



Cross Flow Heat Exchanger H352



H352 Cross Flow Heat Exchanger Shown With
Optional Plain Tube of H352A fitted.

- ***Allows Investigation Of Plain And Finned Cross Flow Heat Exchangers.***
- ***Expandable Free & Forced Convection Heat Transfer Investigation***
- ***Allows Investigation Of Local Heat Transfer Coefficient Around A Cylinder.***
- ***Upgradeable to Computerised Data Acquisition.***
- ***Safe and Suitable For Unsupervised Student Operation.***
- ***Responds Rapidly to Control Changes.***
- ***Negligible Operating and Maintenance Costs.***
- ***Two year Warranty.***



Introduction

The cross flow heat exchanger is a common component in many engineering applications. The normal configuration involves heat transfer between one fluid flowing through a bundle of tubes and another flowing transversely over the outside of the tubes. The tubes may have extended surfaces internally and/or externally in order to enhance heat transfer between the two fluids.

Typical applications include internal combustion engine radiators, air heaters, refrigeration evaporators and condensers, boiler super heaters and economisers. The Hilton Cross Flow Heat Exchanger H352 can utilise any of a number of optional heat exchanger accessories and in addition may be upgraded for computerised data acquisition.

Together with its optional components the unit allows detailed investigation of heat transfer from plain and finned tube bundles in cross flow as well as free and forced convection from flat and extended surfaces.

The unit will be of particular interest to those studying:

- Mechanical Engineering
- Nuclear Engineering
- Chemical Engineering
- Control and Instrumentation
- Plant and Process Engineering
- Building Services
- Engineering Physics
- Refrigeration
- Marine Engineering

Optional Heat Exchanger Accessories

Refer to individual data sheets for details;

H352A Plain Tube and Tube Bundle in Cross Flow.
 H352B Local Heat Transfer Element.
 H352C Finned Tube Bundle in Cross Flow.
 H352D Free and Forced Convection from Flat, Pinned and Finned Plates.
 H352E Heat Pipe Investigation Accessory.
 H352F Pitot Static Traverse Plate
 H352G Water to Air Heat Exchanger Accessory
 HC353A Computer Data Acquisition Upgrade.

Experimental Capabilities

For detailed descriptions and experimental capabilities of the Cross Flow Heat Exchanger H352 with the optional heat exchanger accessories refer to individual data sheets for each optional heat exchanger accessory.

Description

A vertically mounted rectangular section duct with an opaque plastic front cover is connected at its lower end to the intake of a powerful variable speed fan. At the upper end of the duct is a bell mouth air intake. Air is drawn by the fan into the duct and past the heat exchanger accessory before being discharged from the fan.

A pair of manometers allows measurement of the pressure drop across the intake from which the air velocity in the duct may be determined.

At the maximum air velocity (up to 30m/s), the Reynolds number (based on the diameter of a single tube across the duct) is approximately 37,000.

Situated at approximately mid height in the front of the duct is an opening into which any of the various heat exchanger accessories may be located.

Each of the optional heat exchanger accessories is serviced by an instrumentation and control console supplied as part of the Cross Flow Heat Exchanger H352.

The console provides control and measurement of low voltage power to the optional heat exchanger accessories and allows measurement of all the relevant heat exchanger and air stream temperatures. For operator safety the instrumentation console limits all heat exchanger accessories to approximately 100°C and contains electrical overload and earth leakage protection.

The instrumentation and control console also enables installation of the optional computerised data acquisition upgrade that may be either factory fitted or user installed at a later date.

Specification

Cross Flow Heat Exchanger H352

General

A fully instrumented free standing vertical air duct with variable speed fan into which a range of optional heat exchanger accessories may be inserted. Supplied complete with instrumentation and control console suitable for all of the optional heat exchanger accessories. Control console contains temperature limit control and electrical overload protection. Control console may be upgraded for optional computerised data acquisition at any time.

Optional heat exchanger accessories include plain tube, plain tube bundles, finned tube bundles, cylindrical local heat transfer element, free and forced convection flat, finned and pinned plates and a heat pipe investigation upgrade.



Detailed

A vertical free standing air duct with variable speed fan into which a range of optional heat exchanger accessories may be inserted. Duct air velocity is measured using two manometers recording intake depression.

Supplied complete with bench mounting instrumentation console that provides power control and measurement for all of the optional heat exchanger accessories. Instrumentation also allows measurement of the surface, intermediate and free stream temperatures dependant upon the optional heat exchanger accessory in use. The instrumentation console contains temperature limit control for all optional heat exchanger accessories and electrical overload and earth leakage protection.

The instrumentation console also allows installation of the optional computerised data acquisition upgrade at any time.

Optional heat exchanger accessories include:

Plain Tube and Tube Bundle in Cross Flow	H352A
Local Heat Transfer Element	H352B
Finned Tube Bundle in Cross Flow	H352C
Free and Forced Convection From Flat, Pinned and Finned Plates	H352D
Heat Pipe Investigation Accessory	H352E
Pitot Static Traverse Plate	H352F
Water to Air Heat Exchanger Accessory	H352G
Computerised Data Acquisition Upgrade	HC353A

Supplied with a detailed experimental operating and maintenance manual giving example experimental results and sample calculations.

Accessories and spares for two years normal operation together with a full two-year warranty.

Dimensions

Cross Flow Heat Exchanger H352

Height: 1970mm Depth: 440mm
Width: 890mm Weight: 52kg.

Services Required

Electrical: A: 220-240 Volts, Single Phase, 50Hz
(With earth/ground).
Line current up to 6A at 230v

Or

B: 110-120 Volts, Single Phase, 60Hz
(With earth/ground).
Line current up to 12A at 110v

Or

C: 220 Volts, Two Phase (Line-Line),
50/60Hz (With earth/ground).
Line current up to 6A at 220V

Ordering Information

Order as: Cross Flow Heat Exchanger H352

Note :- Order Optional Heat Exchanger Accessories Separately

Electrical Specification

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

Language

Either: English, Spanish, French.

Shipping Specification

Cross Flow Heat Exchanger H352

Net Weight: 52 kg.
Gross Weight 99kg
Packing Case Size 0.813 x 0.559 x 1.473m
Packing Case Volume: 0.22m³

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.



Optional Extra H352A **Plain Tube and Tube Bundle in Cross Flow**



Specification

The accessory includes two clear plastic plates that are designed to fit the aperture in the Cross Flow Heat Exchanger H352 duct.

One plate has a single central hole and the other consists of a six row tube bank with a removable tube in the centre of each row.

An electrically heated cylindrical active element with an integral surface thermocouple is supplied which may be inserted in the apertures in each of the two plates.

Using the single tube plate the active element may be used to investigate the variation in heat transfer, temperature difference and surface heat transfer variation with air stream velocity.

Replacing the removable tube in each row in turn in the tube bundle allows the variation in heat transfer coefficient in a tube bundle to be investigated.

The cylindrical active element plugs directly into the Cross Flow Heat Exchanger H352 instrumentation console and this allows measurement of the low voltage power supplied to the heater and the surface temperature.

The instrumentation console also limits the active element surface temperature to approximately 100°C

Experimental Capabilities

- Steady state determination of heat transfer , temperature difference and surface heat transfer coefficient for a single tube in a transversely flowing air stream at speeds of up to 30m/s
- Steady state determination of the mean surface heat transfer coefficient for tubes in the 1st, 2nd, 3rd, 4th, 5th and 6th rows of a cross flow heat exchanger.
- Determination of the mean surface heat transfer coefficient for cross flow heat exchangers with one to six rows.
- Deduction of the relationship between Nusselt, Reynolds and Prandtl Numbers for each of the six tube rows.

Dimensions

Height: 200mm Depth: 80mm
Width: 210mm Weight: 6.45kg.

Ordering Information

Order as: Plain Tube and Tube Bundle in Cross Flow H352A

Services Required

Electrical and instrumentation services are provided by the **Cross Flow Heat Exchanger H352**, which is an essential item of equipment for operation of the optional Plain Tube and Tube Bundle in Cross Flow H352A.

Shipping Specification

Net Weight 10kg

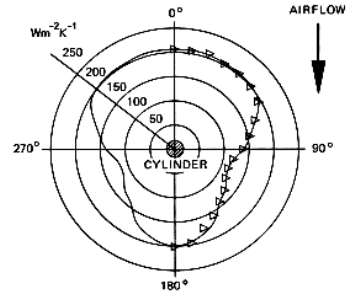
Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request



Optional Extra H352B **Local Heat Transfer Element**



Experimental Capabilities

- Investigation of polar heat transfer coefficient for a single tube in a transversely flowing airstream at speeds of up to 30m/s.
- Determination of the local heat transfer coefficient at the stagnation point on a cylinder in crossflow

Specification

The accessory includes a black plastic plate with circular access hole designed to fit the aperture in the Cross Flow Heat Exchanger H352 duct.

The active element has a circular graduated flange that fits in the access hole and allows the active element to be rotated about its central axis while in the airstream.

The active element consists of a non-metallic circular cylinder coated with an electrically conductive surface and circumferential contacts at each end. Under the conducting surface is a thermocouple designed to measure the local temperature.

The cylindrical active element plugs directly into the Cross Flow Heat Exchanger H352 instrumentation console and this allows measurement of the low voltage power supplied to the heater and the surface temperature.

By passing an electrical current through the conducting surface heat is generated that is carried away by convection until a stable temperature condition is established.

Measurement of the power, the surface temperature and the air stream temperature the convective heat transfer coefficient local to the thermocouple may be calculated.

As the cylinder is non-metallic a variation in surface temperature is established that represents the variation in local heat transfer coefficient. By rotating the cylinder in angular steps results of the type shown may be recorded.

Dimensions

Height: 200mm Depth: 80mm
Width: 210mm Weight: 6.45kg.

Ordering Information

Order as: Plain Tube and Tube Bundle in Cross Flow H352A

Services Required

Electrical and instrumentation services are provided by the **Cross Flow Heat Exchanger H352**, which is an essential item of equipment for operation of the optional Local Heat Transfer Element H352B.

Shipping Specification

Net Weight: 10kg

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request



Optional Extra H352C

Finned Tube Bundle in Cross Flow



Specification

The accessory includes a clear plastic plate that is designed to fit the aperture in the Cross Flow Heat Exchanger H352 duct.

The plate consists of a four row finned tube bank with a removable finned tube in the centre of each row.

An electrically heated finned active element with an integral surface thermocouple is supplied which may be inserted in place of the removable tube in the centre of each row

Replacing the removable tube in each row in turn in the tube bundle allows the variation in heat transfer coefficient in a tube bundle to be investigated.

The finned active element plugs directly into the Cross Flow Heat Exchanger H352 instrumentation console and this allows measurement of the low voltage power supplied to the heater and the surface temperature. The instrumentation console also limits the active element surface temperature to approximately 100°C.

Experimental Capabilities

- Investigation of the effect of external fins on the heat transfer watt density of plain tubes in cross flow.
- Steady state determination of the mean surface heat transfer coefficient for finned tubes in the 1st, 2nd, 3rd and 4th rows of a finned cross flow heat exchanger.

Dimensions

Height: 200mm Depth: 80mm
Width: 210mm Weight: 6.45kg.

Ordering Information

Order as: Finned Tube Bundle in Cross Flow
 H352D

Services Required

Electrical and instrumentation services are provided by the **Cross Flow Heat Exchanger H352**, which is an essential item of equipment for operation of the optional Finned Tube Bundle in Cross Flow H352C.

Shipping Specification

Net Weight: 10kg

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request



Optional Extra H352D

Free and Forced Convection from Flat, Pinned and Finned Plates



Dimensions

Height: 200mm Depth: 80mm
Width: 210mm Weight: 6.45kg.

Ordering Information

Order as: Free and Forced Convection from Flat,
Pinned and Finned Plates H352D

Services Required

Electrical and instrumentation services are provided by the **Cross Flow Heat Exchanger H352**, which is an essential item of equipment for operation of the optional Free and Forced Convection from Flat, Pinned and Finned Plates H352D.

Shipping Specification

Net Weight: 10kg

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Specification

The accessory includes three plates with integral heaters and temperature sensors that are each designed to fit the aperture in the Cross Flow Heat Exchanger H352 duct.

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 expand 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.

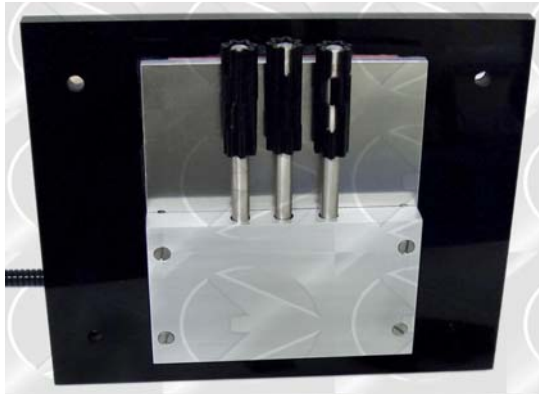
Each of the plates plug directly into the Cross Flow Heat Exchanger H352 instrumentation console and this allows measurement of the low voltage power supplied to the heater and the surface temperatures. The instrumentation console also limits the active element surface temperature to approximately 100°C

Experimental Capabilities

- Investigation of the relationship between power input and surface temperature in free convection on flat, finned and pinned plates.
- Investigation of the relationship between power input and surface temperature in forced convection on flat, finned and pinned plates
- Investigation of the use of extended surfaces to improve heat transfer from the surface.
- Determination of the temperature distribution along an extended surface.



Optional Extra H352E **Heat Pipe Investigation Accessory**



Each of the plate plugs directly into the Cross Flow Heat Exchanger H352 instrumentation console and this allows measurement of the low voltage power supplied to the heater and the surface temperatures.

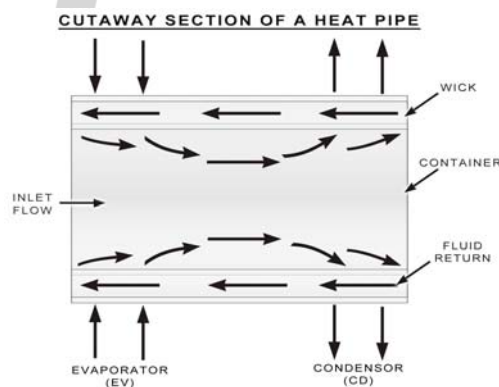
The instrumentation console also limits the active element surface temperature to approximately 100°C

Experimental Capabilities

- Demonstration of heat pipe applications in free and forced convection.
- Investigation of free and forced convective heat transfer to air from a vertical flat plate with and without heat pipe or aluminium rod enhancement

Introduction

Heat Pipes are used in many applications in order to transfer heat rapidly from one location to another. When compared with equivalent cross sections of even high conductivity materials, such as copper and silver, heat pipes are many more times effective.



Specification

The accessory includes a drilled aluminium plate with integral heater and temperature sensor that is designed to fit the aperture in the Cross Flow Heat Exchanger H352 duct.

The flat plate is drilled to accept either finned heat pipes or similar geometry finned aluminium rods. Heat transfer from the simple flat plate may be compared under the same test conditions when either the aluminium rods or heat pipes are inserted.

The heat pipes allow demonstration and investigation of the techniques applied in the electronics and computer industries for component and IC cooling.

Dimensions

Height: 200mm Depth: 80mm
Width: 210mm Weight: 6.45kg.

Ordering Information

Order as: Heat Pipe Investigation Accessory H352E

Services Required

Electrical and instrumentation services are provided by the Cross Flow Heat Exchanger H352, which is an essential item of equipment for operation of the optional Heat Pipe Investigation Accessory H352E

Shipping Specification

Net Weight: 10kg

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request



Optional Extra H352F **Pitot Static Traverse Plate**



Introduction

Cross flow heat exchangers transfer heat from one fluid to another efficiently due to the effect of turbulence induced in the stream by the tubes. The Hilton H352F Pitot Traverse Plate is designed to allow students to investigate the velocity profile both upstream and in the wake of a all of the optional heat exchanger accessories available for the H352 base unit

Specification

The accessory includes a sliding plate, and pitot tube with multiple locations designed to be traversed across the duct of the H352base unit. The plate fits in a location below the main accessory aperture and allows the velocity profile behind all of the optional heat exchangers to be investigated. Also supplied is an upstream pitot tube that can be traversed across the duct to investigate the upstream velocity profile. Pre-fitted static pressure tapings allow local velocities to be determined.

Total and static differential pressures are recorded by manometers secured to the H352 base unit duct.

Experimental Capabilities

- Determination of the velocity profile upstream of a heat exchanger in cross flow.
- Determination of the velocity profile at various distances down stream of a heat exchanger.
- Determination of the velocity profile at various distances down stream of a cylinder in cross flow.

Dimensions

Height: 160mm Depth: 150mm (nominal)
Width: 380mm Weight: 1kg (Nominal)

Ordering Information

Order as: Pitot Static Traverse Plate H352F

Services Required

Electrical and instrumentation services are provided by the Cross Flow Heat Exchanger H352, which is an essential item of equipment for operation of the optional Pitot Static Traverse Plate H352F

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request



Optional Extra H352G **Water to Air Heat Exchanger** **Accessory**



Introduction

Cross flow heat exchangers are used in many industrial applications where it is necessary to transfer heat from one medium to another. The detailed examination of how turbulence from the preceding rows of tubes enhances heat transfer in the following rows is easily investigated using the Hilton H352A Plain Tube Bundle and Tube Bundle in Cross Flow accessory. **The Hilton H352G Water to Air Heat Exchanger** accessory allows the investigation of a practical application where heat is to be transferred from heated water to an air stream.

The H352D tube bundle has a similar format to the H352A accessory thereby allowing a direct comparison to be made.

Specification

The accessory includes a series connected copper tube bundle with flexible flow and return hoses **that is designed to fit the aperture in the Cross Flow Heat Exchanger H352 duct**. The flexible hoses connect to a small service console containing a water heater, reservoir, circulating pump and flowmeter.

The flow and return temperatures of the heated water are measured together with the water flow rate which is also adjustable. This allows investigation of the heat transfer at various operating conditions. The use of a pressure measuring device in the service console allows the pressure drop in the heat exchanger to be recorded and related to the flow rate. This also allows investigation of the pump characteristics.

For operator safety the service console has an internal high temperature cut out, miniature circuit breakers and overload cut out.

Experimental Capabilities

- Determination of heat transfer rates of water and air together with the efficiency.
- Determination of overall heat transfer coefficient and how this is affected by flow velocity.
- Investigation of pressure drop in the heat exchanger at different flow rates and investigation of pump characteristics.

Dimensions

Height: 225mm Depth: 280mm
Width: 435mm Weight: 10kg (Nominal)

Ordering Information

Order as: Water to Air Heat Exchanger
Accessory H352G

Services Required

Electrical: A: 220-240 Volts, Single Phase,
50Hz (With earth/ground).
Line current up to 13A at 230v

or

B: 110-120 Volts, Single Phase,
60Hz (With earth/ground).
Line current up to 26A at 110v

or

C: 220 Volts, Two Phases (Line-Line),
50/60Hz (With earth/ground).
Line current up to 13A at 220V.

Shipping Specification

Net Weight 10kg (Nominal)

Accessories and Spares

Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request



Optional Extra HC353A **Data Acquisition Upgrade**

Hardware details

The Optional Computerised Data Acquisition Upgrade HC353A consists of a 21 channel Hilton Data logger (D103), together with pre-configured, ready to use, WindowsTM compatible educational software.

Factory fitted coupling points on the H352 allow installation of the upgrade to the unit at any time in the machine's extensive life.

The Hilton Data logger (D103) connects, using the cable supplied, to a standard USB port on the user-supplied PC. If more than one logger is required connection is via a second USB port or standard USB hub.

The combined educational software and hardware package allows immediate computer monitoring and display of all relevant parameters on the H352.

Software Details

The pre-configured menu driven Software supplied with the Computer Upgrade HC353A allows all recommended experiments involving the electronic transducers and instruments on the H352 to be carried out with the aid of computerised data acquisition, data storage and on-screen data presentation. This enhances student interest and speeds comprehension of the principles being demonstrated.

Students are presented with either raw data for later hand calculation or alternatively data may be transferred to most spreadsheets for computerised calculation and graphical presentation.

Data may be stored on disc and displayed at any time using the software supplied. Alternatively data may be transferred to any compatible spreadsheet together with individual time and date stamp on each reading for complex analysis.

Additional Data Logging Facility Supplied As Standard

The D103 is the third generation of Hilton Data Logger. It comprises an industrially proven 21 channel interface with 8 thermocouples (type T and K as standard) / differential voltage inputs ($\pm 100\text{mV DC}$), 8 single ended DC voltage inputs ($\pm 8\text{V}$), 4 logic or frequency inputs and one mains voltage input. In addition there are on board 12V DC, $\pm 5\text{V DC}$ and $\pm 15\text{V DC}$ power supplies for most commercially available transducers.

The Hilton Data Logging software supplied as standard with the HC353A package allows the D103 to be disconnected from the H352 and used together with most standard transducers as a stand alone computer data logger for the instrumentation and monitoring of existing laboratory equipment using locally sourced industrial transducers. The software is also backwards compatible with our many second generation D102 data loggers that are already in use worldwide.

Full data logger command protocol and communications details are provided in an extensive user manual that allows other software applications to communicate with the logger via the USB interface. Users can write their own software, typically in LabView, Matlab, C, C++, Visual Basic etc. This further expands the student project capabilities of the HC353A package from teaching and demonstration into the field of research and postgraduate study.

Computer Hardware Requirements

The menu driven Software supplied with the Computer Upgrade HC353A will operate on a PC which has at least 0.5Gb Mb ram, VGA graphics, 1Gb hard drive, CD drive and an available USB port. The software is Windows 2000, XP and 7 compatible.

Ordering Information

Order as: Computerised Data Acquisition
HC353A Upgrade.

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