edibon

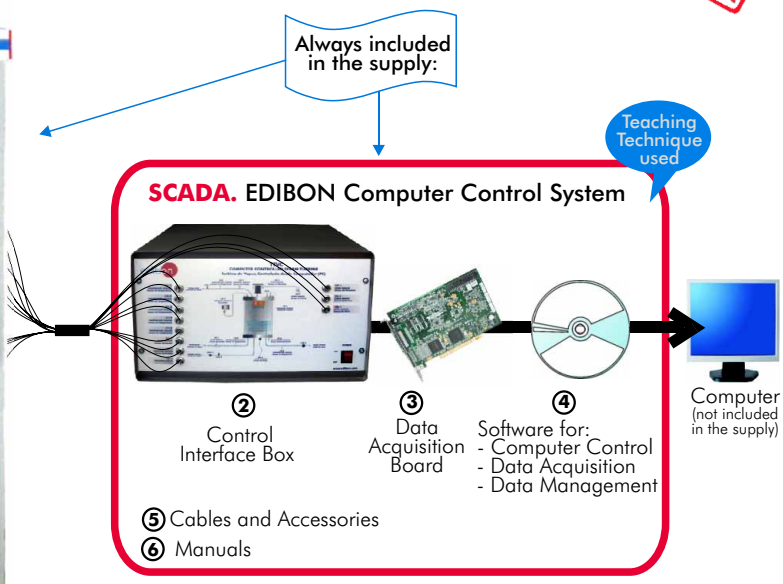
Technical Teaching Equipment

Computer Controlled **Steam Turbine**

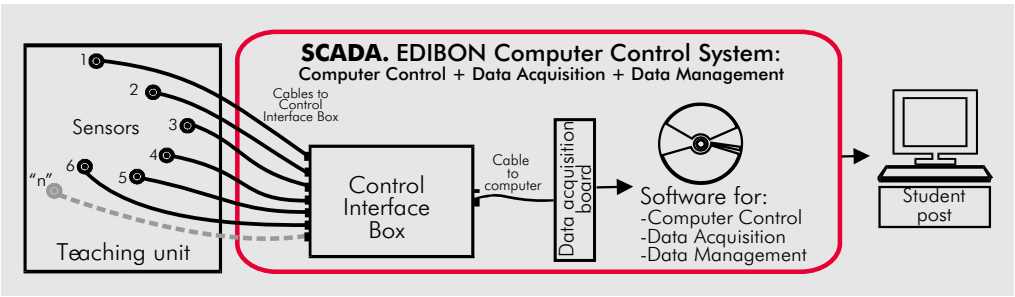
TTVC

EDIBON PATENT

① Unit: TTVC. Steam Turbine



OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL



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Products range
Units
9.- Thermodynamics & Thermotechnics

ISO 9000: Quality Management
(for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate
(total safety)

Certificates ISO 14000 and
ECO-Management and Audit Scheme
(environmental management)

Worlddidac Quality Charter Certificate
(Worlddidac Member)

DESCRIPTION

The TTVC Unit, developed by EDIBON, consists of a steam turbine which works in single stage. It has an injection nozzle with an incidence angle of 20° referred to the rotation plane.

To work with the TTVC unit turbine, it is necessary to have a steam generator in the laboratory. It must have a production of 8 kg/h at minimum pressures of 6 bar. If you have not the suitable generator in the laboratory, EDIBON can offer its Steam Generator (TGW-kWA) suitable to work with this unit.

The unit steam inlet has two solenoid electrovalves mounted in series, that allows a safe work of the installation. The excitation of both valves causes the opening and the steam to reach the turbine.

The steam affects the turbine blades by means of an injector which generates a work on them and which causes the turbine rotation. According to the energy which the steam has, there will be more or less work in the turbine.

The turbine exhaust gases, almost without energy, are collected into a glass chamber, which is called condenser. Here, the steams are condensed to water by a coil action, through which cold water circulates. This cold water suffers a temperature increase, which will be shown to the student as another generation possibility.

To measure the torque, there is a band brake which acts on a pulley which rotates joined to the turbine. The band end is connected to a load cell-force sensor. By means of the action on a manual screw, the band is tensed, braking as it is required, so the load given by the turbine can be determined.

The turbine rotation speed is measured by a speed sensor.

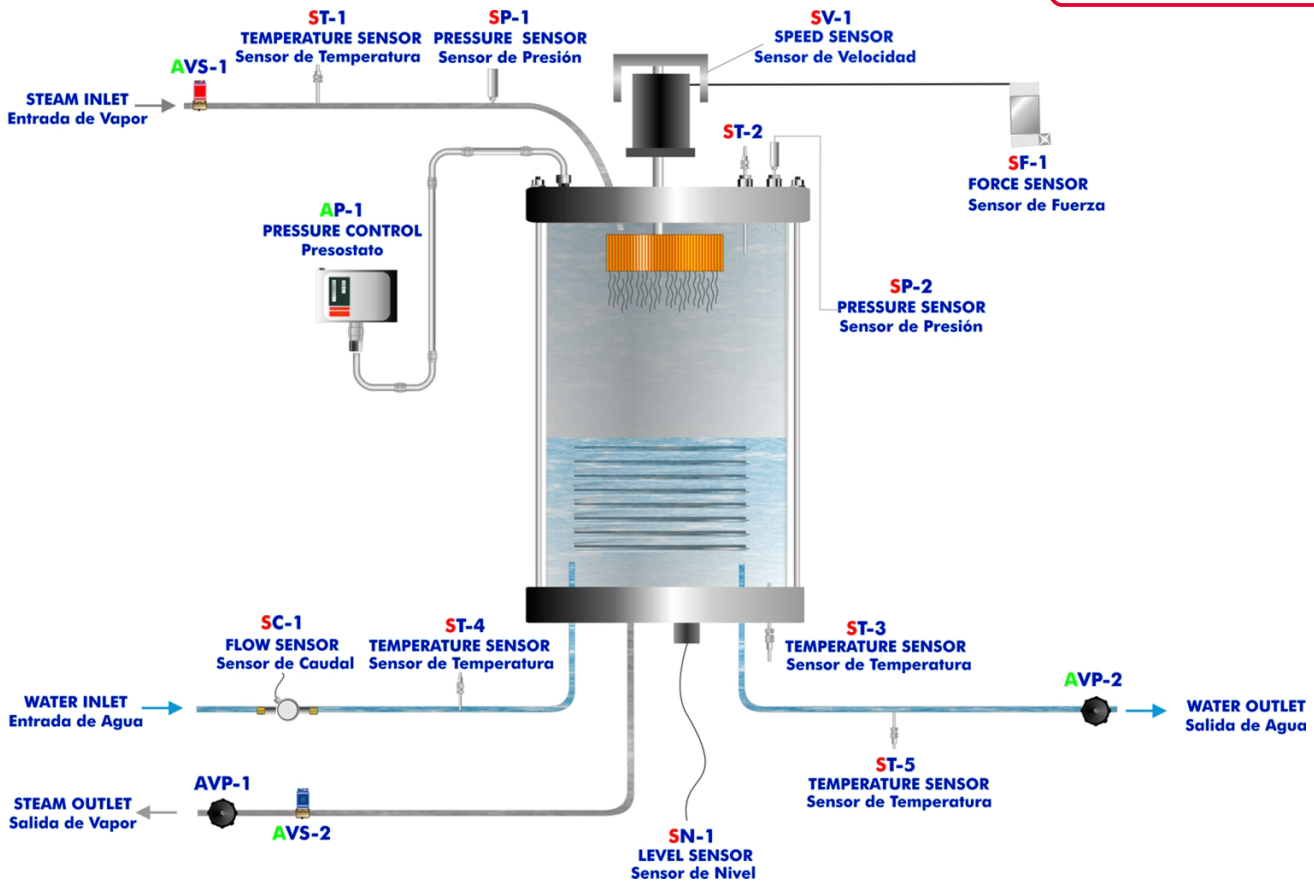
The steam flow is an important variable. It is measured by means of the condensed steam volume during a determined time.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), including: Control interface Box + Data Acquisition Board + Computer Control and Data Acquisition Software, for controlling the process and the parameters involved.

PROCESS DIAGRAM AND ELEMENTS ALLOCATION

3 actuators and 11sensors controlled from any computer, and working simultaneously

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL



Items supplied as stardard

① TTVC. Unit:

Bench top unit mounted on an anodized aluminium structure and panels in painted steel (epoxy paint).

Main metallic elements in stainless steel.

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

Steam turbine mounted on a vertical shaft:

- Axial flow turbine type De Laval, of single stage.
- Maximum speed: 20,000 rpm.
- Power:10W.
- Nozzle:
  - Inlet diameter: 1.5 mm.
  - Outlet diameter: 3 mm.
  - Discharge angle: 20°.
- Turbine rotor:
  - External diameter: 84 mm.
  - Internal diameter: 45 mm.
  - Number of blades: 25.
- Brake:
  - Type friction by means of a band.
  - Pulley diameter: 50 mm.
  - Effective radius: 27 mm.

Water cooled condenser: glass chamber. Into it, there is a coil through which the cold water circulates.

Sensors:

- Pressure sensor for inlet steam, range: 0-10 bar.
- Pressure sensor in the condenser, range: -1 bar to +1.6 bar.
- Load cell. Force sensor, range: 0-20 N.
- Speed sensor, range: 0-40,000 r.p.m.
- Flow sensor for refrigeration water, range: 0.2-6.5 l/min.
- Level sensor to measure the condensate volume or flow.
- 5 Temperature sensors in different points of the unit.

2 Solenoid valves, mounted in series, computer controlled, for system security.

1 Solenoid valve, computer controlled, to evacuate the condenser.

Turbine overspeed protection by means of the control software.

Condenser overpressure switch.

Safety protection methacrylate screens.

TTVC. Unit

② TTVC/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.

TTVC/CIB

Continue...

Items supplied as stardard (continuation)

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.

Number of DMA channels=6.

DAB

Analog output:

Number of **channels=2**.

Resolution=16 bits, 1 in 65536.

Maximum output rate up to: 833 KS/s.

Output range(V)=±10V.

Data transfers=DMA, interrupts, programmed I/0.

Digital Input/Output:

Number of **channels=24 inputs/outputs**.

D0 or DI Sample Clock frequency: 0 to 1 MHz.

Timing: **Counter/timers=2**.

Resolution: Counter/timers: 32 bits.

④ TTVC/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.

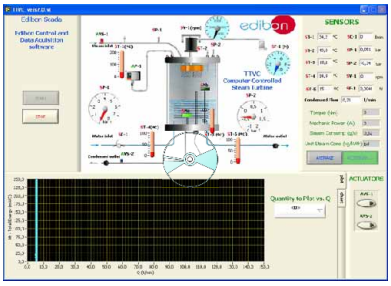
Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

Sampling velocity up to 250,000 data per second guaranteed.

Calibration system for the sensors involved in the process.

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



TTVC/CCSOF

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.

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

Continue...

Additional and optional 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.
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.
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 TTVC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

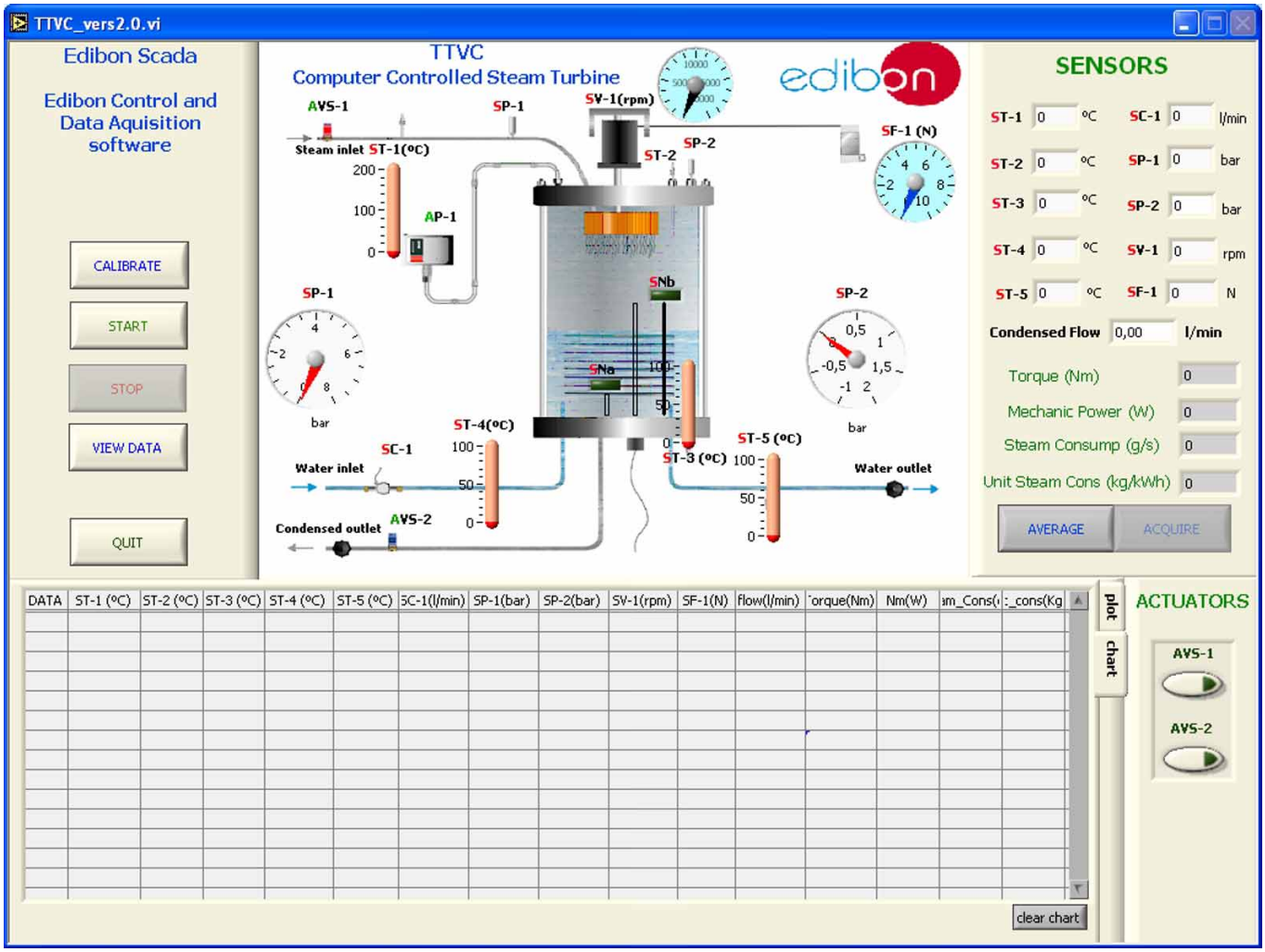
Items available on request

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

⑩ TTVC/FSS. Faults Simulation System.

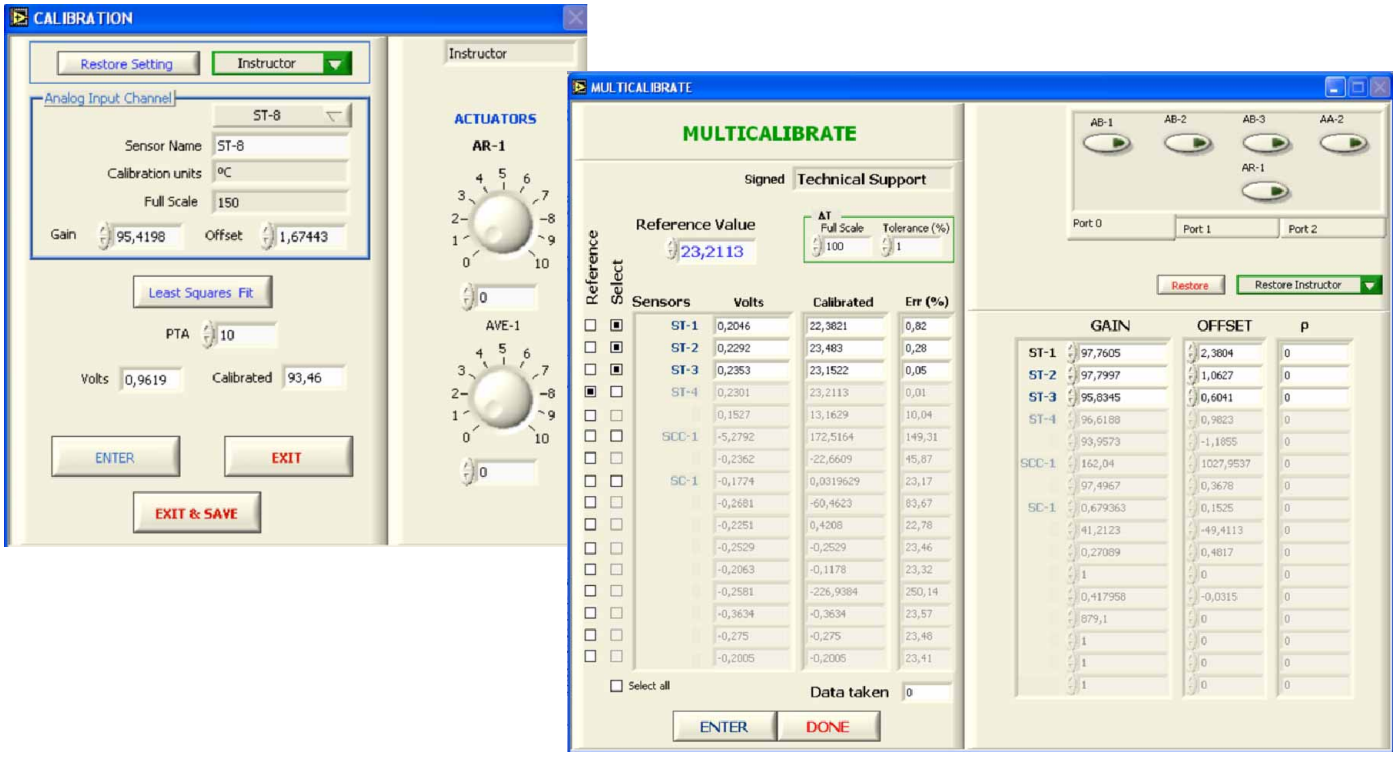
Software Main Screens

Main screen



Note: ST= Temperature sensor. SC= Flow sensor. SP= Pressure sensor. SV= Speed sensor. SF= Force sensor. AVS= Solenoid valve.

Examples of Sensors **Calibration** screens



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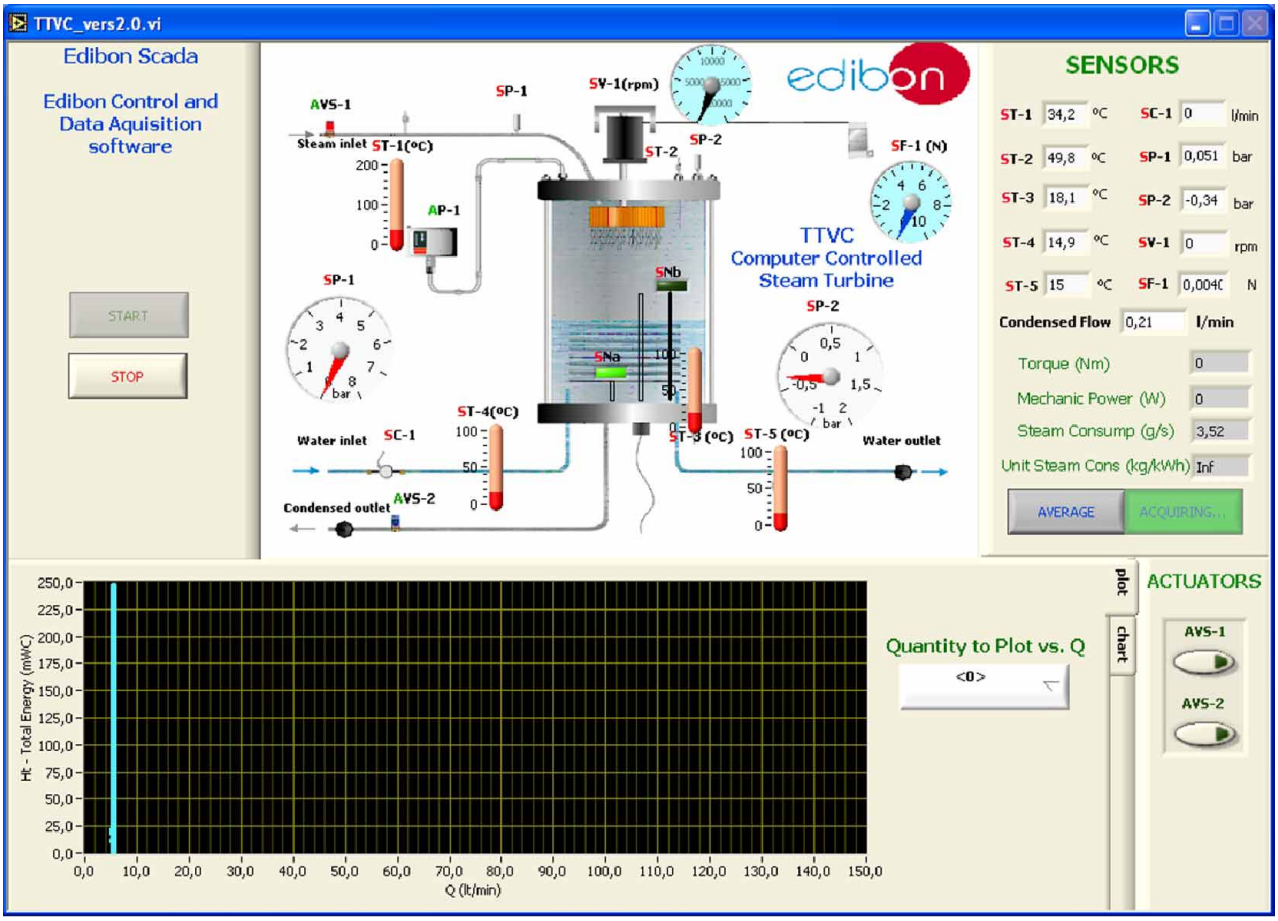
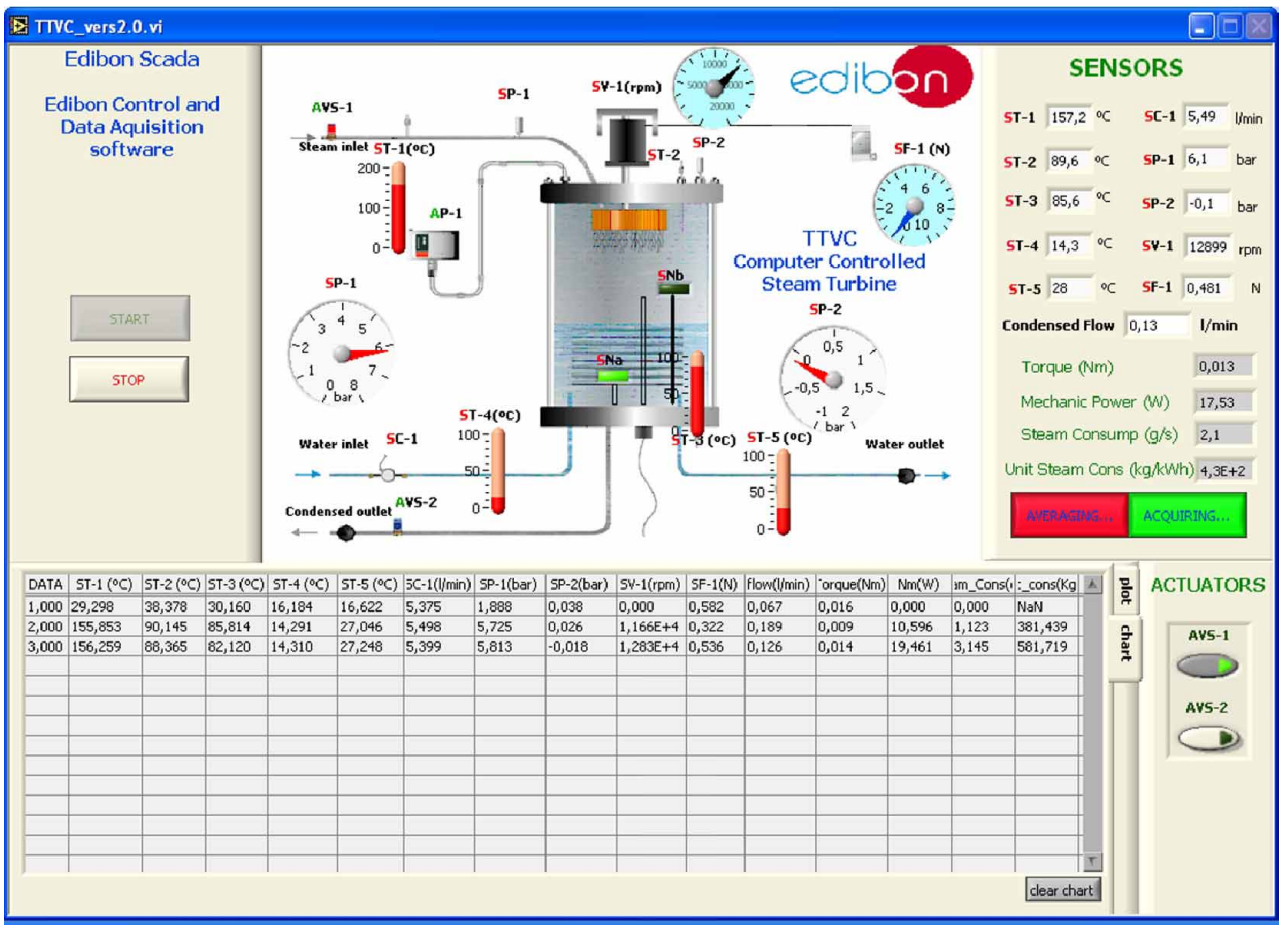
Some typical exercises results

Screen showing how, in real time, the software calculates the mechanic power, the torque and the steam consumption.



Screen showing the turbine software automatically working. Data acquisition at constant flow of condensed.

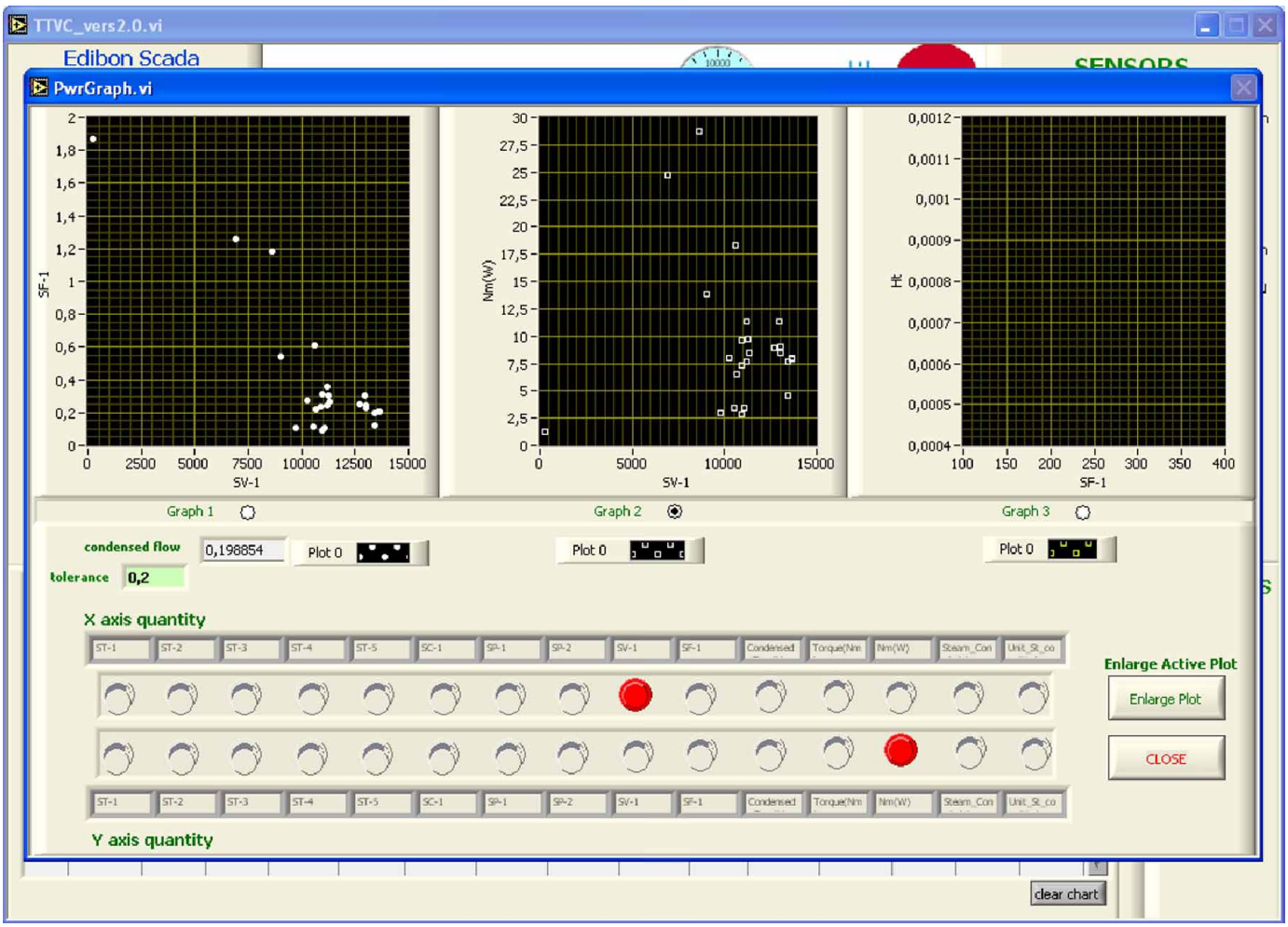


DATA	ST-1 (ºC)	ST-2 (ºC)	ST-3 (ºC)	ST-4 (ºC)	ST-5 (ºC)	SC-1(l/min)	SP-1(bar)	SP-2(bar)	SV-1(rpm)	SF-1(N)	flow(l/min)	Torque(Nm)	Nm(W)	m_Cons(g/s)	_cons(Kg
1,000	29,298	38,378	30,160	16,184	16,622	5,375	1,888	0,038	0,000	0,582	0,067	0,016	0,000	0,000	NaN
2,000	155,853	90,145	85,814	14,291	27,046	5,498	5,725	0,026	1,166E+4	0,322	0,189	0,009	10,596	1,123	381,439
3,000	156,259	88,365	82,120	14,310	27,248	5,399	5,813	-0,018	1,283E+4	0,536	0,126	0,014	19,461	3,145	581,719

Continue...

Some typical exercises results

Representation of the saved data. Auto-scaled system.



EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Calculation of the real flow of condensate.
2.- Determination of the injector discharge coefficient.
3.- Obtaining the characteristic curves of the steam turbine.
4.- Turbine efficiency.
5.- Thermal balances.
6.- Determination of friction losses at various exhaust pressures.
7.- Determination of torque, power and specific steam consumption when operating at constant inlet pressure but with varying exhaust pressure.
8.- Determination of torque, power and specific steam consumption when operating at constant exhaust pressure but with varying inlet pressure.
9.- Determination of power to heat ratio when used as a back pressure turbine.
10.- Determination of thermal efficiency.
11.- Determination of Isentropic efficiency.
12.- Study of the specific steam consumption of the turbine.

Other possible practices:

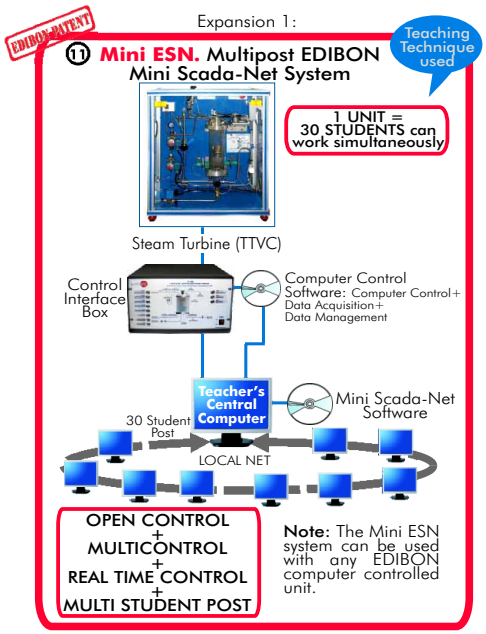
13.- Sensors calibration.

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

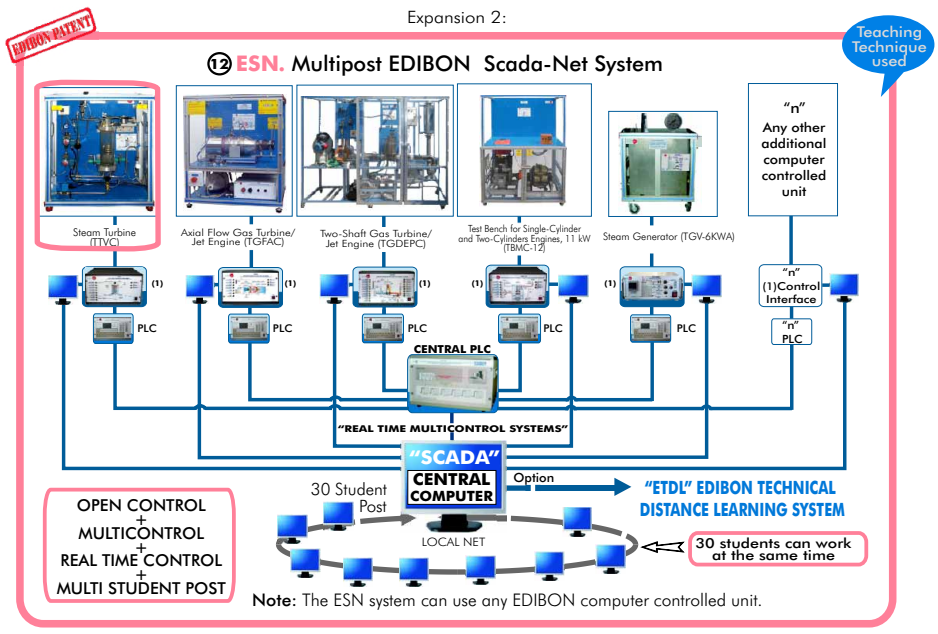
14 - Control of the TTVC unit process through the control interface box without the computer.
15.- Visualization of all the sensors values used in the TTVC unit process.
16.- Calibration of all the sensors included in the TTVC unit process.
17.- Hand on of all the actuators involded in the TTVC unit process.
18.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
19.- Simulation of outside actions, in the cases do not exist hardware elements. (Example: test of complementary tanks, complementary industrial environment to process to be studied, etc).
20.- PLC hardware general use and manipulation.
21.- PLC process application for TTVC unit.
22.- PLC structure.
23.- PLC inputs and outputs configuration.
24.- PLC configuration possibilities.
25.- PLC program languages.
26.- PLC different programming standard languages.
27.- New configuration and development of new process.
28.- Hand on an established process.
29.- To visualize and see the results and to make comparisons with the TTVC unit process.
30.- Possibility of creating new process in relation with the TTVC unit.
31.- PLC Programming Exercises.
32.- Own PLC applications in accordance with teacher and student requirements.

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:



Expansion 2:



ORDER INFORMATION

Items supplied as standard

Minimum configuration for normal operation includes:

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

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

Additional and optional items to the standard supply

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

⑦ PCL-PI.PLC Module.
⑧ TTVC/PLC-SOF. PLC Control Software.
⑨ TTVC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
⑩ TTVC/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./150Hz or 110V./60Hz.
-Water supply.
-Steam supply (EDIBON Steam generator TGV-6kWA, or similar).
-Computer (PC).

DIMENSIONS & WEIGHTS

TTVC Unit:	-Dimensions: 700 x 600 x 800 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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