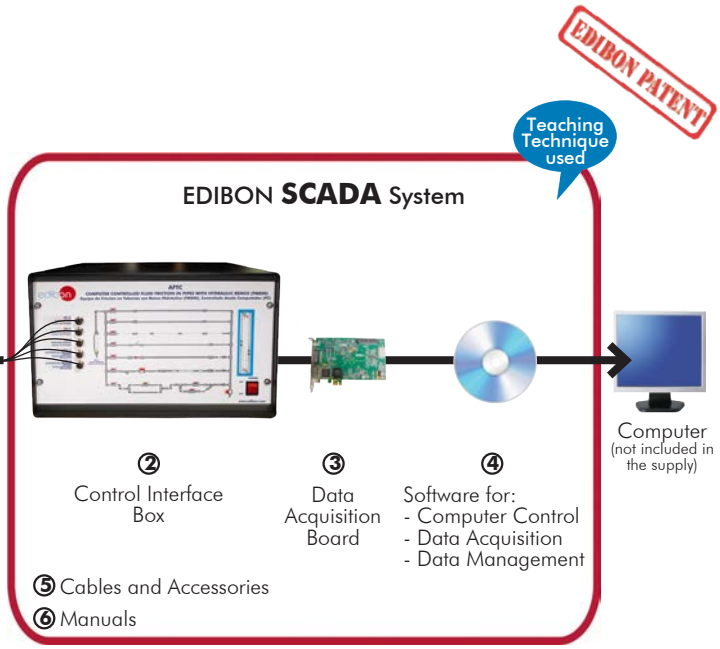
Engineering and Technical Teaching Equipment

Computer Controlled **Fluid Friction in Pipes, with Hydraulics Bench (FME00),** with SCADA

AFTC

① Unit: AFTC. Computer Controlled Fluid Friction in Pipes, with Hydraulics Bench (FME00)



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

Key features:

- **Advanced Real-Time SCADA.**
- **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
80.- FLUID MECHANICS

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)

Certificate and Worlddidac Member

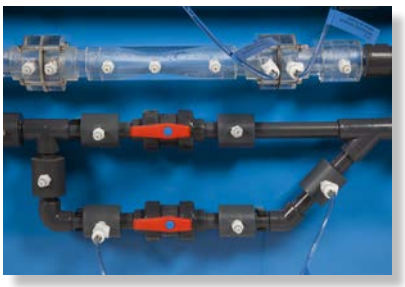
INTRODUCTION

The knowledge of pressure losses occurring in pipes as well as in different hydraulic accessories is very important in the design and dimensioning of pipes systems.

The Computer Controlled Fluid Friction in Pipes, with Hydraulics Bench (FME00), "AFTC", is designed to determine the friction coefficient in pipes of several diameters and roughness, to study the pressure losses and pressure development in different types of valves and fittings and to compare different methods to measure the flow.

GENERAL DESCRIPTION

The unit contains six horizontal straight pipe sections made of different materials and with different diameters and roughness to study their influence in the pressure losses. Additionally, a wide range of accessories are included for the study of losses in straight pipes, several types of valves (gate, ball, angle seat, etc.), pipe fittings (mesh filter, elbows, sudden widening, contraction, etc.) and measuring elements (Venturi tube, Pitot tube, orifice plate flowmeter, flow measuring nozzles, etc.).



AFTC detail

Some of the measuring elements, like the Venturi tube, Pitot tube, etc., are transparent to observe their function.

The different pipe sections, valves and pipe fittings include several pressure measurement points with quick action connections to fit the tubing that is connected to the corresponding pressure measuring device.

The sections can be exchanged without tools.

With this unit pressure losses can be investigated over a wide range of Reynolds numbers, thereby covering the laminar, transitional and turbulent flow regime. Two water manometric tubes and two displacement sensors allow to study the pressure losses in the laminar regime. Two pressure sensors allow to obtain the pressure losses in the turbulent regimen. Additionally, it includes a flow sensor to measure and to compare measurements of flow with the Venturi tube and the Pitot tube.

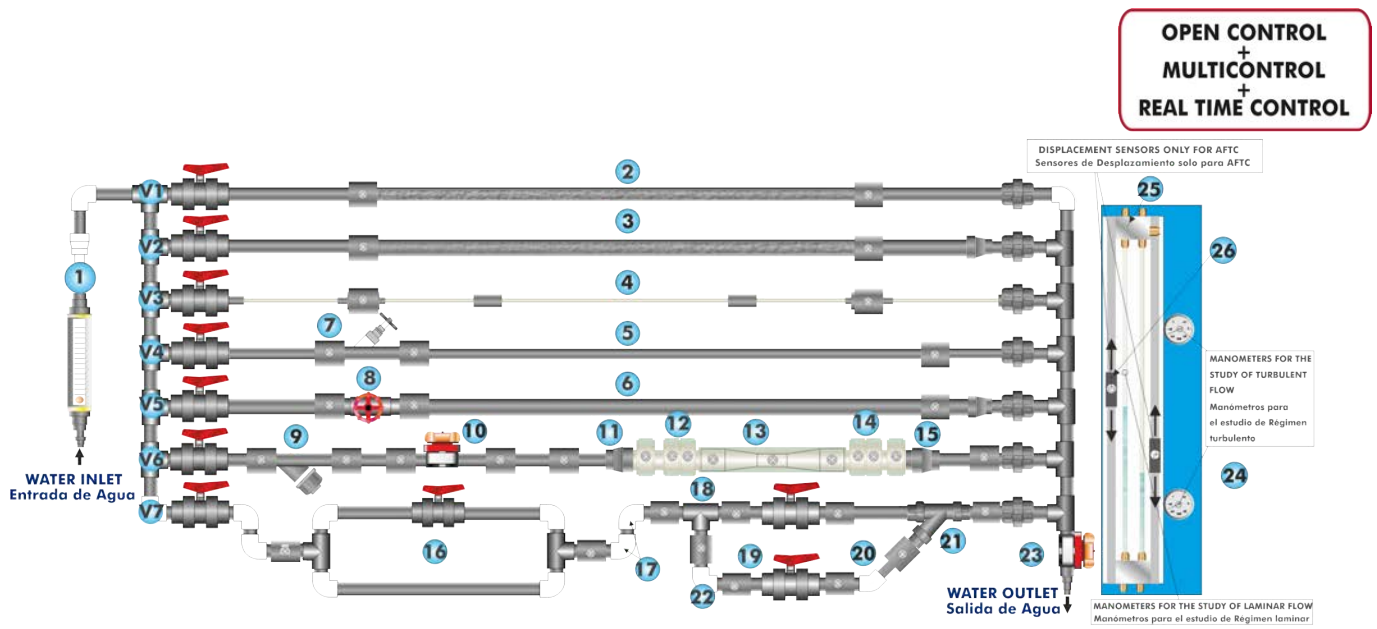
Annular chamber shaped measuring points are located around the measuring elements for an accurate pressure measurement.

The unit includes the Hydraulics Bench (FME00), which incorporates a sump tank and a centrifugal pump to make water flow in a close circuit and to supply the "AFTC" unit, allowing an independent operation of the unit.

A flow sensor measures the flow impelled by the pump.

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.

PROCESS DIAGRAM AND UNIT ELEMENTS ALLOCATION



2 ROUGH PIPE 17mm INNER DIAMETER
Tubería rugosa de diámetro interno 17mm

3 ROUGH PIPE 23mm INNER DIAMETER
Tubería rugosa de diámetro interno 23mm

4 PMMA PIPE 6.5mm INNER DIAMETER
Tubería de metacrilato de diámetro interno 6.5mm

5 SMOOTH PIPE
16.5mm INTERIOR DIAMETER
Tubería lisa de diámetro interno 16.5mm

6 SMOOTH PIPE
26.5 mm INTERIOR DIAMETER
Tubería lisa de diámetro interno de 26.6mm

7 ANGLE SEAT VALVE
Válvula de asiento inclinado

8 GATE VALVE
Válvula de compuerta

9 IN-LINE STRAINER
Filtro de malla

10 DIAPHRAGM VALVE
Válvula de membrana

11 SUDDEN WIDENING 25-40
Ensanchamiento 25a 40mm

12 PITOT TUBE
Tubo de Pitot

13 VENTURI TUBE
Tubo Venturi

14 DIAPHRAGM
Diafragma

15 REDUCTION 40-25mm
Estrechamiento 40-25mm

16 PARALLEL PIPES SYSTEM
Configuración de red en paralelo

17 90° ELBOWS
Codos de 90°

18 "T" JUNCTION
Unión en "T"

19 BALL VALVE
Válvula de bola

20 45° ELBOW
Codo de 45°

21 45° "T"
"T" 45°

22 90° ELBOW
Codo 90°

23 CONTROL VALVE
Válvula de Regulación

24 BOURDON MANOMETER
Manómetro Bourdon

25 WATER MANOMETER
Manómetro de Agua

26 DISPLACEMENT SENSOR (AFTC)
Sensor de Desplazamiento (AFTC)

V1 BALL VALVE
Válvula de bola

V2 BALL VALVE
Válvula de bola

V3 BALL VALVE
Válvula de bola

V4 BALL VALVE
Válvula de bola

V5 BALL VALVE
Válvula de bola

V6 BALL VALVE
Válvula de bola

V7 BALL VALVE
Válvula de bola

AFTC: COMPUTER CONTROLLED FLUID FRICTION IN PIPES, WITH HYDRAULICS BENCH (FME00)
Equipo de Fricción en Tuberías, con Banco Hidráulico (FME00), Controlado desde Computador

AFT: FLUID FRICTION IN PIPES, WITH HYDRAULICS BENCH (FME00)
Equipo de Fricción en Tuberías, con Banco Hidráulico (FME00)

AFT/B: FLUID FRICTION IN PIPES, WITH BASIC HYDRAULIC FEED SYSTEM (FME00/B)
Equipo de Fricción en Tuberías, con Grupo de Alimentación Hidráulica (FME00/B)

AFT/P: FLUID FRICTION IN PIPES
Equipo de Fricción en Tuberías

AFTC AND AFT WITH CONNECTION TO: FME00
Versión AFTC y AFT con conexión: FME00
ONLY THE AFTC VERSION HAS DISPLACEMENT SENSORS
Solo la versión AFTC tiene Sensores de Desplazamiento

1 ROTAMETER: VERSION AFT
FLOW SENSOR: VERSION AFTC
WHITOUT MEASURING DEVICE: VERSION AFT/B
Rotámetro: Versión AFT
Sensor de Caudal: Versión AFTC
Sin Dispositivo de Medida: Versión AFT/B

CONNECTOR TO : BOURDON MANOMETER
WATER MANOMETER
Conector a: Manómetro Bourdon
Manómetro de agua

With this unit there are several options and possibilities:

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

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

① AFTC. Unit:

This unit allows the detailed study of fluid friction pressure losses, which occur when a non-compressible fluid flows through pipes, valves, pipe fittings and flow metering devices.

Anodized aluminum frame and panels made of painted steel.

The unit includes wheels to facilitate its mobility.

Main metallic elements made of stainless steel.

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

Six pipes of different diameter and roughness:

- Rough pipe (PVC): external diameter: 25 mm and internal diameter: 17 mm.
- Rough pipe (PVC): external diameter: 32 mm and internal diameter: 23 mm.
- Smooth pipe (PMMA): external diameter: 10 mm and internal diameter: 6.5 mm.
- Smooth pipe (PVC): external diameter: 20 mm and internal diameter: 16.5 mm.
- Smooth pipe (PVC): external diameter: 32 mm and internal diameter: 26.5mm.
- Smooth pipe (PMMA): external diameter: 25 mm and internal diameter: 17 mm (with measuring elements).

Unit: AFTC

Types of valves:

- Angle-seat valve.
- Gate valve with cones.
- Diaphragm valve.
- Ball valve (straight shut-off valve).
- Straight check valve (non-return).

Types of couplings:

- Mesh filter: 20 mm.
- Sudden widening. Its section changes from 25 mm to 40 mm.
- Sudden contraction. Its section changes from 40 mm to 25 mm.
- 90° elbow: inner diameter: 20 mm.
- "T" junction: inner diameter: 20 mm.
- 45° elbow: inner diameter: 20 mm.
- 45° "T" junction: inner diameter: 20 mm.
- Symmetrical "Y" branch: inner diameter of each pipe: 20 mm.
- Double 90° elbow: inner diameter: 20 mm.

Special couplings (made of methacrylate to observe their operation):

- Pitot tube: length: 30 mm, external diameter: 4 mm and internal diameter: 2.5 mm.
- Venturi tube: length: 180 mm, larger section: 32 mm and smaller section: 20 mm.
- Diaphragm with measuring plate: larger diameter: 25 mm and smaller diameter: 20 mm.

The unit includes several ball valves to conduct the water flow through a certain pipe of the circuit and a regulation valve to regulate the flow that runs through such pipe.

34 pressure tappings with quick action connections.

Two pressure sensors, range: 0 – 30 psi.

One flow sensor, range: 2 – 150 l/min.

Two magnetic displacement sensors, range: 0 - 1 m. Two water manometers, length: 1000 mm.

The unit is designed for use with the Hydraulics Bench (FME00):

- Mobile hydraulic bench, made of fibreglass reinforced polyester, and mounted on wheels for its mobility.
- Computer controlled centrifugal pump, 0.37 kW, 30 - 80 l/min., at 20.1 - 12.8 m.
- Sump tank, capacity: 165 l. Small channel, capacity: 8 l.
- Flow measurement: volumetric tank, gauged from 0 to 7 l for low flow values and from 0 to 40 l for high flow values.
- Control valve to regulate the flow.

The complete unit includes as well:

Advanced Real-Time SCADA.

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.

② AFTC/CIB. Control Interface Box:

The Control Interface Box is part of the SCADA system.

Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student.

All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output.

Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors.

Single cable between the control interface box and computer.

The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure.

Simultaneous visualization in the computer of all parameters involved in the process.

Calibration of all sensors involved in the process.

Real time curves representation about system responses.

Storage of all the process data and results in a file.

Graphic representation, in real time, of all the process/system responses.

All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.

All the actuators and sensors values and their responses are displayed on only one screen in the computer.

Shield and filtered signals to avoid external interferences.

Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.

Real time computer control for pumps, compressors, heating elements, control valves, etc.

Real time computer control for parameters involved in the process simultaneously.

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.

AFTC/CIB

③ DAB. Data Acquisition Board:

The Data Acquisition board is part of the SCADA system.

PCI Express Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI Express.

Analog input:

Number of **channels= 16** single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536.

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

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

Analog output:

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

Maximum output rate up to: 900 KS/s.

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

Digital Input/Output:

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

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

DAB

④ AFTC/CCSOF. 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.

Management, processing, comparison and storage of data.

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

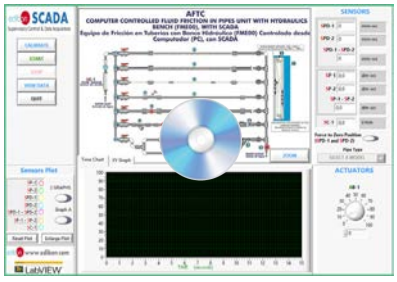
Calibration system for the sensors involved in the process.

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.



AFTC/CCSOF

⑤ Cables and Accessories, for normal operation.

⑥ Manuals:

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

*References 1 to 6 are the main items: AFTC + AFTC/CIB + DAB + AFTC/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.- Determination of pressure loss due to friction in a rough pipe with an internal diameter of 17 mm.
2.- Determination of pressure loss due to friction in a rough pipe with an internal diameter of 23 mm.
3.- Determination of pressure loss due to friction in a smooth pipe with an internal diameter of 6.5 mm.
4.- Determination of pressure loss due to friction in a smooth pipe with an internal diameter of 16.5 mm.
5.- Determination of pressure loss due to friction in a smooth pipe with an internal diameter of 26.5 mm.
6.- Study of the influence of the diameter in the pressure loss due to friction in rough pipes.
7.- Study of the influence of the diameter in the pressure loss due to friction in smooth pipes.
8.- Study of the influence of the roughness in the pressure loss.
9.- Determination of the friction coefficient in a rough pipe with an internal diameter of 17 mm.
10.-Determination of the friction coefficient in a rough pipe with an internal diameter of 23 mm.
11.-Determination of the friction coefficient in a smooth pipe with an internal diameter of 6.5 mm.
12.-Determination of the friction coefficient in a smooth pipe with an internal diameter of 16.5 mm.
13.-Determination of the friction coefficient in a smooth pipe with an internal diameter of 26.5 mm.
14.-Study of the influence of the diameter in the friction coefficient in rough pipes.
15.-Study of the influence of the diameter in the friction coefficient in smooth pipes.
16.-Comparison of the friction coefficient in smooth and rough pipes.
17.-Determination of pressure loss in an angle-seat valve.
18.-Determination of pressure loss in a gate valve.
19.-Determination of pressure loss in a diaphragm valve.
20.-Determination of pressure loss in a ball valve.
21.-Comparison of pressure loss in different types of valves.
22.-Determination of pressure loss in an in-line strainer.
23.-Determination of pressure loss in a 90° elbow.
24.-Determination of pressure loss in a double 90° elbow.
25.-Determination of pressure loss in a 45° elbow.
26.-Determination of pressure loss in a 45° "T".
27.-Determination of pressure loss in a symmetrical "Y" branch.
28.-Determination of pressure loss in a narrowing.
29.-Determination of pressure loss in a gradual widening.
30.-Determination of pressure loss in a diaphragm.
31.-Comparison of pressure loss in the different fittings.
32.-Measurement of the flow with the Venturi tube.
33.-Determination of the discharge coefficient, C_d, in the Venturi d tube.
34.-Measurement of the flow with the Pitot tube.
35.-Determination of the discharge coefficient, C_d, in the Pitot tube.
36.-Comparison between the flow measured in the Venturi and Pitot tubes.

Additional practical possibilities:

37.-Sensors calibration.
38.-Study of the relationship between pressure losses due to fluid friction and the water flow rate.
39.-Determining the relationship between the pipe friction coefficients and Reynolds number for flow through a pipe with roughened bore.
40.-Determining of the resistance coefficients for bends, enlargements and contractions.
41.-Determining of characteristic curves of valves and fittings.

Other possibilities to be done with this Unit:

42.-Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
43.-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.
44.-The Computer Control System with SCADA allows a real industrial simulation.
45.-This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
46.-This unit can be used for doing applied research.
47.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
48.-Control of the AFTC unit process through the control interface box without the computer.
49.-Visualization of all the sensors values used in the AFTC unit process.

- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

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

DIMENSIONS AND WEIGHTS

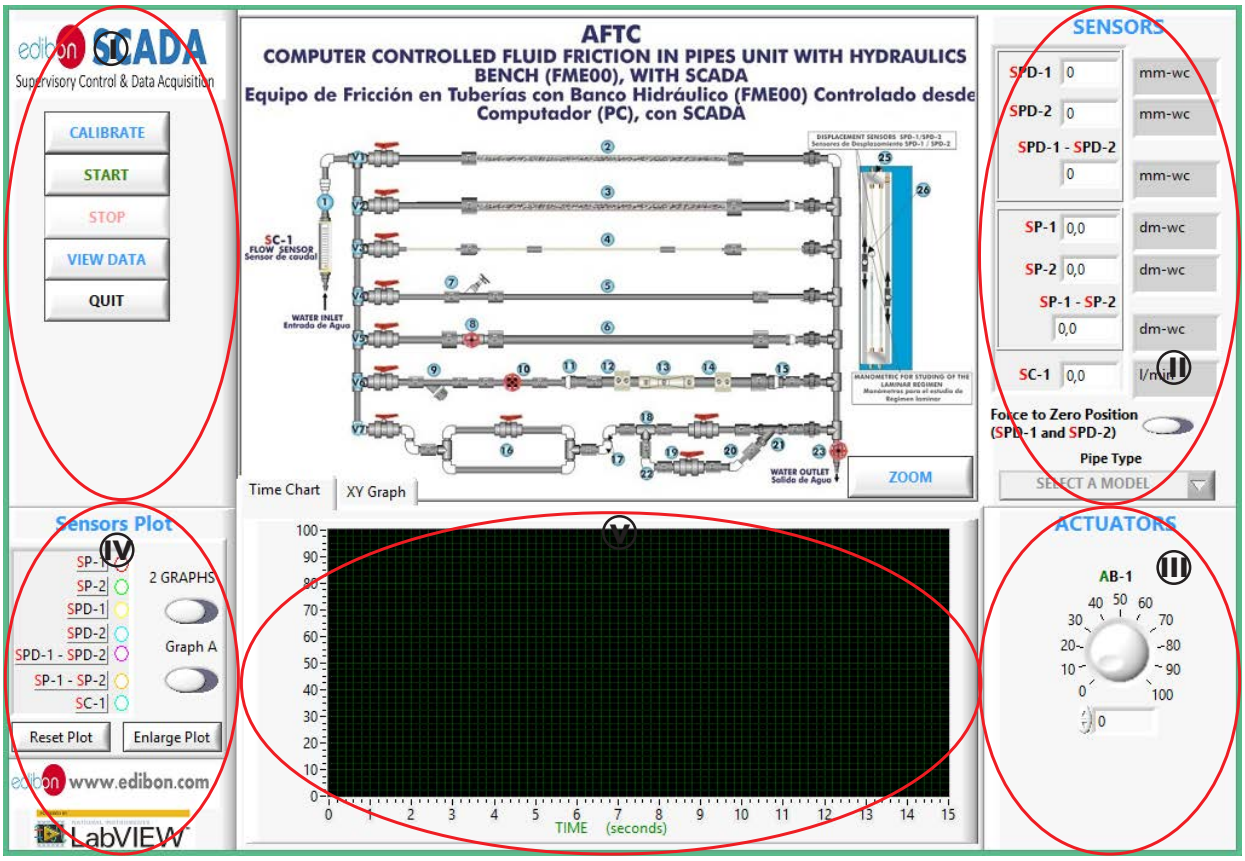
AFTC:
Unit:
-Dimensions: 2100 x 850 x 1000 mm approx.
(82.67 x 33.46 x 39.37 inches approx.)
-Weight: 150 Kg approx.
(330.7 pounds approx.)
Hydraulics Bench (FME00):
-Dimensions: 1130 x 730 x 1000 mm approx.
(44.48 x 28.74 x 39.37 inches approx.)
-Weight: 70 Kg approx.
(154.32 pounds approx.)
Control 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.)

AVAILABLE VERSIONS

Offered in this catalogue:
- AFTC. Computer Controlled Fluid Friction in Pipes, with Hydraulics Bench (FME00).

Offered in others catalogues:
- AFT. Fluid Friction in Pipes Unit with Hydraulics Bench (FME00).
- AFT/B. Fluid Friction in Pipes Unit, with Basic Hydraulics Feed System (FME00/B).
- AFT/P. Fluid Friction in Pipes Unit.

SCADA
Main screen



Ⓘ Main software operation possibilities.

Ⓘ**Ⓘ Sensors displays, real time values, and extra output parameters. Sensors:** SPD=Displacement sensor. SP=Pressure sensor. SC=Flow sensor.

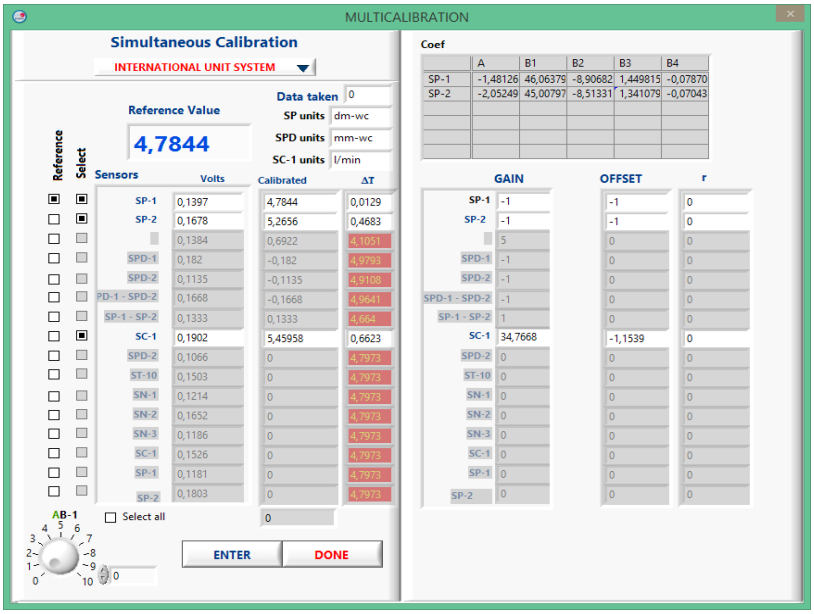
Ⓘ**Ⓘ Actuators controls. Actuators:** AB=Pump.

Ⓘ**Ⓘ** Channel selection and other plot parameters.

Ⓘ**Ⓘ** Real time graphics displays.

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 6) described, we can offer, as optional, other items from 7 to 10.
All these items try to give more possibilities for:

a) Technical and Vocational Education configuration. (ICAI and FSS)
b) Multipost Expansions options. (Mini ESN and ESN)

a) Technical and Vocational Education configuration

⑦ AFTC/ICAI. Interactive Computer Aided Instruction Software System.

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.

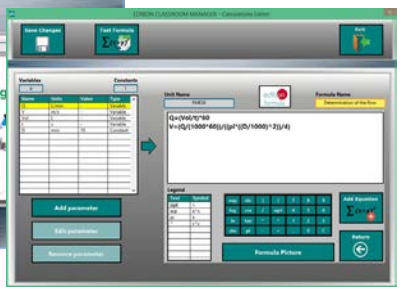
This software is optional and can be used additionally to items (1 to 6).

Instructor Software

- 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.

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



ECAL. EDIBON Calculations Program Package - Formula Editor Screen

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.**

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

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

- 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.

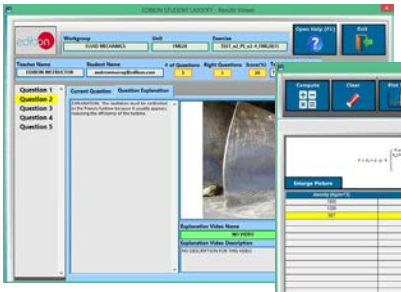
Student Software

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

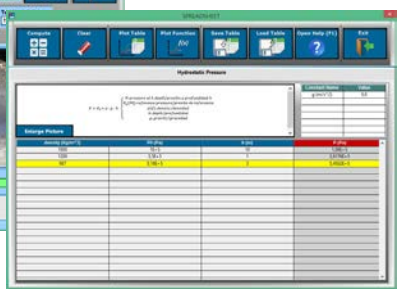
EPE. EDIBON Practical Exercise Program Package Main Screen

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.**



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/files/expansion/ICAI/catalog

⑧ AFTC/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.

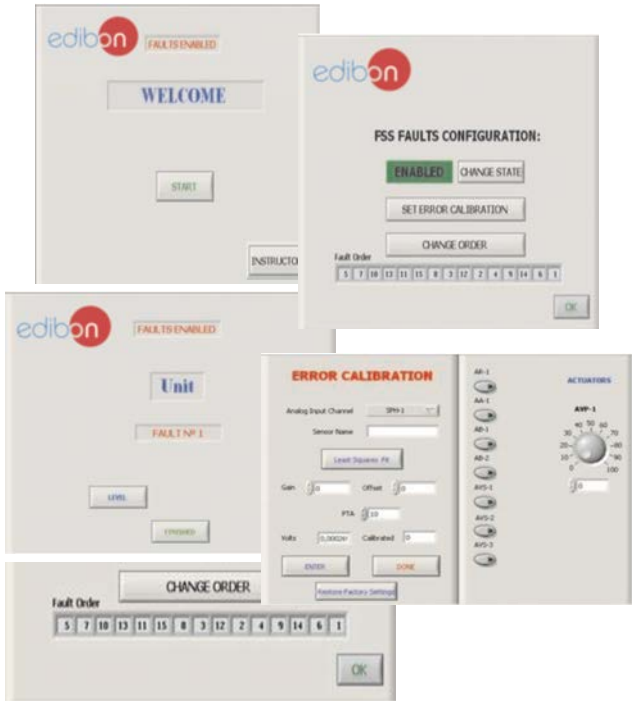
- Reduction or increase of the calculated total response.

- 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/files/expansion/FSS/catalog

b) Multipost Expansions options

⑨ Mini ESN. EDIBON Mini Scada-Net System.

Mini ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously. It is useful for both, Higher Education and/or Technical and Vocational Education.

The Mini ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA 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, connected in a local net.

- Open Control + Multicontrol + Real Time Control + Multi Student Post.

- Instructor controls and explains to all students at the same time.

- Any user/student can work doing "real time" control/multicontrol and visualisation.

- Instructor can see in the computer what any user/student is doing in the unit.

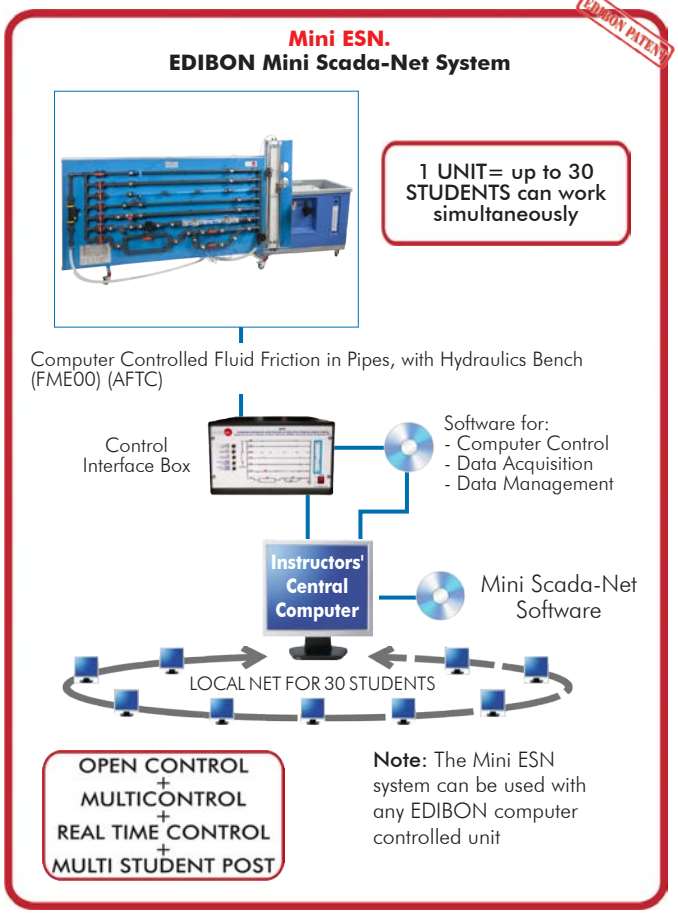
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.

- This system allows you can save time and cost.

- Future expansions with more EDIBON Units.



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

www.edibon.com/products/catalogues/en/Mini-ESN.pdf

⑩ ESN. EDIBON Scada-Net System.

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/products/catalogues/en/units/fluidmechanicsaerodynamics/esn-fluidmechanics/ESN-FLUID_MECHANICS.pdf

ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

① **Unit: AFTC. Computer Controlled Fluid Friction in Pipes, with Hydraulics Bench (FME00).**

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

③ **DAB. Data Acquisition Board.**

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

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

⑥ **Manuals.**

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

Optional items (supplied under specific order)

a) Technical and Vocational Education configuration

⑦ AFTC/ICAI. Interactive Computer Aided Instruction Software System.

⑧ AFTC/FSS. Faults Simulation System.

b) Multipost Expansions options

⑨ Mini ESN. EDIBON Mini Scada-Net System.

⑩ ESN. EDIBON Scada-Net System.

①AFTC. Unit:
This unit allows the detailed study of fluid friction pressure losses, which occur when a non-compressible fluid flows through pipes, valves, pipe fittings and flow metering devices.
Anodized aluminum frame and panels made of painted steel.
The unit includes wheels to facilitate its mobility.
Main metallic elements made of stainless steel.
Diagram in the front panel with distribution of the elements similar to the real one.
Six pipes of different diameter and roughness:
- Rough pipe (PVC): external diameter: 25 mm and internal diameter: 17 mm.
- Rough pipe (PVC): external diameter: 32 mm and internal diameter: 23 mm.
- Smooth pipe (PMMA): external diameter: 10 mm and internal diameter: 6.5 mm.
- Smooth pipe (PVC): external diameter: 20 mm and internal diameter: 16.5 mm.
- Smooth pipe (PVC): external diameter: 32 mm and internal diameter: 26.5mm.
- Smooth pipe (PMMA): external diameter: 25 mm and internal diameter: 17 mm (with measuring elements).

Types of valves:
- Angle-seat valve.
- Gate valve with cones.
- Diaphragm valve.
- Ball valve (straight shut-off valve).
- Straight check valve (non-return).

Types of couplings:
- Mesh filter: 20 mm.
- Sudden widening. Its section changes from 25 mm to 40 mm.
- Sudden contraction. Its section changes from 40 mm to 25 mm.
- 90º elbow: inner diameter: 20 mm.
- "T" junction: inner diameter: 20 mm.
- 45º elbow: inner diameter: 20 mm.
- 45º "T" junction: inner diameter: 20 mm.
- Symmetrical "Y" branch: inner diameter of each pipe: 20 mm.
- Double 90º elbow: inner diameter: 20 mm.

Special couplings (made of methacrylate to observe their operation):
- Pitot tube: length: 30 mm, external diameter: 4 mm and internal diameter: 2.5 mm.
- Venturi tube: length: 180 mm, larger section: 32 mm and smaller section: 20 mm.
- Diaphragm with measuring plate: larger diameter: 25 mm and smaller diameter: 20 mm.

The unit includes several ball valves to conduct the water flow through a certain pipe of the circuit and a regulation valve to regulate the flow that runs through such pipe.
34 pressure tappings with quick action connections.
Two pressure sensors, range: 0 – 30 psi.
One flow sensor, range: 2 – 150 l/min.
Two magnetic displacement sensors, range: 0 - 1 m. Two water manometers, length: 1000 mm.
The unit is designed for use with the Hydraulics Bench (FME00):
- Mobile hydraulic bench, made of fibreglass reinforced polyester, and mounted on wheels for its mobility.
- Computer controlled centrifugal pump, 0.37 kW, 30 - 80 l/min., at 20.1 - 12.8 m.
- Sump tank, capacity: 165 l. Small channel, capacity: 8 l.
- Flow measurement: volumetric tank, gauged from 0 to 7 l for low flow values and from 0 to 40 l for high flow values.
- Control valve to regulate the flow.

The complete unit includes as well:
- Advanced Real-Time SCADA.
- 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.

②AFTC/CIB. Control Interface Box:
The Control Interface Box is part of the SCADA system.
Control interface box with process diagram in the front panel.
The unit control elements are permanently computer controlled.
Simultaneous visualization in the computer of all parameters involved in the process.
Calibration of all sensors involved in the process.
Real time curves representation about system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process.
Shield and filtered signals to avoid external interferences.
Real time computer control with flexibility of modifications from the computer keyboard of the parameters, at any moment during the process.
Real time computer control for parameters involved in the process simultaneously.
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.

③DAB. Data Acquisition Board:
The Data Acquisition board is part of the SCADA system.
PCI Express Data acquisition board (National Instruments) to be placed in a computer slot.
Analog input: Channels= 16 single-ended or 8 differential. Resolution=16 bits, 1 in 65536. Sampling rate up to: 250 KS/s (kilo samples per second).
Analog output: Channels=2. Resolution=16 bits, 1 in 65536.
Digital Input/Output: Channels=24 inputs/outputs.

④AFTC/CCSOF. 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.
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.

⑤Cables and Accessories, for normal operation.

⑥Manuals:
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.- Determination of pressure loss due to friction in a rough pipe with an internal diameter of 17 mm.
2.- Determination of pressure loss due to friction in a rough pipe with an internal diameter of 23 mm.
3.- Determination of pressure loss due to friction in a smooth pipe with an internal diameter of 6.5 mm.
4.- Determination of pressure loss due to friction in a smooth pipe with an internal diameter of 16.5 mm.
5.- Determination of pressure loss due to friction in a smooth pipe with an internal diameter of 26.5 mm.
6.- Study of the influence of the diameter in the pressure loss due to friction in rough pipes.
7.- Study of the influence of the diameter in the pressure loss due to friction in smooth pipes.
8.- Study of the influence of the roughness in the pressure loss.
9.- Determination of the friction coefficient in a rough pipe with an internal diameter of 17 mm.
10.-Determination of the friction coefficient in a rough pipe with an internal diameter of 23 mm.
11.-Determination of the friction coefficient in a smooth pipe with an internal diameter of 6.5 mm.
12.-Determination of the friction coefficient in a smooth pipe with an internal diameter of 16.5 mm.
13.-Determination of the friction coefficient in a smooth pipe with an internal diameter of 26.5 mm.
14.-Study of the influence of the diameter in the friction coefficient in rough pipes.
15.-Study of the influence of the diameter in the friction coefficient in smooth pipes.
16.-Comparison of the friction coefficient in smooth and rough pipes.
17.-Determination of pressure loss in an angle-seat valve.
18.-Determination of pressure loss in a gate valve.
19.-Determination of pressure loss in a diaphragm valve.
20.-Determination of pressure loss in a ball valve.
21.-Comparison of pressure loss in different types of valves.
22.-Determination of pressure loss in an in-line strainer.
23.-Determination of pressure loss in a 90° elbow.
24.-Determination of pressure loss in a double 90° elbow.
25.-Determination of pressure loss in a 45° elbow.
26.-Determination of pressure loss in a 45° "T".
27.-Determination of pressure loss in a symmetrical "Y" branch.
28.-Determination of pressure loss in a narrowing.
29.-Determination of pressure loss in a gradual widening.
30.-Determination of pressure loss in a diaphragm.
31.-Comparison of pressure loss in the different fittings.
32.-Measurement of the flow with the Venturi tube.
33.-Determination of the discharge coefficient, C_d, in the Venturi d tube.
34.-Measurement of the flow with the Pitot tube.
35.-Determination of the discharge coefficient, C_d, in the Pitot tube.
36.-Comparison between the flow measured in the Venturi and Pitot tubes.

Additional practical possibilities:

37.-Sensors calibration.
38.-Study of the relationship between pressure losses due to fluid friction and the water flow rate.
39.-Determining the relationship between the pipe friction coefficients and Reynolds number for flow through a pipe with roughened bore.
40.-Determining of the resistance coefficients for bends, enlargements and contractions.
41.-Determining of characteristic curves of valves and fittings.

Other possibilities to be done with this Unit:

42.-Many students view results simultaneously.
To view all results in real time in the classroom by means of a projector or an electronic whiteboard.
43.-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.
44.-The Computer Control System with SCADA allows a real industrial simulation.
45.-This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.
46.-This unit can be used for doing applied research.
47.-This unit can be used for giving training courses to Industries even to other Technical Education Institutions.
48.-Control of the AFTC unit process through the control interface box without the computer.
49.-Visualization of all the sensors values used in the AFTC unit process.
- Several other exercises can be done and designed by the user.

a) Technical and Vocational Education configuration

⑦ AFTC/ICAI. Interactive Computer Aided Instruction Software System.

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 AFTC/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.

b) Multipost Expansions options

⑨ Mini ESN. EDIBON Mini Scada-Net System.

EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.

The Mini ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA 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, 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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