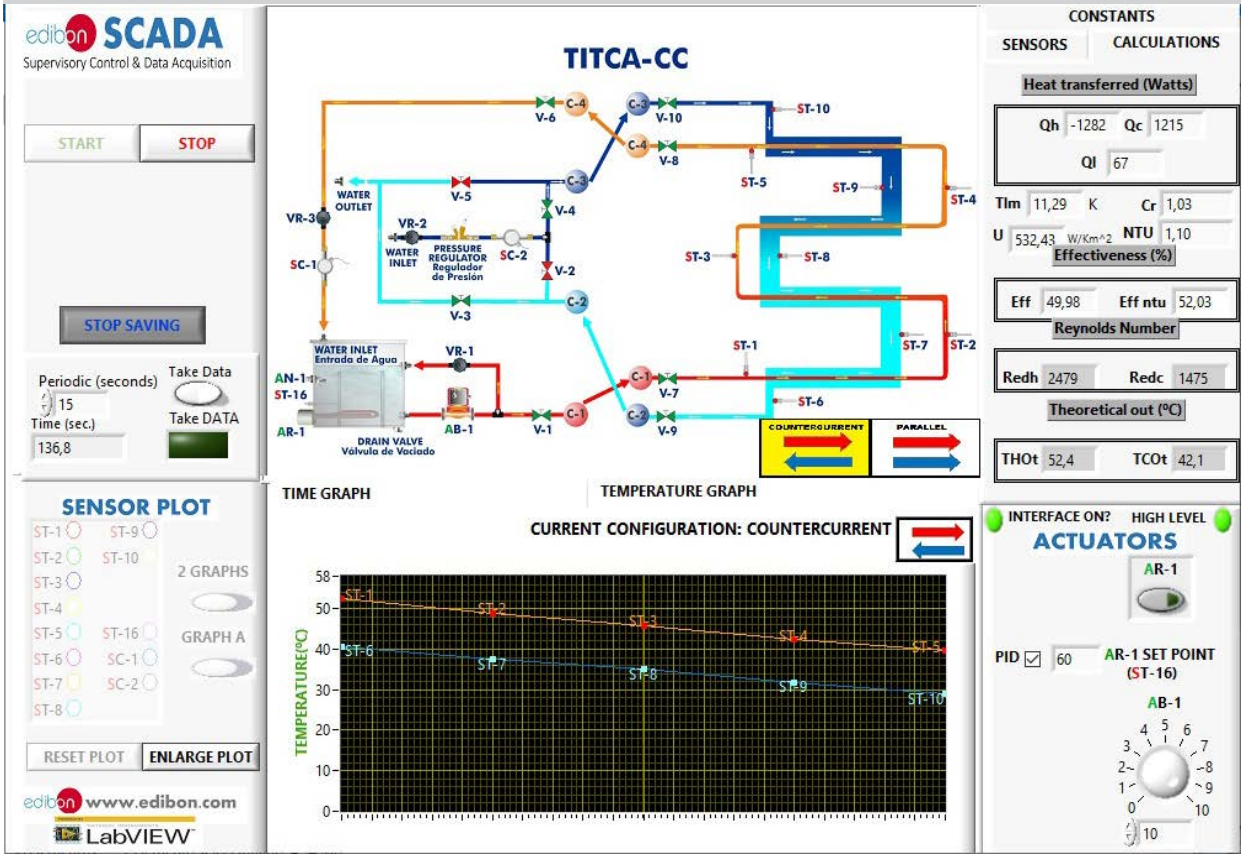
Extended Concentric Tube Heat Exchanger (TITCA) Main Screens

Working option: Counter-current (CC)
Sensors:



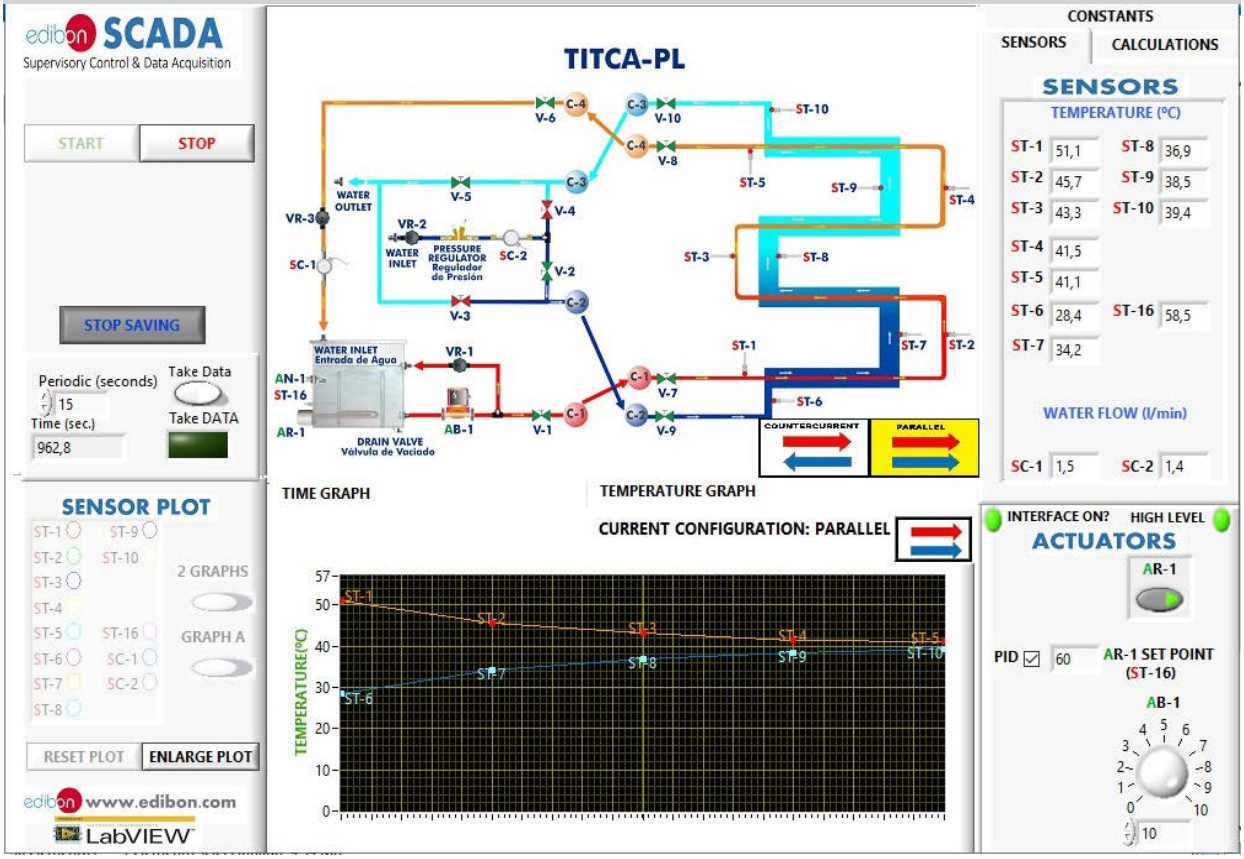
Note:
Sensors: ST=Temperature sensor. SC=Flow sensor.
Actuators: AB=Pump. AR=Heating element. AN= Level switch.

Calculations:

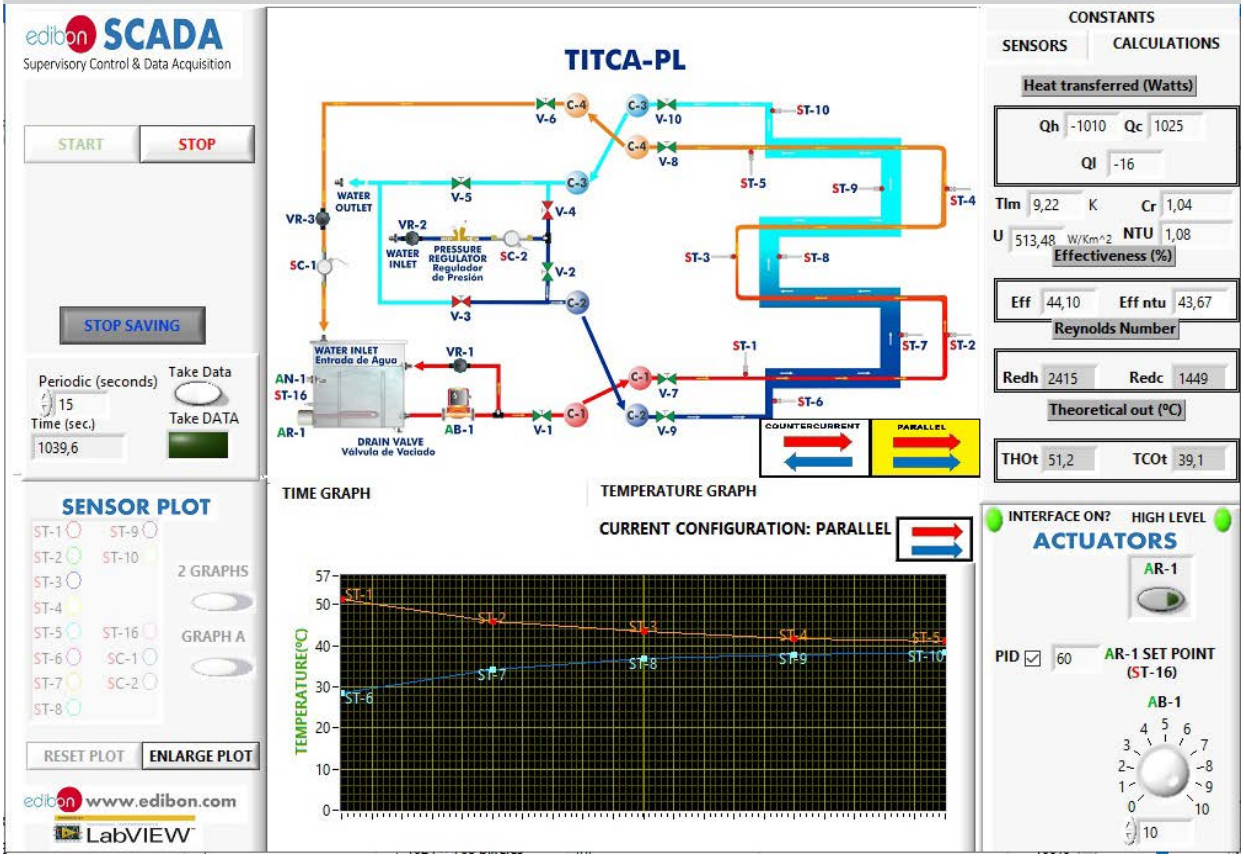


Extended Concentric Tube Heat Exchanger (TITCA) Main Screens (continuation)
Working option: Co-current (PL).

Sensors:

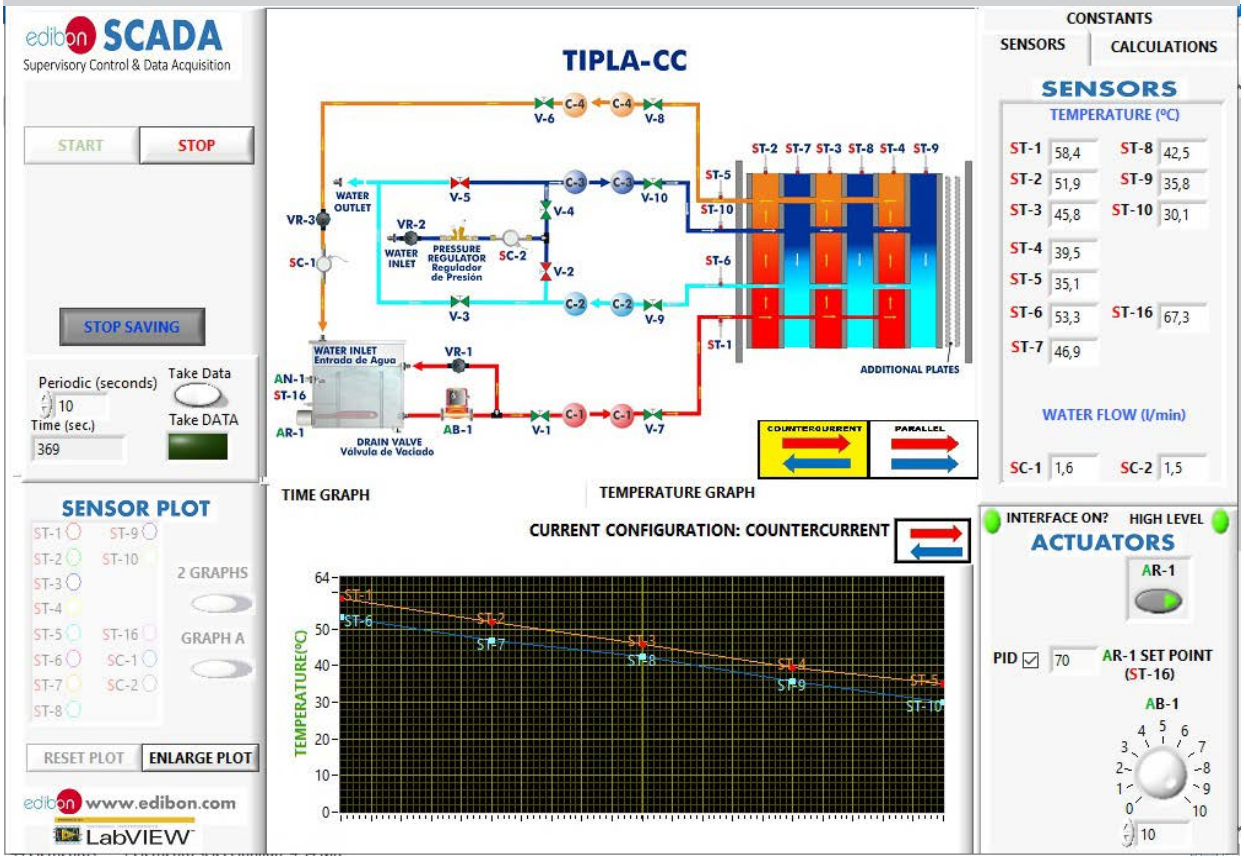


Calculations:



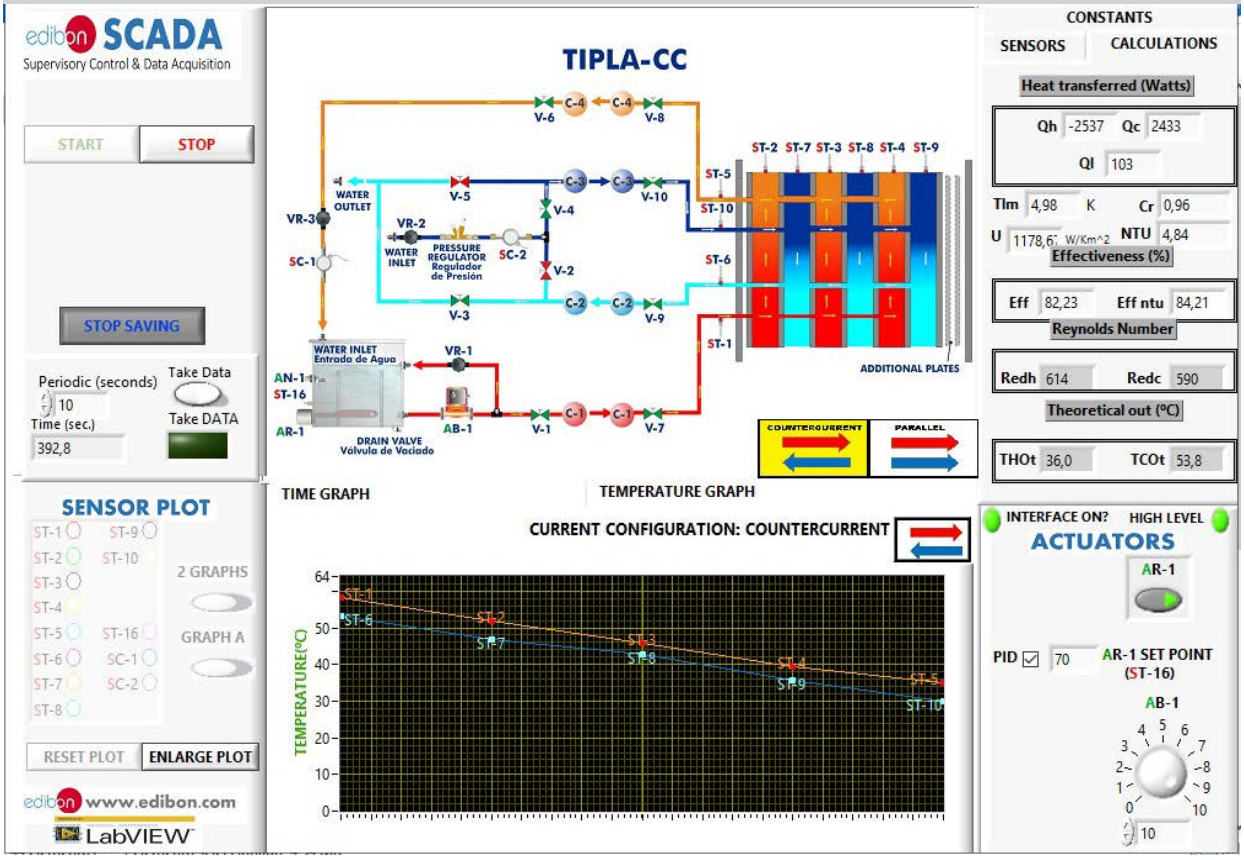
Extended Plate Heat Exchanger (TIPLA) Main Screens

Working option: Counter-current (CC)
Sensors:



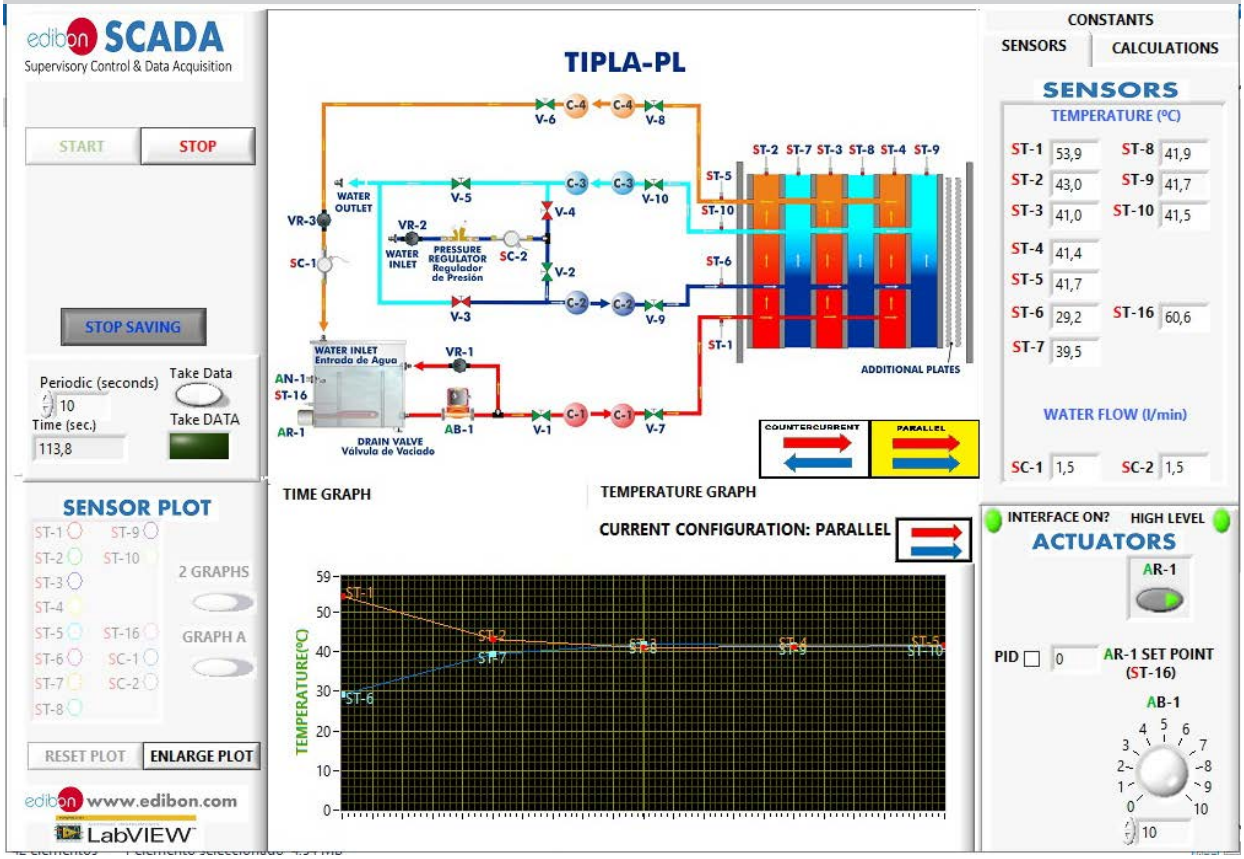
Note:
Sensors: ST=Temperature sensor. SC=Flow sensor.
Actuators: AB=Pump. AR=Heating element. AN= Level switch

Calculations:

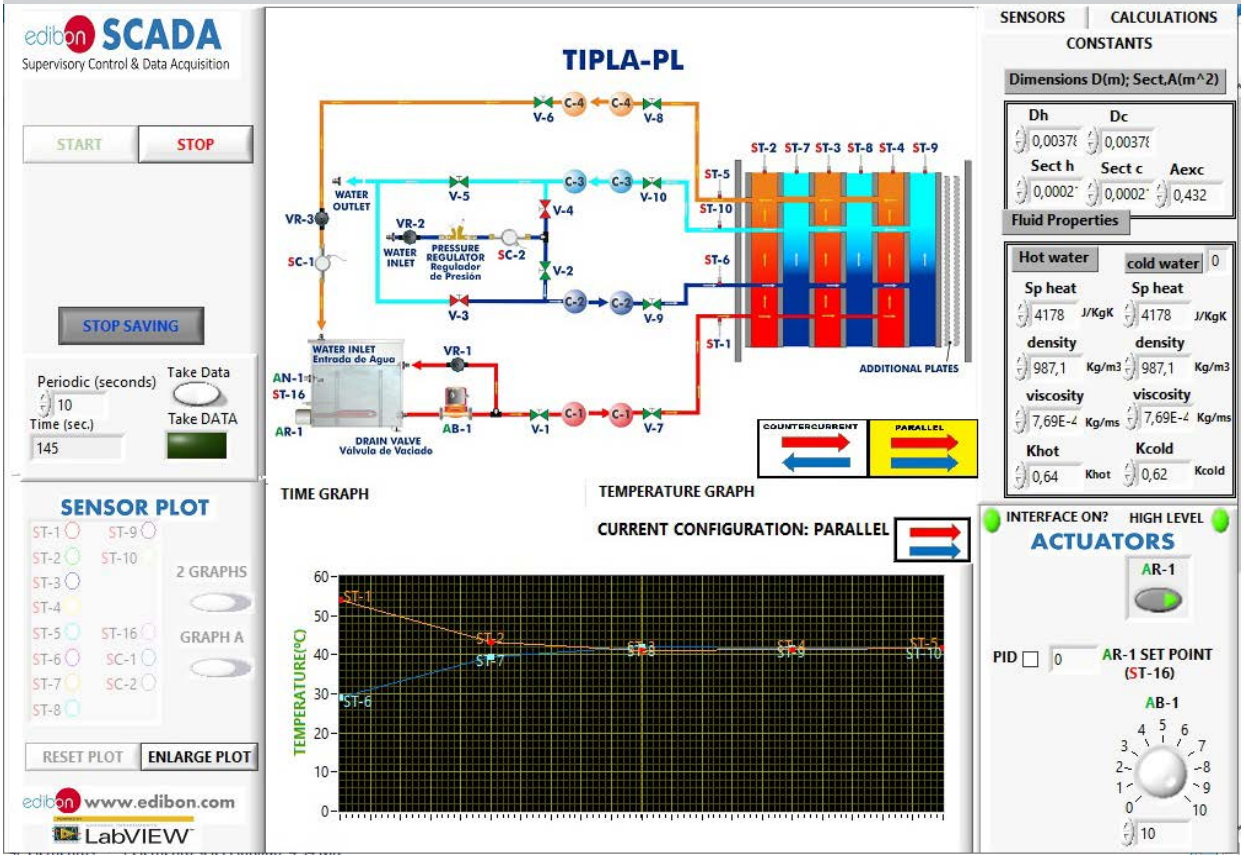


Extended Plate Heat Exchanger (TIPLA) Main Screens (continuation)
Working option: Co-current (PL).

Sensors:

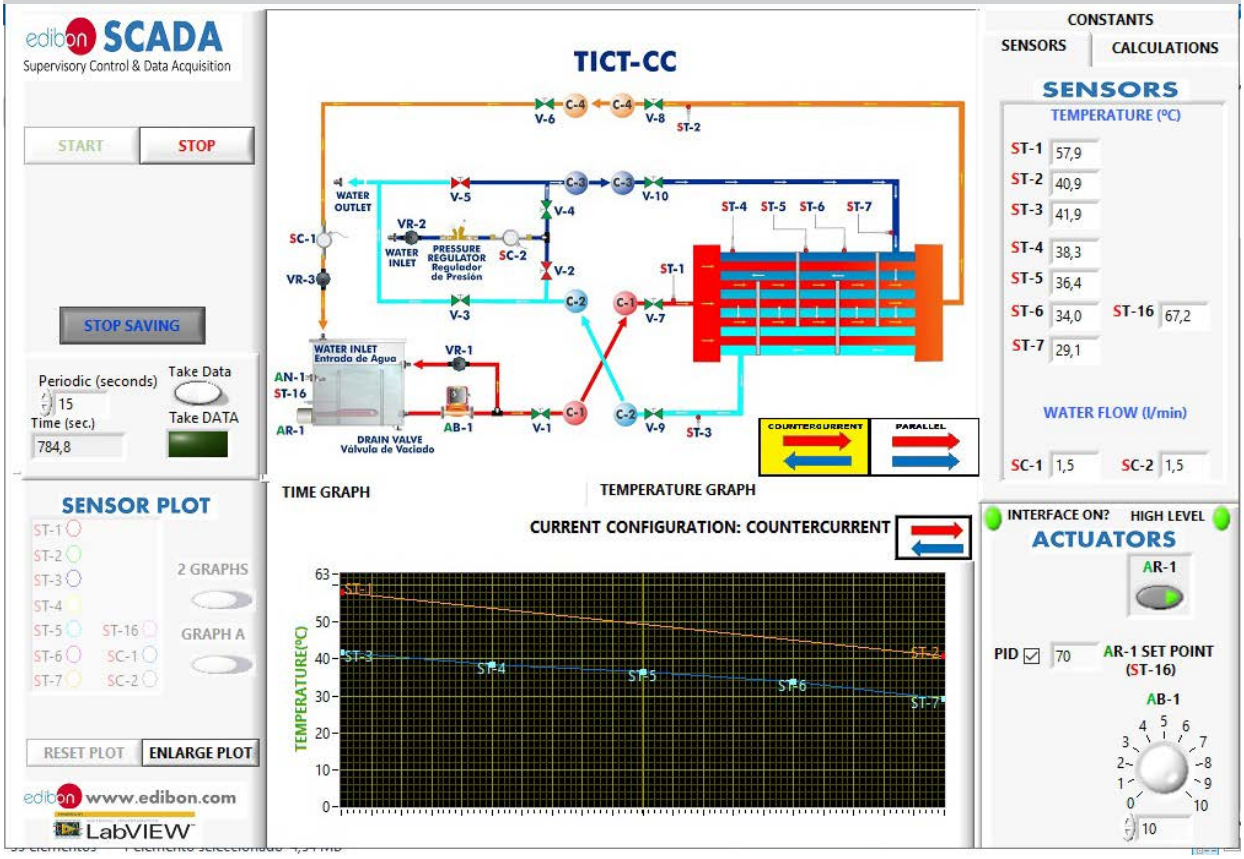


Calculations:



Shell & Tube Heat Exchanger (TICT) Main Screens
Working option: Counter-current (CC)

Sensors:

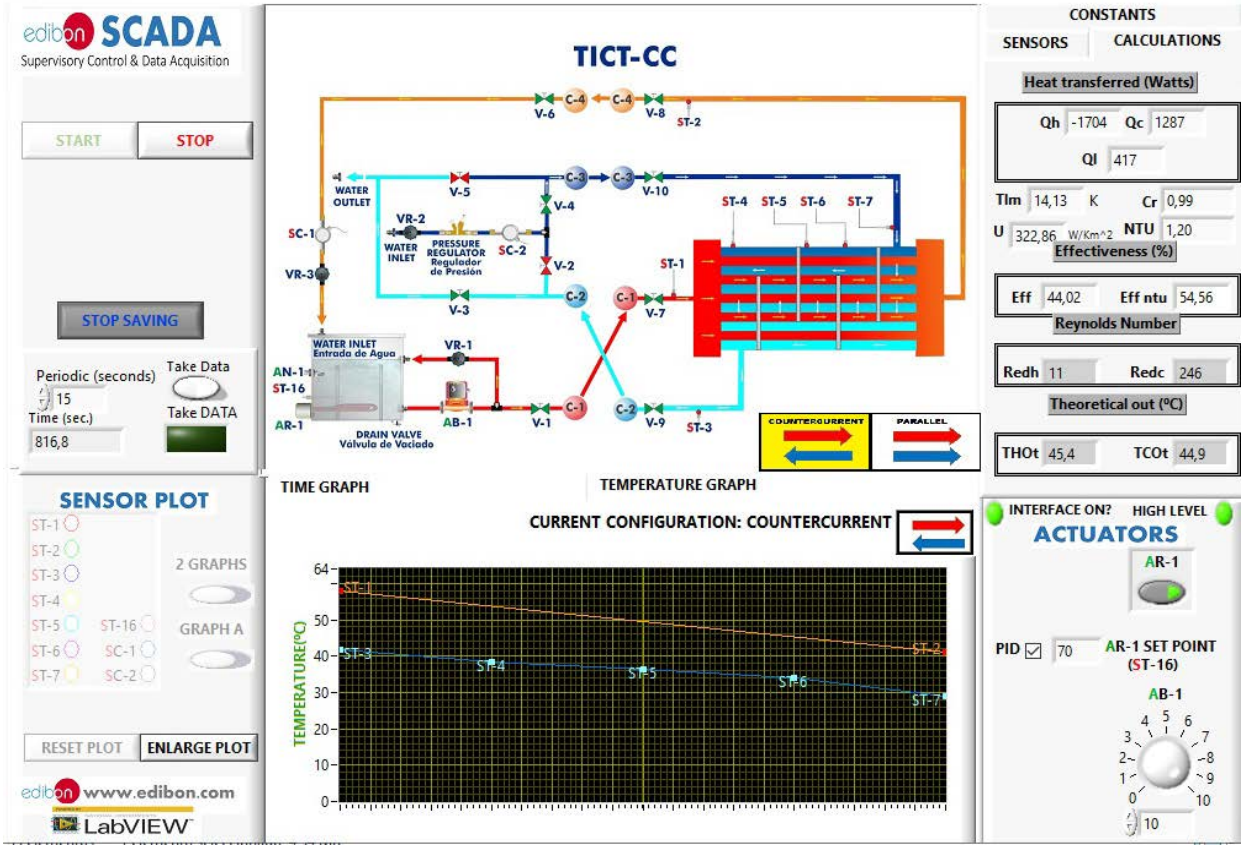


Note:

Sensors: ST=Temperature sensor. SC=Flow sensor.

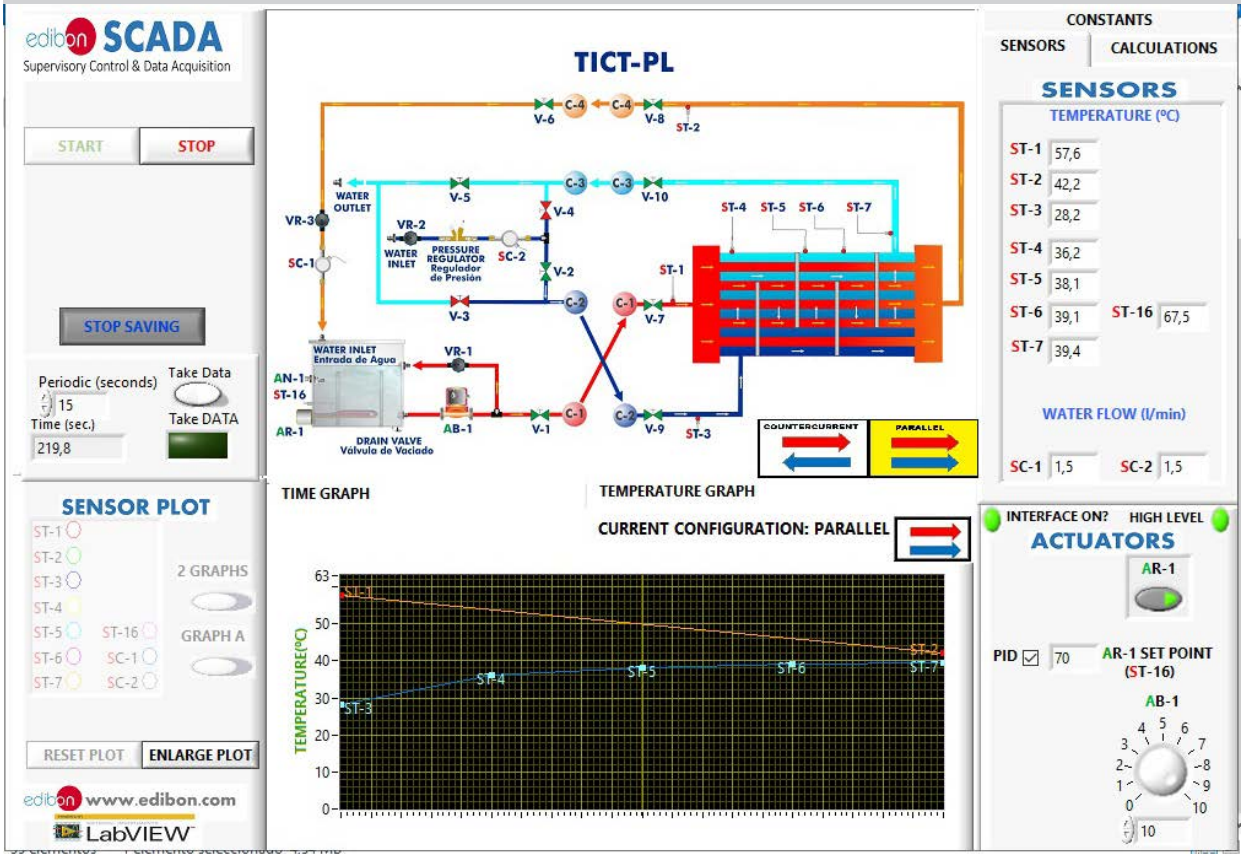
Actuators: AB=Pump. AR=Heating element. AN= Level switch.

Calculations:

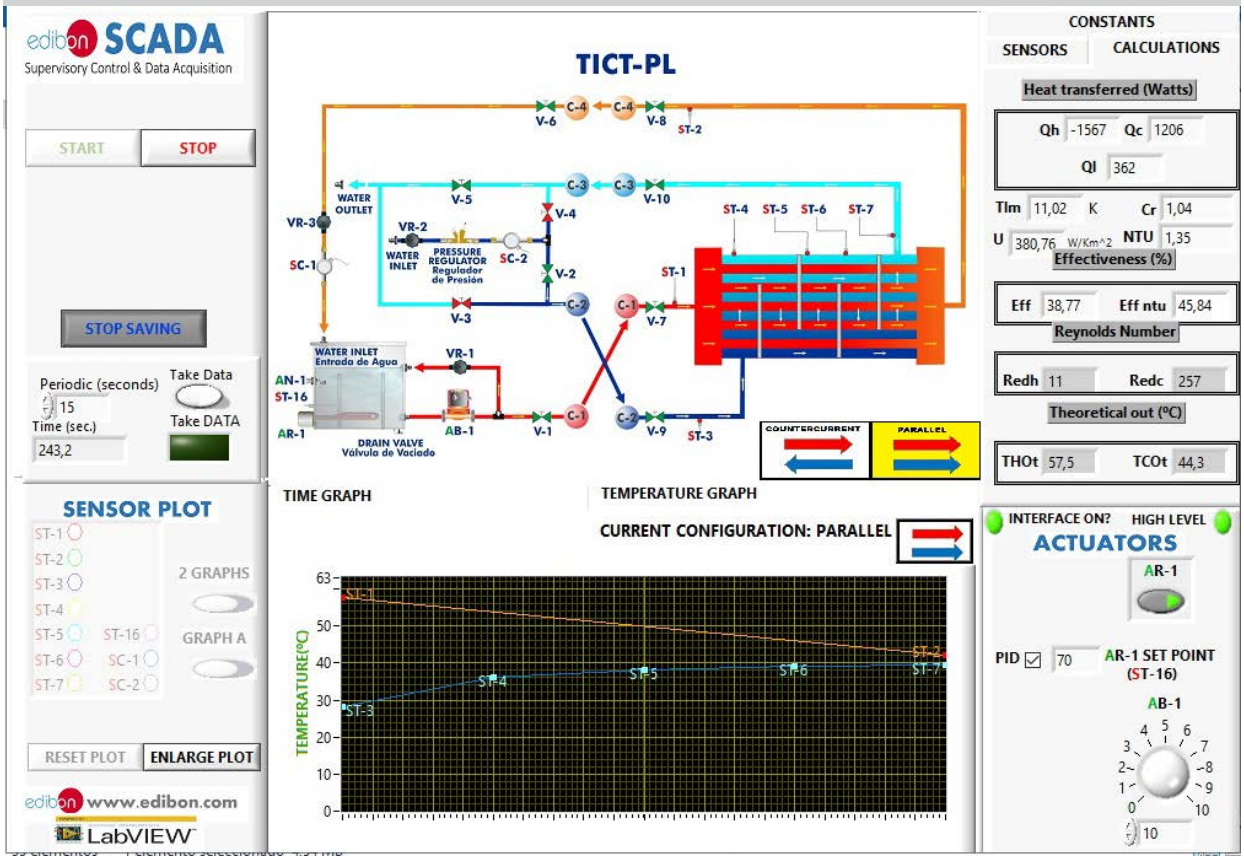


Shell & Tube Heat Exchanger (TICT) Main Screens (continuation)
Working opcion: Co-current (PL).

Sensors:

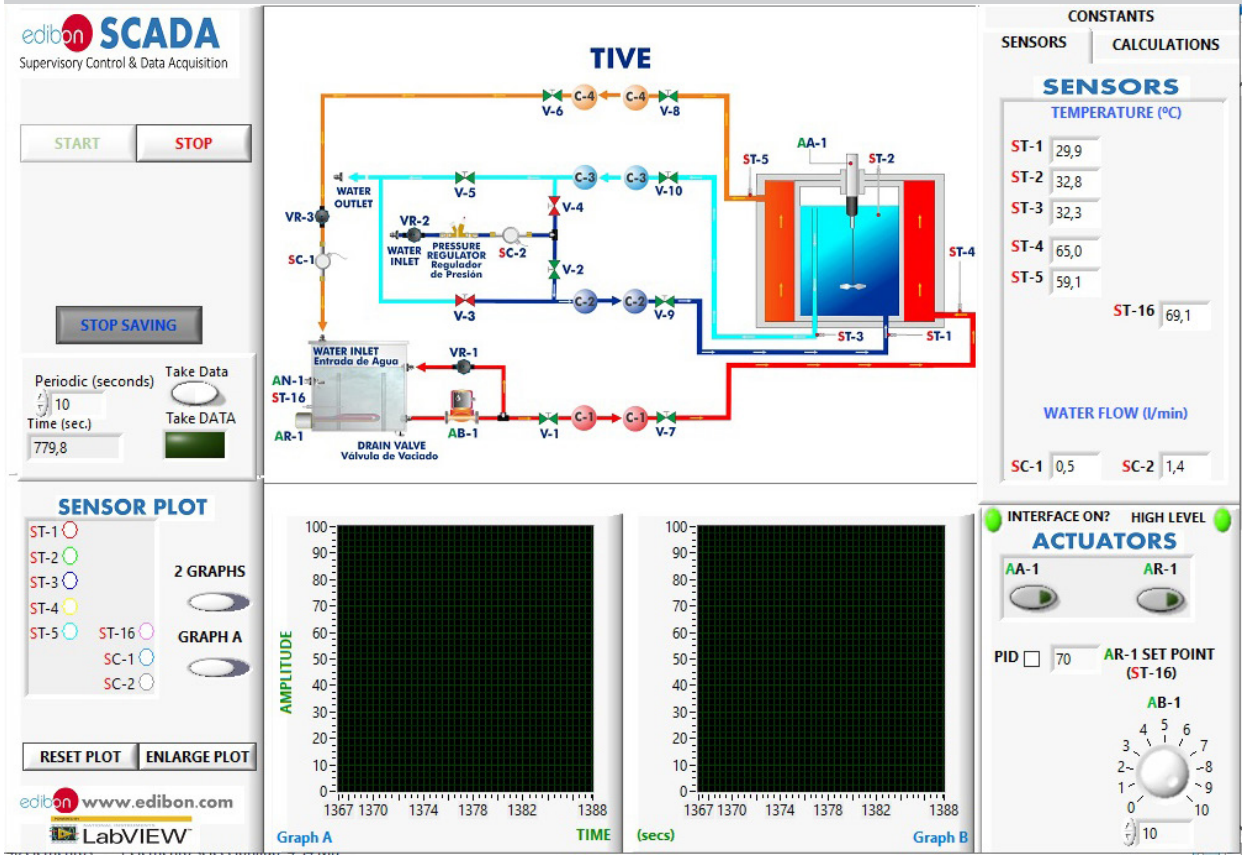


Calculations:



Jacketed Vessel Heat Exchanger (TIVE) Main Screens

Sensors:

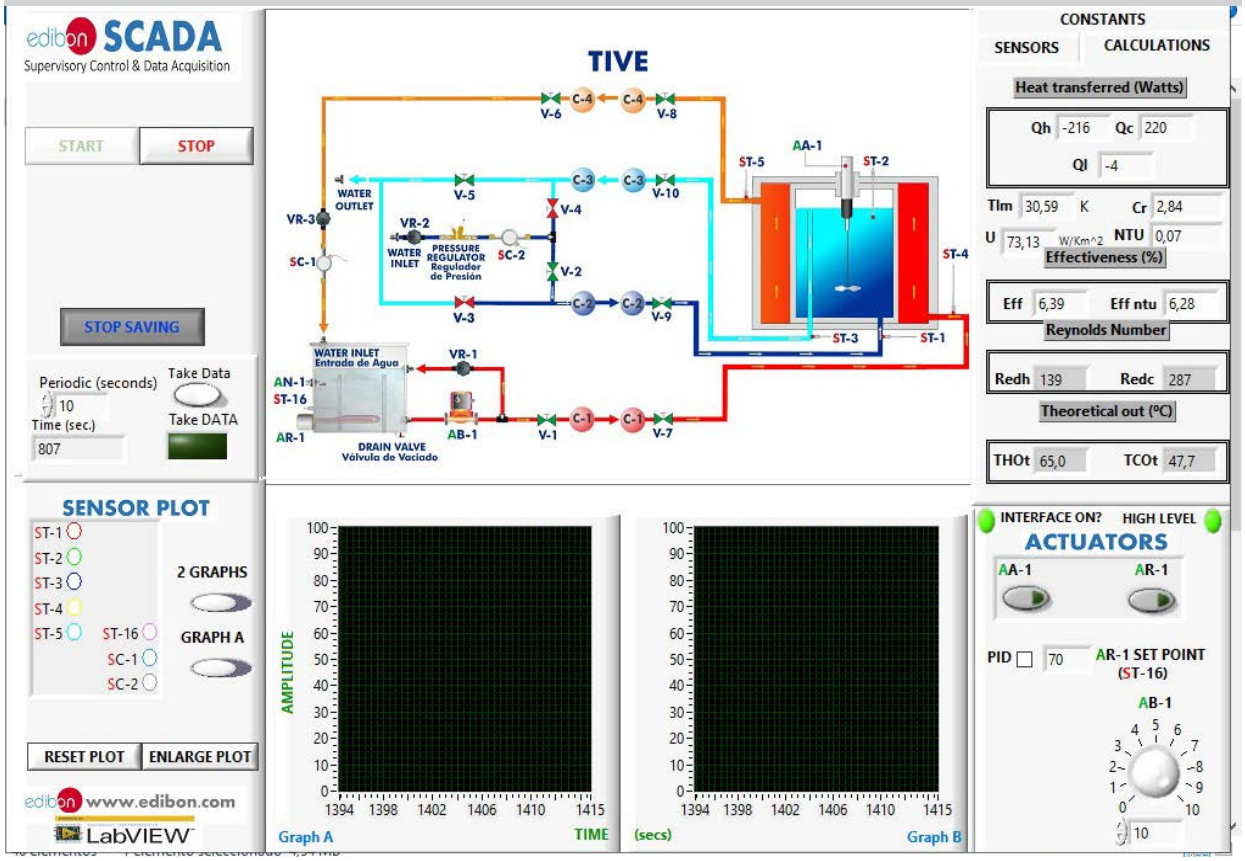


Note:

Sensors: ST=Temperature sensor. SC=Flow sensor.

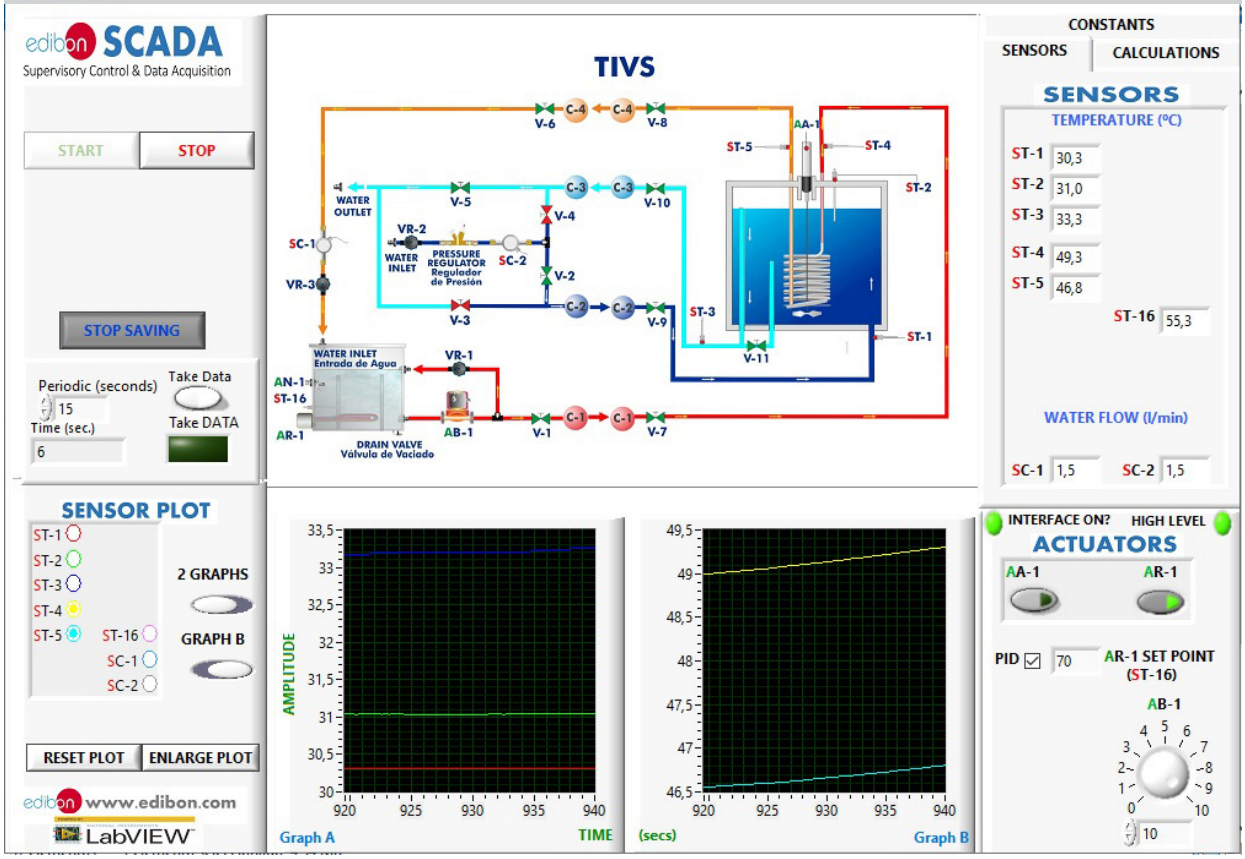
Actuators: AB=Pump. AR=Heating element. AA=Stirrer. AN= Level switch

Calculations:



Coil Vessel Heat Exchanger (TIVS) Main Screens

Sensors:

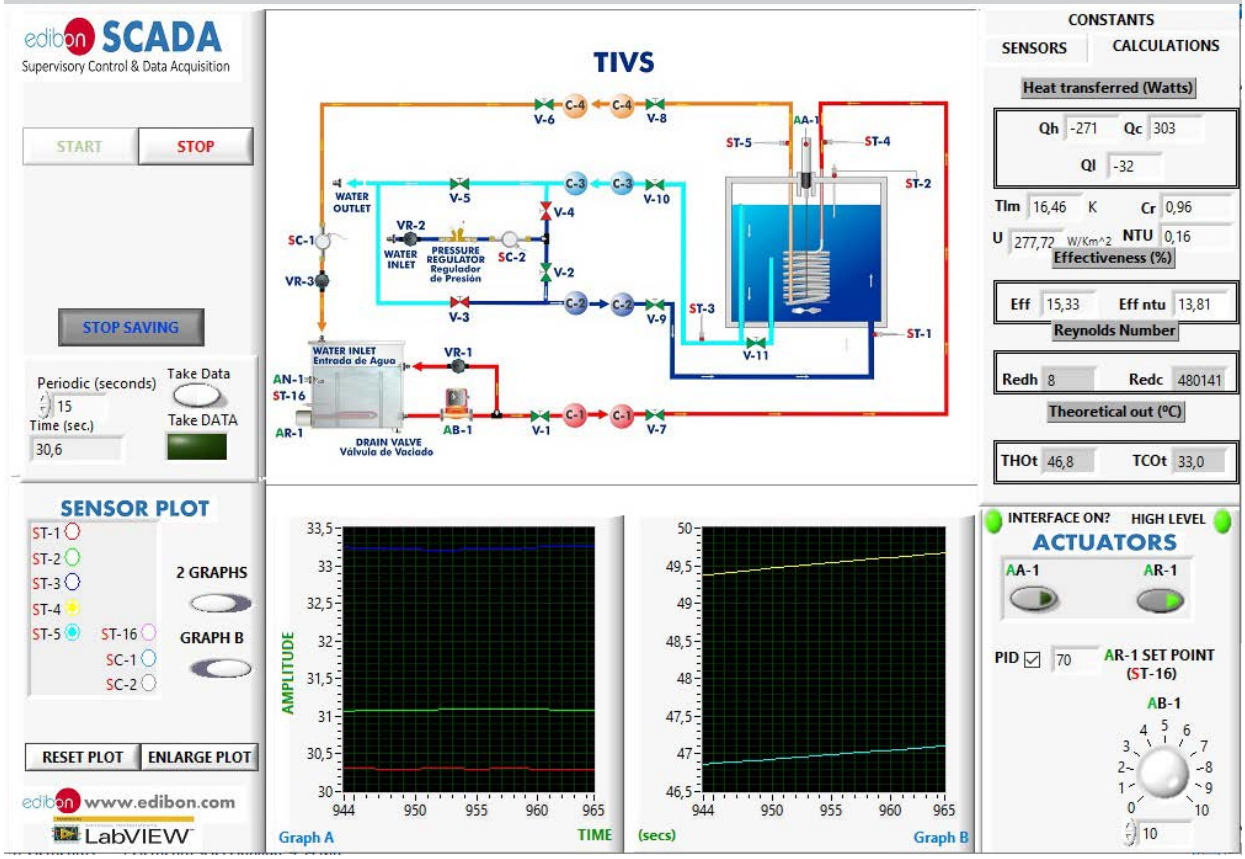


Note:

Sensors: ST=Temperature sensor. SC=Flow sensor.

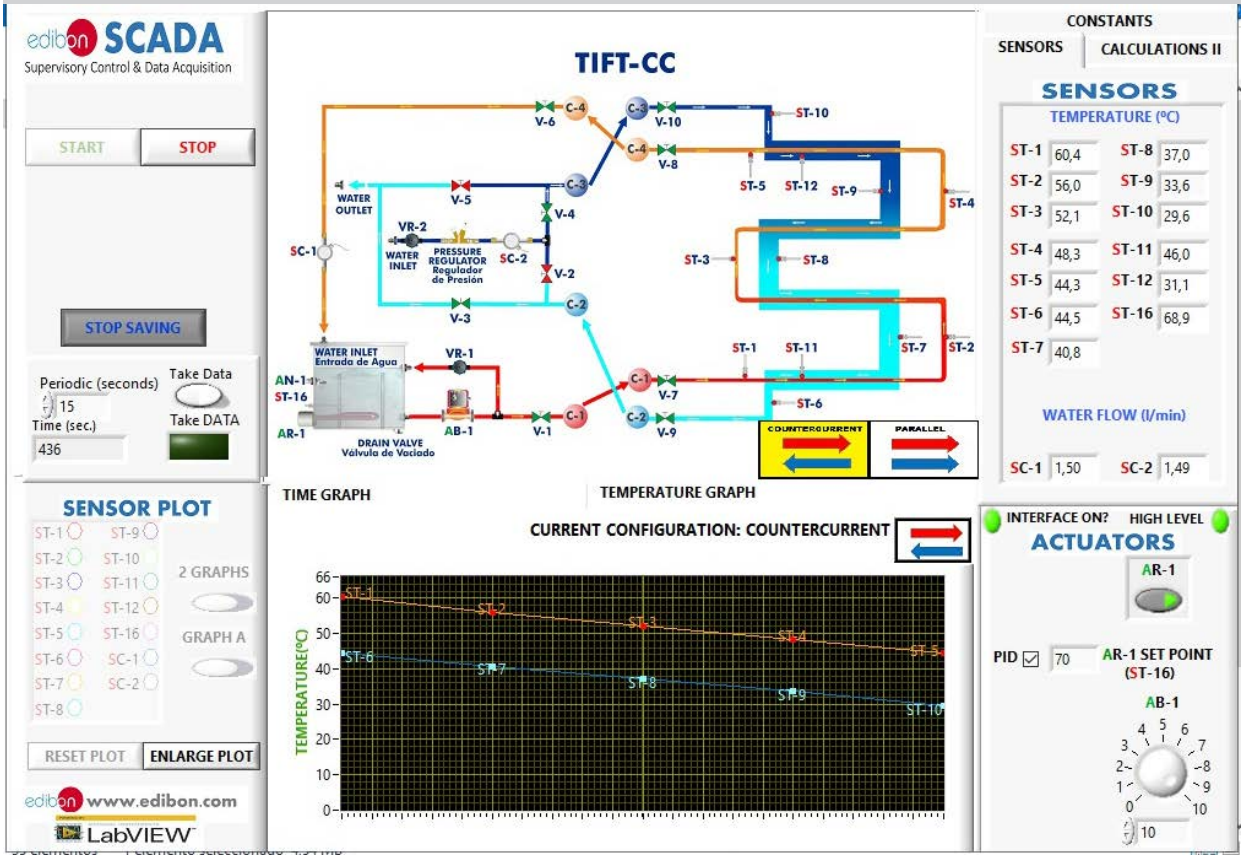
Actuators: AB=Pump. AR=Heating element. AA=Stirrer. AN= Level switch.

Calculations:



Turbulent Flow Heat Exchanger (TIFT) Main Screens
Working option: Counter-current (CC).

Sensors:

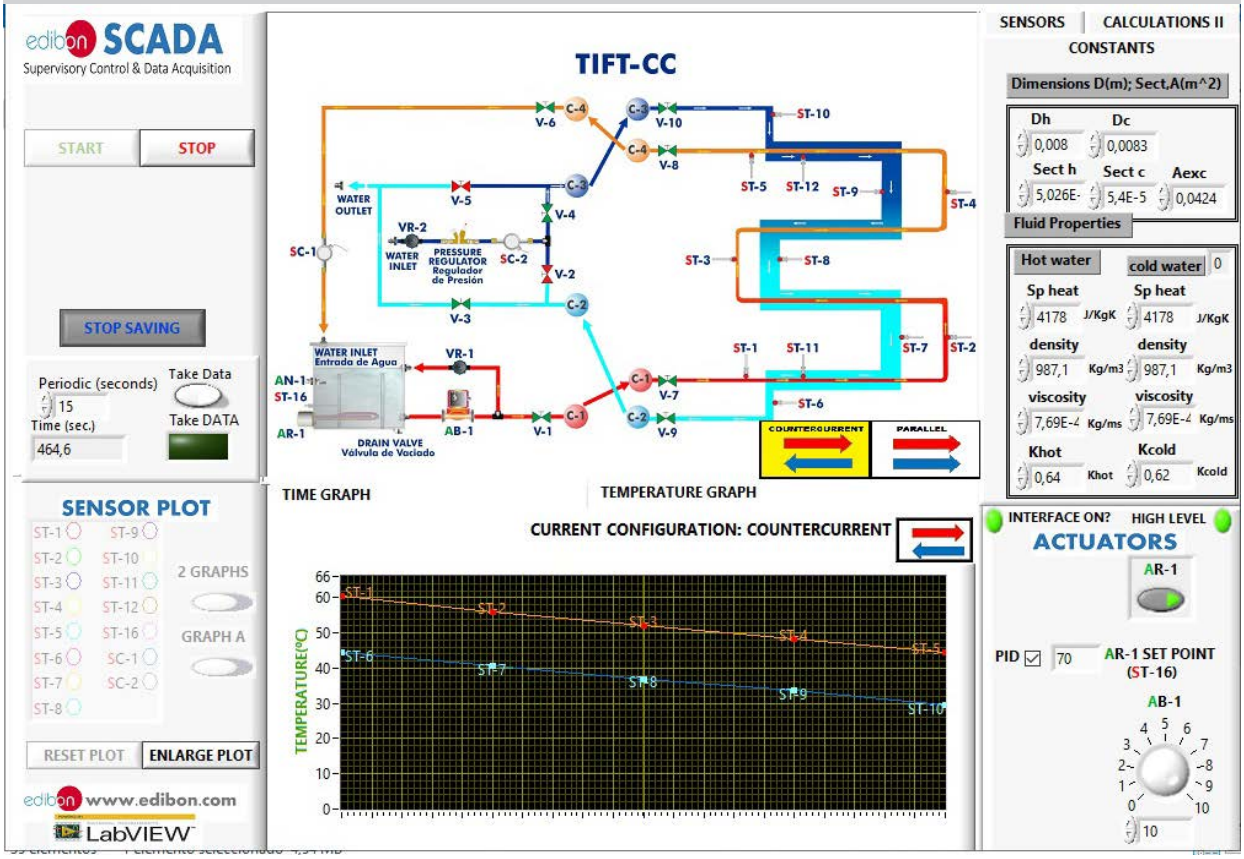


Note:

Sensors: ST=Temperature sensor. SC=Flow sensor.

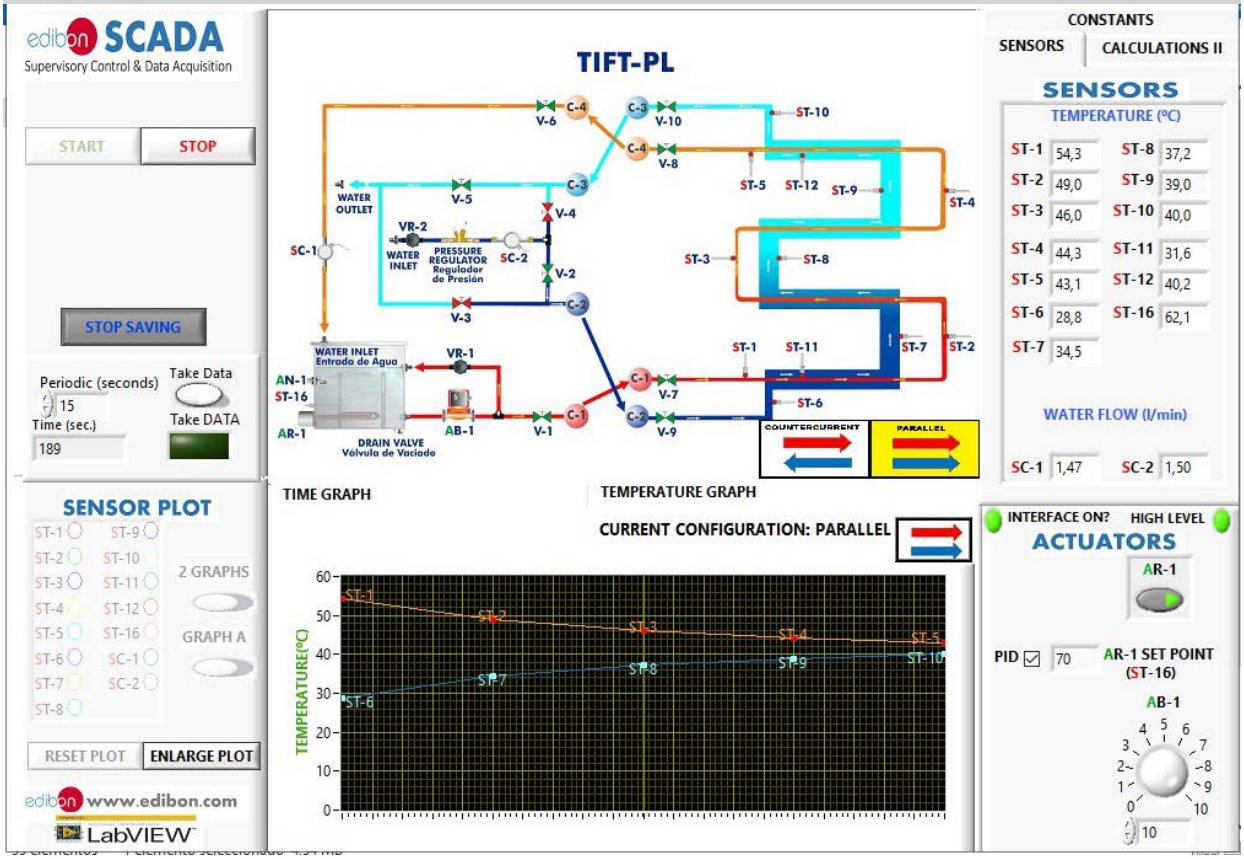
Actuators: AB=Pump. AR=Heating element. AN= Level switch.

Calculations:

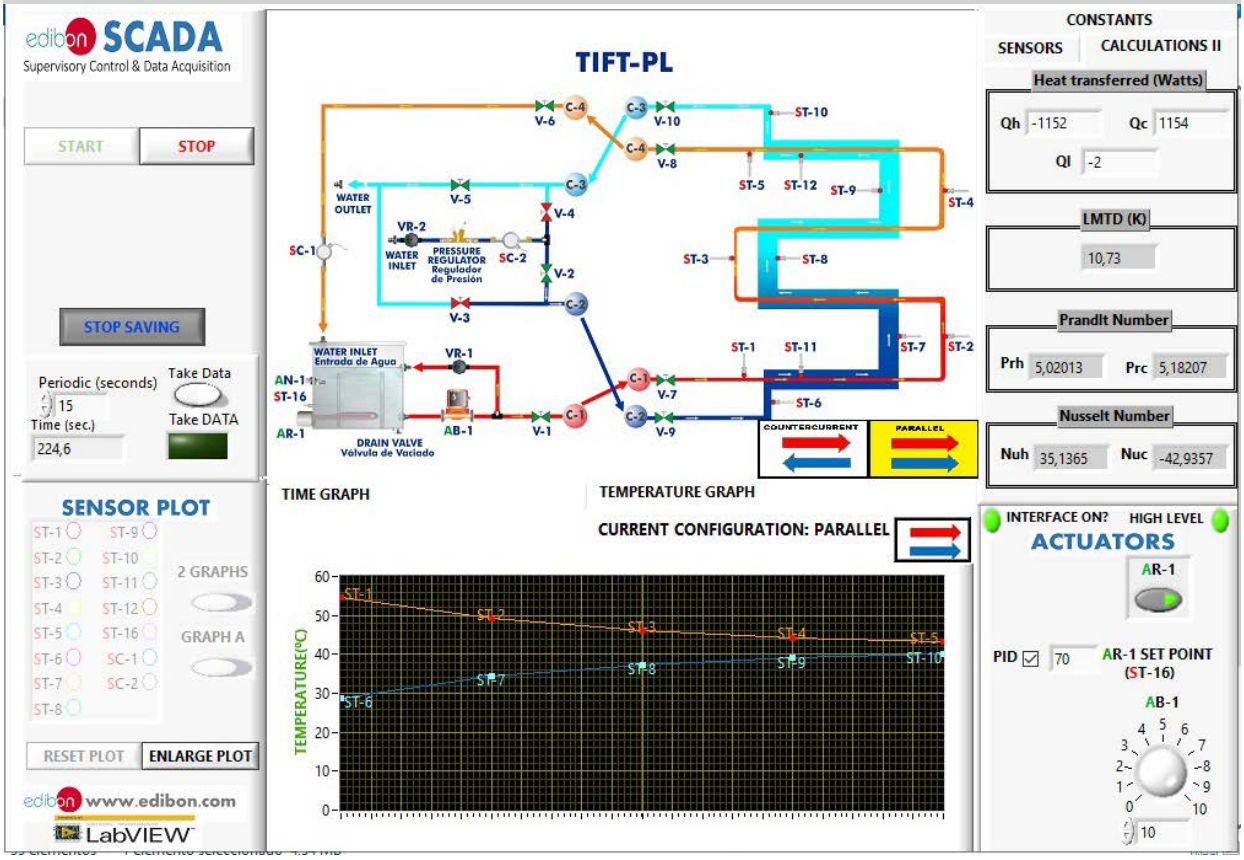


Turbulent Flow Heat Exchanger (TIFT) Main Screens (continuation)
Working option: Co-current (PL)

Sensors:

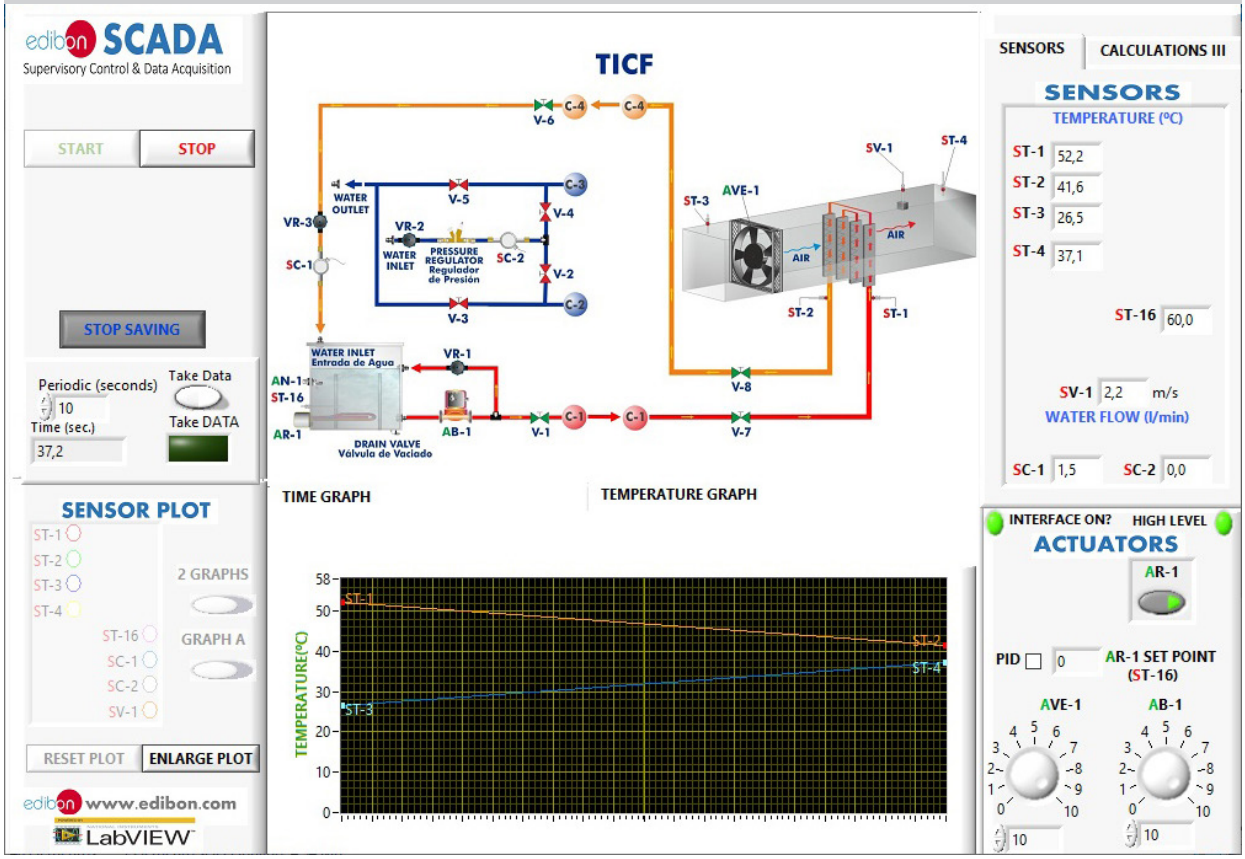


Calculations:



Cross Flow Heat Exchanger (TICF) Main Screens

Sensors:

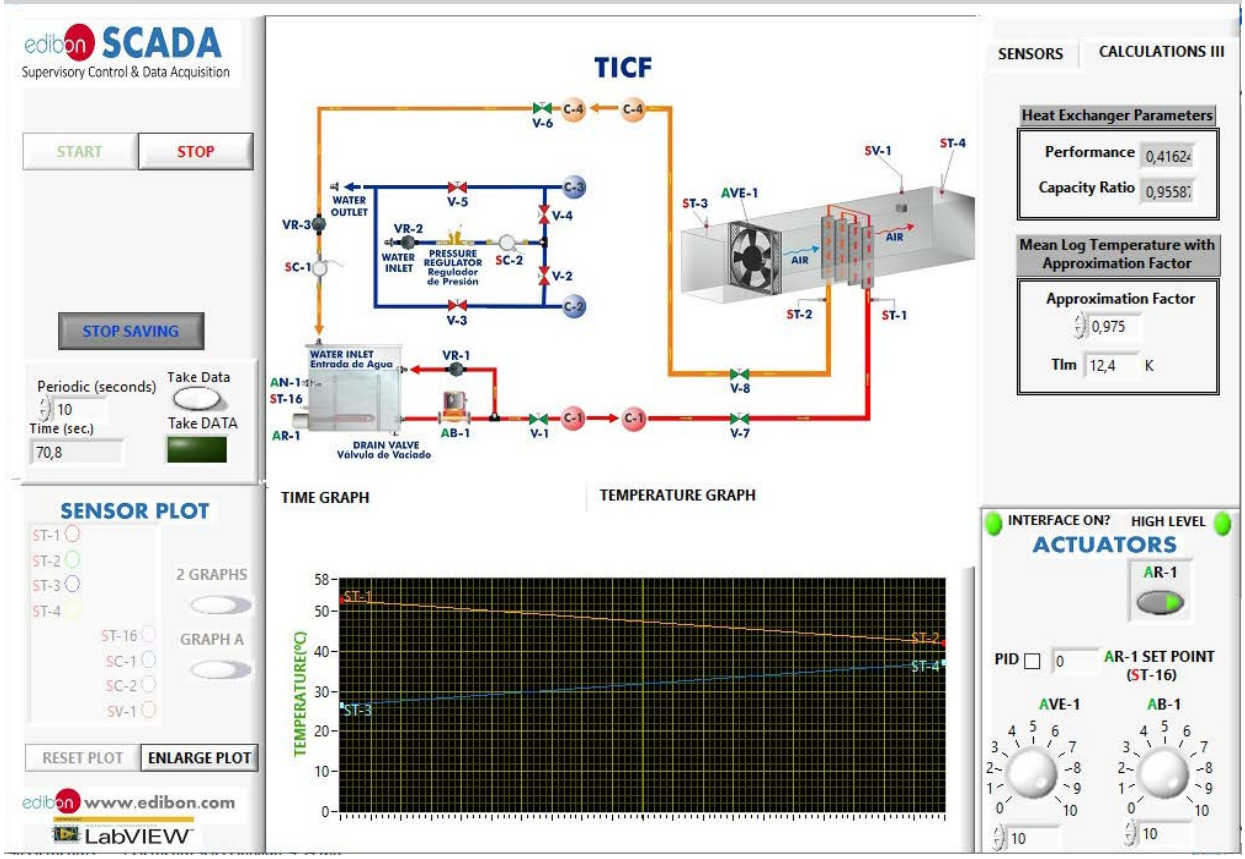


Note:

Sensors: ST=Temperature sensor. SC=Flow sensor. SV=Velocity sensor.

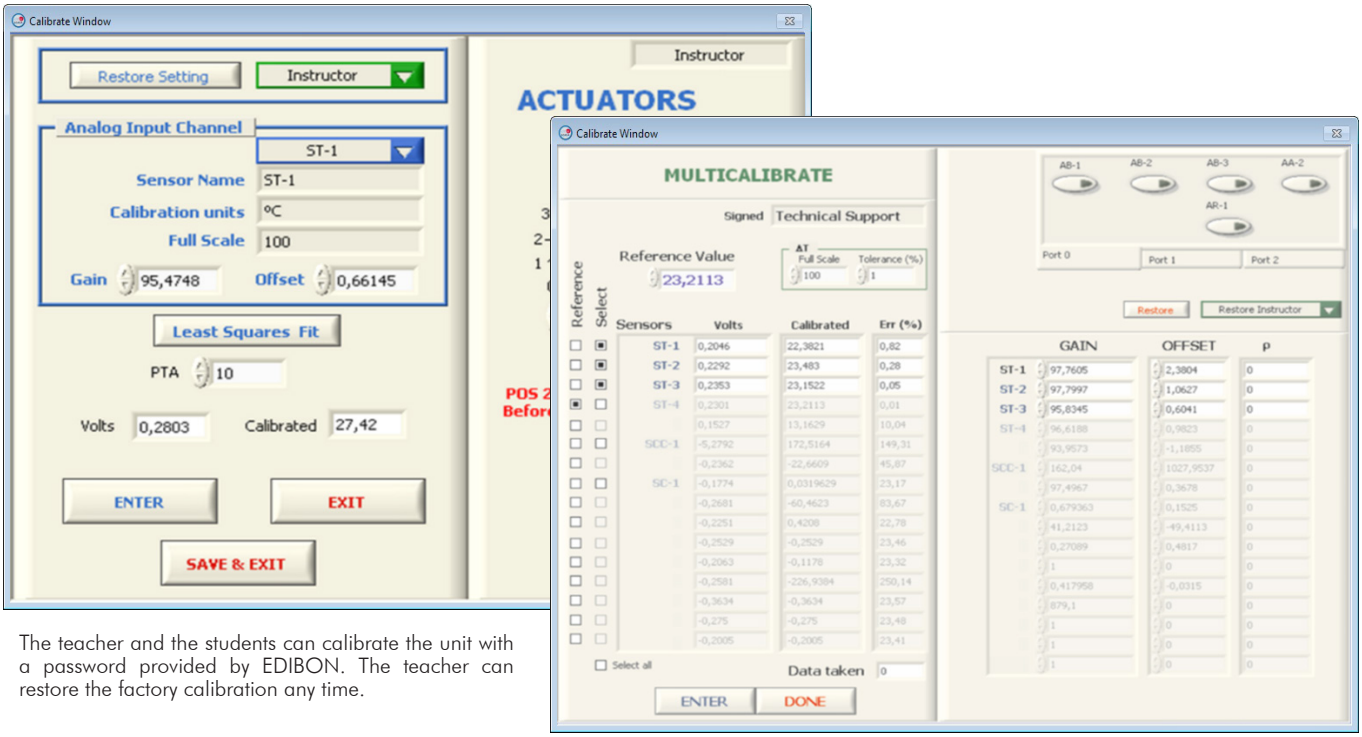
Actuators: AB=Pump. AR=Heating element. AVE=Fan. AN= Level switch.

Calculations:



Software for Sensors Calibration

Example of screen



The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.

Additionally to the main items (1 to 5) described, we can offer, as optional, other items from 6 to 10.
All these items try to give more possibilities for:

a) Industrial configuration. (PLC)
b) Technical and Vocational Education configuration. (ICAI and FSS)
c) Multipost Expansions options. (MINI ESN and ESN)

a) Industrial configuration

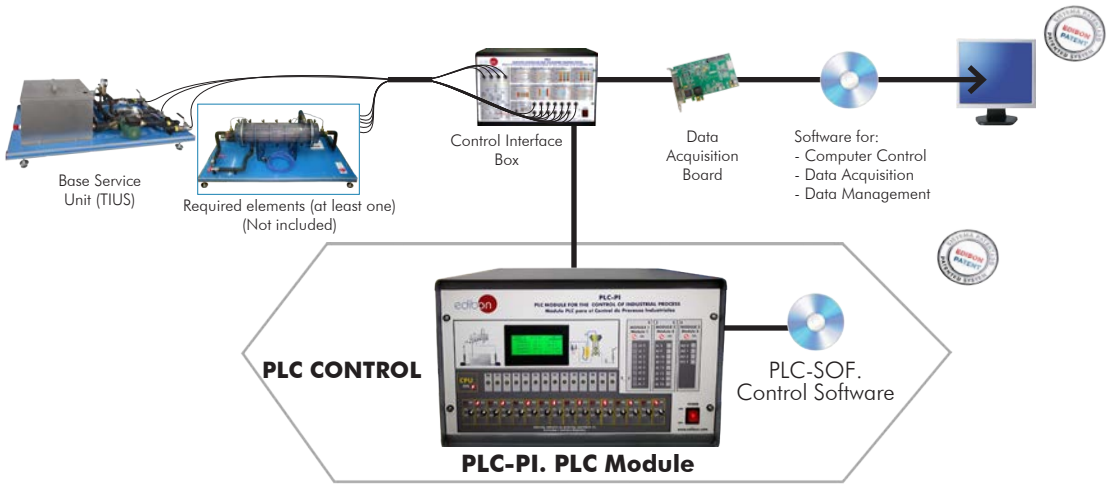
⑥ **PLC. Industrial Control using PLC** (it includes PLC-PI Module plus PLC-SOF Control Software):

-PLC-PI. PLC Module:

This unit is common for the modules type "TI" and can work with one or several modules.
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.).

-TICC/PLC-SOF. PLC Control Software:

Always included with PLC supply.
Each Heat Exchanger has its own Software.



Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.- PLC inputs and outputs configuration.
11.- PLC configuration possibilities.
12.- PLC program languages.
13.- PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
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 particular unit process.
17.- Possibility of creating new process in relation with the particular unit.
18.- PLC Programming Exercises.
19.- Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑦ TICC/ICAI. Interactive Computer Aided Instruction Software.

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

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

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- **User Data Base Management.**
- **Administration and assignment of Workgroup, Task and Training sessions.**
- **Creation and Integration of Practical Exercises and Multimedia Resources.**
- **Custom Design of Evaluation Methods.**
- **Creation and assignment of Formulas & Equations.**
- **Equation System Solver Engine.**
- **Updatable Contents.**
- **Report generation, User Progression Monitoring and Statistics.**

- ESL-SOF. EDIBON Student Labsoft (Student Software).

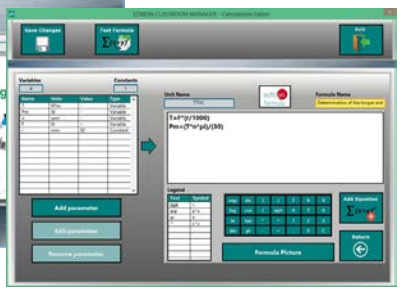
ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

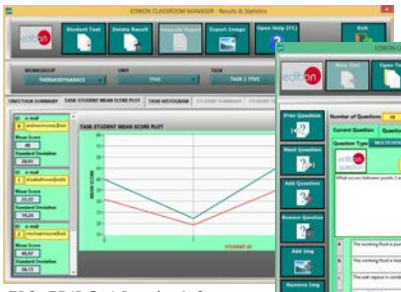
- **Student Log-In & Self-Registration.**
- **Existing Tasks checking & Monitoring.**
- **Default contents & scheduled tasks available to be used from the first session.**
- **Practical Exercises accomplishment by following the Manual provided by EDIBON.**
- **Evaluation Methods to prove your knowledge and progression.**
- **Test self-correction.**
- **Calculations computing and plotting.**
- **Equation System Solver Engine.**
- **User Monitoring Learning & Printable Reports.**
- **Multimedia-Supported auxiliary resources.**

Instructor Software

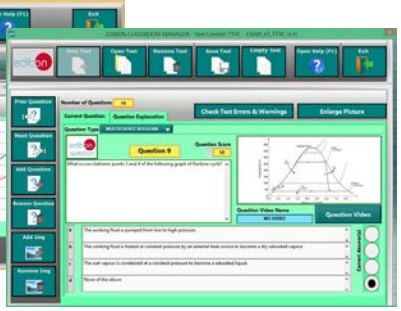
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



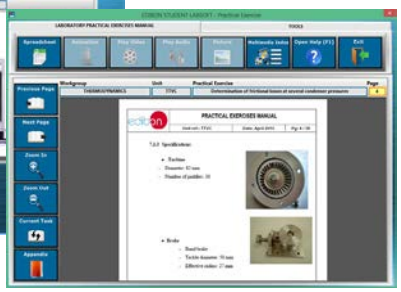
ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram



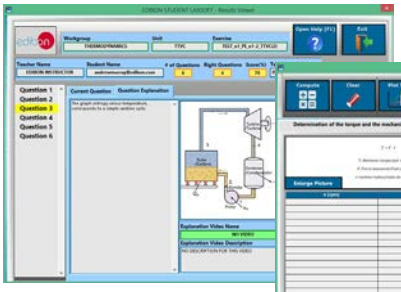
ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question

Student Software

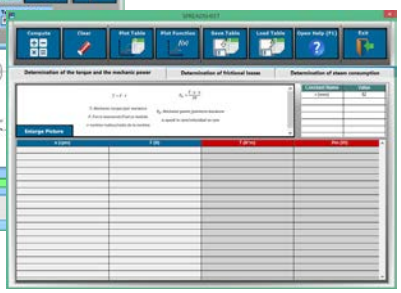
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

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

www.edibon.com/en/interactive-computer-aided-instruction-software

⑧ TICC/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 in 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.**

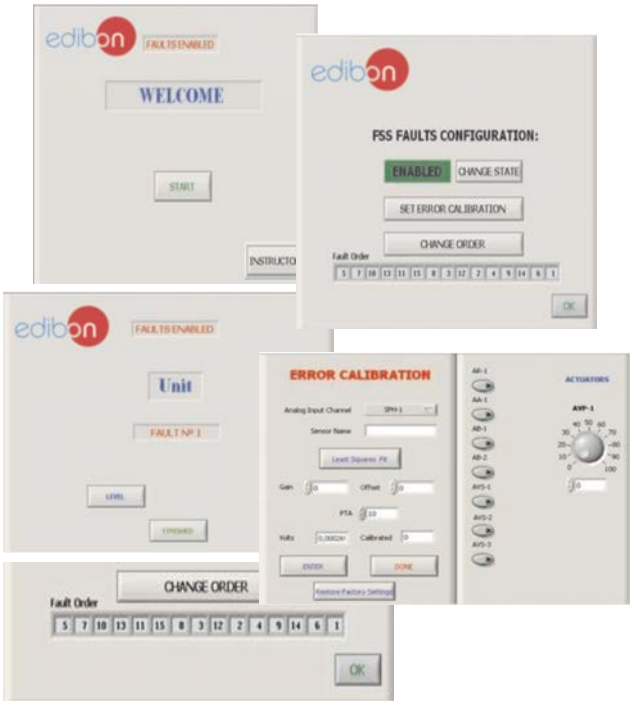
Faults in the controls execution:

- **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/en/fault-simulation-system

c) Multipost Expansions options

⑨ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

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 of the adaptation of any EDIBON Computer Controlled Unit with SCADA and PID Control integrated in a local network.

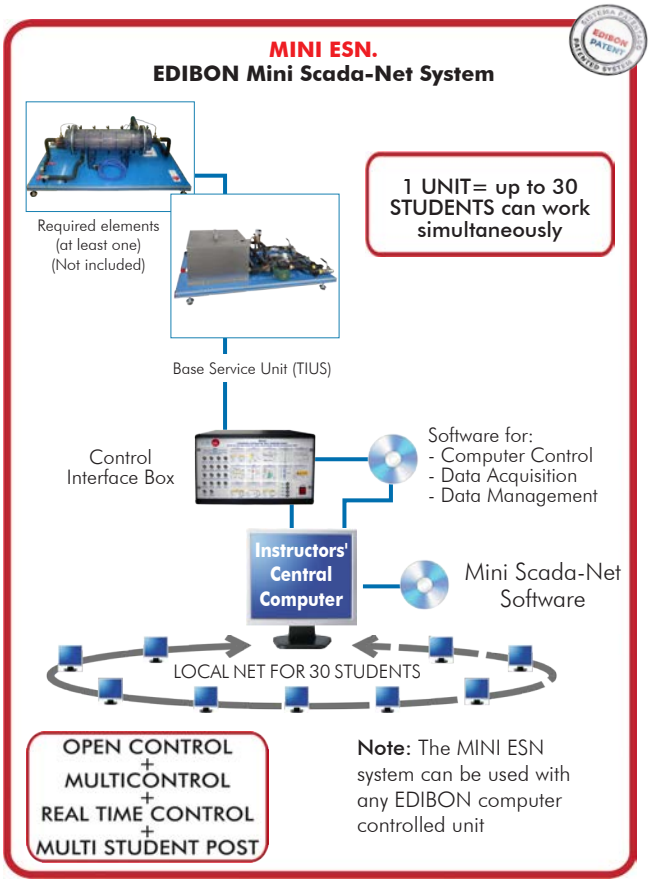
This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

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/en/edibon-scada-net

⑩ ESN. EDIBON Scada-Net Systems.

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/en/edibon-scada-net

Main items (always included in the supply)

Minimum supply always includes:

① **TIUS. Base Service Unit** (Can work with the Required elements (at least one) (Not included)).

② **TICC/CIB. Control Interface Box.** (Can work with the Required elements (at least one) (Not included)).

③ **DAB. Data Acquisition Board.** (Can work with the Required elements (at least one) (Not included)).

④ **Cables and Accessories**, for normal operation.

⑤ **Manuals.**

Required elements (at least one) to be used with the Base Service Unit "TIUS":

TITC. Concentric Tube Heat Exchanger for TICC. (+)

TITCA. Extended Concentric Tube Heat Exchanger for TICC. (+)

TIPL. Plate Heat Exchanger for TICC. (+)

TIPLA. Extended Plate Heat Exchanger for TICC. (+)

TICT. Shell & Tube Heat Exchanger for TICC. (+)

TIVE. Jacketed Vessel Heat Exchanger for TICC. (+)

TIVS. Coil Vessel Heat Exchanger for TICC. (+)

TIFT. Turbulent Flow Heat Exchanger for TICC. (+)

TICF. Cross Flow Heat Exchanger for TICC. (+)

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

Optional items (supplied under specific order)

a) Industrial configuration

⑥ PLC. Industrial Control using PLC (it includes PLC-PI Module plus PLC-SOF Control Software):

- PCL-PI. PLC Module.
- TSTCC/PLC-SOF. PLC Control Software.

b) Technical and Vocational Education configuration

⑦ TICC/ICAI. Interactive Computer Aided Instruction Software.

⑧ TICC/FSS. Faults Simulation System.

c) Multipost Expansions options

⑨ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

⑩ ESN. EDIBON Scada-Net Systems.

① TIUS. Base Service Unit:

Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This unit is common for the required elements (at least one) (Not included).
This unit performs the following tasks:
- Heating the water.
- Pumping of hot water.
- Change in the direction of cold water flows.
- Cold and hot water measures.

Stainless steel tank (30 l), equipped with:
- Electric heating element (3000 W) with thermostat (70 °C), to heat the water, computer controlled. PID temperature control.
- Temperature sensor ("J" type) to measure the water temperature.
- Level switch to control the water level in the tank.
- Stainless steel cover to avoid the contact with hot water. In this cover there is a hole that allows us to visualize the water level and also to stuff the tank.
- Draining water valve.

Centrifugal pump with speed control from computer, range: 0 – 3 l/min.
Two flow sensors, one for hot water and the other for cold water, range: 0.25 – 6.5 l/min.
Control valves for the cold and hot water.
Four ball valves that, depending on how we manipulate them, give us co-current or counter-current flux in the exchanger.
Two ball valves to control and drain the hot water of the base unit.
Pressure regulator to avoid the introduction of too much pressure in the exchangers, tared at 0.6 bar.
Four flexible tubes to connect with the different exchangers.
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 ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
- 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.

Required elements (at least one) (Not included):

TITC. Concentric Tube Heat Exchanger for TICC:

Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Concentric Tube Heat Exchanger for TICC allows the study of heat transfer between hot water flowing through an internal tube and cold water flowing in the ring area lying between the internal and the external tubes.
This exchanger allows measuring hot and cold water temperatures at different points of the exchanger.
The exchanger is formed by two concentric copper tubes with hot water circulating through the interior tube and cold water circulating in the ring space.
This exchanger has two equal sections of 500 mm each one, where heat transfer takes place.
Exchange length: L = 2 x 0.5 = 1 m.
Internal tube:
- Internal diameter: $D_{int} = 16 \bullet 10^{-3}$ m.
- External diameter: $D_{ext} = 18 \bullet 10^{-3}$ m.
- Thickness = $10\ m^{-3}$.
- Heat transfer internal area: $A_h = 0.0503\ m^2$.
- Heat transfer external area: $A_c = 0.0565\ m^2$.

External tube:
- Internal diameter: $D_{int} = 26 \bullet 10\ m^{-3}$.
- External diameter: $D_{ext} = 28 \bullet 10\ m^{-3}$.
- Thickness = $10\ m^{-3}$.

Six temperature sensors ("J" type):
- Three temperature sensors for measuring cold water temperature:
  - Cold water inlet.
  - Cold water mid-position.
  - Cold water outlet.
- Three temperature sensors for measuring hot water temperature:
  - Hot water inlet.
  - Hot water mid-position.
  - Hot water outlet.

Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) TITC/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.

TITCA. Extended Concentric Tube Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Extended Concentric Tube Heat Exchanger for TICC allows the study of heat transfer between hot water flowing through an internal tube and cold water flowing in the ring area lying between the internal and the external tubes.
This exchanger allows measuring hot and cold water temperatures at different points of the exchanger.
"TITCA" is a more sophisticated unit than "TITC", with four longer tube sections, giving four times the overall heat transfer area and three interim temperature measurement points (temperature sensors) in each fluid stream.
This exchanger has sufficient heat transfer area for demonstrating the typical counter-current flow conditions where the outlet of the heated stream is hotter than the outlet of the cooled stream.
The exchanger is formed by two concentric copper tubes with hot water circulating through the interior tube and cold water circulating in the ring space.
This exchanger has four equal sections of 1000 mm each one, where heat transfer takes place.
Exchange length: L=4x1=4 m.
Internal tube:
- Internal diameter: $D_{int} = 16 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 18 \cdot 10^{-3}$ m.
- Thickness = 10^{-3} m.
- Heat transfer internal area: $A_h = 0.0503$ m^2.
- Heat transfer external area: $A_c = 0.0565$ m^2.

External tube:
- Internal diameter: $D_{int} = 26 \cdot 10^{-3}$ m.
- External diameter: $D_{ext} = 28 \cdot 10^{-3}$ m.
- Thickness = 10^{-3} m.

Ten temperature sensors ("J" type):
- Five temperature sensors for measuring cold water temperature:
  - Cold water inlet.
  - Cold water at different interim positions (3).
  - Cold water outlet.
- Five temperature sensors for measuring hot water temperature:
  - Hot water inlet.
  - Hot water at different interim positions (3).
  - Hot water outlet.

Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) TITCA/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.

TIPL. Plate Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Plate Heat Exchanger for TICC allows the study of heat transfer between hot and cold water through alternate channels formed between parallel plates.
The exchanger allows measuring cold and hot temperatures at the inlet and outlet of the exchanger.
Formed by corrugated stainless steel plates. It can be dismantled to observe its structure.
Four ports or connections of hot and cold water input and output.
Maximum flow: 12 m^3/h.
Maximum work pressure: 10 bar.
Maximum work temperature: 100 °C.
Minimum work temperature: 0 °C.
Maximum number of plates: 20.
Internal circuit capacity: 0.176 l.
External circuit capacity: 0.22 l.
Area: 0.32 m^2.
Four temperature sensors ("J" type):
- Two temperature sensors for measuring cold water temperature (inlet and outlet).
- Two temperature sensors for measuring hot water temperature (inlet and outlet).

Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) TIPL/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.

TIPLA. Extended Plate Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Extended Plate Heat Exchanger for TICC allows the study of heat transfer between hot and cold water through alternate channels formed between parallel plates.
The exchanger allows measuring cold and hot temperatures at different points of the exchanger.
Formed by corrugated stainless steel plates. It can be dismantled to observe its structure.
Four ports or connections of hot and cold water input and output.
Maximum flow: 12 m^3/h.
Maximum work pressure: 10 bar.
Maximum work temperature: 100 °C.
Minimum work temperature: 0 °C.
Maximum number of plates: 20.
Internal circuit capacity: 0.176 l.
External circuit capacity: 0.22 l.
Area: 0.32 m^2.
Ten temperature sensors ("J" type):
Five temperature sensors for measuring cold water temperature (inlet, outlet and interim positions).
Five temperature sensors for measuring hot water temperature (inlet, outlet and interim positions).
Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) TIPLA/CCSOF. PID Computer Control+Data Acquisition+Data Management Software for Extended Plate Heat Exchanger for TICC (TIPLA).
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.

TICT. Shell & Tube Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Shell & Tube Heat Exchanger for TICC consists on a group of tubes inside the heat exchanger. The hot water flows through the internal tubes and the cooling water circulates through the space between the internal tubes and the shell.
There are traverse baffles placed in the shell to guide the cold water to maximize the heat transfer.
Formed by tubes of stainless steel with hot water circulating in the interior.
Four segmented baffles located transversaly in the shell.
Exchange length of the shell and each tube: L = 0.5 m.
Internal tube (21 tubes):
Internal diameter: $D_{int} = 8 \cdot 10^{-3}$ m.
External diameter: $D_{ext} = 10 \cdot 10^{-3}$ m.
Thickness = 10^{-3} m.
Internal heat transfer area: $A_h = 0.0126$ m^2.
External heat transfer area: $A_c = 0.0157$ m^2.
Shell:
Internal diameter: $D_{int,c} = 0.148$ m.
External diameter: $D_{ext,c} = 0.160$ m. Thickness = $6 \cdot 10^{-3}$ m.
Seven temperature sensors ("J" type), for measuring cold and hot water temperatures at different points of the exchanger.
Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) TICT/CCSOF. PID Computer Control+Data Acquisition+Data Management Software for Shell & Tube Heat Exchanger for TICC (TICT).
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.

TIVE. Jacketed Vessel Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Jacketed Vessel Heat Exchanger for TICC allows the study of heat transfer between hot water flowing through a jacket and the cold water contained in a vessel.

It can work in continuous supply or in a batch process (heating of a constant mass of water contained in a vessel).
The exchanger allows measuring temperatures at the inlet and outlet of the exchanger in cold as well as in hot water.
Inner tank:
Made of stainless steel.
Volume: 3.20 l.
Two overflows of different length that allow the exit of the water in the vessel through its upper part allowing two work volumes to be adjusted.
Jacket surrounds the vessel through where hot water flows:
Made of stainless steel.
Jacket volume: 5.90 l.
Electric stirrer.
Five temperature sensors ("J" type):
Three temperature sensors for measuring cold water temperature.
Two temperature sensors for measuring hot water temperature.
Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) TIVE/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.

TIVS. Coil Vessel Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Coil Vessel Heat Exchanger for TICC allows the study of heat transfer between hot water flowing through a coil and cold water contained in the vessel.
It can work in continuous supply or in a batch process.
Formed by a methacrylate vessel, volume: 6 l.
Two overflows let the output of water from the vessel in the upper part allowing two work volumes to be adjusted.
Copper coil where the water circulates:
D_{int} = 4.35 mm.
D_{ext} = 6.35 mm.
Total length of the tube that forms the coil: 1.5 m.
Electric stirrer.
Five temperature sensors ("J" type):
Three temperature sensors for measuring cold water temperature.
Two temperature sensors for measuring hot water temperature.
Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
(+) TIVS/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.

TIFT. Turbulent Flow Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
This Turbulent Flow Heat Exchanger for TICC let us study the heat transfer between hot water that circulates through an internal tube and cold water that flows through the annular zone between the internal and the external tube. This exchanger let us measure cold water and hot water temperatures at different points of the exchanger.
Formed by two copper concentric tubes with hot water circulating through the internal tube and cold water circulating through the annular space.
The exchanger has 4 equal sections of 500 mm each one, where the heat transfer takes place.
Exchange length: L = 4 x 0.5 = 2 m.
Internal tube:
Internal diameter: $D_{int} = 8 \cdot 10^{-3}$ m.
External diameter: $D_{ext} = 10 \cdot 10^{-3}$ m.
Thickness = 10^{-3} m.
Internal heat transfer area: $A_h = 0.0377$ m^2.
External heat transfer area: $A_c = 0.0471$ m^2.
External tube:
Internal diameter: $D_{int,c} = 13 \cdot 10^{-3}$ m.
External diameter: $D_{ext,c} = 15 \cdot 10^{-3}$ m.
Thickness = 10^{-3} m.

Twelve temperature sensors: ("J" type):
Cold water temperature sensor at the exchanger inlet or outlet.
Hot water sensor at the exchanger inlet.
Cold water sensor between the first and second stretch of the exchanger.
Hot water sensor between the first and second stretch of the exchanger.
Cold water sensor between the second and third stretch of the exchanger.
Hot water sensor between the second and third stretch of the exchanger.
Cold water sensor between the third and fourth stretch of the exchanger.
Hot water sensor between the third and fourth stretch of the exchanger.
Cold water temperature sensor at the exchanger inlet or outlet.
Hot water sensor at the exchanger outlet.
Temperature sensor of the exterior surface of the interior tube at the exchanger inlet.
Temperature sensor of the exterior surface of the interior tube at the exchanger outlet.
Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) TIFT/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.

TICF. Cross Flow Heat Exchanger for TICC:
Bench-top unit.
Anodized aluminum frame and panels made of painted steel.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
The Cross Flow Heat Exchanger for TICC is designed to study heat transfer between two fluids in cross flow configuration.
Hot water flow coming from the base unit enters and leaves a radiator perpendicular to an air current, which is generated by a fan.
The heat exchanger allows to measure water and air temperatures at the inlet and outlet of the exchanger.
Poly methyl methacrylate (PMMA) rectangular duct of 800 x 200 x 200 mm.
Radiator located across the air duct.
The fins of the radiator are made of aluminum and have a heat transfer area of 35000 mm^2.
Axial fan with speed control from computer (PC). It provides a maximum air velocity of 3 m/s.
Four "J" type temperature sensors to measure input and output water and air temperatures.
Velocity sensor to measure air velocity, range: 0 – 4 m/s.
Two ball valves.
Easy connection to the Base Service Unit, "TIUS".
This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.

(+) TICF/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.

② **TICC/CIB. Control Interface Box:**
This control interface is common for the required elements (at least one) (Not included).
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:**
Common for the required elements (at least one) (Not included).
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 **Cables and Accessories**, for normal operation.

⑤ **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 the Main Items

Practices to be done with the Concentric Tube Heat Exchanger for TICC (TITC):

1.- Global energy balance in the heat exchanger and the study of losses.

2.- Exchanger effectiveness determination. NTU Method.

3.- Study of the heat transfer under counter-current and co-current flow conditions.

4.- Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

5.- Sensors calibration.

6.- Study of the hysteresis of the flow sensor.

Practices to be done with the Extended Concentric Tube Heat Exchanger for TICC (TITCA):

7.- Global energy balance in the heat exchanger and the study of losses.

8.- Exchanger effectiveness determination. NTU Method.

9.-Study of the heat transfer under counter-current and co-current flow conditions.

10.-Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

11.-Sensors calibration.

12.-Study of the hysteresis of the flow sensor.

Practices to be done with the Plate Heat Exchanger for TICC (TIPL):

13.-Global energy balance in the heat exchanger and the study of losses.

14.-Exchanger effectiveness determination. NTU Method.

15.-Study of the heat transfer under counter-current and co-current flow conditions.

16.-Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

17.-Sensors calibration.

18.-Study of the hysteresis of the flow sensor.

Practices to be done with the Extended Plate Heat Exchanger for TICC (TIPLA):

19.-Global energy balance in the heat exchanger and the study of losses.

20.-Exchanger effectiveness determination. NTU Method.

21.-Study of the heat transfer under counter-current and co-current flow conditions.

22.-Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

23.-Sensors calibration.

24.-Study of the hysteresis of the flow sensor.

Practices to be done with the Shell & Tube Heat Exchanger for TICC (TICT):

25.-Global energy balance in the heat exchanger and the study of losses.

26.-Exchanger effectiveness determination. NTU Method.

27.-Study of the heat transfer under counter-current and co-current flow conditions.

28.-Flow influence on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

29.-Sensors calibration.

30.-Study of the hysteresis of the flow sensor.

Practices to be done with the Jacketed Vessel Heat Exchanger for TICC (TIVE):

31.-Global balance of energy in the heat exchanger and losses study.

32.-Determination of the exchanger effectiveness. NTU Method.

33.-Influence of the flow on the heat transfer. Calculation of the number of Reynolds.

34.-Influence of the vessel stirring on the heat transfer when operating in batches.

35.-Influence of the vessel's water volume on the heat transfer when operating in batches.

Additional practical possibilities:

36.-Sensors calibration.

37.-Study of the hysteresis of the flow sensor.

Practices to be done with the Coil Vessel Heat Exchanger for TICC (TIVS):

38.-Global balance of energy in the heat exchanger and the study of losses.

39.-Determination of the exchanger effectiveness. NTU Method.

40.-Influence of the flow on the heating transfer. Calculation of Reynolds number.

41.-Influence of the stirring vessel on the heat transfer with operation in batches.

42.-Influence of the water volume in the vessel on the heat transfer with operation in batches.

Additional practical possibilities:

43.-Sensors calibration.

44.-Study of the hysteresis of the flow sensor.

Practices to be done with the Turbulent Flow Heat Exchanger for TICC (TIFT):

45.-Global energy balance in the heat exchanger and loss study.

46.-Determination of the exchanger effectiveness. NTU Method.

47.-Study of the heat transfer in counter-current and co-current flow conditions.

48.-Flow influence on heat transfer. Reynolds number calculation.

49.-Obtaining of the correlation that relates Nusselt number with Reynolds number and Prandtl number.

50.-Obtaining of the heat transfer coefficients by convection.

Additional practical possibilities:

51.-Sensors calibration.

52.-Study of the hysteresis in the flow sensors.

Practices to be done with the Cross Flow Heat Exchanger for TICC (TICF):

53.-Introduction to the concept of psychometric properties.

54.-Effect of temperature differential on the heat transfer coefficient.

55.-Familiarization with cross flow heat exchanger.

56.-Overall energy balance in the heat exchanger and study of losses.

57.-Determination of the exchanger effectiveness (NTU method).

58.-Influence of air and water flow on the heat transfer. Reynolds number calculation.

Additional practical possibilities:

59.-Sensors calibration.

60.-Study of the hysteresis in the flow sensors.

Other possibilities to be done with this Unit:

61.-Many students view results simultaneously.

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

62.-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.

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

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

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

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

67.-Control of the TICC unit process through the control interface box without the computer.

68.-Visualization of all the sensors values used in the TICC 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

⑥ **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.

-TICC/PLC-SOF. PLC Control Software:

Always included with PLC supply. Each Heat Exchanger has its own Software.

Practices to be done with PLC-PI:

1.- Control of the particular unit process through the control interface box without the computer.
2.- Visualization of all the sensors values used in the particular unit process.
3.- Calibration of all sensors included in the particular unit process.
4.- Hand on of all the actuators involved in the particular unit process.
5.- Realization of different experiments, in automatic way, without having in front the particular unit. (These experiments can be decided previously).
6.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrialenvironment to the process to be studied, etc).
7.- PLC hardware general use.
8.- PLC process application for the particular unit.
9.- PLC structure.
10.-PLC inputs and outputs configuration.
11.-PLC configuration possibilities.
12.-PLC program languages.
13.-PLC different programming standard languages (ladder diagram (LD), structured text (ST), instructions list (IL), sequential function chart (SFC), function block diagram (FBD)).
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 particular unit process.
17.-Possibility of creating new process in relation with the particular unit.
18.-PLC Programming Exercises.
19.-Own PLC applications in accordance with teacher and student requirements.

b) Technical and Vocational Education configuration

⑦ **TICC/ICAI. Interactive Computer Aided Instruction Software.**

This complete software package consists of an Instructor Software (EDIBON Classroom Manager - ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft - ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).

ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc...so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.

- ESL-SOF. EDIBON Student Labsoft (Student Software).

ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

⑧ TICC/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 in 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) Multipost Expansions options

⑨ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.

MINI ESN. 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 of 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 improvement of the product.

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Edition: ED01/21
Date: September/2021

REPRESENTATIVE: