

Free and Forced Convection - HT19X

The Armfield Free and Forced Convection unit has been specifically designed to demonstrate the phenomena of natural (free) and forced convection.



Heat guard

Cylindrical pin surface Heat Exchanger

Finned surface Heat Exchanger

Flat plate surface Heat Exchanger

Hardware Description

The Armfield Free and Forced Convection unit has been specifically designed to demonstrate the phenomena of natural (free) and forced convection. Temperature profiles and heat flux over three different heat transfer surfaces can be easily studied.

The HT19X is designed for use with the Armfield HT10X Heat Transfer Service Unit.

This unit consists of a bench mounted vertical air duct positioned on the top of a centrifugal fan. The air duct incorporates an aperture positioned at the rear wall of the duct, into which three different types of heat-transfer surfaces can be inserted. The three types of heat exchangers supplied are; flat plate, cylindrical pins and finned surface.

Incorporating an electrical heating element, with positive thermal cut-out, and thermocouples for precise temperature measurement. The clamping mechanism ensures accurate alignment of the surface

inside the duct. The front wall of the duct is acrylic to allow viewing of the heated surface and measurement sensors.

For forced convection, the centrifugal fan draws ambient air upward through a flow straightener and over the heated surface. A manually variable throttle controls the air flow.

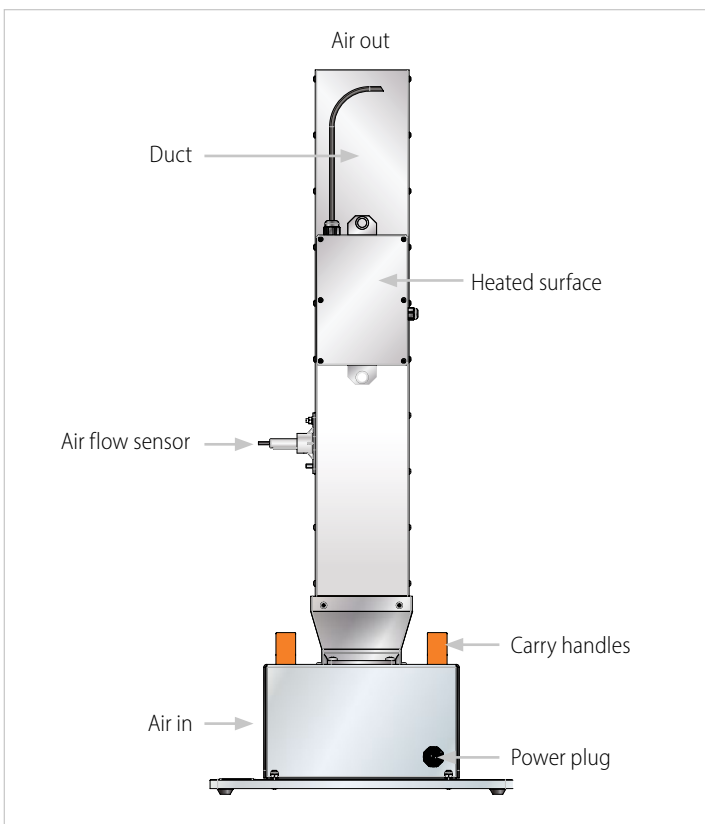
An air-velocity sensor measures the air velocity inside the duct upstream of the heat exchanger.

Thermocouples measure the air temperature before and after the heated surface, together with the surface temperature at three positions along the extended surface exchangers.

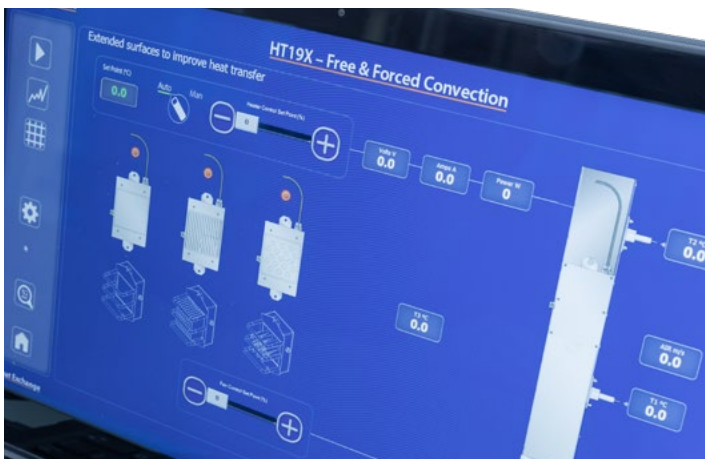
On the HT19X heater power, air flow rate and the configuration of the heated surfaces can all be controlled via the ArmBUS Desktop software, from where PID controller settings for heater temperature are located. Air velocity can be adjusted through the HT19X software control screen.

Experimental Capabilities

- ▶ Relationship between surface temperature and power input in free convection
- ▶ Relationship between surface temperature and power input in forced convection
- ▶ Understanding of the use of extended surfaces to improve heat transfer from the surface
- ▶ Determining the temperature distribution along an extended surface
- ▶ Comparing characteristics of a vertical and horizontal flat plate in free convection
- ▶ Determining the characteristic velocity, the Reynolds, Grashof and Rayleigh numbers for a flat plate in free convection
- ▶ Calculation of the average heat-transfer coefficient of the pinned heater in forced convection
- ▶ Comparing horizontal and vertical configurations for a finned exchanger in free convection



Schematic diagram – HT19X



HT19X mimic diagram and control screen

Requirements

Scale

HT
10X



All electrical requirements are obtained from the service unit

Essential accessories

HT10X Computer-Controlled Heat Transfer Service Unit

Ordering specification

- ▶ A bench mounted unit specifically designed to demonstrate the phenomena of free and forced convection and to measure temperature profiles from three different heat transfer surfaces
- ▶ Comprises a vertical air duct, with a transparent front for visibility mounted on a fan at the base of the duct, three heat transfer surfaces, air flow, and temperature probes
- ▶ Technical data is included for each of the three heat transfer surfaces, which will enable students and researchers to compare practical results with theoretical analysis for free and forced convection
- ▶ Three heat transfer surfaces supplied: a flat plate surface area 0.011m^2 , pinned extended surface area 0.0525m^2 , and finned extended surface area 0.1414m^2
- ▶ Vertical duct incorporates a transparent front wall allowing complete visualisation of the process and identification of the air flow and temperature sensors
- ▶ Each heat transfer surface is fitted with its own heater (240W) and thermocouples, to enable easy interchange
- ▶ All heat transfer surfaces incorporate guards to permit safe use outside of the duct for performing free convection experiments
- ▶ ArmBUS software includes separate exercises for each of the heat transfer surfaces in free or forced convection and records of all measured variables for analysis and comparison of the performances
- ▶ K-type thermocouples measure the air temperature in the duct before and after the heater, as well as the surface temperature of the heat transfer surfaces
- ▶ Heater can be voltage or PID controlled allowing for the temperature set-point to be achieved rapidly and maintained within 0.1°C
- ▶ The air flow is measured by an air-velocity sensor, which is inserted inside the duct
- ▶ Mounted on a PVC baseplate which is designed to stand on the Heat Transfer Service Unit with simple plug-in connections
- ▶ A comprehensive instruction manual is included

Overall dimensions

Length	0.35m
Width	0.30m
Height	0.95m

Packed and crated shipping specifications

Volume	0.2m^3
Gross weight	24kg

Ordering codes

HT19X

Issue: 1

URL: <http://www.armfield.co.uk/ht10x>

Applications

Me ChE CE IP

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