Computer Controlled **Laminar/Viscous Flow Heat Transfer Unit**, with SCADA and PID Control

**TFLVC**

**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.

For more information about Key Features, click here
There are common physical situations in which, due to different purposes, it is required to transfer heat from a hot fluid to a cold fluid, for example energy saving (fuel) or obtaining a fluid at an optimal temperature. There is a wide variety of units, called heat exchangers, to transfer heat.

There are many different types of heat exchangers depending on their construction, operation, heat transfer mechanism, number of fluids involved, etc.

A type of exchange commonly used in industry is when a fluid is forced to flow around a solid, for example inside a tube and, due to the temperature difference between both elements, the heat exchange by convection takes place. Heat is transferred at a rate that depends on the properties of the fluid and on flow condition, laminar or turbulent.

The Computer Controlled Laminar/Viscous Flow Heat Transfer Unit, “TFLVC”, allows to study heat transfer between hot oil flowing in laminar flow through an internal tube and cold water that flows through the annulus (ring-shaped area) between the internal and the external tubes.

Oil circuit (hot fluid):
- The hot oil flows along a closed circuit through the internal tube of the exchanger. An electric heating element, placed in the heating tank, heats the oil up to a specific temperature. This temperature is controlled by the heating element (PID control), limiting the temperature to 90 ºC.
- The oil goes out of the tank impelled by a pump. A flow sensor measures the oil flow. The oil cools down along the exchanger and then returns to the heating tank, starting a new cycle. There is a regulation valve at the inlet of the heating tank to determine the flow rate of hot oil in the circuit.
- The flow of oil can also be controlled by changing the speed of the pump through the software and with the regulation valve located in the bypass.
- There is a purge valve in the circuit to drain and clean the circuit and the heating tank.

Water circuit (cold fluid):
- The cold water comes from the tap and flows through the annulus formed between the internal and external tube of the exchanger.
- The cold water flow is controlled by a regulation valve and is measured by a flow sensor. Water enters the exchanger and its temperature rises. Afterwards, water goes out of the system.
- The cold water can enter the exchanger by both ends (co-current or counter-current flow), depending on the position of the valves.

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.

INTRODUCTION

GENERAL DESCRIPTION

The Computer Controlled Laminar/Viscous Flow Heat Transfer Unit, “TFLVC”, is a laboratory scale unit designed to study heat transfer between hot oil flowing in laminar flow through an internal tube and cold water that flows through the annulus (ring-shaped area).

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION
With this unit there are several options and possibilities:

- Main items: 1, 2, 3, 4, 5 and 6.
- Optional items: 7, 8, 9, 10 and 11.

Let us describe first the main items (1 to 6):

1. **TFLVC. 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.

   Concentric tubes heat exchanger with hot oil flowing through internal tube and cold water flowing through the ring-shaped area:

   - Exchanger length = 0.92 m.
   - Internal tube:
     - Internal diameter: \( D_{\text{Int}} = 10 \times 10^{-3} \text{ m} = 10 \text{ mm} \).
     - External diameter: \( D_{\text{Ext}} = 12 \times 10^{-3} \text{ m} = 12 \text{ mm} \).
     - Heat transfer internal area: \( A_i = 0.0289 \text{ m}^2 \).
     - Heat transfer external area: \( A_e = 0.0347 \text{ m}^2 \).
   - External tube:
     - Internal diameter: \( D_{\text{Int,h}} = 16 \times 10^{-3} \text{ m} = 16 \text{ mm} \).
     - External diameter: \( D_{\text{Ext,h}} = 18 \times 10^{-3} \text{ m} = 18 \text{ mm} \).

   Heating tank made of stainless steel with a capacity of 6 l, with computer controlled heating element (600 W).

   PID control.

   Computer controlled circulation pump for the hot oil.

   Three regulation valves to control the cold water flow and hot oil flow and the bypass flow of the pump.

   Four ball valves to fix a co-current or counter-current flow.

   Oil flow sensor, range: 0.05 – 0.5 m³/h.

   Water flow sensor, range: 0.25 – 6.5 l/min.

   Seven “J” type temperature sensors to measure the temperature of the water, the oil and the wall at several points along the exchanger.

   Bottle of Mobiltherm 605 oil for heat transfer.

   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.
TFLVC/CIB. Control Interface Box:
The Control Interface Box is part of the SCADA system. Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student. All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer. The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure. Simultaneous visualization in the computer of all parameters involved in the process.

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.

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.

DAB. Data Acquisition Board:
The Data Acquisition board is part of the SCADA system. PCI Express Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI Express.

Analog input:
Number of channels = 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second). Input range (V)= ± 10 V. Data transfers=DMA, interrupts, programmed I/O. DMA channels=6.

Analog output:
Number of channels=2. Resolution=16 bits, 1 in 65536. Maximum output rate up to: 900 KS/s. Output range (V)= ± 10 V. Data transfers=DMA, interrupts, programmed I/O.

Digital Input/Output:
Number of channels=24 inputs/outputs. D0 or DI Sample Clock frequency: 0 to 100 MHz. Timing: Number of Counter/timers=4. Resolution: Counter/timers: 32 bits.

TFLVC/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.

Cables and Accessories, for normal operation.

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

References 1 to 6 are the main items: TFLVC + TFLVC/CIB + DAB + TFLVC/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.
EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

1.- Demonstration of a concentric tube heat exchanger with cocurrent and counter-current flow in laminar/viscous flow.
2.- Energy balance of the heat exchanger.
3.- Determination of surface heat transfer coefficients on the oil and water sides and determination of the overall heat transfer coefficient.
4.- Flow influence on the heat transfer. Reynolds number calculation.
5.- Relationship between Nusselt Number and Graetz Number for Reynolds Numbers up to 1400.

Additional practical possibilities:
6.- Sensors calibration.
Other possibilities to be done with this Unit:
7.- Many students view results simultaneously.
   To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
8.- Open Control, Multicontrol and Real Time Control.
   This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters, etc, in real time.
9.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
10.-This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
11.-This unit can be used for doing applied research.
12.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
13.-Control of the TFLVC unit process through the control interface box without the computer.
14.-Visualization of all the sensors values used in the TFLVC unit process.
   - By using PLC-PI additional 19 more exercises can be done.
   - Several other exercises can be done and designed by the user.

DIMENSIONS AND WEIGHTS

TFLVC:
Unit:
- Dimensions: 1000 x 770 x 670 mm approx. (39.37 x 30.31 x 26.37 inches approx.).
- Weight: 80 kg approx. (176 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.).

REQUIRED SERVICES
- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Water supply and drain.
- Computer.

SIMILAR UNITS AVAILABLE

Offered in this catalog:
- TFLVC. Computer Controlled Laminar/Viscous Flow Heat Transfer Unit.

Offered in other catalog:
- TFLVB. Laminar/Viscous Flow Heat Transfer Unit.

- Electrical supply: single-phase 200 VAC – 240 VAC/50 Hz or 110 VAC – 127 VAC/60 Hz.
- Water supply and drain.
- Computer.
The teacher and the students can calibrate the unit with a password provided by EDIBON. The teacher can restore the factory calibration any time.
Example of an exercise of heat exchange between oil and water fluids in counter current:
A heat exchange between cold fluid (water) and hot fluid (oil) is produced, with a distribution of typical temperatures for this process:

ST-2>ST-4>ST-6  ST-3>ST-5>ST-7  ST-2>ST-3  ST-4>ST-5  ST-6>ST-7

Example of an exercise of heat exchange between oil and water fluids in direct or parallel current:
The temperature of the hot fluid (oil) in the thermostatic bath (ST-1) changes until reaching the set point (70 ºC). The heating element (AR-1) is turned on or off by the PID control order.
Additionally to the main items (1 to 6) described, we can offer, as optional, other items from 7 to 11. 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

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

- PLC-PI. PLC Module:
  - Metallic box.
  - Circuit diagram in the module front panel.
  - Front panel:
    - Digital inputs (X) and Digital outputs (Y) block:
      - 16 Digital inputs, activated by switches and 16 LEDs for confirmation. (red)
      - 14 Digital outputs (through SCSI connector) with 14 LEDs for message. (green)
    - Analog inputs block:
      - 16 Analog inputs (-10 V. to + 10 V.) (through SCSI connector).
    - Analog outputs block:
      - 4 Analog outputs (-10 V. to + 10 V.) (through SCSI connector).
    - Touch screen:
  - 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.).

-TFLVC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

The software has been designed using Labview and it follows the unit operation procedure and linked with the Control Interface Box used in the Computer Controlled Laminar/Viscous Flow Heat Transfer Unit (TFLVC).

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 industrial environment 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

**TFLVC/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.

For more information see ICAI catalogue. Click on the following link: www.edibon.com/en/files/expansion/ICAI/catalog
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:

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:
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<td>⑤ Cables and Accessories, for normal operation.</td>
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<td>*IMPORTANT: Under TFLVC we always supply all the elements for immediate running as 1, 2, 3, 4, 5 and 6.</td>
<td>c) Multipost Expansions options</td>
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<td>⑦ MINI ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.</td>
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TENDER SPECIFICATIONS (for main items)

1. **TFLVC. 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.
   - Concentric tubes heat exchanger with hot oil flowing through internal tube and cold water flowing through the ring-shaped area:
     - Exchanger length = 0.92 m.
     - Internal tube:
       - Internal diameter: $D_{int} = 10 \times 10^{-3} \text{ m} = 10 \text{ mm}$.
       - External diameter: $D_{ext} = 12 \times 10^{-3} \text{ m} = 12 \text{ mm}$.
     - Heat transfer internal area: $A_i = 0.0289 \text{ m}^2$.
     - Heat transfer external area: $A_e = 0.0347 \text{ m}^2$.
     - Internal tube:
       - Internal diameter: $D_{int} = 16 \times 10^{-3} \text{ m} = 16 \text{ mm}$.
       - External diameter: $D_{ext} = 18 \times 10^{-3} \text{ m} = 18 \text{ mm}$.
   - Heating tank made of stainless steel with a capacity of 6 l, with computer controlled heating element (600 W).
   - PID control.
   - Computer controlled circulation pump for the hot oil.
   - Three regulation valves to control the cold water flow and hot oil flow and the bypass flow of the pump.
   - Four ball valves to fix a co-current or counter-current flow.
   - Oil flow sensor, range: 0.05 – 0.5 m³/h.
   - Water flow sensor, range: 0.25 – 6.5 l/min.
   - Seven “J” type temperature sensors to measure the temperature of the water, the oil and the wall at several points along the exchanger.
   - Bottle of Mobiltherm 605 oil for heat transfer.
   - Internal diameter: $D_{int} = 16 \times 10^{-3} \text{ m} = 16 \text{ mm}$.
   - External tube:
     - Internal diameter: $D_{int} = 10 \times 10^{-3} \text{ m} = 10 \text{ mm}$.
     - External diameter: $D_{ext} = 18 \times 10^{-3} \text{ m} = 18 \text{ mm}$.
   - Calibration of all sensors involved in the process.
   - Simultaneous visualization in the computer of all parameters 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).
   - 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).
   - Shield and filtered signals to avoid external interferences.
   - Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

2. **TFLVC/CIB. Control Interface Box:**
   - The Control Interface Box is part of the SCADA system.
   - Control interface box with process diagram in the front panel.
   - The unit control elements are permanently computer controlled.
   - Simultaneous visualization in the computer of all parameters involved in the process.
   - Calibration of all sensors involved in the process.
   - Real time curves representation about system responses.
   - All the actuators’ values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
   - Shield and filtered signals to avoid external interferences.
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   - Real time PID control for parameters involved in the process simultaneously.
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   - Shield and filtered signals to avoid external interferences.
   - Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software.

3. **DAB. Data Acquisition Board:**
   - The Data Acquisition board is part of the SCADA system.
   - PCI Express Data Acquisition board (National Instruments) to be placed in a computer slot.
   - Analog input: Channels = 24 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. Sampling rate up to: 250 KS/s (kilo samples per second).
   - Digital Input/Output: Channels=24 inputs/outputs.
   - The Data Acquisition board model may change at any moment, providing the same or better features than those required for the unit.

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

5. **Cables and Accessories:**
   - for normal operation.

6. **Manuals:**
   - This unit is supplied with 8 manuals: Required Services, Assembly and Installation, Interface and Control Software, Starting-up, Safety, Maintenance, Calibration & Practices Manuals.
Exercises and Practical Possibilities to be done with the Main Items

1.- Demonstration of a concentric tube heat exchanger with cocurrent and counter-current flow in laminar/viscous flow.
2.- Energy balance of the heat exchanger.
3.- Determination of surface heat transfer coefficients on the oil and water sides and determination of the overall heat transfer coefficient.
4.- Flow influence on the heat transfer. Reynolds number calculation.
5.- Relationship between Nusselt Number and Graetz Number for Reynolds Numbers up to 1400.

Additional practical possibilities:

6.- Sensors calibration.

Other possibilities to be done with this Unit:

7.- Many students view results simultaneously.
   - To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

8.- Open Control, Multicontrol and Real Time Control.
   - This unit allows intrinsically and/or extrinsically to change the span, gains; proportional, integral, derivative parameters; etc., in real time.

9.- The Computer Control System with SCADA and PID Control allow a real industrial simulation.
10.- This unit is totally safe as uses mechanical, electrical/electronic, and software safety devices.
11.- This unit can be used for doing applied research.
12.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
13.- Control of the TFLVC unit process through the control interface box without the computer.
14.- Visualization of all the sensors values used in the TFLVC unit process.
   - By using PLC-PI additional 19 more exercises can be done.
   - Several other exercises can be done and designed by the user.
TENDER SPECIFICATIONS (for optional items)

a) Industrial configuration

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.

- TFLVC/PLC-SOF. PLC Control Software:
  For this particular unit, always included with PLC supply.

Practices to be done with PLC-PI:

1. Control of the 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 industrial environment 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

TFLVC/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.
  • Updateable 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.
**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:
- 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.**