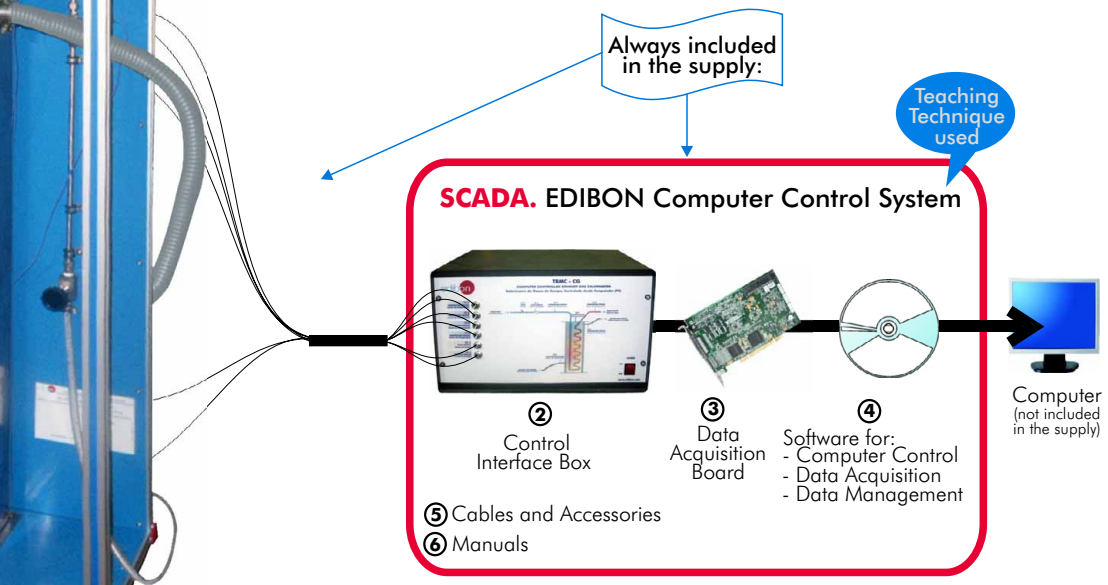
Computer Controlled **Exhaust Gas Calorimeter**

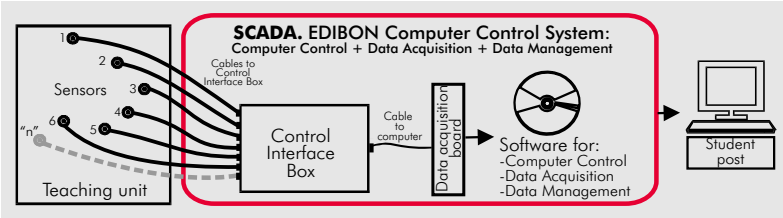
TBMC-CG

Technical Teaching Equipment

EDIBON PATENT



① Unit: TBMC-CG. Exhaust Gas Calorimeter



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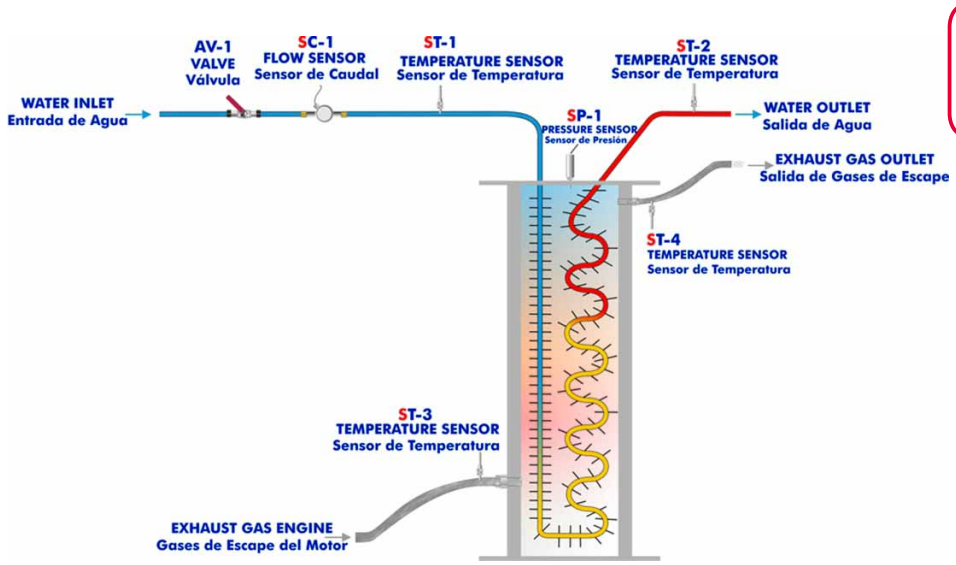
Products
Products range
Units
9.-Thermodynamics & Thermotechnics

PROCESS DIAGRAM AND ELEMENTS ALLOCATION



OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

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 TBMC-CG Exhaust Gases Calorimeter developed by EDIBON is a suitable teaching equipment to measure the heat contained in the exhaust gases of a engine.

The Thermal energy emitted by an engine to exterior is considered as a loss.

The calorimeter is mounted on a laminated aluminium profiles structure and panels in painted steel. The main element consists on a double-wall tank made in stainless steel. Through the tank interior the exhaust gases of a combustion engine flow from the lower to the upper part. These gases cross the external surface of a finned steel pipe. Through the pipe interior, crosscurrent water flows with the aim of absorbing the heat contained in the gases which flow through the exterior.

The function of the double-wall is having an air chamber between the gases to be analyzed and the external environment to minimize the heat losses with the exterior.

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.

SPECIFICATIONS

Items supplied as standard

① TBMC-CG. Unit:

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.
The main element consists on a double-wall tank, made in stainless steel, with a finned steel pipe heat exchanger inside.
- **Exchange volume: 13 l.**
- **Heat exchange area on exhaust gas side: 1.2 m^2.**
- **Heat exchange area on water side: 0.17 m^2.**

Exhaust gas inlet at the bottom of the unit.
Exhaust gas outlet at the upper part of the unit
Water inlet and outlet connections and hoses are supplied.
Connection between engine and calorimeter using an exhaust gas a heat-resistant hose.
Regulation valve for the cooling water flow rate.
4 Temperature sensors, "J" type, at different process stages, for measurement of:
- **Exhaust gases temperature at the input.**
- **Gases temperature at the calorimeter output.**
- **Water temperature at the calorimeter input.**
- **Water temperature at the calorimeter output.**

Flow sensor to measure the cooling water flow.
Pressure sensor for gases under analysis, range: 0-1 bar.
Measuring ranges:
- **Exhaust gas temperature: 0-600º C.**
- **Water temperature: 0-600º C.**
- **Flow rate: 0-600 l./hour.**

The unit incorporates wheels for its mobility.

TBMC-CG. Unit

② TBMC-CG/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 for -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.

TBMC-CG/CIB

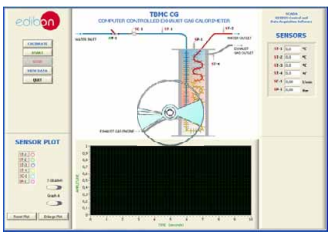
③ DAB. Data Acquisition Board:

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: 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.

DAB

④ TBMC-CG/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.
Comparative analysis of the obtained data, after to 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.



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

Continue...

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.
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 TBMC-CG/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.

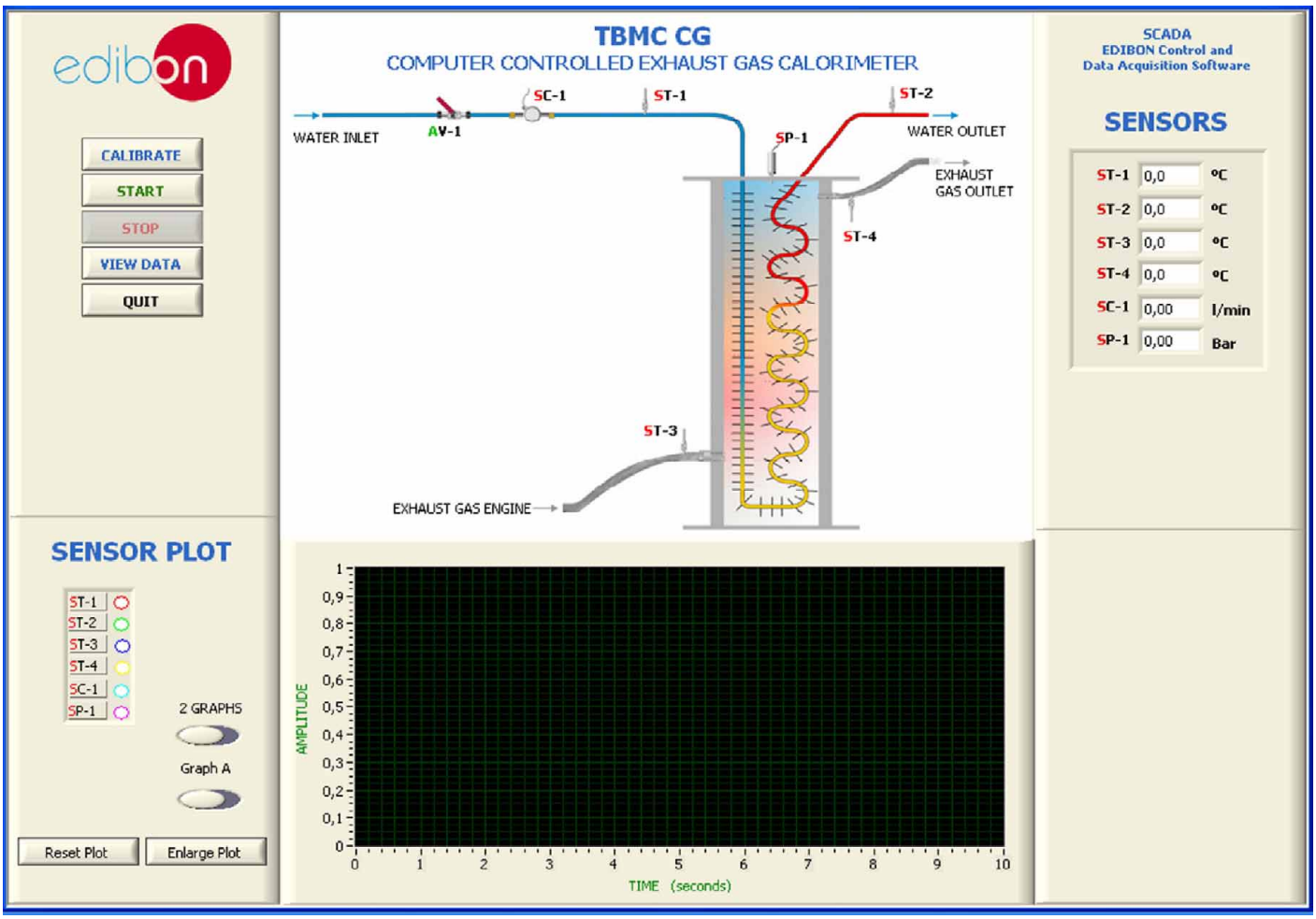
Items available on request

⑨ TBMC-CG/CAL. Computer Aided Learning Software (Results Calculation and Analysis).

⑩ TBMC-CG/FSS. Faults Simulation System.

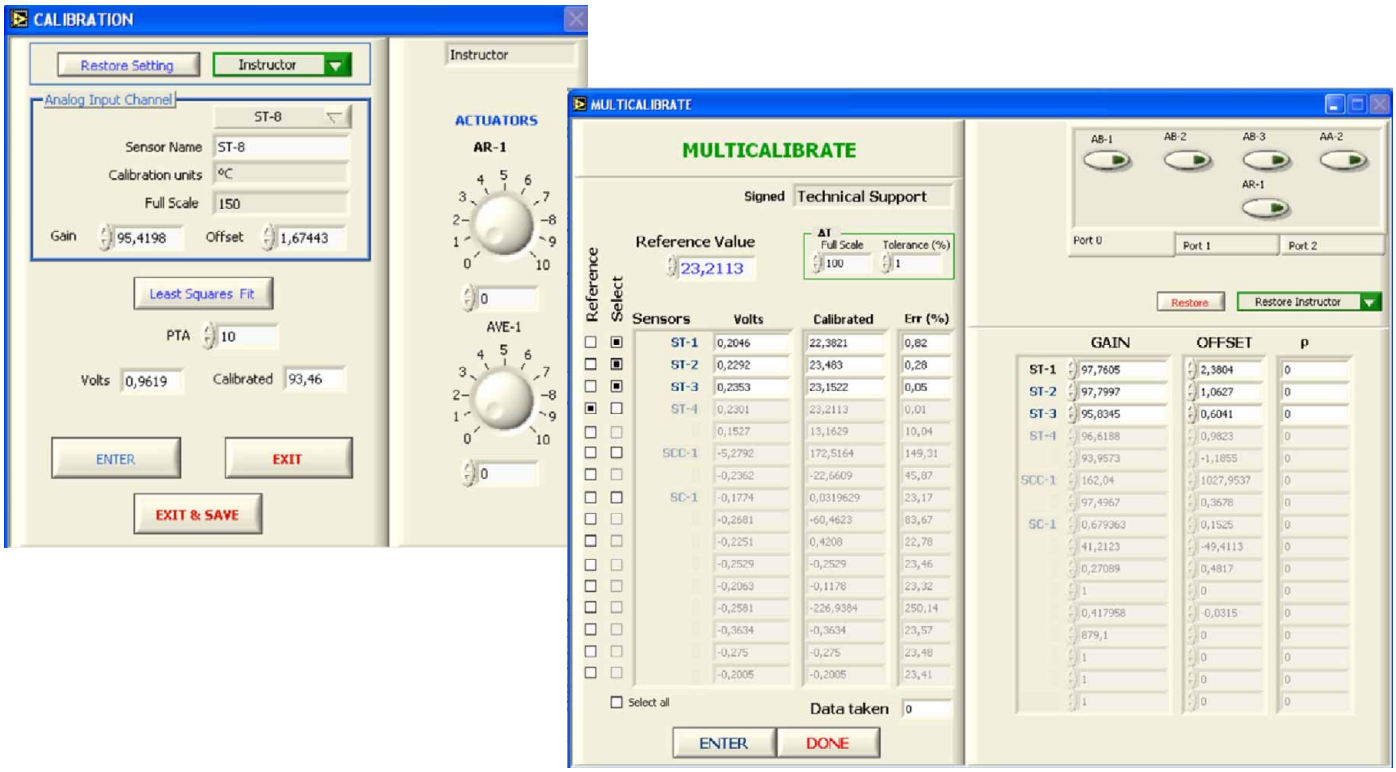
Software Main Screens

Main screen



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

Examples of Sensors Calibration screens



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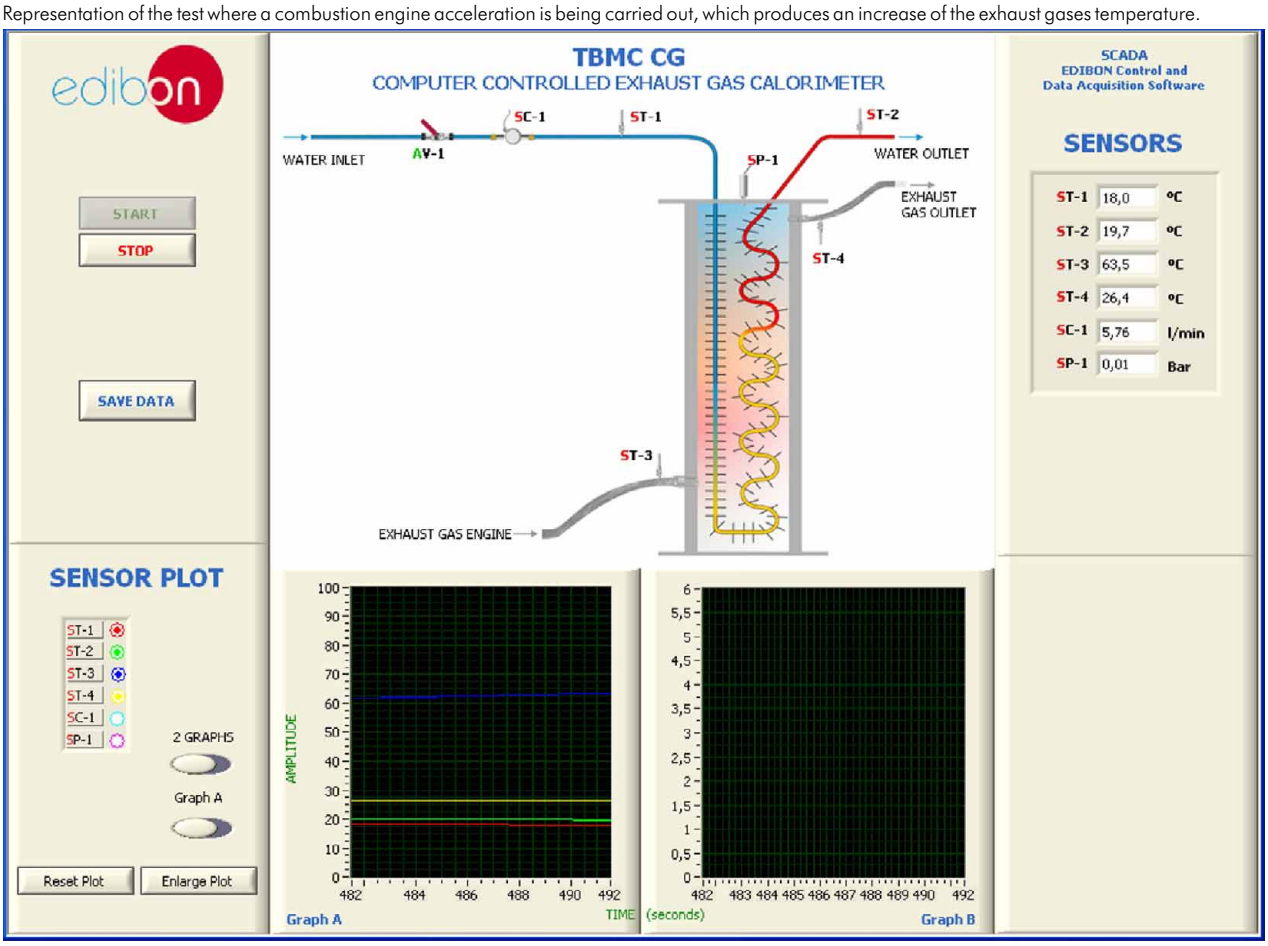
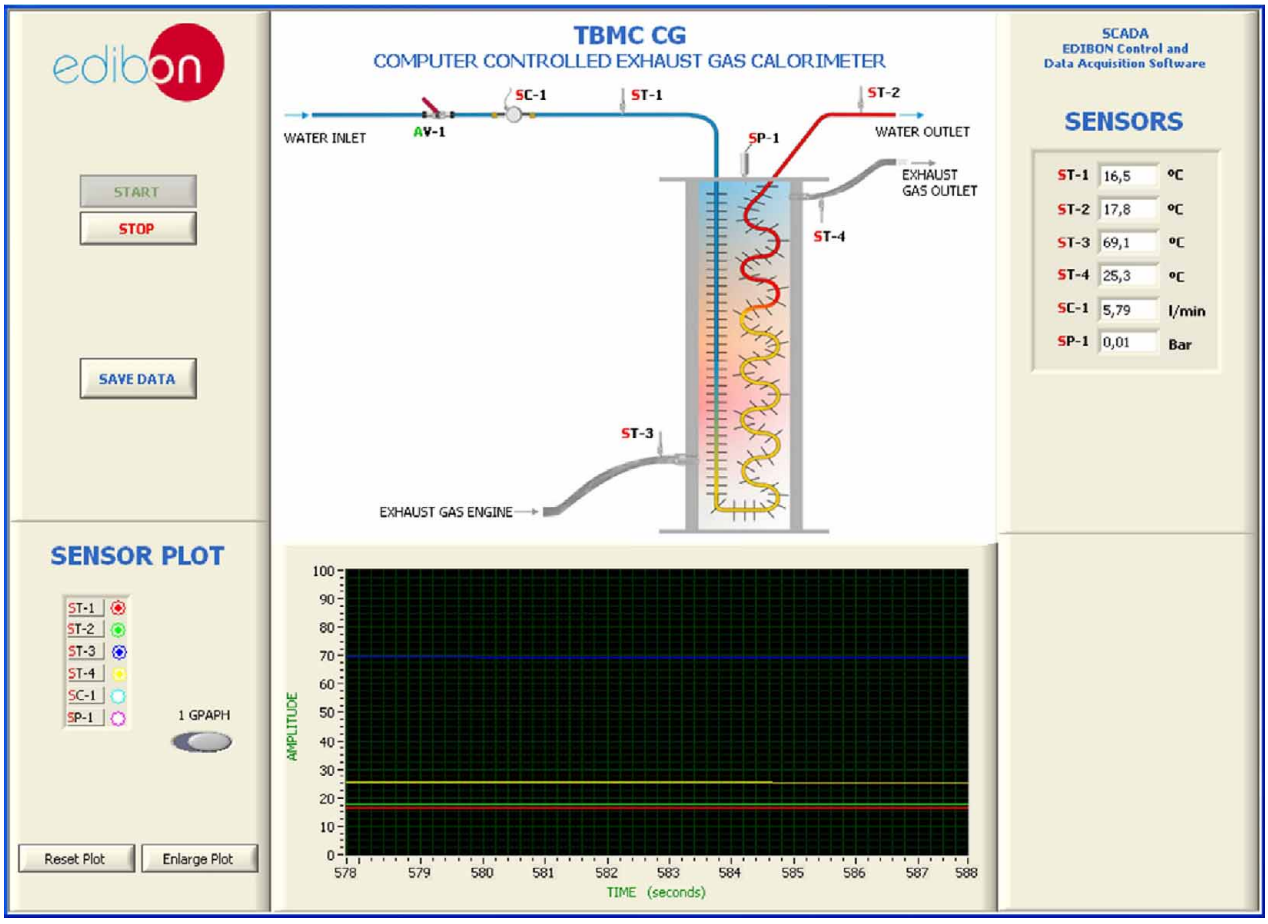
Some typical exercises results

Representation of the test where a combustion engine acceleration is being carried out, which produces an increase of the exhaust gases temperature.



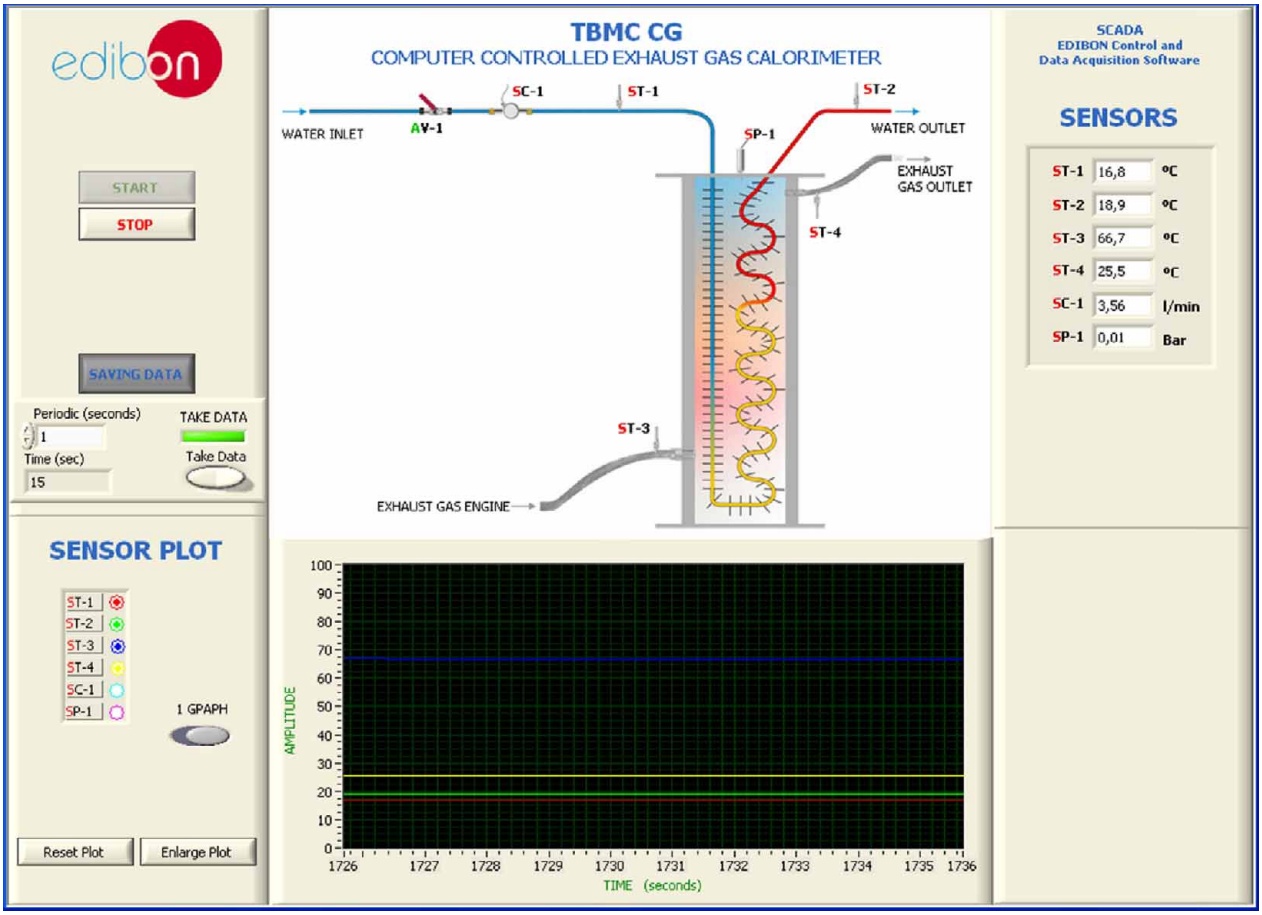
Possibility of amplifying the graphs in real time.



Continue...

Some typical exercises results

By clicking "SAVE DATA", the readings are saved in a file to visualize them later.



EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

1.- Determination of the heat content of exhaust gases from test engines.

2.- Heat and energy balance studies.

3.- Determination of exhaust gas thermal output power given up.

4.- To determine the specific heat capacity of exhaust gases.

Other possible practices:

5.- Sensors calibration.

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

6.- Control of the TBMC-CG unit process through the control interface box without the computer.

7.- Visualization of all the sensors values used in the TBMC-CG unit process.

8.- Calibration of all sensors included in the TBMC-CG unit process.

9.- Hand on of all the actuators involved in the TBMC-CG unit process.

10.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).

11.- 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).

12.- PLC hardware general use and manipulation.

13.- PLC process application for TBMC-CG unit.

14.- PLC structure.

15.- PLC inputs and outputs configuration.

16.- PLC configuration possibilities.

17.- PLC program languages.

18.- PLC different programming standard languages (literal structured, graphic, etc.).

19.- New configuration and development of new process.

20.- Hand on an established process.

21.- To visualize and see the results and to make comparisons with the TBMC-CG unit process.

22.- Possibility of creating new process in relation with the TBMC-CG unit.

23.- PLC Programming Exercises.

24.- Own PLC applications in accordance with teacher and student requirements.

POSSIBILITIES OF OTHER AVAILABLE EXPANSIONS

Expansion 1:

EDIBON PATENT

Teaching Technique used

⑪ Mini ESN. Multipost EDIBON Mini Scada-Net System

1 UNIT = 30 STUDENTS can work simultaneously

Exhaust Gas Calorimeter (TBMC-CG)

Control Interface Box

Computer Control Software: Computer Control + Data Acquisition + Data Management

Teacher's Central Computer

Mini Scada-Net Software

30 Student Post

LOCAL NET

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL + MULTI STUDENT POST

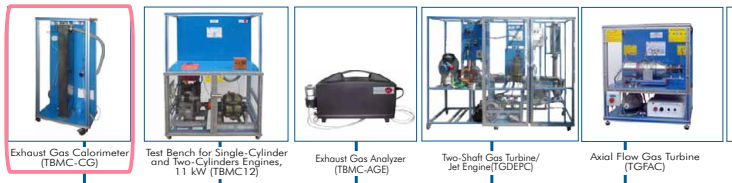
Note: The Mini ESN system can be used with any EDIBON computer controlled unit.

Expansion 2:

EDIBON PATENT

Teaching Technique used

⑫ ESN. Multipost EDIBON Scada-Net System



Exhaust Gas Calorimeter (TBMC-CG)

Test Bench for Single-Cylinder and Two-Cylinders Engines, 11 kW (TBMC12)

Exhaust Gas Analyzer (TBMC-AGE)

Two-Shaft Gas Turbine/ Jet Engine(TGDEPC)

Axial Flow Gas Turbine (TGFAC)

"n" Any other additional computer controlled unit

(1) PLC

"n" (1)Control Interface

"n" PLC

CENTRAL PLC

"REAL TIME MULTICONTROL SYSTEMS"

"SCADA" CENTRAL COMPUTER

Option

"ETDL" EDIBON TECHNICAL DISTANCE LEARNING SYSTEM

30 Student Post

LOCAL NET

30 students can work at the same time

OPEN CONTROL + MULTICONTROL + REAL TIME CONTROL + MULTI STUDENT POST

Note: The ESN system can use any EDIBON computer controlled unit.

ORDER INFORMATION

Items supplied as standard

Minimum configuration for normal operation includes:

① **Unit: TBMC-CG. Exhaust Gas Calorimeter.**

② **TBMC-CG/CIB. Control Interface Box.**

③ **DAB. Data Acquisition Board.**

④ **TBMC-CG/CCSOF. Computer Control + Data Acquisition + Data Management Software.**

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

⑥ **Manuals.**

* **IMPORTANT: Under TBMC-CG 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 TBMC-CG/PLC-SOF. PLC Control Software.

⑨ TBMC-CG/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).

⑩ TBMC-CG/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.
- Water supply.
- Drainage.
- Computer (PC).

DIMENSIONS & WEIGHTS

TBMC-CG. Unit:	-Dimensions: 600 x 500 x 1500 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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