EXPERIMRNT 8: TO DETERMINE THE EMISSIVITY OF THE NON – BLACK SURFACE.

Introduction

Radiation is one of the modes of heat transfer, which does not require any material medium for its propagation. All bodies can emit radiation & have also the capacity to absorb all or a part of the radiation coming from the surrounding towards it. The mechanism is assumed to be electromagnetic in nature and is a result of temperature difference.

Thermodynamic considerations show that an ideal radiator or black body will emit energy at a rate proportional to the fourth power of the absolute temperature of the body. Other types of surfaces such as glossy painted surface or a polished metal plate do not radiate as much energy as the black body, however the total radiation emitted by these bodies still generally follow the fourth power proportionality.

To take account of the gray nature of such surfaces, the factor called emissivity (ε), which relates the radiation of the gray surface to that of an ideal black surface, is used. The emissivity of the surface is the ratio of the emissive power of the surface to the emissive power of the black surface at the same temperature. Emissivity is the property of the surface and depends upon the nature of the surface and temperature.

Specifications

1. Test Plate = Aluminum dia:165mm, radius = 82.5 mm
2. Black Plate = Aluminum dia:165mm,radius = 82.5 mm
3. Heater Nichrome strip wound on mica sheet and sandwiched between two mica sheets = 350 watts each approx.
4. Dimmer stat for both plate 0 – 2amp
5. Voltmeter 0 –260 V
6. Ammeter 0 – 2 Amp
7. Enclosure size 580mm x 300mm x 300mm approximately with one side of Perspex sheet.
8. Thermocouples – Chromel Alumel – (7 No's).
9. Temperature indicator 0 – 300 ˚C.
10. ON/OFF switch

Approximate Values of Emissivity for Some Common Material

	MATERIAL	TEMPERATURE	EMISSIVITY
Metals	Polished copper, Steel, Stainless Steel, Nickel Aluminum(anodized)	20˚C 90 - 540˚C	0.15 (increases with temperatures) 0.75 to 0.85
Non- Metals	Brick, Wood, Marble, water	20 – 100˚C	0.80 to 1

Instrument Image

Procedure

1. Gradually increase the input to the heater to black plate and adjust it to some value viz. 30, 50, 75 watts and adjust the heater input to test plate slightly less than the Black plate 27, 35, 55 watts etc.
2. Check the temperature of the two plates with small time intervals and adjust the Input of test plate only, by the dimmer stat so that the two plates will be maintained at the same temperature.
3. This will required some trial and error and one has to wait sufficiently (more than One hour or so) to obtain the steady state condition.
4. After attaining the steady state condition record the temperatures. Voltmeter and ammeter readings for both the plates.
5. The same procedure is repeated for various surface temperatures in increasing Order.

Observation Table

SR.NO	Black plate $T_b=(T_1+T_2+T_3)/3^\circ C$					Test plate $T_t=(T_4+T_5+T_6)/3^\circ C$					Enclosure temp $T_a=T_7^\circ C$
	V_1	I_1	T_b			V_2	I_2	T_t			T_a
			T_1	T_2	T_3			T_4	T_5	T_6	

Calculation

1. **Heat input to the black plate:-**

   Q_b = Heater input black plate.

   $Q_b = V_1 \times I_1$

2. **Heat input to the test plate:-**

   Q_t = Heater input to test plate.

   $Q_t = V_2 \times I_2$

3. Emissivity of test plate:-

$$E_t = \frac{Qt(T_b{}^4 - T_a{}^4)}{Qt(T_t{}^4 - T_a{}^4)}$$

Area of plate,

A = Area of plates =0.020096 m^2

$$A = \frac{\pi}{4} d^2$$

d = Diameter Of plate = 160mm

$T_b = (T_1+T_2+T_3)/3$= Temperature of black plate °C

$T_a = T_7$ = Ambient temperature °C

$T_t = (T_4+T_5+T_6)/3$= Temperature of test plate °C

E_t = Emissivity of non-black test plate

Conclusion

Marks Obtained **Sign of Faculty**