cussons
TECHNOLOGY

# P3210

# HEAT TRANSFER BENCH AND EXPERIMENTS WITH OPTIONAL DATA ACQUISITION

## FEATURES

- Large range of add-on experiments in heat transfer, air flow and aerodynamics.
- Well instrumented including dual sloping manometer, barometer and pitot static tube.
- Additional equipment easily and quickly fitted.
- Enables a series of forced convection heat transfer coefficients to be derived.
- Data logging outputs of heater current and voltage, surface temperature and air temperature available as an option.

## PRINCIPLE EXPERIMENTS

- To determine the relationship between Nusselt's and Reynold's numbers applied to a single heated tube positioned transversely to a stream of air.
- To determine the effect of change of diameter on the heat transfer coefficient to a single tube in cross flow.
- To determine the effect of change of position of the heated tube within a cross flow tube bundle.
- To examine the effect of heat transfer of a Flat Plate ( with P3214 ) and a Finned Pipe arrangement ( with P3215)

## INTRODUCTION

A range of experiments in the field of Heat Transfer has been developed for the basic Air Flow Bench to meet the needs of this growing area of study. In each of the individual cases described the local convective heat transfer from the heated wall surface to the air is examined by measuring the power used to maintain the surface of the electrically heated model at constant temperature. The amount of heat used has minimal effect on the bulk temperature of the air flow, thus greatly simplifying the experimental technique.

The relationship between Nusselt, Prandtl and Reynold's numbers can be investigated by varying the air flow rate, the electrical power to the model and hence the surface temperature. The effect of the change of air flow rate on the pressure drop over the test models can also be investigated. The velocity of the air flow in the test section is determined by means of a pitot static tube.

Cussons P3210 Cross Flow Heat Transfer Bench affords the study of forced convection from the surface of a heated tube positioned transversely to a stream of air, either on its own or at various positions within a cross flow tube bundle. Alternative sizes of heated tubes are included to enable the student to

determine the effect of tube diameter on the heat transfer coefficient.

This particular apparatus incorporates the variable low voltage power source and temperature read-out facility required for each experiment. With the fan switched off, natural convection studies can be carried out.

## DESCRIPTION

The P3210 Heat Transfer Bench consists of a Cussons P3200 Air Flow Bench and a Cussons P3219 Cross Flow Heat Transfer Experiment.

The basic Air Flow Bench consists of a welded steel frame, mounted on castors, and provides two work surfaces for experiments and integral storage space. A tangential fan (i.e. fitted with a narrow chord centrifugal impeller), directly driven from a single phase induction motor, provides the necessary air flow for experiments. The fan is capable of providing a flow of 500 litres/second at a static pressure rise of 800 pascals. Instrumentation supplied with the bench comprises a dual multi-slope manometer with dial type barometer, a conical inlet flow measuring device, a pitot static tube for traversing the duct. An optional data logging system with various modules is available to provide 0-10V dc analogue outputs of all air flow measurement for interfacing to a computer system.

The Cross Flow Heat Transfer Experiment comprises an experimental unit and an instrument module. The instrument module can be used with either of the other optional heat transfer experiments namely P3212 Parallel Flow Heat Transfer Experiment and P3213 Mixed Flow Heat Transfer Experiment.

The cross flow experiment consists of a test section in black acrylic material complete with a bell mouthed inlet which is simply and easily connected to the fan inlet by means of quick release toggle catches. The test section with its square cross section, is recessed to accommodate the particular test model used without unduly disturbing the air flow stream. The internal dimensions of the test section are 130 mm high by 140 mm deep, while diameters of the heated tubes are 9.5 and 12.7 mm respectively.

Two test modules are provided, the first housing either of the two heated tubes, the second housing a tube bundle into which the heated tube can be positioned in any of the tube banks. A further 2 additional test modules are available as options—P3214 Flat Plate Heating Element and P3215 Finned Pipe arrangement

Pressure tapping points are provided in the test section enabling the pressure drop over the model to be measured and a connection for the pitot static tube, used to measure the air flow velocity is also included. The instrument module contains the heater power source and temperature read-out facility includes a voltage regulating system, combined digital/analogue read-outs of voltage and current and a digital temperature meter which indicates the difference in temperature between the bulk air stream and the surface of the heated tube.

The instrument module includes interface amplifiers to provide 0-10V dc analogue outputs suitable for data logging of the two measured temperatures, the heater current and the heater voltage.

## TENDER SPECIFICATION

### P3210 - Heat Transfer Bench

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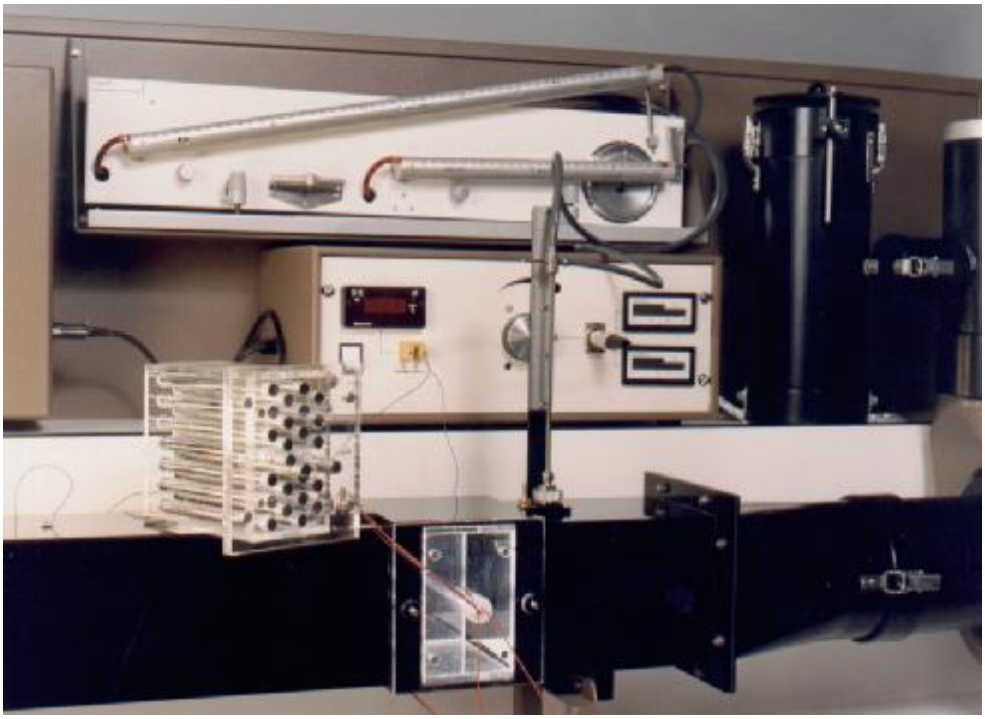
### N.B. This bench includes the following item :

### P3219 - Cross Flow Heat Transfer Experiment

Consists of a square section air flow tunnel designed to be connected to the fan inlet of either P3200 Air Flow Bench or the P3240 Fan Test Set. Provision is made part way along the air flow tunnel to install any



**Detailed view of Cross Flow Heat Transfer Apparatus**

one of the two interchangeable model inserts supplied. One insert allows a single heated tube of either 12.7 mm or 9.5 mm diameter to be located across the horizontal centre line of the duct. The other insert is a tube bundle model in which a heated tube can be placed in any one row of the bundle. The test section affords a means of simulating a Cross Flow Heat Exchanger, a series of blank tubes being inserted transversely within the section. Various configurations can be achieved, comprising a single tube or, up to four tube blanks. An electrically heated tube complete with surface mounted thermocouple is provided, to replace any of the blank tubes within the test section. A low voltage power source complete with wattmeter indicates the power dissipated by the electrical heater. These items are mounted in a control box along with a millivoltmeter for indicating the output from the surface temperature thermocouple mounted on the heater. The unit comes complete with two heated tubes of different diameters, each of which can be used individually or within the tube banks. Natural convection studies for single tubes is also catered for by the unit, the fan being switched off for these tests.

In addition to experiments on forced convective external heat transfer from cylinders and tube bundles the apparatus can also be used to investigate the pressure drop across the tube bundles and natural convection from a single horizontal tube.

In addition 2 further optional test module inserts are available—

### P3214 Flat Plate Experiment

### P3215 Finned Pipe Experiment

## OPTIONAL EQUIPMENT

### P3205 - Signal Conditioning System

For barometric pressure, 0-50 mbar and 0-25 mbar air pressures and fan motor current.

### P3209 - Data Logger complete with PC

## SERVICES

For connection to 220/240 volt single phase 50 or 60Hz supply, other voltages to special order.

## SHIPPING DETAILS

*Case size:-* 196 x 94 x 185 cm
*Gross weight:-* 420 kg.

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