TC 01.1 - HEAT EXCHANGER SUPPLY UNIT

The TC 01.1 equipment is the core of the whole heat exchanger. TC 01.1 is the module that provides hot and cold water to the heat exchangers, in addition to measuring the temperatures and flow rates for each device.

All connections are fast and self-sealant, allowing a quick and simple replacement of exchangers without any loss of fluid. The connections for hot and cold water are clearly differentiated to avoid mistakes.

The unit has a tank for hot water with 4,5 litre capacity, as well as electronic controllers both of temperature and water level. The water storage system is protected against overheating, low water level and overflowing.

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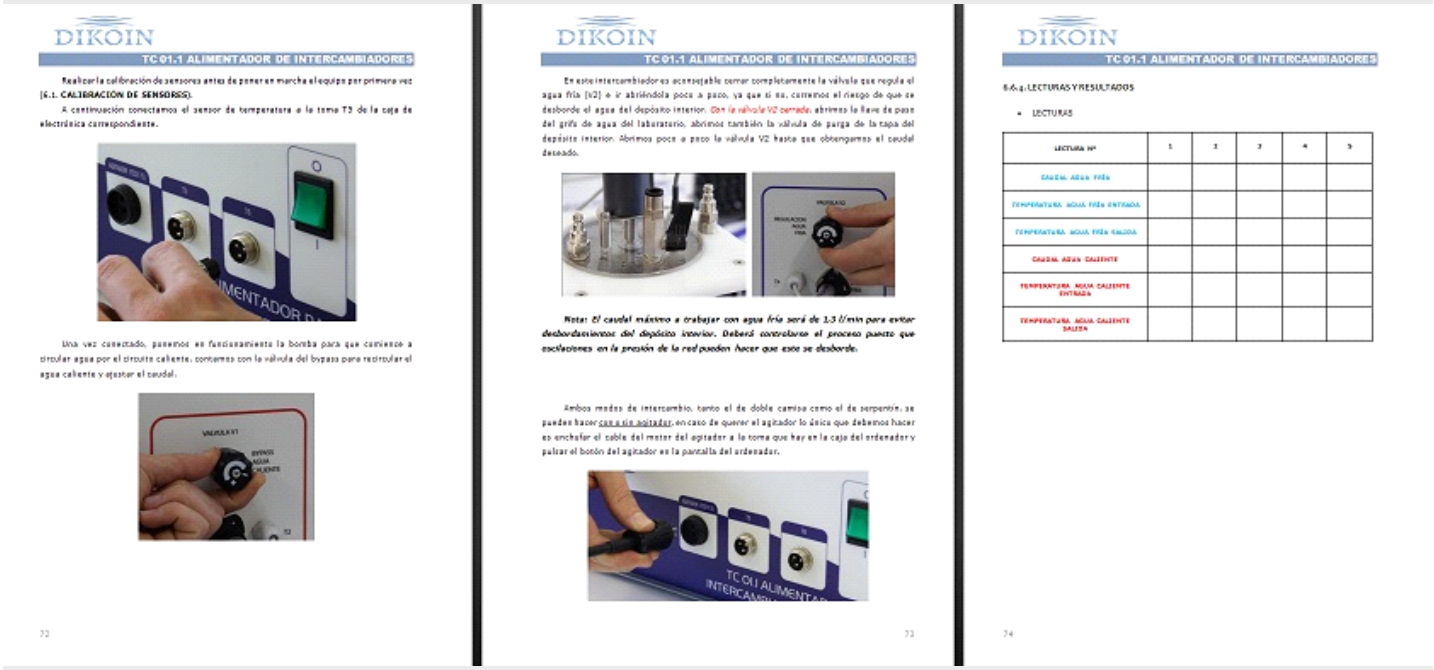

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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

Realizar la calibración de sensores antes de poner en marcha el equipo por primera vez

6.1. CALIBRACIÓN DE SENSORES.

A continuación conectamos el sensor de temperatura a la toma T3 de la caja de electrónica correspondiente.

Una vez conectado, ponemos en funcionamiento la bomba para que comience a circular agua por el circuito caliente, contamos con la válvula del bypass para recircular el agua caliente y ajustar el caudal.

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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

En este intercambiador es aconsejable cerrar completamente la válvula que regula el agua fría (V2) e ir abriéndola poco a poco, ya que si no, corremos el riesgo de que se desborde el agua del depósito interior. *Con la válvula V2 cerrada*, abrimos la llave de paso del grifo de agua del laboratorio, abrimos también la válvula de purga de la tapa del depósito interior. Abrimos poco a poco la válvula V2 hasta que obtengamos el caudal deseado.

Nota: El caudal máximo a trabajar con agua fría será de 1.3 l/min para evitar desbordamientos del depósito interior. Deberá controlarse el proceso puesto que oscilaciones en la presión de la red pueden hacer que este se desborde.

Ambos modos de intercambio, tanto el de doble camisa como el de serpentín, se pueden hacer con o sin agitador, en caso de querer el agitador lo única que debemos hacer es enchufar el cable del motor del agitador a la toma que hay en la caja del ordenador y pulsar el botón del agitador en la pantalla del ordenador.

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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

6.6.4. LECTURAS Y RESULTADOS

- LECTURAS

LECTURA Nº	1	2	3	4	5
CAUDAL AGUA FRÍA					
TEMPERATURA AGUA FRÍA ENTRADA					
TEMPERATURA AGUA FRÍA SALIDA					
CAUDAL AGUA CALIENTE					
TEMPERATURA AGUA CALIENTE ENTRADA					
TEMPERATURA AGUA CALIENTE SALIDA					

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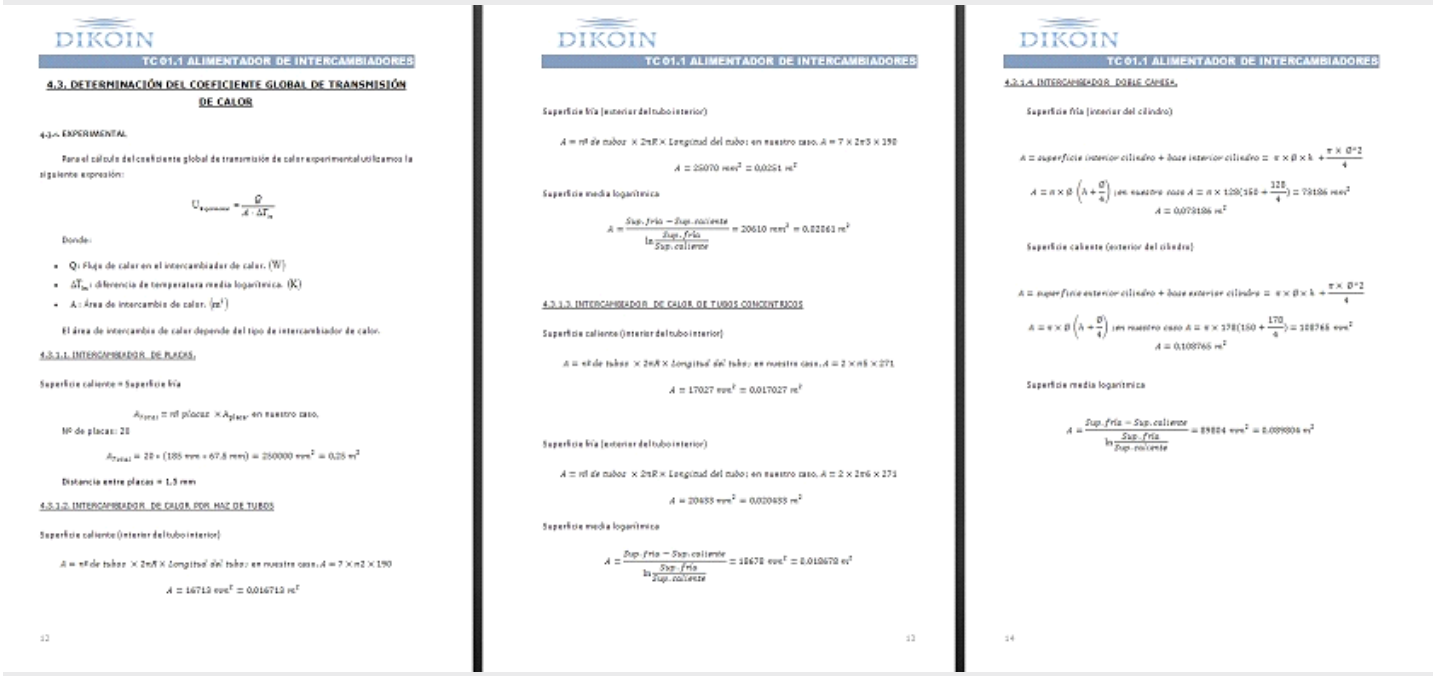
The manual shows clearly and with a lot of images, the hole process to operate the equipment.



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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

4.3. DETERMINACIÓN DEL COEFICIENTE GLOBAL DE TRANSMISIÓN DE CALOR

4.3.A. EXPERIMENTAL

Para el cálculo del coeficiente global de transmisión de calor experimental utilizamos la siguiente expresión:

$$U_{experimental} = \frac{Q}{A \cdot \Delta T_m}$$

Donde:

- Q: Flujo de calor en el intercambiador de calor. (W)
- ΔT_m: diferencia de temperatura media logarítmica. (K)
- A: Área de intercambio de calor. (m^2)

El área de intercambio de calor depende del tipo de intercambiador de calor.

4.3.1.1. INTERCAMBIADOR DE PLACAS.

Superficie caliente = Superficie fría

A_{total} = nº placas $\times A_{placa}$ en nuestro caso.

Nº de placas: 28

$$A_{total} = 28 \times (185\ mm \times 67.8\ mm) = 250000\ mm^2 = 0.25\ m^2$$

Distancia entre placas = 1.3 mm

4.3.1.2. INTERCAMBIADOR DE CALOR POR HAZ DE TUBOS

Superficie caliente (interior del tubo interior)

A = nº de tubos $\times 2\pi R \times$ Longitud del tubo; en nuestro caso. $A = 7 \times \pi 2 \times 190$

$$A = 16713\ mm^2 = 0.016713\ m^2$$

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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

Superficie fría (exterior del tubo interior)

A = nº de tubos $\times 2\pi R \times$ Longitud del tubo; en nuestro caso. $A = 7 \times 2\pi 5 \times 190$

$$A = 25070\ mm^2 = 0.0251\ m^2$$

Superficie media logarítmica

$$A = \frac{Sup.\ frío - Sup.\ caliente}{\ln \frac{Sup.\ frío}{Sup.\ caliente}} = 20610\ mm^2 = 0.02061\ m^2$$

4.3.1.3. INTERCAMBIADOR DE CALOR DE TUBOS CONCENTRICOS

Superficie caliente (interior del tubo interior)

A = nº de tubos $\times 2\pi R \times$ Longitud del tubo; en nuestro caso. $A = 2 \times \pi 5 \times 271$

$$A = 17027\ mm^2 = 0.017027\ m^2$$

Superficie fría (exterior del tubo interior)

A = nº de tubos $\times 2\pi R \times$ Longitud del tubo; en nuestro caso. $A = 2 \times 2\pi 6 \times 271$

$$A = 20433\ mm^2 = 0.020433\ m^2$$

Superficie media logarítmica

$$A = \frac{Sup.\ frío - Sup.\ caliente}{\ln \frac{Sup.\ frío}{Sup.\ caliente}} = 18678\ mm^2 = 0.018678\ m^2$$

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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

4.2.1.4. INTERCAMBIADOR DOBLE CAMISA.

Superficie fría (interior del cilindro)

$$A = superficie\ interior\ cilindro + base\ interior\ cilindro = \pi \times \emptyset \times h + \frac{\pi \times \emptyset^2}{4}$$

$$A = \pi \times \emptyset \left(h + \frac{\emptyset}{4}\right) \text{ en nuestro caso } A = \pi \times 120(150 + \frac{120}{4}) = 73186\ mm^2$$

$$A = 0.073186\ m^2$$

Superficie caliente (exterior del cilindro)

$$A = superficie\ exterior\ cilindro + base\ exterior\ cilindro = \pi \times \emptyset \times h + \frac{\pi \times \emptyset^2}{4}$$

$$A = \pi \times \emptyset \left(h + \frac{\emptyset}{4}\right) \text{ en nuestro caso } A = \pi \times 178(150 + \frac{170}{4}) = 108766\ mm^2$$

$$A = 0.108765\ m^2$$

Superficie media logarítmica

$$A = \frac{Sup.\ fría - Sup.\ caliente}{\ln \frac{Sup.\ fría}{Sup.\ caliente}} = 89884\ mm^2 = 0.0898804\ m^2$$

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The instruction manual explains and shows all the theoretical foundations, as well as all the mathematic expressions used during the experimentation.

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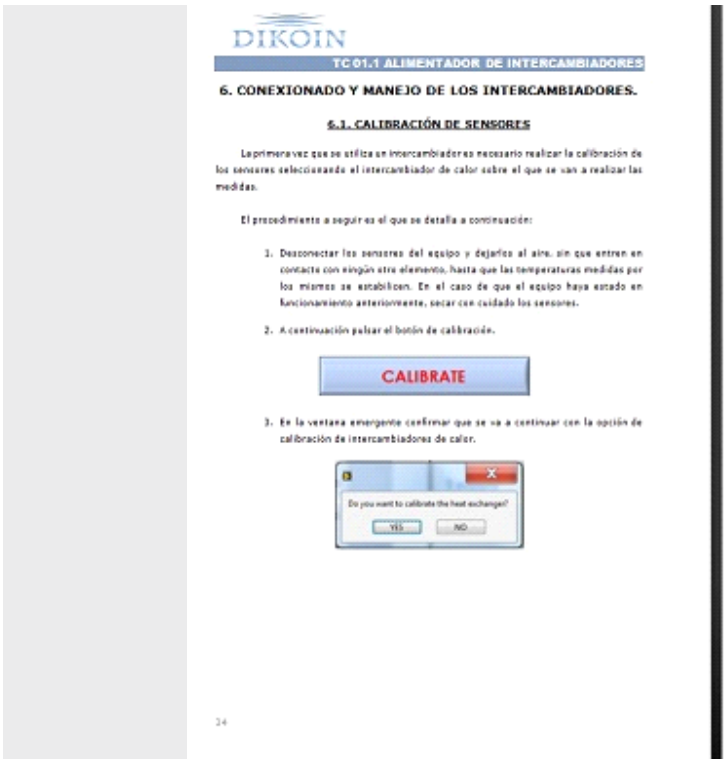

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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

6. CONEXIONADO Y MANEJO DE LOS INTERCAMBIADORES.

6.1. CALIBRACIÓN DE SENSORES

La primera vez que se utiliza un intercambiador es necesario realizar la calibración de los sensores seleccionando el intercambiador de calor sobre el que se van a realizar las medidas.

El procedimiento a seguir es el que se detalla a continuación:

1. Desconectar los sensores del equipo y dejarlos al aire, sin que entren en contacto con ningún otro elemento, hasta que las temperaturas medidas por los mismos se estabilicen. En el caso de que el equipo haya estado en funcionamiento anteriormente, secar con cuidado los sensores.
2. A continuación pulsar el botón de calibración.

3. En la ventana emergente confirmar que se va a continuar con la opción de calibración de intercambiadores de calor.

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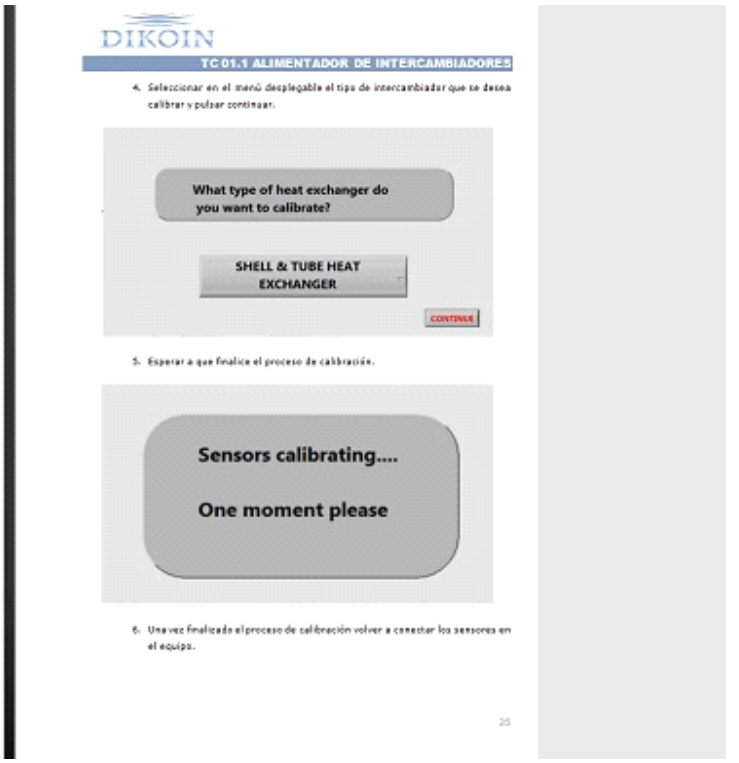

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TC 01.1 ALIMENTADOR DE INTERCAMBIADORES

4. Seleccionar en el menú desplegable el tipo de intercambiador que se desea calibrar y pulsar continuar.

5. Esperar a que finalice el proceso de calibración.

6. Una vez finalizado el proceso de calibración volver a conectar los sensores en el equipo.

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The equipment has an automatic sensor calibration system.

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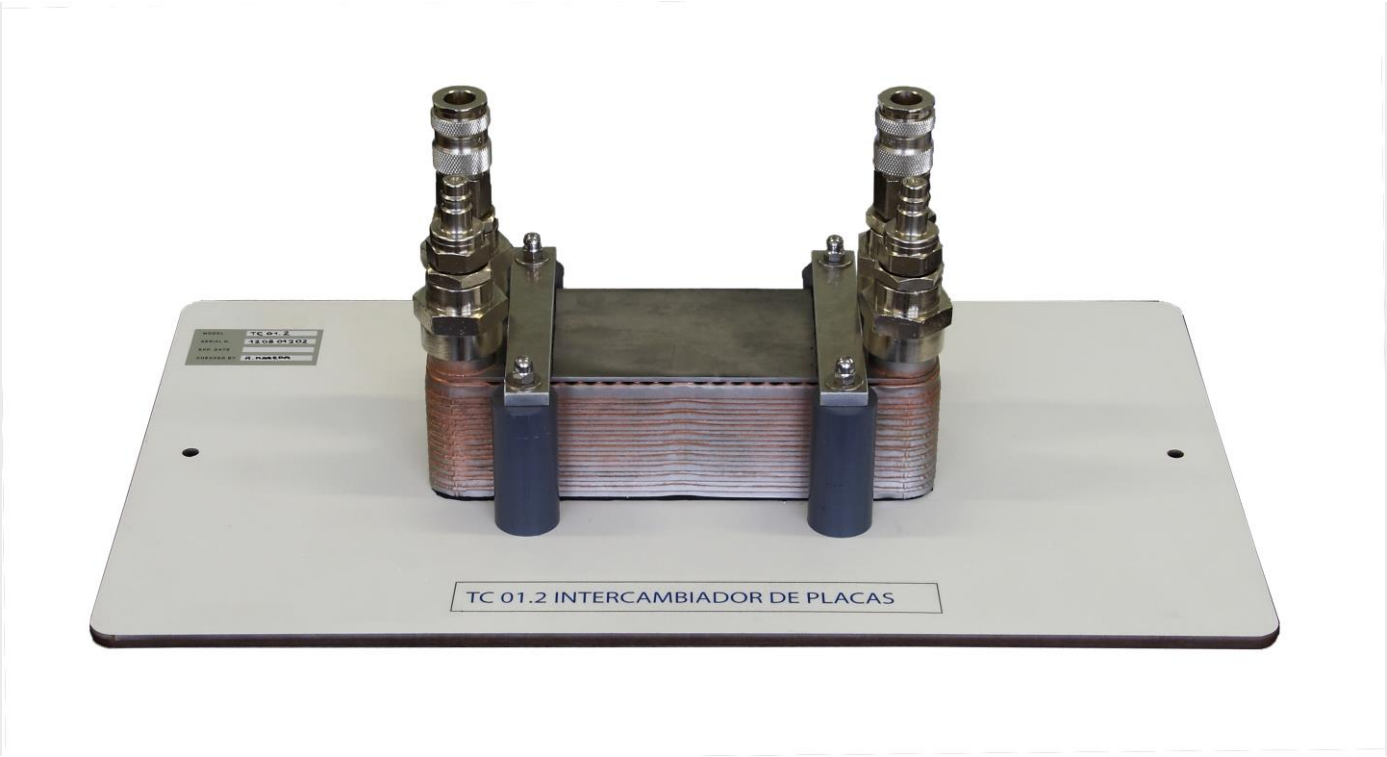
TC 01.1 - HEAT EXCHANGER SUPPLY UNIT



Optional Accessory: TC 01.2 - PLATE HEAT EXCHANGER
In the plate heat exchanger, the hot and cold flows alternating sides pass through the gaps left by the plates, thus resulting in heat transfer.

The advantage of this type of heat exchanger is a compact configuration, and therefore are suitably used in confined spaces.

The plates have a geometry that causes a turbulence in the fluid, improving heat transfer.

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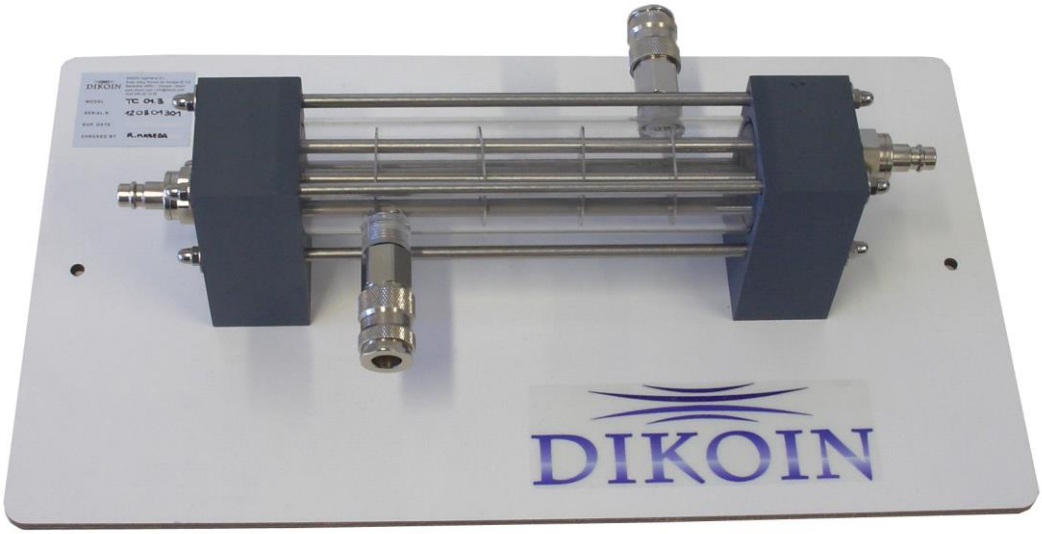
TC 01.1 - HEAT EXCHANGER SUPPLY UNIT



Optional Accessory: TC 01.3 - SHELL TUBE HEAT EXCHANGER
The shell tube heat exchanger is one of the most widely used in the industrial sector.

In this exchanger, the cool fluid passes through a series of tubes grouped in parallel inside the shell, whereas the heated fluid goes through the whole vessel that encloses the tubes, thus resulting in heat transfer.

The advantage of this type of heat exchanger is its compact design and the possibility to work at higher pressures than other designs.

This exchanger can operate with co-current or countercurrent flows.

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TC 01.1 - HEAT EXCHANGER SUPPLY UNIT

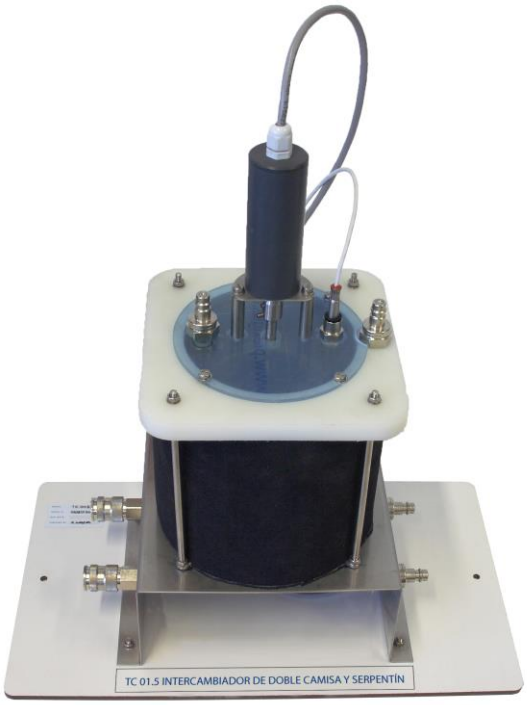
Optional Accessory: TC 01.4 - TUBULAR HEAT EXCHANGER
The concentric tube heat exchanger is the simplest in design among all the heat exchangers.

It consists of two parallel tubes filled with cold fluid running. Inside each tube there is another pipe, smaller in diameter, filled with the heated fluid, thereby producing heat transfer.
The advantage of this exchanger is its simple design.

The exchanger is arranged in two halves, and has incorporated thermocouples at midpoints, so as to significantly improve the learning outcome, because the change in temperature over the heat exchanger is clearly visible.

This exchanger can operate with co-current or countercurrent flows.

TC 01.1 - HEAT EXCHANGER SUPPLY UNIT



Optional Accessory: TC 01.5 - DOUBLE JACKETED VESSEL AND COIL HEAT EXCHANGER
This type of exchanger is generally used in the chemical and process industry, when a very well adjusted temperature is needed.

The exchanger can work with the vessel, or with the coil, and also there is the possibility to work with a continuous flow in the vessel, or to heat a given quantity of water.

This exchanger also has a thermocouple to keep a continuous reading of the fluid temperature inside the vessel, as well as a variable-speed mixer, to study how it affects heat exchange.

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TC 01.1 - HEAT EXCHANGER SUPPLY UNIT

LEARNING OBJECTIVES

- Demonstration of heat transfer.
- Comparison of different types of heat exchangers.
- Comparison of results with flows co-current and countercurrent.
- Transfer coefficient measurement, the effects of flow rate and temperature differential.
- Calculation of energy balance and efficiency.

TECHNICAL DATA

- Adjustable from 0 to 1.5 kW heater from the computer.
- Peripheral Pump:
  - Maximum flow: 10 l / min (5m wc)
  - Power consumption: 180W
- Hot water maximum temperature: 60ºC.
- Maximum hot water flow rate: 5 l / min
- The unit is supplied with an electronic and computerized monitoring system, including computer.

ACCESSORIES

- TC 01.2 PLATE HEAT EXCHANGER.
- TC 01.3 SHELL TUBE HEAT EXCHANGER.
- TC 01.4 TUBULAR HEAT EXCHANGER.
- TC 01.5 DOUBLE JACKETED VESSEL AND COIL HEAT EXCHANGER.

Note:

The heat exchangers are not included in the 01.1 TC team. 01.1 The TC team needs at least one exchanger to operate. (The plate heat exchanger shown in the image is not included with the unit)

REQUIREMENTS

- Electrical connection 230V/50Hz
- Water input minimum of: 5 l/min
- Waste water connection

NOTE:
The equipment is being updated and the aspect can change.

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