P3300 THERMAL RADIATION AND NATURAL CONVECTION APPARATUS

INTRODUCTION

The Cussons P3300 Thermal Radiation and Natural Convection Heat Transfer Apparatus is a self- contained bench mounted unit, designed to demonstrate the essential features of heat transfer by radiation and natural convection from various heating element shapes under varying conditions of ambient pressure and element surface temperature.

FEATURES

- Different gases can be used allowing comparative heat transfer tests to be conducted.
- Heater orientation can be vertical or horizontal and positioning is remote from the walls of the closed vessel to ensure substantially free convection.
- Alternative heat sources can be supplied to demonstrate the effects of change of emissivity and element shape.

DESCRIPTION

The heating element contained within the test vessel is an electrical resistance element whose input power is controlled by a potentiometer. A temperature indicator monitors the temperature at each thermocouple, one measuring ambient and one on the heating element.

A Bourdon tube gauge mounted on the unit measures pressure from +1 bar to -1 bar and to cater for the high vacuum conditions a McLeod gauge, also panel mounted, covers the range 0 to 200 mbar absolute.
The self-contained vacuum pump fitted to the equipment caters for vacuum conditions down to less than 0.1 mbar, and there is provision for an external pressure source input to be used to allow investigations up to 2 bar absolute.

The basic element shape provided is cylindrical, but other element shape variations can be investigated by using Cussons P3301 Kit. Additionally the gas surrounding the element can be varied so that the effect of changes in gas properties on heat transfer may be studied.

EXPERIMENTAL CAPABILITY

- Demonstration of the Stefan Boltzman law of radiation and determination of the constant for differing ambient conditions.
- A study of the concept and parameters of emissivity.
- An investigation of natural convection for different gases, introducing the Prandtl, Grashof and Nusselt dimensionless groups.
- A determination of the natural convection heat transfer coefficient at different pressures.
- An investigation of the effects of orientation of the heat source on the convection heat transfer coefficient.

With the P3301 and P3302 Pressure Test Cover further investigations can be carried out:

- The effect of changes of shape of the heat source on natural convection.
- The effect of change of emissivity value of the heat source on radiated heat.

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PRINCIPLE OF OPERATION

Two principal forms of heat transfer, radiation and convection will take place from the electrically heated test element to the vessel walls. The heat transfer coefficient can be determined from the element's surface temperature, surface area, and the ambient (vessel wall) temperature. This, combined with knowledge of the electrical power supplied to the test element allows the total heat transfer rate to be determined (See Fig. 1).

The 'heat transferred' by radiation will be independent of the pressure within the vessel whilst that transferred by convection will decrease as the vessel pressure decreases. At a fixed heat input (see Fig. 2), a plot of temperature difference against vessel pressure can be extrapolated to give temperature difference at zero pressure, from which the radiated heat transfer coefficient can be determined. Subsequently, the heat transfer by convection can be evaluated for any pressure by the method of subtraction.

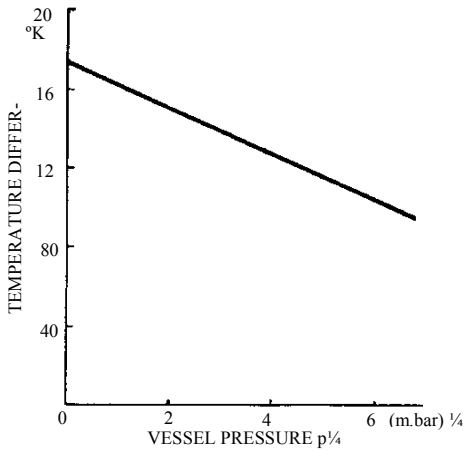

FIG. 2 Temperature Difference v Vessel Pressure

ACCESSORIES

P3301 Set of additional heating elements of different surface areas, shapes and emissivity, i.e.

- cylindrical element of larger diameter than that supplied with P3300
- cylindrical element of low emissivity value (chromed)
- flat plate element

P3302 Pressure test cover with 'O' ring and clamping device

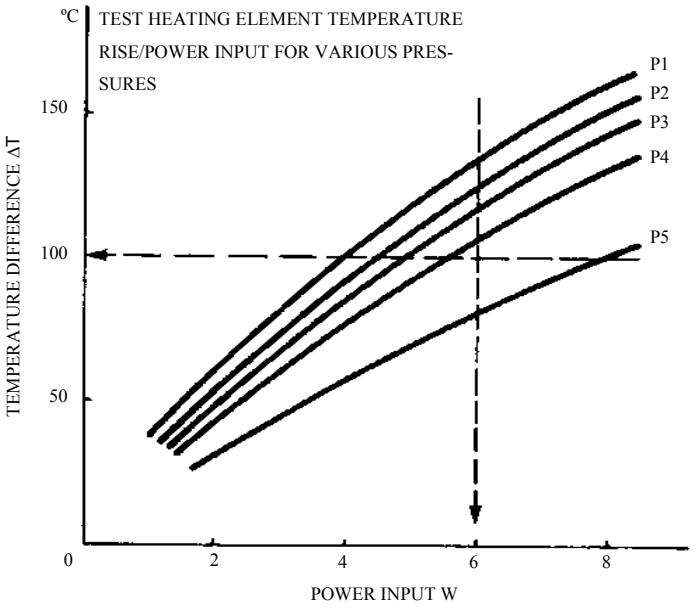

FIG. 1 Temperature Difference v Power Input

TENDER SPECIFICATION

The P3300 apparatus consists of a self-contained bench mounted unit complete with vacuum pump. A heating element (which can be varied) is housed in a chamber designed to withstand vacuum pressures down to less than 0.1 mbar or, with an alternative cover, pressures up to 2 bar absolute. Element heating controls, pressure and temperature indications and suitable ambient medium controls for the chamber are included to enable a series of investigations to be performed on heat transfer by radiation and natural convection.

INSTALLATION REQUIREMENTS

220/240V, Single phase, 50 or 60 Hz supply. Other voltages to special order

DIMENSIONS AND WEIGHTS

Length: 0.6m
Width: 0.8m
Height: 0.7m
Nett weight: 60kg