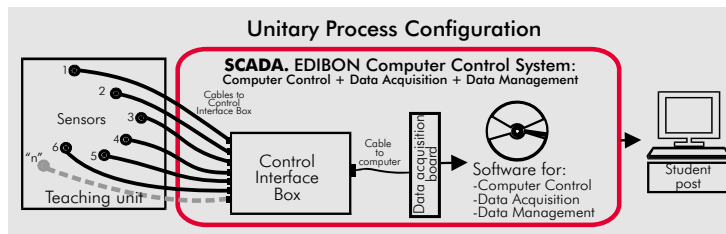


① Unit: TTEC. Bench Top Cooling Tower

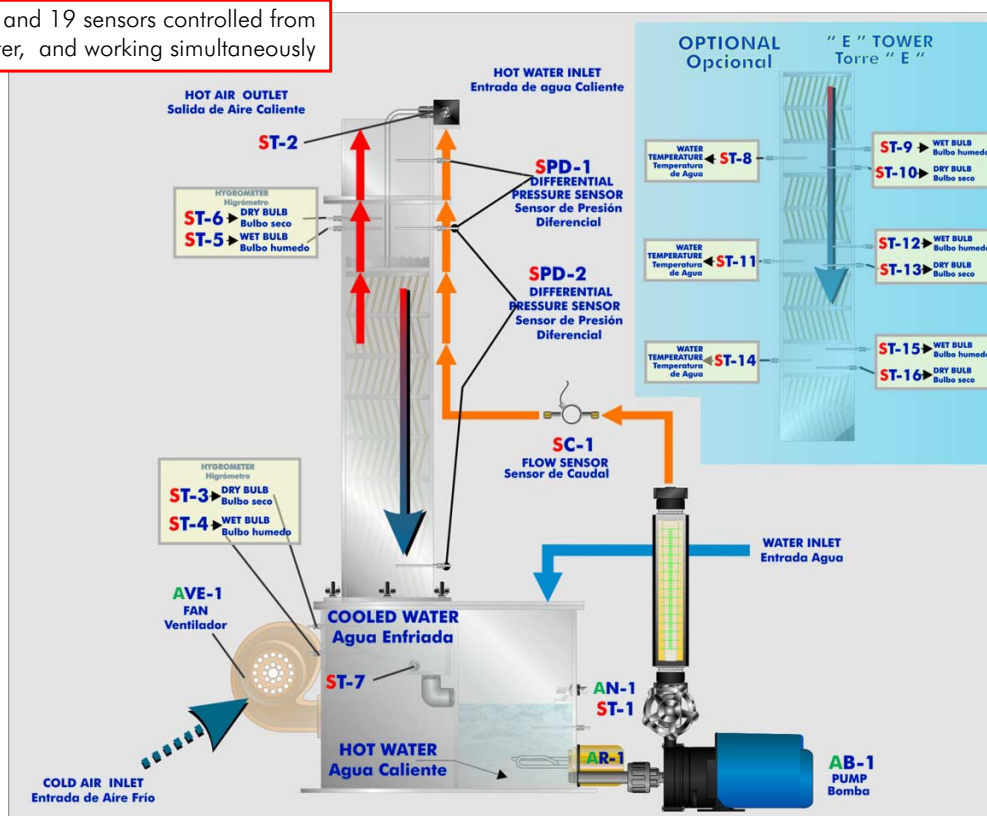


www.edibon.com

Products
Products range
Units
9. -Thermodynamics & Thermotechnics

PROCESS DIAGRAM AND ELEMENTS ALLOCATION

6 actuators and 19 sensors controlled from any computer, and working simultaneously



**OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL**

Note:

SPD=Differential Pressure sensor.

SC=Flow sensor.

ST=Temperature sensor.

AN=Level switch.

AB=Pump

AR=Heater resistance.

DESCRIPTION

The Bench Top Cooling Tower has been perfectly developed to offer to the students the opportunity of appreciate the construction, design and operative characteristics of a modern cooling system by evaporating water. The unit is a good example of "open system" through which two currents of fluids (water and air) flow and where a transfer of matter from one current to the other occurs.

With this unit, the performance of the cooling system will be studied, as well as balances of matter and energy, and the effects of:

- Volume of air flowing.
- Volume of water flowing.
- Water temperature.
- Cooling load.

Packing density. For this last study it is necessary to have at least several types of columns with different packing factors at one's disposal.

This computer controlled unit is supplied with the EDIBON Computer Control System (SCADA), including: a Control Interface Box + a Data Acquisition Board + a Computer Control and Data Acquisition Software, for controlling the process and the parameters involved.

SPECIFICATIONS

Items supplied as standard

① TTEC. Unit:

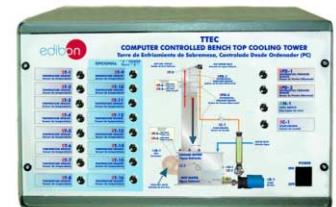
- Bench top unit.
- Anodized aluminium structure.
- Panels and main metallic elements in stainless steel.
- Diagram in the front panel with similar distribution that the elements in the real unit.
- Water propeller pump, maximum flow of water of 120 l./h. - 2 l./min.
- Air propeller with a fan speed computer controlled (145 m³/h max., 3000 rpm).
- Heater resistance (60° C. max.), computer controlled.
- Water tank (14 l. capacity), with water level gauge.
- On/Off level switch for filling the tank.
- Solenoid valves.
- Flow sensor.
- 2 Differential pressure sensors, range: 0 - 1" H₂O.
- Up to 16 Temperature sensors type "J" (of wet bulb, dry bulb and water temperature), according to the column supplied. Range: -60°C to 200°C.
- Column type B: N° of levels: 8. N° of sheets by level: 10. Total surface: 1.013 m². Height of packaging: 650mm. Density Area/volume: 58 m²/m³.
- Optional Columns: (not included in the standard supply)
 - Column type A: N° of levels: 8. N° of sheets by level: 19. Total surface: 1.915 m². Height of packaging: 650 mm. Density Area/volume: 112.64 m²/m³.
 - Column type C: N° of levels: 8. N° of sheets by level: 7. Total surface: 0.680 m². Height of packaging: 650 mm. Density Area/volume: 40.02 m²/m³.
 - Column type D: No packaging.
 - Column type E: (Packing characteristics column): with packing arranged to allow measurement of air and water properties within column. Fitted with temperature sensors in 3 points. Sensors: 7 temperature sensors of Dry Bulb, 7 temperature sensors of Wet Bulb and 3 water temperature sensors.
 - N° of levels: 8. N° of sheets by level: 19. Height of column: 1100mm. Height of packaging: 650 mm. Density Area/volume: 112.64 m²/m³.



TTEC. Unit

② TTEC/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 PID control with flexibility of modifications from the computer keyboard of the PID parameters, at any moment during the process. Real time PID and on/off control for pumps, compressors, resistances, control valves, etc. Real time PID control for parameters involved in the process simultaneously. Proportional control, integral control and derivative control, based on the real PID mathematical formula, by changing the values, at any time, of the three control constants (proportional, integral and derivative constants).
- Open control allowing modifications, at any time and in a real time, of parameters involved in the process simultaneously. Possibility of automatization of the actuators involved in the process.
- Three safety levels, one mechanical in the unit, other electronic in control interface and the third one in the control software.



TTEC/CIB

③ DAB. Data Acquisition Board:

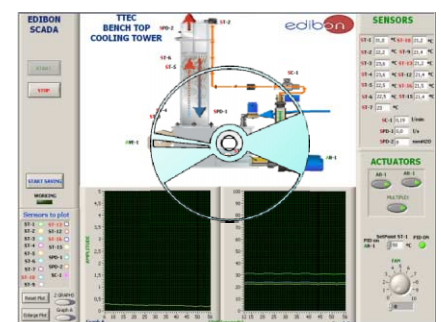
- PCI Data acquisition board (National Instruments) to be placed in a computer slot. Bus PCI.
- Analog input:
 - Number of channels= 16 single-ended or 8 differential. Resolution= 16 bits, 1 in 65536.
 - Sampling rate up to: 250 KS/s (Kilo samples per second).
 - Input range (V) = ±10V. Data transfers=DMA,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



DAB

④ TTEC/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.
- Analog and digital PID control. Menu for PID and set point selection required in the whole work range.
- 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 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.



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

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 VDC).

Relay output: 14 (250 VA 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).

⑧ TTEC/PLC-SOF. PLC Control Software:

For this particular unit, always included with PLC supply.



PLC-PI

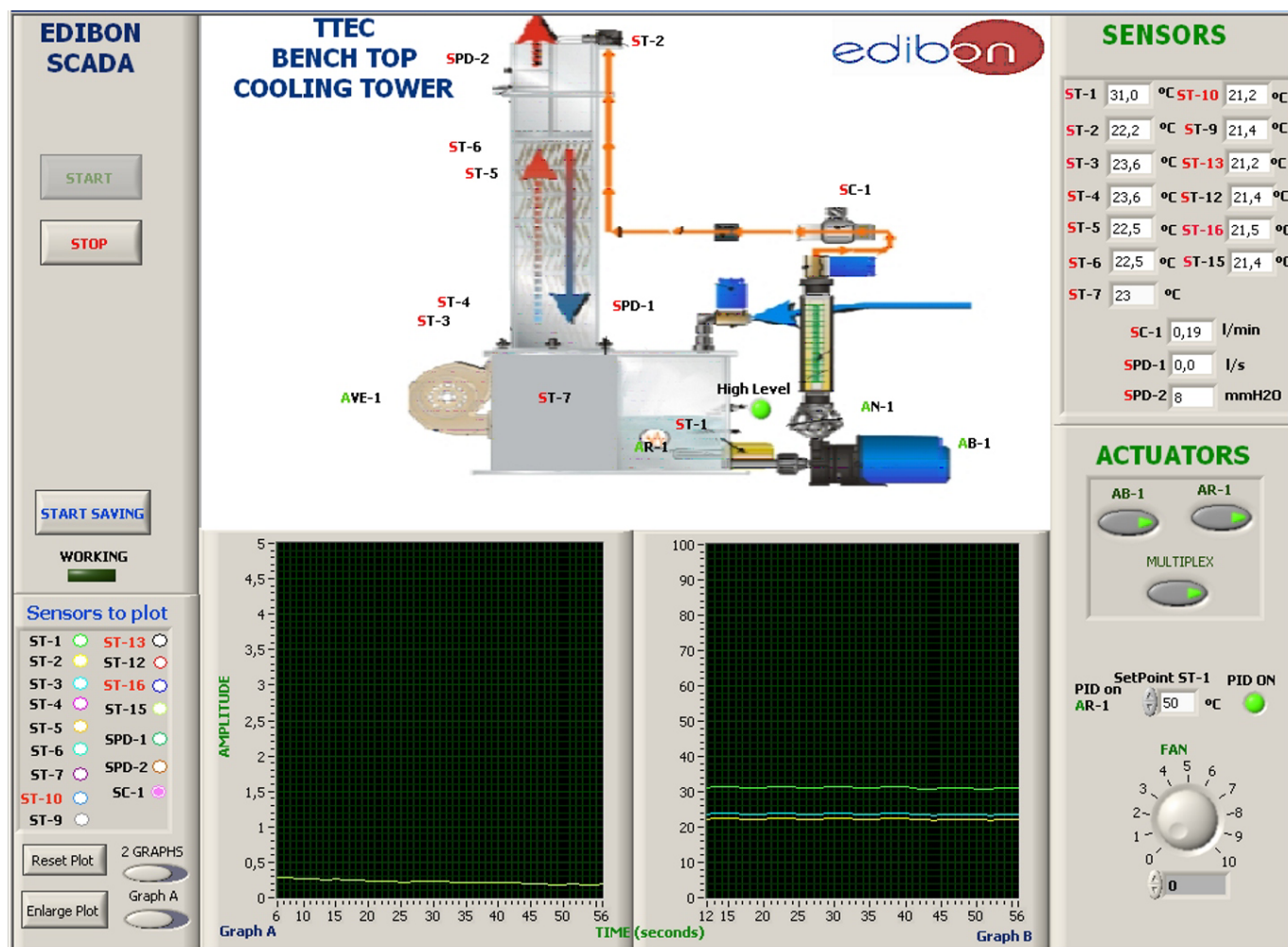
Items available on request

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

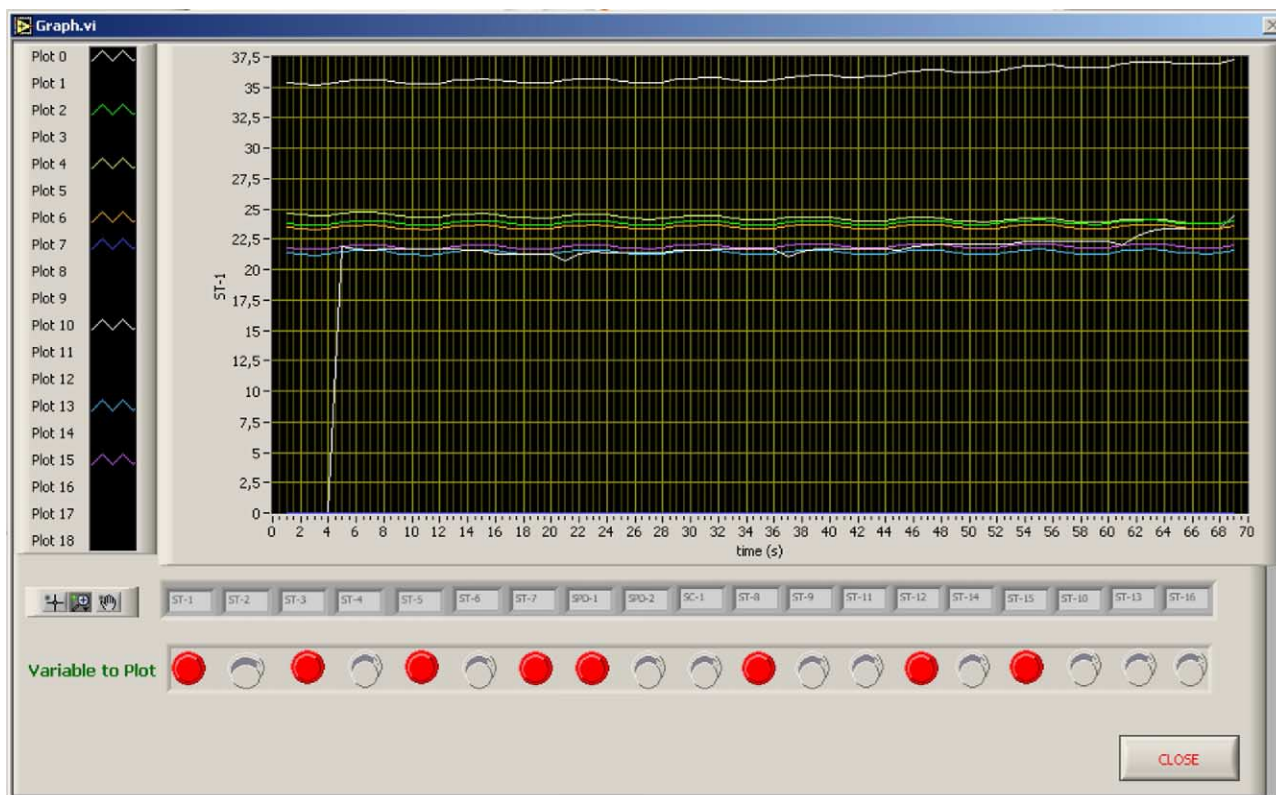
⑩ TTEC/FSS. Faults Simulation System.

Software Main Screens

Main screen



Note: ST= Temperature sensor. SPD=Differential pressure sensor. SC=Flow sensor. AVS=Solenoid valve. AR= Heater resistance. AB=Pump. AVE=Fan.



Continue...

Software Main Screens (continuation)

Examples of Sensors Calibration screens

Restore Factory Settings

Analog Input Channel SC-1

Sensor Name SC-1

Least Squares Fit

Gain 0,543297
Offset -0,074266

PTA 10

Volts 0,2859
Calibrated 0,08108

ENTER

DONE

ACTUATORS

AR-1 ☐

AB-1 ☐

MULTIPLEX ☐

FAN

4 5 6
3 7
2 8
1 9
0 10

0

Simultaneous

Reference Value 0
Data taken 0

Reference Select

| Sensors | Volt | Calibrated | AT |
|--|--------|------------|------|
| <input type="checkbox"/> ST-1 | 0,2326 | 5,6364 | 5,64 |
| <input type="checkbox"/> ST-2 | 0,2171 | 5,0818 | 5,08 |
| <input type="checkbox"/> ST-3 | 0,2217 | 5,1681 | 5,17 |
| <input type="checkbox"/> ST-4 | 0,2359 | 5,7223 | 5,72 |
| <input type="checkbox"/> ST-5 | 0,2315 | 5,6076 | 5,61 |
| <input checked="" type="checkbox"/> PH-1 | 1,266 | 8,6189 | 8,62 |
| <input type="checkbox"/> PH-2 | 1,2372 | 8,3103 | 8,31 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-1 | 0 | 0 | 0 |
| <input type="checkbox"/> ST-2 | 0 | 0 | 0 |

☐ Select all
-1

GAIN

| | GAIN | OFFSET | r |
|------|----------|---------|---|
| ST-1 | 95,424 | 2,0422 | 0 |
| ST-2 | 96,3041 | 2,4978 | 0 |
| ST-3 | 95,137 | 2,226 | 0 |
| ST-4 | 95,8529 | 1,6402 | 0 |
| ST-5 | 95,5404 | 2,1131 | 0 |
| PH-1 | -7,84547 | 16,7403 | 0 |
| PH-2 | -7,91359 | 16,5076 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-1 | 0 | 0 | 0 |
| ST-2 | 0 | 0 | 0 |

AR-1 ☐

AB-1 ☐

AB-2 ☐

AB-3 ☐

ENTER

DONE

Polynomial FIT nonlinear ☐

EXERCISES AND PRACTICAL POSSIBILITIES

Some Practical Possibilities of the Unit:

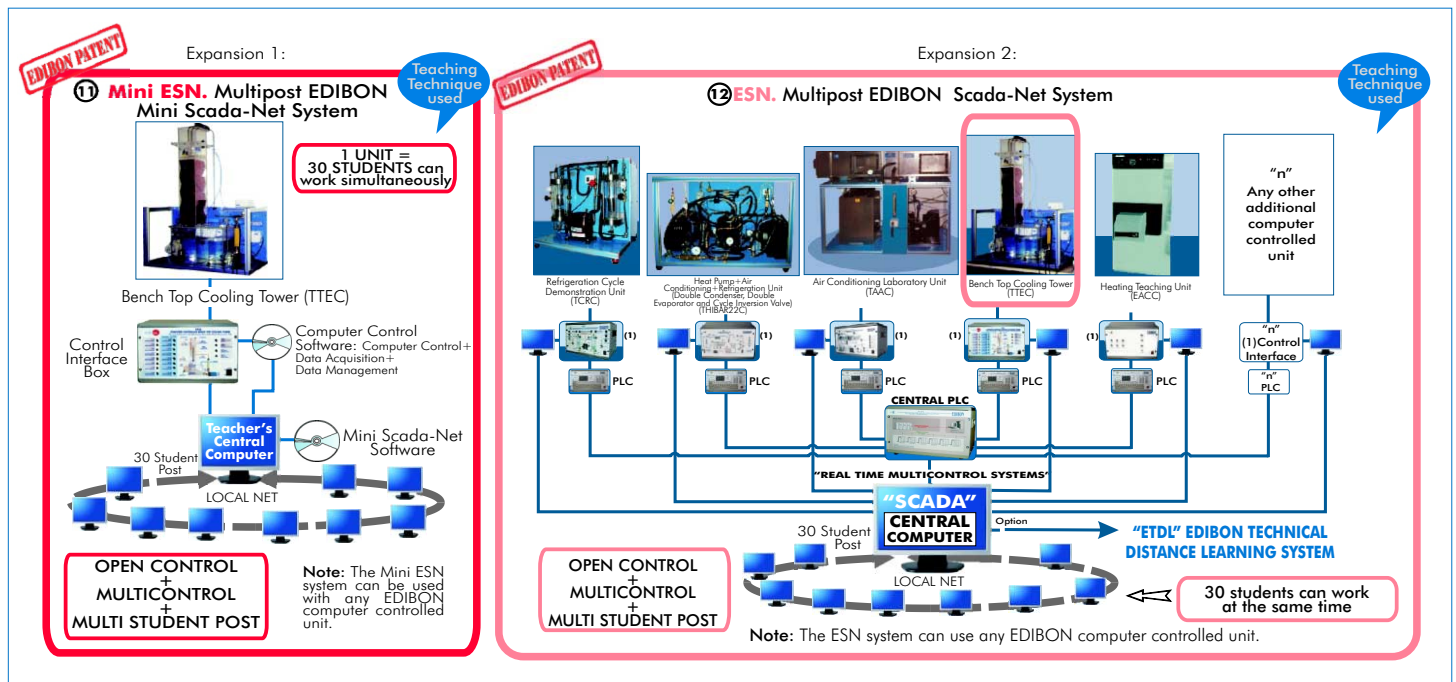
- 1.- Process observation inside a bench top cooling tower.
 - 2.- Determination of evaporation velocity.
 - 3.- Mass balance. Use of psychrometric charts.
 - 4.- Energy balance.
 - 5.- Effect of cooling load against "Wet bulb approach".
 - 6.- Relation between air velocity, wet bulb approach and head loss.
 - 7.- Determination of the cooling capacity.
 - 8.- Determination of the cooling capacity for different cooling towers.
 - 9.- Thermodynamic properties.
 - 10.- Evaporation from a wet bed.
 - 11.- Observation of water flow pattern and distribution.
 - 12.- Control system: Temperature sensors calibration.
 - 13.- Control system: PID temperature control.
 - 14.- Control system: Flow sensors calibration.
 - 15.- Study of flow sensor hysteresis.
 - 16.- Control system: Determination of adjustment parameters of a PWM controller.
 - 17.- Differential pressure sensors calibration.
- Other possible practices:
- 18.- Variation of specific enthalpy with pressure.
 - 19.- Properties of air.
 - 20.- Use of a psychrometric map.
 - 21.- Determination of water flow.

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

- 22.- Control of the TTEC unit process through the control interface box without the computer.

- 23.- Visualization of all the sensors values used in the TTEC unit process.
- 24.- Calibration of all sensors included in the TTEC unit process.
- 25.- Hand on of all the actuators involved in the TTEC unit process.
- 26.- Realization of different experiments, in automatic way, without having in front the unit. (This experiment can be decided previously).
- 27.- 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).
- 28.- PLC hardware general use and manipulation.
- 29.- PLC process application for TTEC unit.
- 30.- PLC structure.
- 31.- PLC inputs and outputs configuration.
- 32.- PLC configuration possibilities.
- 33.- PLC program languages.
- 34.- PLC different programming standard languages (ladder structured, graphic, etc.).
- 35.- New configuration and development of new process.
- 36.- Hand on an established process.
- 37.- To visualize and see the results and to make comparisons with the TTEC unit process.
- 38.- Possibility of creating new process in relation with the TTEC unit.
- 39.- PLC Programming Exercises.
- 40.- 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: TTEC. Bench Top Cooling Tower. (It includes Column type "B").
- ② TTEC/CIB. Control Interface Box.
- ③ DAB. Data Acquisition Board.
- ④ TTEC/CCSOF. Computer Control + Data Acquisition + Data Management Software.
- ⑤ Cables and Accessories, for normal operation.
- ⑥ Manuals.

***IMPORTANT:** Under TTEC 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 TTEC/PLC-SOF. PLC Control Software.
- ⑨ TTEC/CAL. Computer Aided Learning Software (Results Calculation and Analysis). (Available on request).
- ⑩ TTEC/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: 220V./50 Hz or 110 V. /60 Hz.
- Water supply.
- Computer (PC).

DIMENSIONS & WEIGHTS

- TTEC Unit: -Dimensions: 1000x450x1400 mm. approx.
 -Weight : 100 Kg. approx.
- Control Interface Box: -Dimensions: 490x330x310 mm. approx.
 -Weight: 10 Kg. approx.
- PLC Module (PLC-PI): -Dimensions: 490x330x310 mm. approx.
 -Weight: 30 Kg. approx.

OPTIONAL COLUMNS

Column type A:

- Nº of levels: 8
- Nº of sheets by level: 19
- Total surface: 1.915 m²
- Height of packaging: 650 mm
- Density Area/volume: 112.64 m²/m³



Column type C:

- Nº of levels: 8
- Nº of sheets by level: 7
- Total surface: 0.680m²
- Height of packaging: 650 mm
- Density Area/volume: 40.02 m²/m³



Column type D:

- No packaging.



Column type E

(Packing characteristics column):
 with packing arranged to allow measurement of air and water properties within column. Fitted with temperature sensors in 3 points.

Sensors:

- 7 Temperature sensor of Dry Bulb.
- 7 Temperature sensors of Wet Bulb.
- 3 Water temperature sensors.

- Nº of levels: 8
- Nº of sheets by levels: 19
- Height of column: 1100 mm
- Height of packing: 650 mm
- Density Area/volume: 112.64 m²/m³



AVAILABLE VERSIONS

Offered in this catalogue:

-TTEC. **Computer Controlled Bench Top Cooling Tower.**

Offered in other catalogue:

-TTEB. **Bench Top Cooling Tower.**

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



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Issue: ED01/09
 Date: January/2009

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