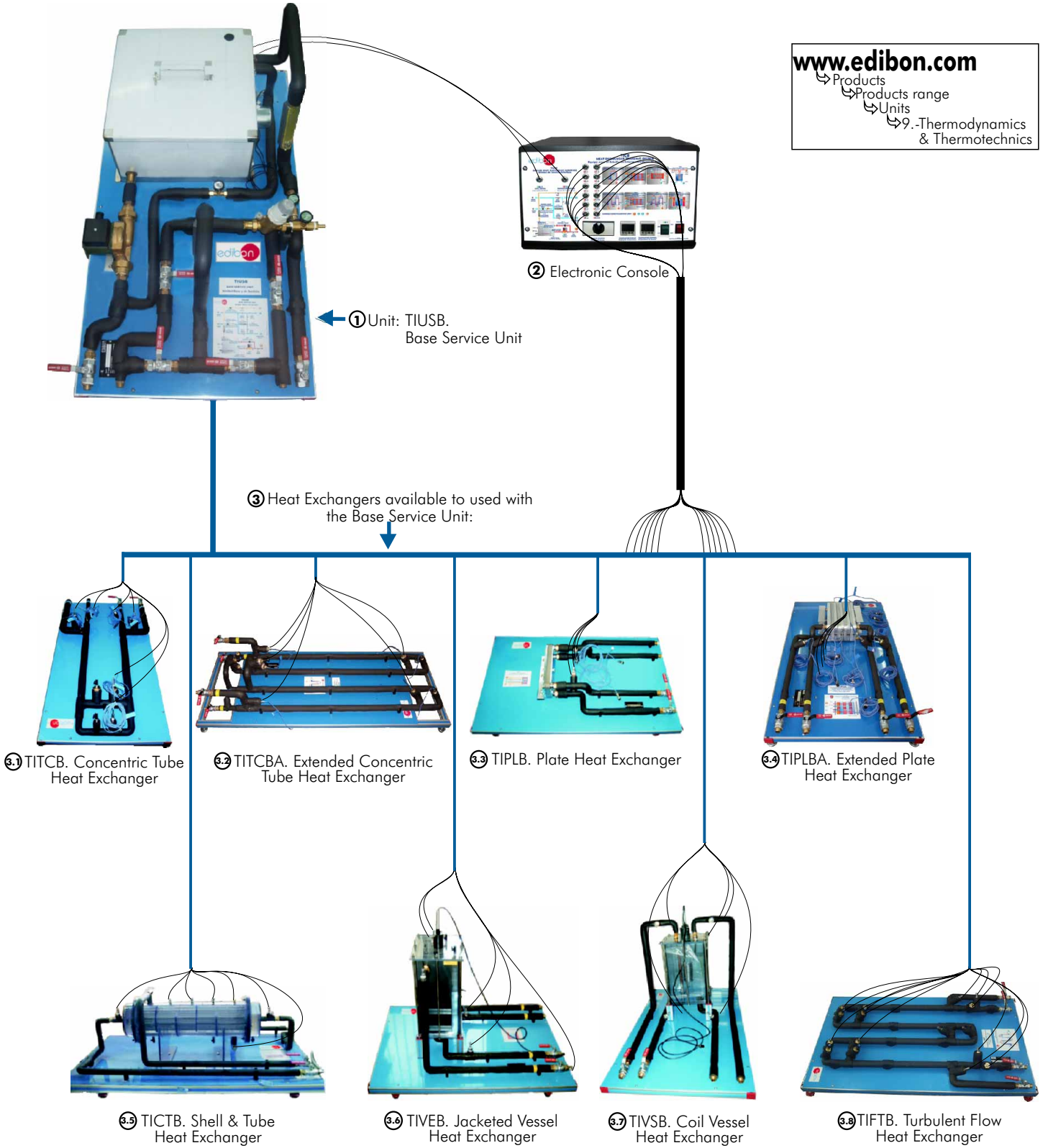
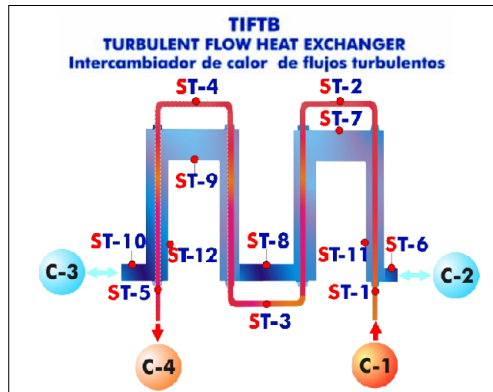
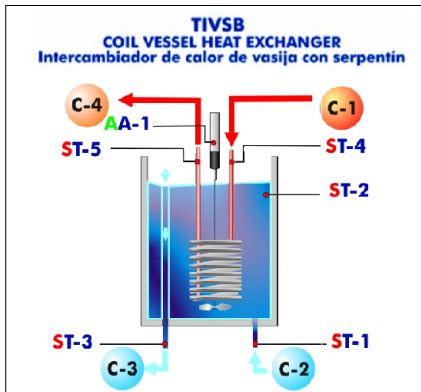
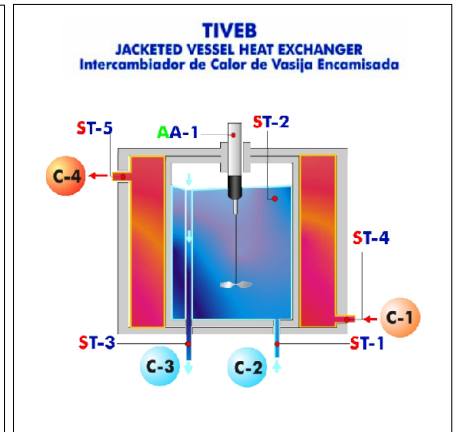
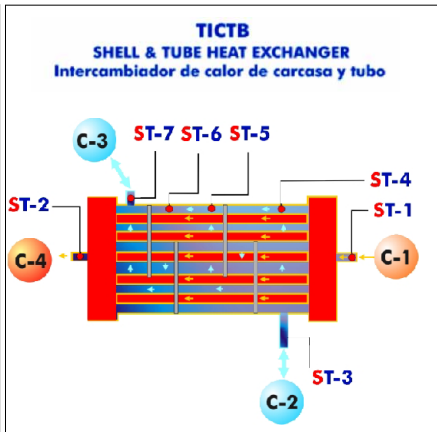
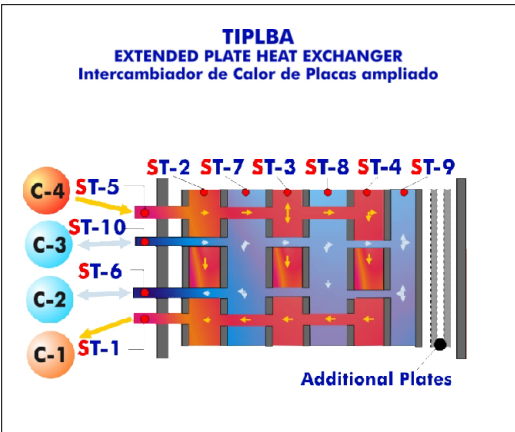
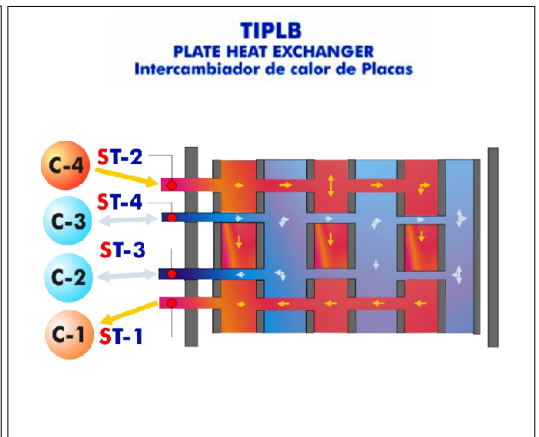
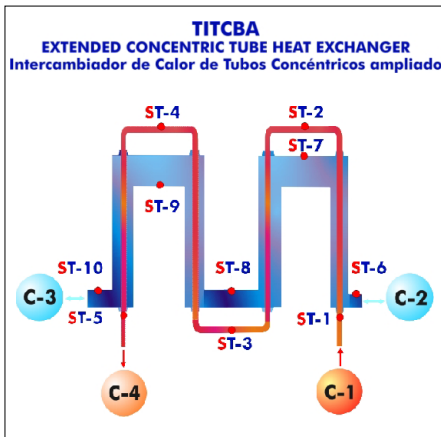
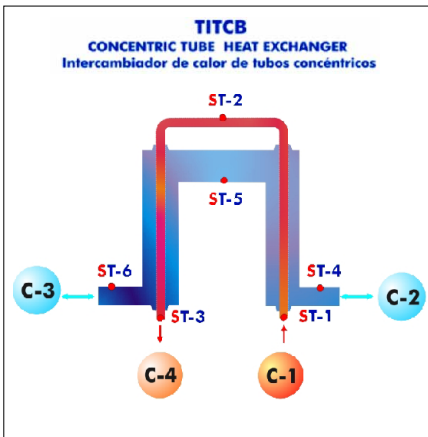
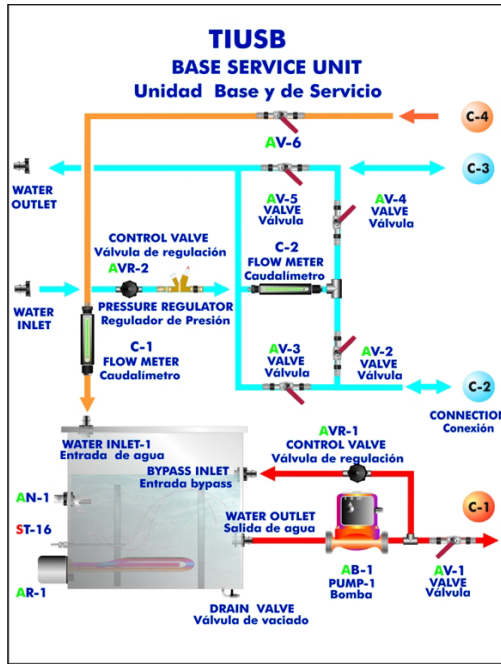


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 ↳ 9. Thermodynamics & Thermotechnics





Note: ST=Temperature sensor. C=Flow meter. AR=Heating resistance. AB=Pump. AA=Stirrer. AN=Level switch. AV=Valve. AVR=Regulation Valve. ©=Connection between Base Service Unit and Exchanger

Common items for Heat Exchangers type "TI..B":

① TIUSB. Base Service Unit:

This unit is common for Heat Exchangers type "TI..B" and can work with one or several exchangers.

This unit performs the following tasks:

- Heating the water.
- Pumping of hot water.
- Change in the direction of cold water flows.
- Cold and hot water measures.

Anodized aluminium structure and panel 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.

Stainless steel tank (30 l.), equipped with:

- Electric heating resistance (3000W) with thermostat (70° C), to heat the water.
- Temperature sensor type "J" to measure the water temperature.
- Level switch to control the water level of the tank.
- Stainless steel cover to avoid the contact with the hot water. In this cover exists an hole to allows us to visualize the water level and even to stuff the tank.
- Draining water valve.

Centrifugal pump. Range: 0 - 3 l. /min.

2 Flow meters, one for hot water and the other for cold water. Range: 0.2 to 2 l./min.

Control valve for the cold water.

4 Ball valves that, depending on how do we manipulate them, they give us parallel or crosscurrent flux in the exchanger.

Regulation pressure valve to avoid the introduction of too much pressure in the exchangers, tared at 0.6 bar.

4 flexible tubes to connect with the different exchangers.

Cables and accessories, for normal operation.



TIUSB

② Electronic Console:

This unit is common for Heat Exchangers type "TI..B" and can work with one or several exchangers.

Metallic box.

Temperature sensors connections.

Digital display for temperature sensors.

Selector for temperature sensors.

Level switch connector.

Heating resistance control (temperature control).

Heating resistance connection.

Pump switch.

Pump connection.

Main switch.



Electronic Console

③ Heat Exchangers available to be used with the Base Service Unit (TIUSB):

3.1 TITCB. Concentric Tube Heat Exchanger:

This Concentric Tube Heat Exchanger allows the study of heat transfer between hot water flowing through an internal tube and cold water flowing in the ring area lying between the internal and external tubes.

This exchanger allows measuring hot and cold water temperatures in different points of the exchanger.

Anodized aluminium structure and panel 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 exchanger is formed by two concentric copper tubes with hot water circulating through the interior tube and cold water circulating in the ring space.

This exchanger has 2 equal sections of 500 mm each one, where heat transfer takes place.

Exchange length $L = 2 \times 0.5 = 1$ m.

Internal tube:

Internal diameter: $D_{int} = 16 \cdot 10^{-3}$ m. External diameter: $D_{ext} = 18 \cdot 10^{-3}$ m.

Thickness = 10^{-3} m.

Heat transfer internal area: $A_h = 0.0503$ m². Heat transfer external area: $A_c = 0.0565$ m².

External tube:

Internal diameter: $D_{int} = 26 \cdot 10^{-3}$ m. External diameter: $D_{ext} = 28 \cdot 10^{-3}$ m.

Thickness = 10^{-3} m.

6 Temperature sensors ("J" type):

3 Temperature sensors for measuring cold water temperature:

- Cold water inlet.
- Cold water mid-position.
- Cold water outlet.

3 Temperature sensors for measuring hot water temperature:

- Hot water inlet.
- Hot water mid-position.
- Hot water outlet.

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TITCB

3.2 TITCBA. Extended Concentric Tube Heat Exchanger:

This Extended Concentric Tube Heat Exchanger allows the study of heat transfer between hot water flowing through an internal tube and cold water flowing in the ring area lying between the internal and external tubes.

This exchanger allows measuring hot and cold water temperatures in different points of the exchanger.

TITCBA is a more sophisticated unit than TITCB, with four longer tube sections, giving four times the overall heat transfer area and three interim temperature measurement points (temperature sensors) in each fluid stream.

This exchanger has sufficient heat transfer area for demonstrating the typical counter current flow conditions where the outlet of the heated stream is hotter than the outlet of the cooled stream.

Anodized aluminium structure and panel 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 exchanger is formed by two concentric copper tubes with hot water circulating through the interior tube and cold water circulating in the ring space.

This exchanger has 4 equal sections of 1000 mm each one, where heat transfer takes place.

Exchange length: $L = 4 \times 1 = 4$ m.

Internal tube:

Internal diameter: $D_{int} = 16 \cdot 10^{-3}$ m. External diameter: $D_{ext} = 18 \cdot 10^{-3}$ m.

Thickness = 10^{-3} m.

Heat transfer internal area: $A_h = 0.0503$ m². Heat transfer external area: $A_c = 0.0565$ m².

External tube:

Internal diameter: $D_{int} = 26 \cdot 10^{-3}$ m. External diameter: $D_{ext} = 28 \cdot 10^{-3}$ m.

Thickness = 10^{-3} m.

10 Temperature sensors ("J" type):

5 Temperature sensors for measuring cold water temperature:

- Cold water inlet.
- Cold water in different interim positions (3).
- Cold water outlet.

5 Temperature sensors for measuring hot water temperature:

- Hot water inlet.
- Hot water in different interim positions (3).
- Hot water outlet.

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TITCBA

③ Heat Exchangers available to be used with the Base Service Unit (TIUSB): (continuation)

3.3 TIPLB. Plate Heat Exchanger:

This Plate Heat Exchanger allows the study of heat transfer between hot and cold water through alternate canals formed between parallel plates.

The exchanger allows measuring cold and hot temperatures at the inlet and outlet of the exchanger.

Anodized aluminium structure and panel 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.

Formed by corrugated stainless steel plates. This can be dismantled to observe its structure.

4 ports or connections of input and output of hot and cold water.

Maximum flow: 12m³/h.

Maximum work pressure: 10 bar.

Maximum work temperature: 100° C.

Minimum work temperature: 0° C.

Maximum number of plates: 20.

Internal circuit capacity: 0.176 l.

External circuit capacity: 0.22l.

Area: 0.32m².

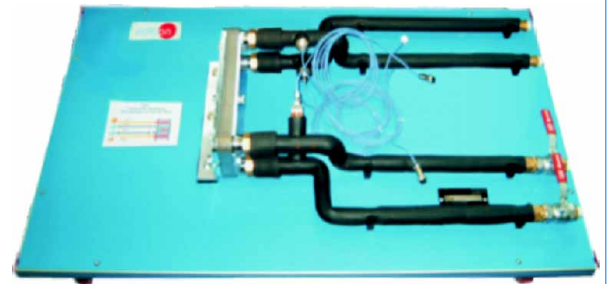
4 Temperature sensors ("J" type):

2 Temperature sensors for measuring cold water temperature (inlet and outlet).

2 Temperature sensors for measuring hot water temperature (inlet and outlet).

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TIPLB

3.4 TIPLBA. Extended Plate Heat Exchanger:

This Extended Plate Heat Exchanger allows the study of heat transfer between hot and cold water through alternate canals formed between parallel plates.

The exchanger allows measuring cold and hot temperatures in different points of the exchanger.

Anodized aluminium structure and panel 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.

Formed by corrugated stainless steel plates. This can be dismantled to observe its structure.

4 ports or connections of input and output of hot and cold water.

Maximum flow: 12m³/h.

Maximum work pressure: 10 bar.

Maximum work temperature: 100° C.

Minimum work temperature: 0° C.

Maximum number of plates: 20.

Internal circuit capacity: 0.176 l.

External circuit capacity: 0.22 l.

Area: 0.32m².

10 Temperature sensors ("J" type):

5 Temperature sensors for measuring cold water temperature (inlet, outlet and interim positions).

5 Temperature sensors for measuring hot water temperature (inlet, outlet and interim positions).

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TIPLBA

③ **Heat Exchangers** available to be used with the Base Service Unit (TIUSB):(continuation)

③.5 **TICTB. Shell & Tube Heat Exchanger:**

It consists of a group of tubes inside the heat exchanger. The hot water flows through the internal tubes and cooling water circulates through the space between the internal tubes and the shell.

There are traverse baffles placed in the shell to guide the cold water maximize the heat transfer.

Anodized aluminium structure and panel 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.

Formed by tubes of stainless steel with hot water circulating in the interior.

4 segmented baffles located transversal in the shell.

Exchange length of the shell and each tube: $L = 0.5\text{m}$

Interior tube (21 tubes):

Internal diameter: $D_{int} = 8 \cdot 10^{-3}\text{ m}$.

External diameter: $D_{ext} = 10 \cdot 10^{-3}\text{ m}$.

Thickness = 10^{-3} m .

Internal heat transfer area: $A_i = 0.0126\text{ m}^2$.

External heat transfer area : $A_c = 0.0157\text{m}^2$.

Shell:

Internal diameter: $D_{int,c} = 0.148\text{ m}$.

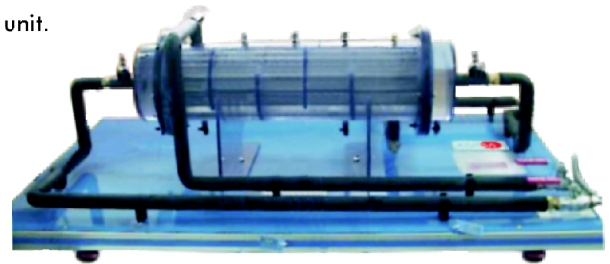
External diameter: $D_{ext,c} = 0.160\text{ m}$.

Thickness = $6 \cdot 10^{-3}\text{ m}$.

7 Temperature sensors ("J" type), for measuring cold and hot water temperatures in different points of the exchanger.

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TICTB

③.6 **TIVEB. Jacketed Vessel Heat Exchanger:**

This Jacketed Vessel Heat Exchanger allows the study of heat transfer between hot water flowing through a jacket and the cold water contained in a vessel.

It can work in continuous supply or in a batch process (heating of a constant mass of water containing in a vessel).

The exchanger allows measuring temperatures at the inlet and outlet of the exchanger in cold as well as in hot water.

Anodized aluminium structure and panel 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.

Constituted of a vessel.

Vessel total volume: 14 l.

Interior vessel volume: 7 l. approx.

Jacket volume: 7 l. approx.

An overflow or a pipe that allows the exit of the water in the vessel through its upper part to maintain a constant flow during the process with continuous supply.

A jacket that surrounds the vessel through where hot water flows.

An electric stirrer with a stirring rod of propeller shape and a turn range between 50 and 300 rpm.

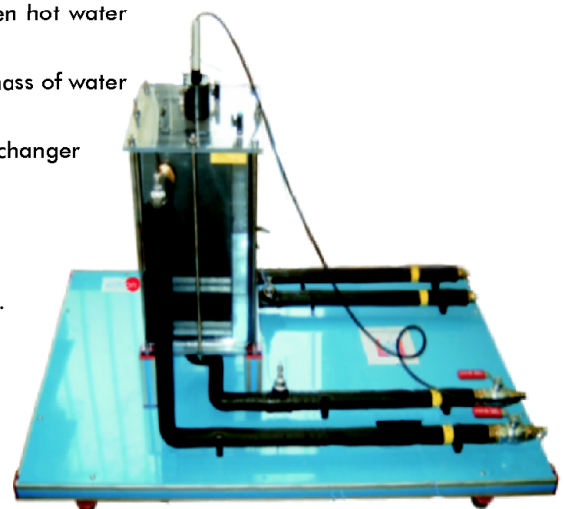
5 Temperature sensors ("J" type):

3 Temperature sensors for measuring cold water temperature.

2 Temperature sensors for measuring hot water temperature.

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TIVEB

③ **Heat Exchangers** available to be used with the Base Service Unit (TIUSB): (continuation)

③.7 **TIVSB. Coil Vessel Heat Exchanger:**

This heat exchanger allows the study of heat transfer between hot water flowing through a coil and cold water contained in the vessel.

It can work in continuous supply or in a batch process.

Anodized aluminium structure and panel 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.

Formed by a pvc-glass vessel, volume: 14 l.

An overflow or pvc-glass tube lets the output of water from the vessel in the upper part in order to maintain the flow constant for continue supply process.

A copper coil where the water circulates:

$$D_{int} = 4.35 \text{ mm. } D_{ext} = 6.35 \text{ mm.}$$

Total longitude of the tube that forms the coil: 5 m.

Total diameter of coil: 0.1 m.

An electric stirrer using a stirring rod forming a propeller and with a turn range between 50 and 300 rpm.

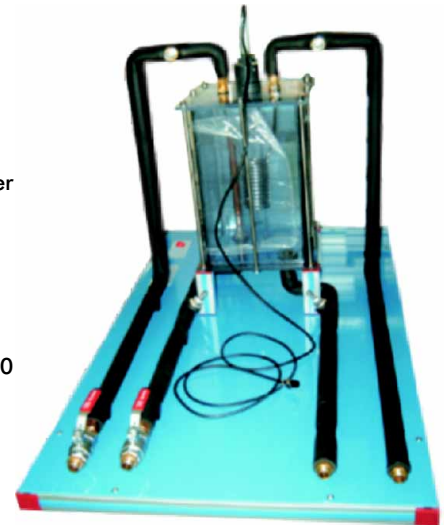
5 Temperature sensors ("J" type):

3 Temperature sensors for measuring the cold water temperature.

2 Temperature sensors for measuring the hot water temperature.

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TIVSB

③.8 **TIFTB. Turbulent Flow Heat Exchanger:**

This Turbulent Flow Heat Exchanger let us the heat transfer study between hot water that circulates through an internal tube and cold water that flows through the annular zone between the internal and the external tubes. This exchanger let us to measure cold water and hot water temperatures in different points of the exchanger.

Anodized aluminium structure and panel 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.

Formed by two copper concentric tubes with hot water circulating through the internal tube and cold water circulating through the annular space.

The exchanger has 4 equal sections of 500 mm each one, where the heat transfer takes place.

Exchange length: $L = 4 \times 0.5 = 2 \text{ m.}$

Internal tube:

Internal diameter: $D_{int} = 8 \cdot 10^{-3} \text{ m.}$

External diameter: $D_{ext} = 10 \cdot 10^{-3} \text{ m.}$

Thickness = 10^{-3} m.

Internal heat transfer area: $A_h = 0.0377 \text{ m}^2.$

External heat transfer area: $A_c = 0.0471 \text{ m}^2.$

External tube:

Internal diameter: $D_{int,c} = 13 \cdot 10^{-3} \text{ m.}$

External diameter: $D_{ext,c} = 15 \cdot 10^{-3} \text{ m.}$

Thickness = 10^{-3} m.

12 Temperature sensors ("J" type):

Cold water temperature sensor at the exchanger inlet or outlet.

Hot water sensor at the exchanger inlet.

Cold water sensor between the first and second stretch of the exchanger.

Hot water sensor between the first and second stretch of the exchanger.

Cold water sensor between the second and third stretch of the exchanger.

Hot water sensor between the second and third stretch of the exchanger.

Cold water sensor between the third and fourth stretch of the exchanger.

Hot water sensor between the third and fourth stretch of the exchanger.

Cold water temperature sensor at the exchanger inlet or outlet.

Hot water sensor at the exchanger outlet.

Temperature sensor of the exterior surface of the interior tube at the exchanger inlet.

Temperature sensor of the exterior surface of the interior tube at the exchanger outlet.

Easy connection with the Base Service Unit.

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.



TIFTB

④ **Cables and accessories**, for normal operation.

⑤ **Manuals:**

This system is supplied with the following manuals for each Heat Exchanger: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance & Practices Manuals.

Some Practical Possibilities of the System:

Practices to be done with the Concentric Tube Heat

Exchanger (TITCB):

- 1.- Global energy balance in the heat exchanger and the study of losses.
- 2.- Exchanger effectiveness determination. NTU Method.
- 3.- Study of the heat transfer under of countercurrent and parallel flow conditions.
- 4.- Flow influence in the heat transfer. Reynolds number calculation.

Practices to be done with the Extended Concentric Tube

Heat Exchanger (TITCBA):

- 5.- Global energy balance in the heat exchanger and the study of losses.
- 6.- Exchanger effectiveness determination. NTU Method.
- 7.- Study of the heat transfer under of countercurrent and parallel flow conditions.
- 8.- Flow influence in the heat transfer. Reynolds number calculation.

Practices to be done with the Plate Heat Exchanger

(TIPLB):

- 9.- Global energy balance in the heat exchanger and the study of losses.
- 10.- Exchanger effectiveness determination. NTU Method.
- 11.- Study of the heat transfer under of countercurrent and parallel flow conditions.
- 12.- Flow influence in the heat transfer. Reynolds number calculation.

Practices to be done with the Extended Plate Heat

Exchanger (TIPLBA):

- 13.- Global energy balance in the heat exchanger and the study of losses.
- 14.- Exchanger effectiveness determination. NTU Method.
- 15.- Study of the heat transfer under of countercurrent and parallel flow conditions.
- 16.- Flow influence in the heat transfer. Reynolds number calculation.

Practices to be done with the Shell & Tube Heat

Exchanger (TICTB):

- 17.- Global energy balance in the heat exchanger and the study of losses.
- 18.- Exchanger effectiveness determination. NTU Method.
- 19.- Study of the heat transfer under of countercurrent and parallel flow conditions.
- 20.- Flow influence in the heat transfer. Reynolds number calculation.

Practices to be done with the Jacketed Vessel Heat

Exchanger (TIVEB):

- 21.- Global balance of energy in the heat exchanger and losses study.
- 22.- Determination of the exchanger effectiveness. NTU Method.
- 23.- Influence of the flow in the heat transfer. Calculation of the number of Reynolds.
- 24.- Influence of the stirring of the vessel on the heat transfer when operating in batches.
- 25.- Influence of the vessel's water volume on the heat transfer when operating in batches.

Practices to be done with the Coil Vessel Heat

Exchanger (TIVSB):

- 26.- Global balance of energy in the heat exchanger and the study of losses.
- 27.- Determination of the exchanger effectiveness. NTU Method.
- 28.- Influence of the flow in the heating transfer. Calculation of Reynolds number.
- 29.- Influence of the stirring vessel in the heat transfer with operation in batches.
- 30.- Influence of the water volume in the vessel about the heat transfer with operation in batches.

Practices to be done with the Turbulent Flow Heat

Exchanger (TIFTB):

- 31.- Global energy balance in the heat exchanger and losses study.
- 32.- Determination of the exchanger effectiveness. NTU Method.
- 33.- Study of the heat transfer in crosscurrent and parallel flow conditions.
- 34.- Flow influence in heat transfer. Reynolds number calculation.
- 35.- Obtaining of the correlation that relates Nusselt number with Reynolds number and Prandtl number.
- 36.- Obtaining of the heat transfer coefficients by convection.

ORDER INFORMATION

Items always supplied as minimum configuration

Common items for Heat Exchangers type "TI..B":

- ① TIUSB. **Base Service Unit.** (Common for Heat Exchangers type "TI..B" and can work with one or several exchangers).
- ② **Electronic Console.** (Common for Heat Exchangers type "TI..B" and can work with one or several exchangers).

③ Heat Exchangers available to be used with the Base and Service Unit (TIUSB):

- ③.1 TITCB. **Concentric Tube Heat Exchanger**, and / or
 - ③.2 TITCBA. **Extended Concentric Tube Heat Exchanger**, and / or
 - ③.3 TIPLB. **Plate Heat Exchanger**, and / or
 - ③.4 TIPLBA. **Extended Plate Heat Exchanger**, and / or
 - ③.5 TICTB. **Shell & Tube Heat Exchanger**, and / or
 - ③.6 TIVEB. **Jacketed Vessel Heat Exchanger**, and / or
 - ③.7 TIVSB. **Coil Vessel Heat Exchanger**, and / or
 - ③.8 TIFTB. **Turbulent Flow Heat Exchanger.**
- ④ **Cables and Accessories**, for normal operation.
 - ⑤ **Manuals.**

REQUIRED SERVICES

- Electrical supply: single-phase 220 V. 50Hz or 110V. 60 Hz.
- Water supply (0 to 6l./min. approx).
- Drainage.

DIMENSIONS & WEIGHTS

TIUSB Unit:	-Dimensions: 1100 x 630 x 500 mm. approx. -Weight: 50 Kg. approx.
TITCB Unit:	-Dimensions: 1100 x 630 x 320 mm. approx. -Weight: 20 Kg. approx.
TITCBA Unit:	-Dimensions: 1500 x 700 x 320 mm. approx. -Weight: 30 Kg. approx.
TIPLB Unit:	-Dimensions: 1100 x 630 x 320 mm. approx. -Weight: 20 Kg. approx.
TIPLBA Unit:	-Dimensions: 1200 x 700 x 320 mm. approx. -Weight: 25 Kg. approx.
TICTB Unit:	-Dimensions: 1100 x 630 x 400 mm. approx. -Weight: 30 Kg. approx.
TIVEB Unit:	-Dimensions: 1100 x 630 x 700 mm. approx. -Weight: 35 Kg. approx.
TIVSB Unit:	-Dimensions: 1100 x 630 x 700 mm. approx. -Weight: 30 Kg. approx.
TIFTB Unit:	-Dimensions: 1100 x 630 x 350 mm. approx. -Weight: 20 Kg. approx.
Electronic Console:	-Dimensions: 490 x 330 x 310 mm. approx. -Weight: 10 Kg. approx.

AVAILABLE VERSIONS

Offered in this catalogue:

-TICB. **Heat Exchangers Training System.**

Offered in other catalogue:

-TICC. **Computer Controlled Heat Exchangers Training System.**

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



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REPRESENTATIVE: