HEAT TRANSFER LAB

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HEAT TRANSFER SERVICE UNIT HT 10XC

The Armfield HT10XC is a service unit, which can be used in conjunction with a range of small scale accessories for a wide range of demonstrations into the modes of heat transfer. The factors that affect heat transfer can be investigated and some of the practical problems associated with the transfer of heat can be clearly demonstrated.

The heat transfer accessories may be individually connected to the HT10XC service unit, which provides the necessary electrical supplies and measurement facilities for investigation and comparison of the different heat transfer characteristics.

A specific feature of the HT10XC is that it incorporates the facilities and safety features to allow the accessories to be remotely controlled from an external computer, where this is appropriate. With suitable (user provided) software, this means that the equipment can be operated remotely, for instance over an intra-net or even over the internet. All the facilities can also be accessed locally using the front panel controls and display.

Requirements

Single phase mains electrical supply:

HT10XC-A: 230V, 50Hz, @ 5A  
HT10XC-B: 115V, 60 Hz, @ 10A  
HT10XC-G: 220V, 60Hz, @ 5A

Shipping Specification

HT10XC only
Volume: 0.05m³  
Gross Weight: 15kg

Overall dimensions

HT10XC only
Height: 0.24 m  
Width: 0.32 m  
Depth: 0.39 m
Computer Controlled Combined Convection and Radiation

A hot surface loses heat (heat is transferred) to its surroundings by the combined modes of convection and radiation. In practice these modes are difficult to isolate and therefore an analysis of the combined effects at varying surface temperature and air velocity over the surface provides a meaningful teaching exercise.

The heated surface studied is a horizontal cylinder which can be operated in free convection or forced convection when located in the stream of moving air. Measurement of the surface temperature of the uniformly heated cylinder and the electrical power supplied to it allows the combined effects of radiation and convection to be compared with theoretical values. The dominance of convection at lower surface temperatures and the dominance of radiation at higher surface temperatures can be demonstrated as can the increase in heat transfer due to forced convection.

On the HT14C, the heater power and the air flow are controlled via the HT10XC, either from the front panel, or from the computer software. On HT14 these are controlled manually.

OVERALL DIMENSIONS
HT14; HT14C:
Height: 1.20m Height: 1.20m
Width: 0.35m Width: 0.49m
Depth: 0.30m Depth: 0.44m

SPECIFICATION
HT14; HT14C:
Volume: 0.1m³ Volume: 0.2m³
Gross weight: 9kg Gross Weight: 13kg
HT12C - Computer Controlled Radial Heat Conduction

The Armfield Radial Heat Conduction accessories have been designed to demonstrate the application of the Fourier Rate equation to simple steady-state conduction radially through the wall of a tube. The arrangement, using a solid metal disk with temperature measurements at different radii and heat flow radially outwards from the centre to the periphery, allows the temperature distribution and flow of heat by radial conduction to be investigated.

On the HT12C the heater power and the cooling water flow rate are controlled via the HT10XC, either from the front panel or from the computer software. On the HT12 these are controlled manually.

ESSENTIAL ARMFIELD EQUIPMENT
HT12C requires HT10XC Computer Controlled Heat Transfer Service Unit.
HT12 requires either HT10XC or HT10X Heat Transfer Service Units.

SERVICES REQUIRED
Cold water supply: 1.5 litres/min @ 1 Barg
All electrical requirements are obtained from the service unit.

OVERALL DIMENSIONS
HT12: HT12C:
Height: 0.19m Height: 0.19m
Width: 0.35m Width: 0.43m
Depth: 0.18m Depth: 0.18m

SHIPPING SPECIFICATION
HT12: HT12C:
Volume: 0.03m³ Volume: 0.04m³
Gross weight: 5kg Gross Weight: 6kg
HT30XC Computer Controlled Heat Exchanger Service Module

A range of small scale heat exchangers, designed to illustrate the principles and techniques of indirect heat transfer between fluid streams. Different types of heat exchanger can be mounted on a common bench-top service unit. Small scale versions of commonly used industrial heat exchangers are available (including plate, tubular and ‘shell and tube’) for analysis and comparison. The equipment is controlled by a user supplied personal computer, which serves as the operator interface. Full data logging, control and educational software is supplied with the equipment. In addition, the equipment has been fitted with failsafe systems, including a watchdog circuit, which allows for safe operation from a remote computer.

REQUIREMENTS

Single phase mains electricity supply:

HT30XC-A: 230V, 50Hz, 10Amp
HT30XC-B: 115V, 60Hz, 20Amp
HT30XC-G: 230V, 60Hz, 10Amp

Cold water supply and drain:

5 Litres/minute at 1bar Gauge (Min)

SPECIFICATION

Volume: 0.33m³
Gross weight: 33kg

DIMENSIONS

Height: 0.45m (service unit only)
Width: 1.0m
Depth: 0.5m
The shell and tube heat exchanger is commonly used in the food and chemical process industries. This type of exchanger consists of a number of tubes in parallel enclosed in a cylindrical shell. Heat is transferred between one fluid flowing through the tubes and another fluid flowing through the cylindrical shell around the tubes.

The miniature exchanger supplied is designed to demonstrate liquid to liquid heat transfer in a 1-7 shell and tube heat exchanger (one shell and 7 tubes with two transverse baffles in the shell).

**Specification**

Volume: 0.06 m³  
Gross Weight 5 kg

**Armfield Accessories**

HT30XC or HT30X Heat Exchanger Service Unit

**Overall dimensions**

Height 0.19m  
Width 0.43m  
Depth 0.39m
HT11 Linear Heat Conductor

The Armfield Linear Heat Conduction accessory has been designed to demonstrate the application of the Fourier Rate equation to simple steady-state conduction in one dimension. The unit can be configured as a simple plane wall of uniform material and constant cross sectional area or composite plane walls with different materials or changes in cross sectional area to allow the principles of heat flow by linear conduction to be investigated. Measurement of the heat flow and temperature gradient allows the thermal conductivity of the material to be calculated. The design allows the conductivity of thin samples of insulating material to be determined.

**Experimental Capabilities**

- Understanding the use of the Fourier Rate Equation in determining rate of heat flow through solid materials
- Measuring the temperature distribution for steady-state conduction of energy through a uniform plane wall and a composite plane wall
- Determining the constant of proportionality (thermal conductivity k) of different materials (conductors and insulators)
- Measuring the temperature drop at the contact face between adjacent layers in a composite plane wall (contact resistance)
- Measuring the temperature distribution for steady-state conduction of energy through a plane wall of reduced cross-sectional area
- Understanding the application of poor conductors (insulators)
- Observing unsteady-state conduction (qualitative only)

**Armfield equipment**

HT10X Heat Transfer Service Unit

**Armfield Accessories**

HT10X-304 Educational Software with USB interface
Requirements

Cold water supply:

1.5 litres/min @ 1 Barg

Specification

Volume: 0.04m³
Gross weight: 5kg

Overall dimensions

Height: 0.29m
Width: 0.43m
Depth: 0.21m
The UOP20 family is a modular system of teaching evaporators for chemical engineering departments. Using the various modules a wide range of configurations can be implemented: rising; single or double effect; forward, backward or parallel feed.

The evaporators are fully computer compatible, supplied with educational software including process control and data logging facility, suitable for use with a personal computer.
Evaporator Service Unit (UOP20X)

The Evaporator Service Unit (UOP20X) contains all the services and facilities to implement a laboratory evaporation system. It comprises a feed pump and pre-heat system, vacuum pump, condenser, collection vessels and control console containing a full set of instrumentation, all mounted in a sturdy steel framework.

Two mounting positions are provided for the modular evaporation columns.

Two basic variants of the UOP20X are available, dependent on whether it is required to use steam as the process heating source or pressurised hot water:

The UOP20X-STM includes a steam control valve and steam pressure gauge. It is powered from an external steam source such as the Armfield UOP10 or any other suitable laboratory steam supply.

The UOP20X-PHW includes a pumped recirculating pressurised hot water system complete with integral 3 term temperature controller. Therefore service requirements are simply an appropriate electrical supply and a cooling water supply.

Each UOP20X includes a control console, containing all of the electrical components, controls and displays for the evaporator. Twelve process temperatures, three conductivity readings and the vacuum level can be displayed.

It also includes pre-heat temperature controller, speed controls for the feed pump and recirculation pumps, the computer interface and electric mains switching controls.

When coupled to a suitable PC, using the two USB interfaces, a wide range of sophisticated data logging and educational software facilities is available. Furthermore the UOP20 can be operated in remote control mode, whereby the majority of the control panel functions can be implemented directly from the PC. Although a wide range of products may be concentrated in the evaporator, the software includes algorithms so that when potassium chloride is used the computer display indicates the product concentrations directly. These are calculated in real-time from the temperature and conductivity readings. The computer software also includes a fully configurable PID controller for performing process control experiments.

The vacuum pump and display can be used to show the effect of vacuum on evaporation temperature. In a double effect system the vacuum is applied to the second stage.
Evaporator Columns

Each evaporator column contains a stainless steel evaporation tube, within an insulated heated jacket for the hot water or steam. These are mounted on a back plate together with a glass cyclone to separate the concentrated product from the evaporated steam.

Also included on the back plate of each evaporation column is a recirculation pump and associated pipework, together with thermocouples to measure the temperatures of the product and heating fluid at a number of points. Two basic types of evaporation column are available: UOP22, a rising film evaporation column.

A number of variants are defined for each column type, dependent on whether it is a first or second effect unit, and whether it is located in the first or the second position on the UOP20X service unit.

UOP22-11 Rising Film Evaporation Column (1st effect, 1st position)
UOP22-22 Rising Film Evaporation Column (2nd effect, 2nd position)

OVERALL DIMENSIONS
Height: 2.5m
Width: 1.5m
Depth: 0.9m

SPECIFICATION
UOP20X:
including up to two evaporation columns:
Volume: 5m³
Gross weight: 450Kg max.
Evaporator Column Length: 1m
Pressurised Water Heater: 4KW
Feed Pre-Heater: 2KW
Conductivity displays: 0-100mS
It is essential that the three basic modes of heat transfer; Conduction, Convection and Radiation are understood by students as a foundation for further studies involving heat transfer and temperature measurement.

The Hilton Heat Transfer Service Unit H111 may be connected to any of seven optional demonstration units each demonstrating a fundamental mode of heat transfer or a combination of modes of heat transfer and a range of experiments to reinforce the learning process.

The Hilton Heat Transfer Service Unit H111 is bench mounted, operates from a conventional single-phase electrical power supply and provides both control and instrumentation for each of the seven optional demonstration units.

The seven optional units are: -

- Linear Heat Conduction H111A
- Radial Heat Conduction H111B
- Laws of Radiant Heat Transfer & Radiant Heat Exchange H111C
- Combined Convection and Radiation H111D
- Extended Surface Heat Transfer H111E

**SPECIFICATION**

**Electrical Specification**

Either:  
A: 220-240 Volts, Single Phase, 50Hz(With earth/ground).
B: 110-120 Volts, Single Phase, 60Hz(With earth/ground).

**Service Unit**

Net Weight: 12.3 kg.
Packing Case Volume: 0.22m³
FREE AND FORCED CONVECTION FROM FLAT, PINNED AND FINNED PLATES H111P

A bench top accessory designed to allow students to experimentally investigate both free (natural) convection and forced convection. The accessory includes a small, variable velocity wind tunnel with a digital velocity meter and a central aperture. Three plates with integral heaters and temperature sensors are also supplied that are designed to fit in the central aperture in the wind tunnel.

A heated flat plate with surface thermocouple may be directly compared with a similar pinned plate and finned plate also fitted with a surface thermocouple. In addition to expanding understanding of the heat transfer enhancement from extended surfaces, the pinned and finned plates each have three thermocouples arranged at intervals along a fin and a pin. This allows investigation of the temperature distribution along the extended surfaces.

SPECIFICATION

Net Weight 30kg
Packing Case Volume 0.28m³

DIMENSIONS

Height: 1300mm
Depth: 300mm
Width: 350mm
Weight: 20kg.
The Cussons P7665 Boiler Control Demonstration Unit has been designed to demonstrate clearly and simply a range of boiler control sequences relating to oil or gas fired boilers. Since steam pressure is ‘simulated’ the whole functioning of a boiler may be studied in a relatively safe situation. The Demonstration Unit can act as a valuable teaching aid for the training of boiler operating personnel in the diagnosis of boiler system faults which may occur in practice.

**FAULT SWITCH FUNCTIONS**

*Switch Fault*

A Blower motor failure  
B Ignition transformer failure  
C Pilot flame solenoid failure  
D Main flame solenoid failure  
E Power failure  
F Ignition circuit fuse failure  
G Pressure gauge system fault  
H Feedwater pump fault  
I Pump fuse failure  
J Pressure switch failed open  
K Pressure switch failed closed  
M Closed electrode probe short circuited  
N Photocell operation fault

**Specifications**  
Gross weight: 410 kgs
Nett weight: 220 kgs
Case size: 134 x 96 x 193 cm