



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 past the surface provides a meaningful teaching exercise.

HT14/HT14C

HEAT TRANSFER AND THERMODYNAMICS

HT14 Combined Convection and Radiation

HT14C Computer Controlled Combined Convection and Radiation – Issue 4

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, so 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 enables 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.

Above: HT14C Computer Controlled Radial Heat Conduction Accessory shown with the HT10XC - Service Unit

Ordering Specification

- A small-scale accessory to introduce students to the principles of combined convection (free and forced) with radiation from a horizontal heated cylinder
- Comprises a heated cylinder mounted in a vertical air duct, with a fan at the base of the duct, which can be used to provide a variable air flow over the cylinder
- Heater rating 100W at 24V DC
- K-type thermocouples measure the air temperature upstream and the surface temperature of the cylinder
- On the computer-controlled unit, the air flow is electronically adjustable over the range 0-7 m/s by a variable-speed fan, otherwise it is manually adjustable
- The air flow rate is measured by a vane-type anemometer in the outlet duct
- The accessory is mounted on a PVC baseplate, which is designed to stand on the bench top and connect to the Heat Transfer Service Unit without the need for tools
- A comprehensive instruction manual is included

Experimental Capabilities

- Determining the combined heat transfer ($Q_{\text{radiation}} + Q_{\text{convection}}$) from a horizontal cylinder in natural convection over a wide range of power inputs and corresponding surface temperatures
- Measuring the domination of the convective heat transfer coefficient H_c at low surface temperatures and the domination of the radiation heat transfer coefficient H_r at high surface temperatures
- Determining the effect of forced convection on the heat transfer from the cylinder at varying air velocities

Technical Details

The equipment consists of a centrifugal fan with a vertical outlet duct. At the top of the duct there is a heated cylinder. The mounting arrangement for the cylinder in the duct is designed to minimise loss of heat by conduction to the wall of the duct.

The surface of the cylinder is coated with heat-resistant paint which provides a consistent emissivity close to unity. A K-type thermocouple (T10) attached to the wall of the cylinder, at mid position, enables the surface temperature to be measured under the varying operating conditions.

A variable-speed fan blows air through the outlet duct and a vane-type anemometer within the fan outlet duct enables the air velocity in the duct to be measured. On the HT14C the fan is a variable-speed fan with electronic control.

On HT14 a manually adjustable throttle plate permits the air velocity to be varied. A K-type thermocouple (T9) in the outlet duct allows the ambient air temperature to be measured upstream of the heated cylinder.

Essential Accessories

HT10XC Computer Controlled Heat Transfer Service Unit

Requirements

All electrical requirements are obtained from the service unit.

HT14-A / HT14C-A:	230V	1ph	50Hz
HT14-B / HT14C-B:	115V	1ph	60Hz
HT14-G / HT14C-G:	230V	1ph	60Hz

NOTE: the supply rating of the HT14/HT14C must be the same as that of the HT10X/HT10XC that it is used with

Shipping Specification

	HT14:	HT14C:
Volume:	0.1m ³	0.2m ³
Gross weight:	9kg	13kg

Overall Dimensions

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

Ordering Codes

HT14-A / HT14C-A:	230V	1ph	50Hz
HT14-B / HT14C-B:	115V	1ph	60Hz
HT14-G / HT14C-G:	230V	1ph	60Hz