edibon

Technical Teaching Equipment

Computer Controlled
Nozzle Performance Test Unit

TFTC

EDIBON PATENT

① Unit: TFTC. Nozzle Performance Test Unit

Always included in the supply:

Teaching Technique used

SCADA . EDIBON Computer Control System

② Control Interface Box

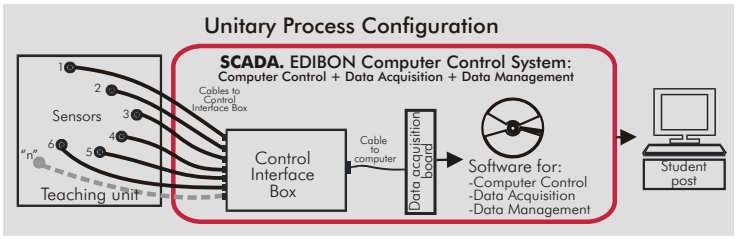
③ Data Acquisition Board

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

Computer (not included in the supply)

⑤ Cables and Accessories

⑥ Manuals



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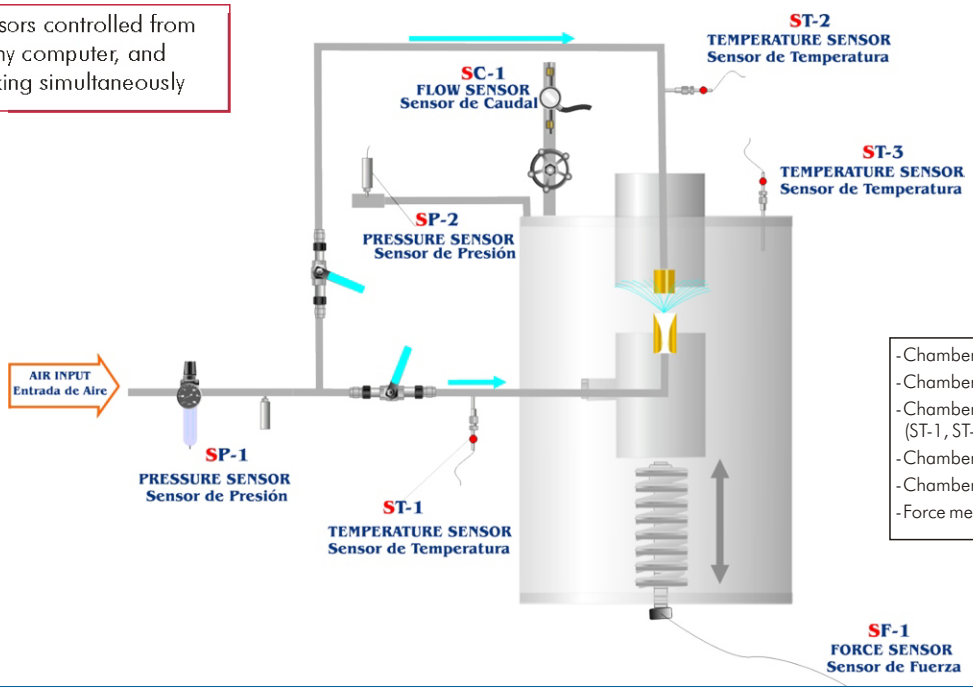
Products
Products range
Units
9.-Thermodynamics & Thermotechnics

PROCESS DIAGRAM AND ELEMENTS ALLOCATION

7 sensors controlled from any computer, and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL



- Chamber inlet pressure measurement (SP-1).
- Chamber pressure measurement (SP-2).
- Chamber inlets air temperature measurement (ST-1, ST-2).
- Chamber temperature measurement (ST-3).
- Chamber outlet air flow measurement (SC-1).
- Force measurement (SF-1).

ISO:9001-2000 Certificate of Approval. Reg. No. E204034

European Union Certificate

Certificates ISO 14001: 2004 and ECO-Management and Audit Scheme (environmental management)

Worlddidac Quality Charter Certificate
Worlddidac Member

DESCRIPTION

This unit has been specially designed to allow students to investigate the performance of a nozzle (kinetic energy and thrust).

This test unit consists of a pressure chamber, with two supports for the nozzles, and a force sensor in its bottom support. Depending on the user wishes to work, the nozzle will be coiled to the bottom or to the top support. On the side in which the nozzle has not been coiled, the user will put the lid on which the air will fall. This lid makes a system that allows the air to be separated from it as soon as the air has impacted tangentially on the incidence direction, not on the antiparalell direction to the incidence direction. Thus, the measured force will be only the incident one, without any kind of reaction due to the "rebound" of the jet.

By means of a valves system, the user will be able to obtain that the air comes into the chamber in its bottom or in its top part. Besides the pressure in the chamber can be controlled by means output pressure valve.

Moreover, three temperature sensors are avalaible, two in the chamber inlets and another one in the chamber. The pressure can be measured at any moment at the chamber inlet and inside, whereas a sensor in its outlet calculates the air flow that comes out from the chamber.

Finally, the impulse/reaction force made by the jet coming from the nozzle is measured by a force sensor, which consists of a simple spring.

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

SPECIFICATIONS

Items supplied as standard

① TFTC. Unit:

Bench top unit.
Anodized aluminium structure and panels in painted steel. Main metallic elements in stainless steel.
Diagram in the front panel with similar distribution to the elements in the real unit.
Chamber in stainless steel, diameter: 200 mm. approx. and height: 400 mm. approx.
Nozzles kit (5 nozzles) of 2 mm. of nominal throat. 1 convergent nozzle (with ratio:1) and 4 convergent-divergent nozzles with 1.2, 1.4, 1.6 and 2 ratio, respectively. Divergence 10° (included).
2 Pressure sensors from 0-10 bar. One to measure the chamber inlet pressure and other to measure the chamber pressure.
2 Temperature sensors ("J" type, range: -40 to 750°C) to measure chamber inlets temperatures.
1 Temperature sensor ("J" type, range: -40 to 750°C) to measure the chamber temperature.
Flow sensor (to measure the chamber outlet air flow), range: 0-500 l./min.
Force sensor, range: 3.5 N
2 deviation valves to direct air to the nozzle or to the chamber.
Chamber valve to control chamber pressure (outlet pressure valve).
Inlet pressure regulation valve (air regulator:0-10 bar) with humidity filter, where the laboratory compressor will be connected.
Nozzles may be changed in seconds.

TFTC Unit

② TFTC/CIB. Control Interface Box :

Control interface box with process diagram in the front panel and with the same distribution that the different elements located in the unit, for an easy understanding by the student. All sensors, with their respective signals, are properly manipulated from -10V. to +10V. computer output. Sensors connectors in the interface have different pines numbers (from 2 to 16), to avoid connection errors. Single cable between the control interface box and computer.
The unit control elements are permanently computer controlled, without necessity of changes or connections during the whole process test procedure. **Simultaneously visualization in the computer of all parameters involved in the process. Calibration of all sensors involved in the process.**
Real time curves representation about system responses. Storage of all the process data and results in a file. Graphic representation, in real time, of all the process/system responses.
All the actuators' values can be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. All the actuators and sensors values and their responses are placed in only one computer screen.
Shield and filtered signals to avoid external interferences.
Real time 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, resistances, control valves, etc.
Open control allowing modifications, at any time and in a real time , of parameters involved in the process simultaneously.
Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.

TFTC/CIB

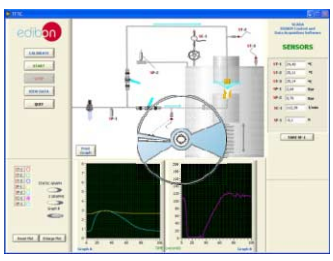
③ DAB. Data Acquisition Board:

PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.
Analog input: Number of **channels= 16** single-ended or 8 differential. **Resolution=16 bits**, 1 in 65536.
Sampling rate up to: 250 KS/s (Kilo samples per second).
Input range (V)=± 10V. Data transfers=DMA, interrupts, programmed I/0. DMA channels=6.
Analog output: Number of **channels=2**. **Resolution=16 bits**, 1 in 65536. Max. output rate up to: 833 KS/s.
Output range(V)=±10V. Data transfers=DMA, interrupts, programmed I/0.
Digital Input/Output: Channels=24 inputs/outputs. D0 or DI Sample Clock frequency: 0 to 1 MHz.
Timing: **Counter/timers=2**. Resolution: Counter/timers: 32 bits.

DAB

④ TFTC/CCSOF. Computer Control+Data Acquisition+Data Management Software:

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.** Registration and visualization of all process variables in an automatic and simultaneously way. **Flexible, open and multicontrol software**, developed with actual windows graphic systems, acting simultaneously on all process parameters. **Management, processing, comparison and storage of data.**
Sampling velocity up to 250,000 data per second guaranteed.
Student calibration system for all sensors involved in the process.
It allows the registration of the alarms state and the graphic representation in real time. Comparative analysis of the obtained data, after the process and modification of the conditions during the process. **Open software, allowing to the teacher to modify texts, instructions. Teacher's and student's passwords** to facilitate the teacher's control on the student, and allowing the access at different work levels.
This unit allows that the 30 students of the classroom can visualize simultaneously all results and manipulation of the unit, during the process, by using a projector.



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

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Complementary items to the standard supply

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

⑦ PLC-PI. PLC Module:

Circuit diagram in the front panel.

Front panel:

Digital inputs(X) and Digital outputs (Y) block:

16 Digital inputs, activated by switches and 16 LEDs for confirmation (red).

14 Digital outputs (through SCSI connector) with 14 LEDs for message (green).

Analog inputs block:

16 Analog inputs (-10V. to + 10V.)(through SCSI connector).

Analog outputs block:

4 Analog outputs (-10V. to + 10V.)(through SCSI connector).

Touch screen:

High visibility and multiple functions.
Display of a highly visible status.
Recipe function.
Bar graph function.
Flow display function.
Alarm list.
Multi language function.
True type fonts.

Back panel:

Power supply connector.
Fuse 2A.
RS-232 connector to PC.

Inside:

Power supply outputs: 24 Vdc, 12 Vdc, -12 Vdc, 12 Vdc variable.

Panasonic PLC:

High-speed scan of 0.32 μsec. for a basic instruction.
Program capacity of 32 Ksteps, with a sufficient comment area.
Free input AC voltage(100 to 240 V AC).
DC input:16 (24 V DC).
Relay output: 14 (250 V A AC/2 A).
High-speed counter.
Multi-point PID control.
Digital inputs/outputs and analog inputs/outputs Panasonic modules.

Communication RS232 wire, to computer (PC).

PLC-PI

⑧ TFTC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

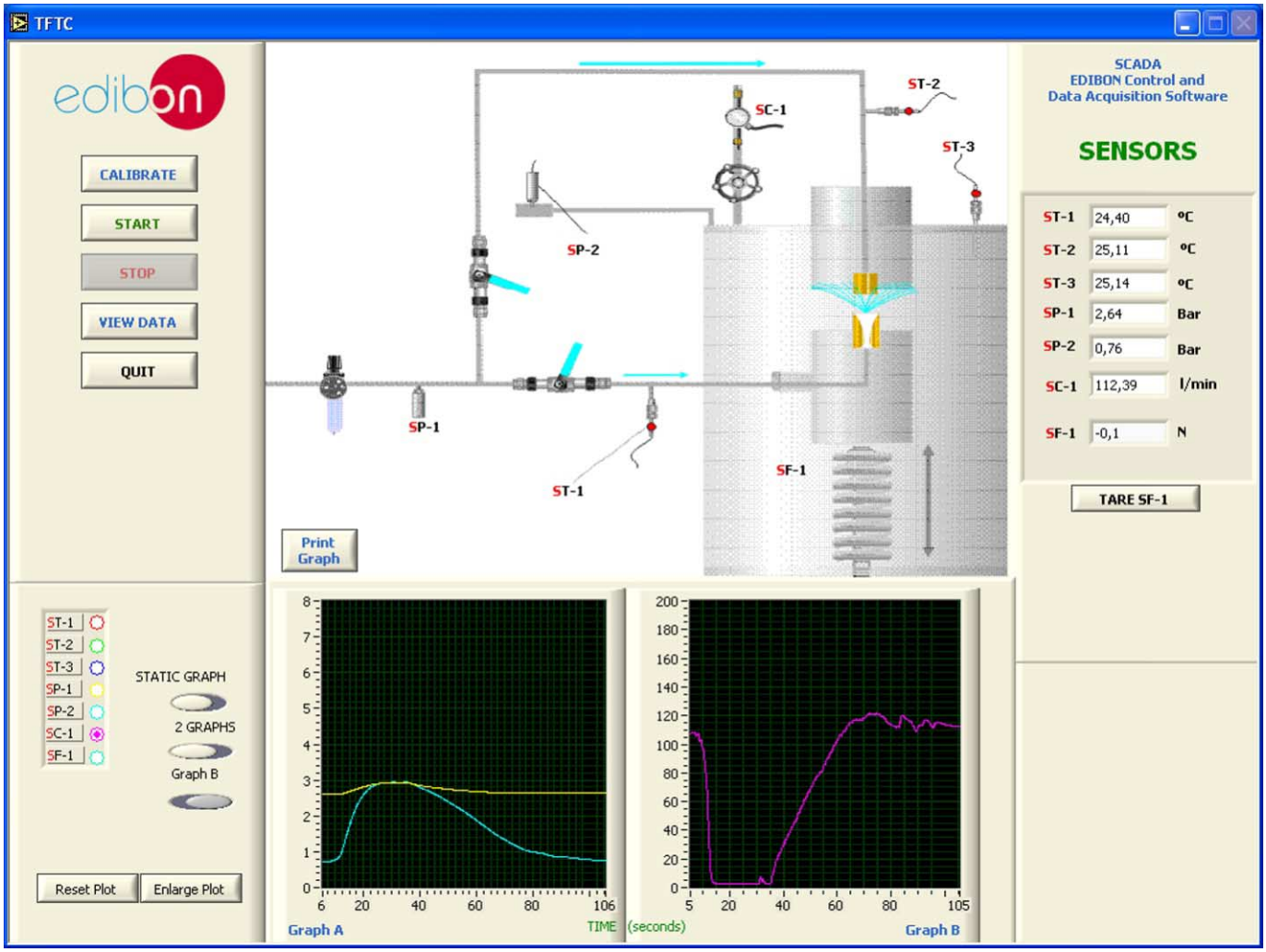
Items available on request

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

⑩ TFTC/FSS. Faults Simulation System.

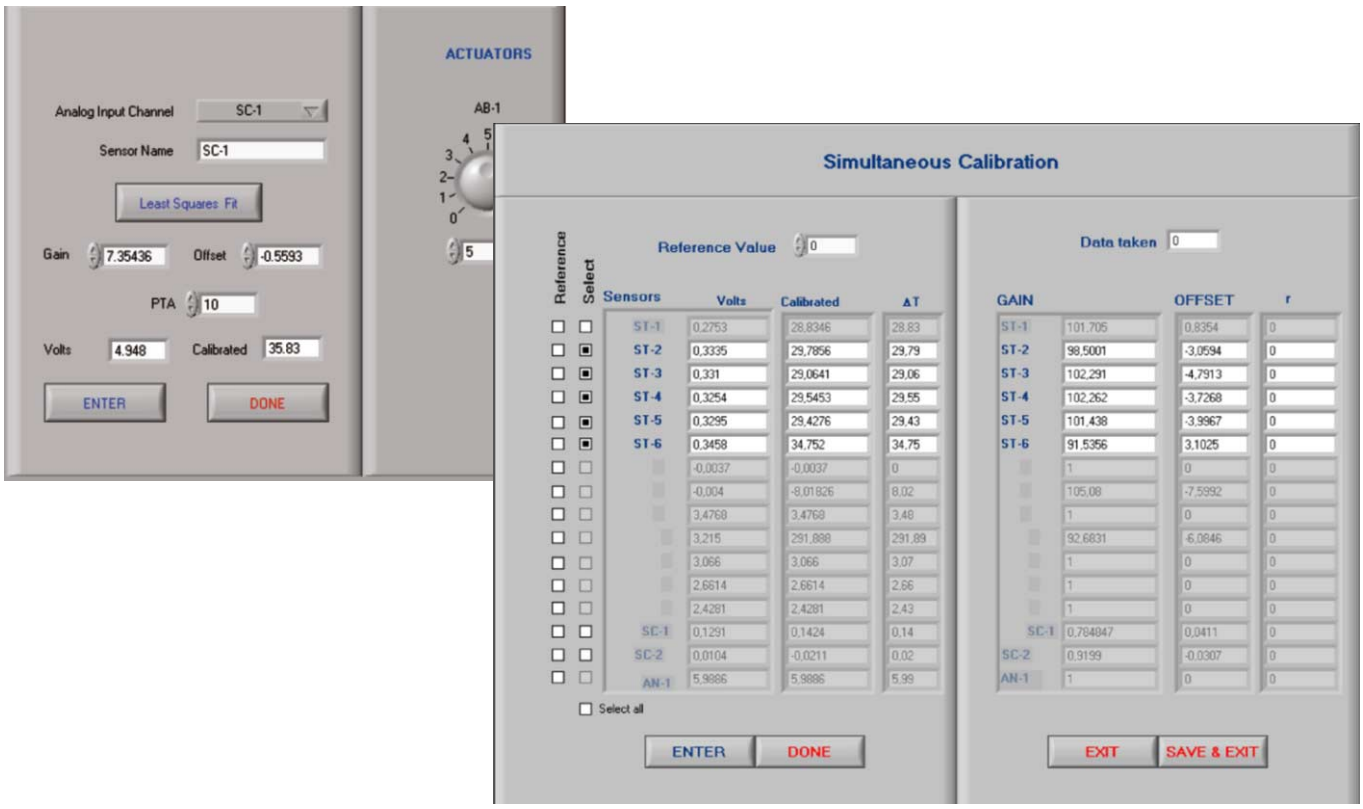
Software Main Screens

Main screen



Note: ST=Temperature sensor. SP= Pressure sensor. SC=Flow sensor. SF= Force sensor.

Examples of Sensors Calibration screens



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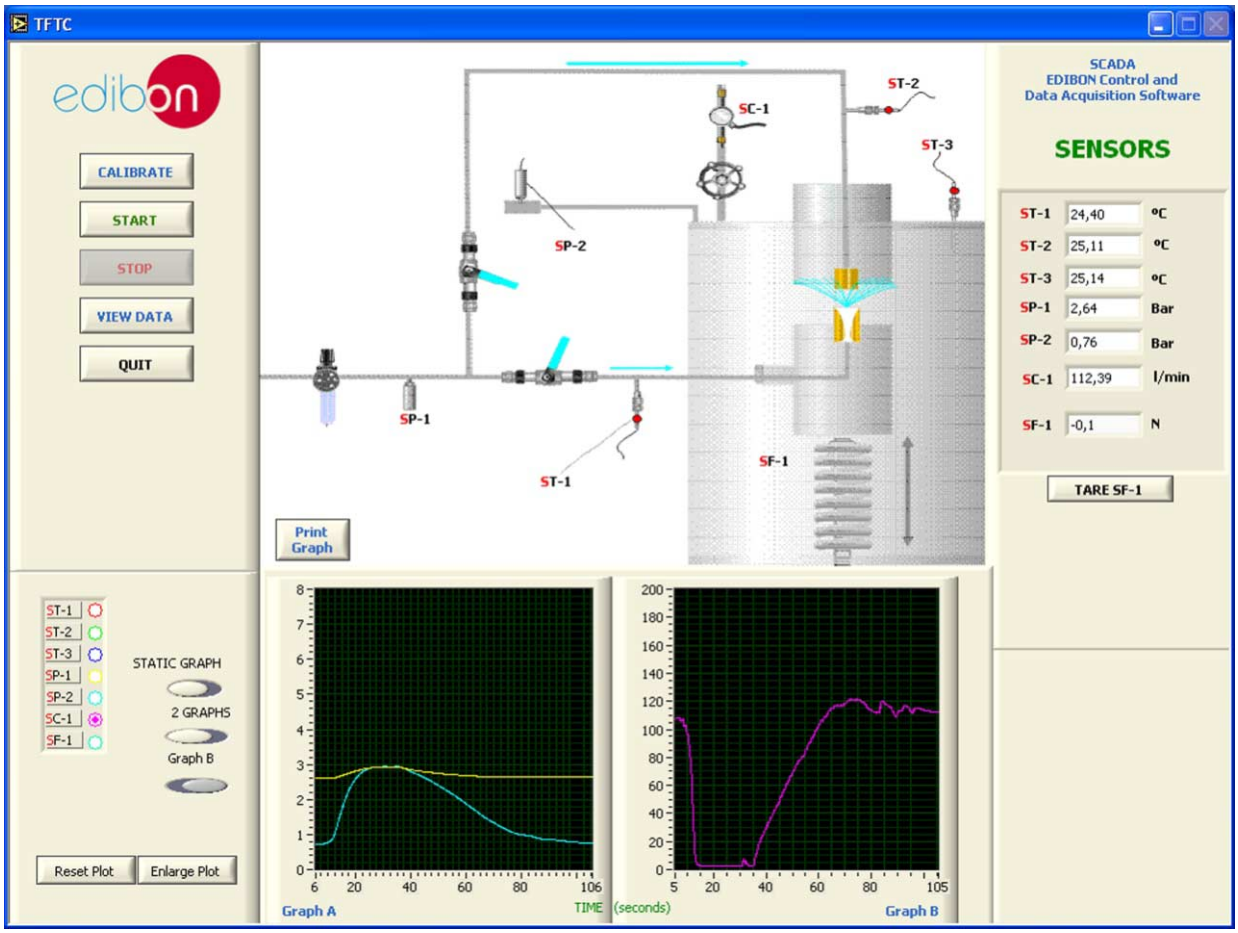
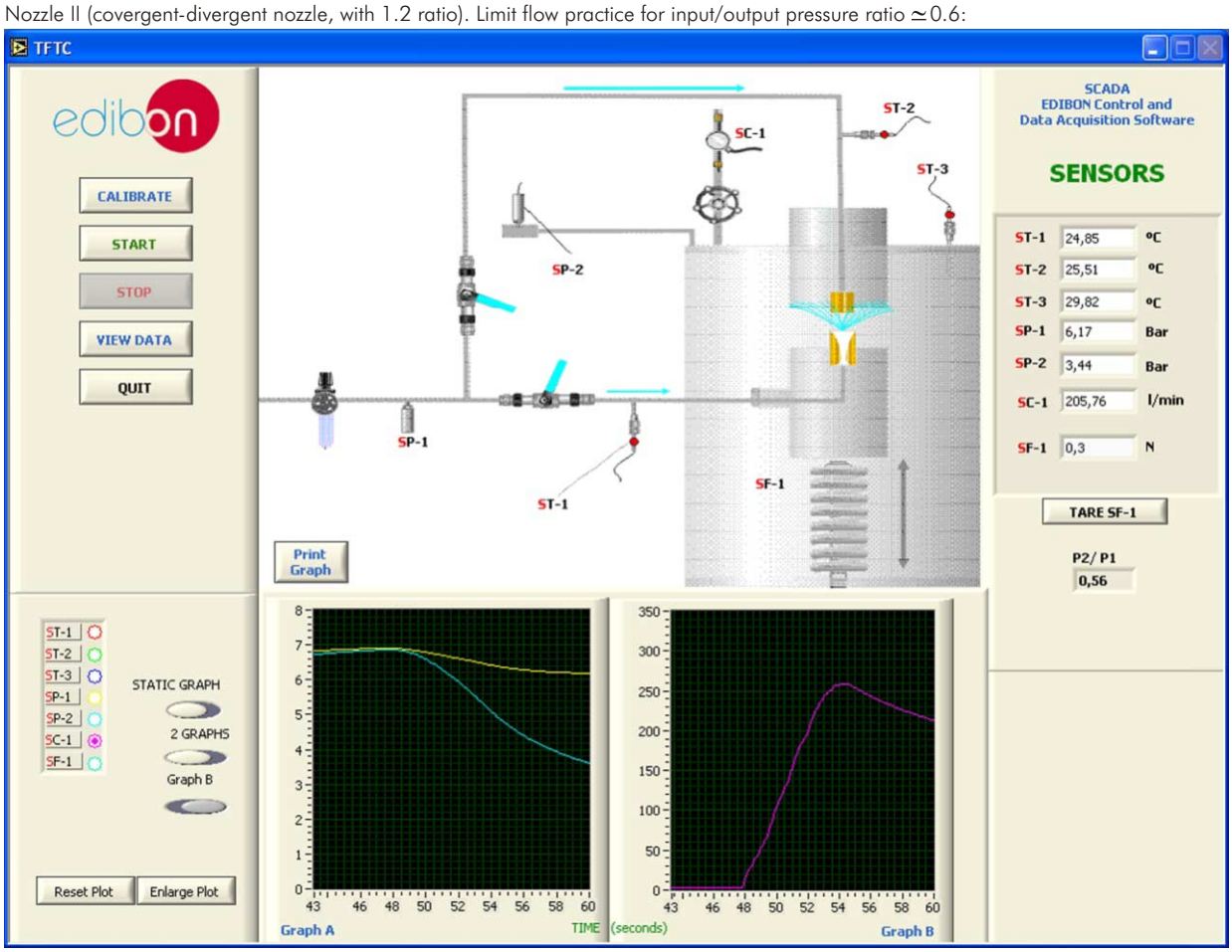
Some typical exercises results

"CHOKING" PHENOMENON DEMONSTRATION

Nozzle I (covergent nozzle). Limit flow practice for input/output pressure ratio ≃ 0.5:



Nozzle II (covergent-divergent nozzle, with 1.2 ratio). Limit flow practice for input/output pressure ratio ≃ 0.6:



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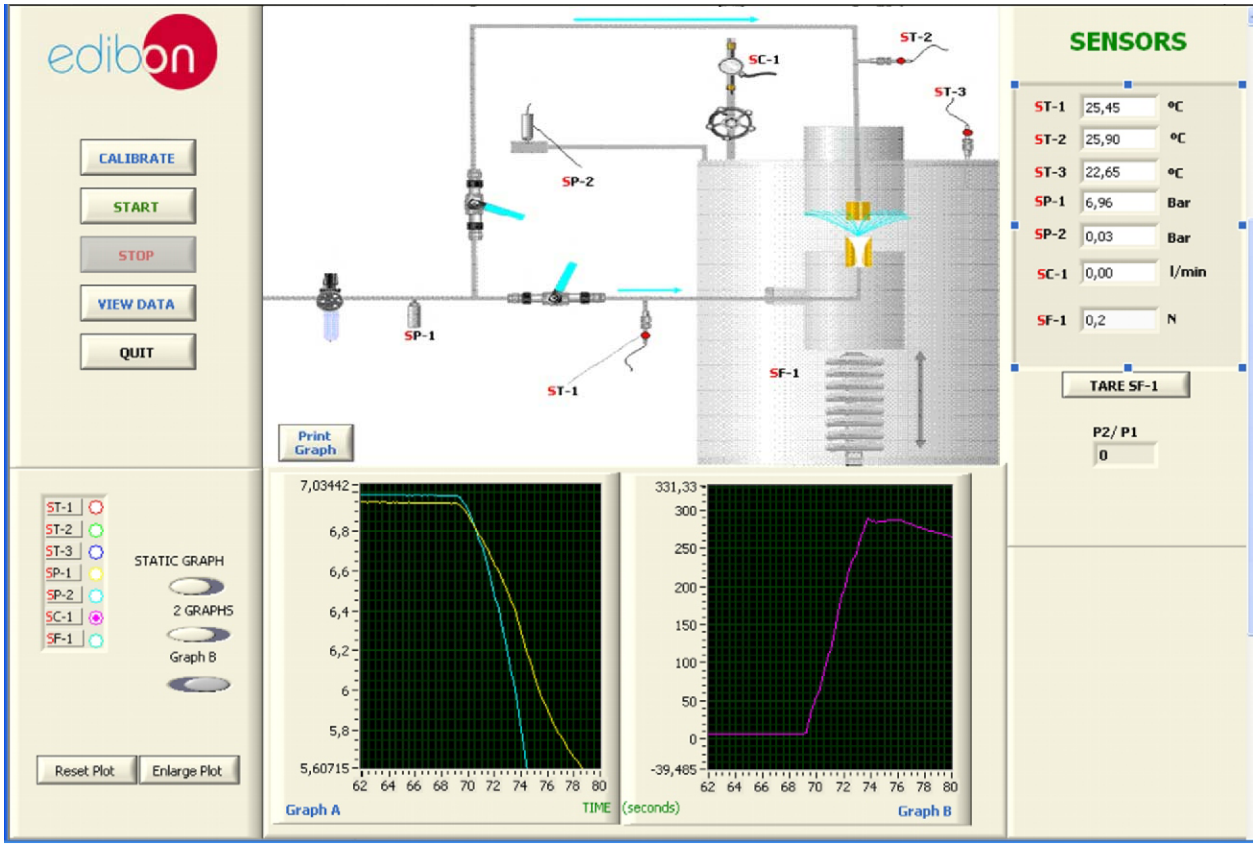
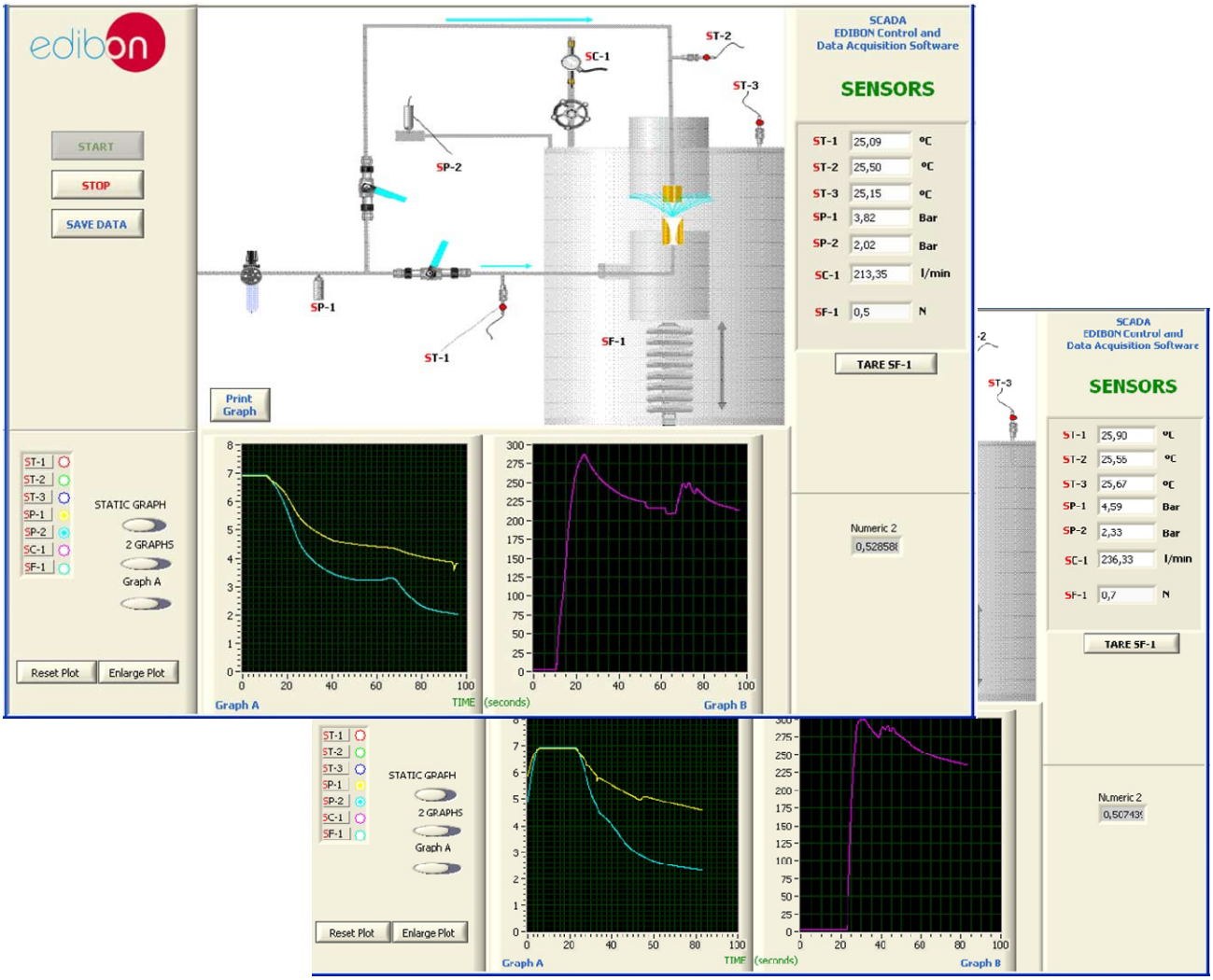
Some typical exercises results

Nozzle III (covergent-divergent nozzle, with 1.4 ratio). Limit flow practice for input/output pressure ratio ≃ 0.7:



Nozzle IV (covergent-divergent nozzle, with 1.6 ratio). Limit flow practice for input/output pressure ratio ≃ 0.8:



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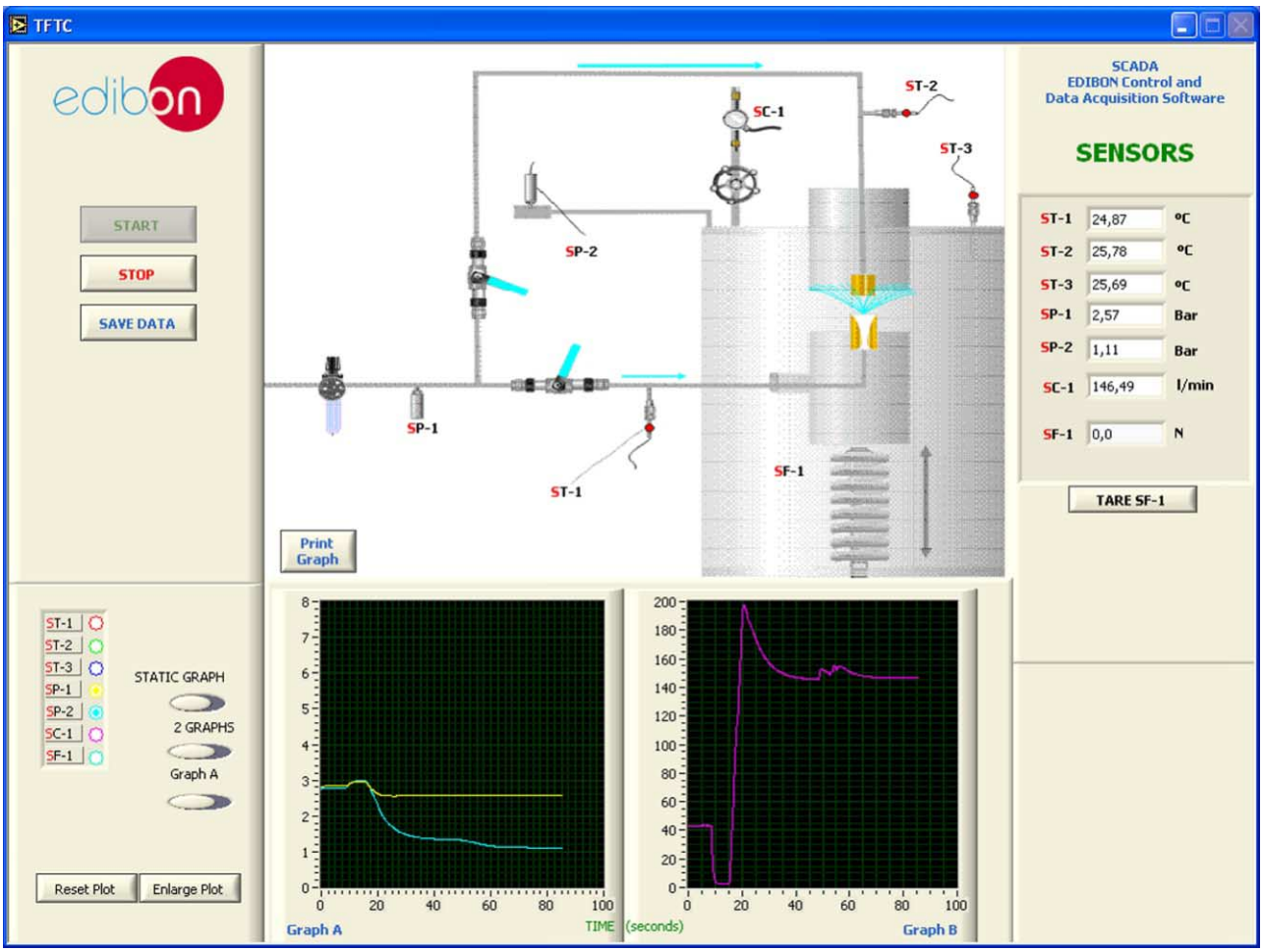
Some typical exercises results

Nozzle V (covergent-divergent nozzle, with 2 ratio). Limit flow practice for input/output pressure ratio ≃ 0.9:



EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Demonstration of the phenomenon of "choking".
2.- Determination of jet reaction and specific thrust at a variety of inlet and back pressure.
3.- Determination of inlet pressure effect on mass flow rate, for a given back pressure.
4.- Comparison of actual mass flow rate with the theoretical value.
5.- Determination of the back pressure effect on the mass flow rate.
6.- Calculation of nozzle efficiencies.
7.- Determination of the jet velocity and the nozzle efficiency.
8.- Determination of the jet reaction and the specific pushing.
9.- Simple and classical method used to determine jet velocity.
10.- Measurement of mass flow rate and coefficient of discharge.
11.- By means the sensors measurements we can get mass flow rate, jet speed, efficiency and pushing for a variety of nozzles operating for a wide range of pressure ratios from 1.0 to aproximately 0.5.

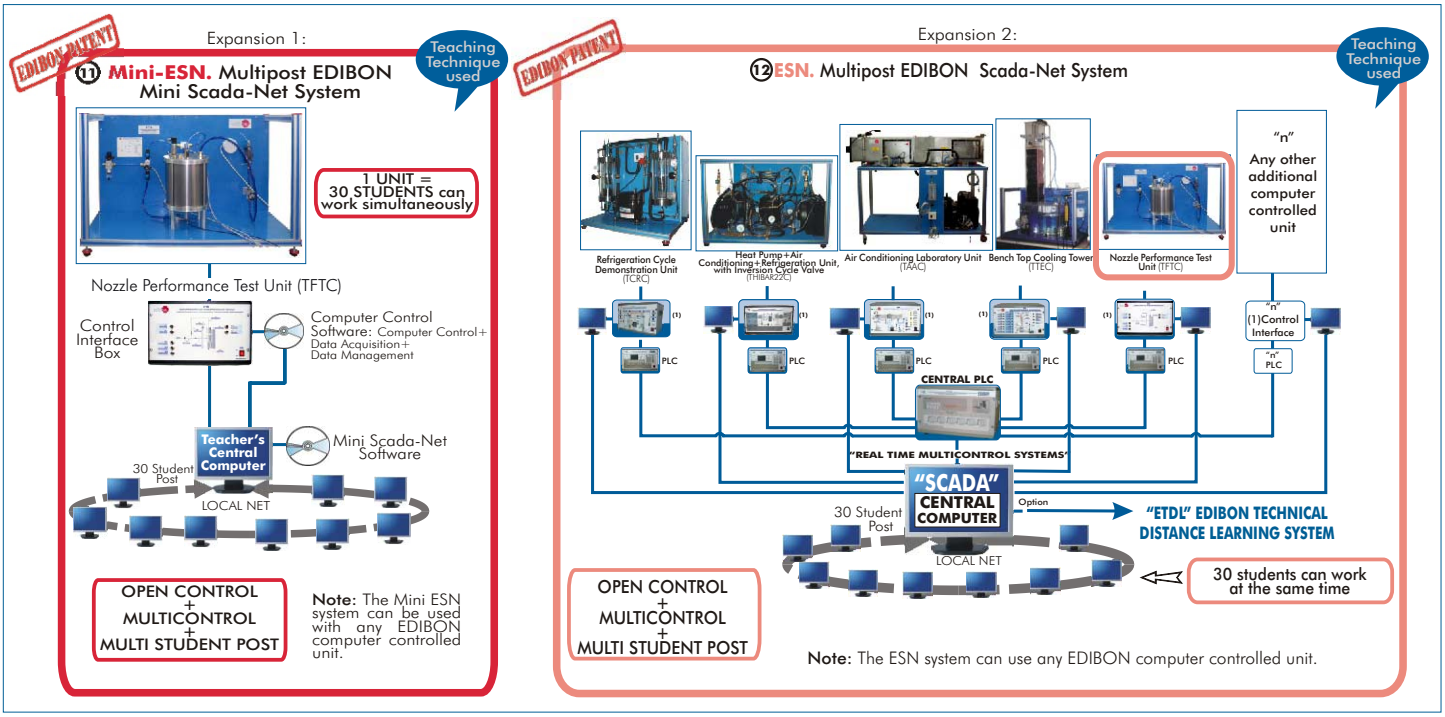
Other possible practices:

12.- Sensors calibration.

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

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

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS



ORDER INFORMATION

Items supplied as standard

Minimum configuration for normal operation includes:

① **Unit: TFTC. Nozzle Performance Test Unit.**
② **TFTC/CIB.Control Interface Box.**
③ **DAB.Data Acquisition Board.**
④ **TFTC/CCSOF. Computer Control + Data Acquisition + Data Management Software.**
⑤ **Cables and Accessories**, for normal operation.
⑥ **Manuals.**

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

Complementary items to the standard supply

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

⑦ PCL-PI.PLC Module.
⑧ TFTC/PLC-SOF. PLC Control Software.
⑨ TFTC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
⑩ TFTC/FSS. Faults Simulation System. (Available on request).

Expansions

⑪ Mini ESN. Multipost EDIBON Mini Scada-Net System.
⑫ ESN. Multipost EDIBON Scada-Net System.

REQUIRED SERVICES

-Electrical supply: single-phase, 220V./50Hz. or 110V./60Hz.
-Compressed air (5 bar approx.)
-Computer (PC).

DIMENSIONS & WEIGHTS

TFTC Unit:	-Dimensions: 1000 x 700 x 600 mm. approx. -Weight :60 Kg. approx.
Control Interface Box:	-Dimensions: 490 x 330 x 310 mm. approx. -Weight: 10 Kg. approx.
PLC Module (PLC-PI):	-Dimensions: 490 x 330 x 310 mm. approx. -Weight: 30 Kg. approx.

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

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