# EXPERIMRNT 9: TO DETERMINE THE STEFAN BOLTZMANN CONSTANT FOR GIVEN MATERIAL

## Introduction

The most commonly used law of thermal radiation is the Stefan Boltzmann law, which states that thermal radiation (heat flux) or emissive power of black surface is directly proportional to the fourth power of absolute temperature of the surface & is given by .

$$Q / A = \sigma T^4 \text{ Watt/ } m^2 K^4$$

The constant of proportionality σ is called the Stefan Boltzmann constant and has a value of $5.67 \times 10^{-8}$ $W/m^2 K^4$ in S.I unit

## Description

The apparatus consists of flanged copper hemisphere fixed on flat non-conducting plate. The outer surface is enclosed in a metal jacket used to heat at some suitable temperature. Four thermocouples are attached to various points on the surface and is measured by a temperature indicator.

The disc which is mounted in Bakelite plate is fitted in a hole drilled in the center of the base plate.

Thermocouple is used to measure the temperature of disc

When the disc is inserted the temperature change with time is used to calculate the Stefan Boltzmann constant.

## Instrument Image

## Specifications

1. Hemispherical enclosure dia. :136 mm.
2. Water Jacket Diameter :150 mm
3. Water Jacket Height :155 mm
4. Base Plate Bakelite Dia : 12 mm
5. Mass of test Disc : 0.0026 kg

## Procedure

1. Fill the water in upper tank.
2. Switch on the immersion heater and heat it up to around 70 C shown on $T_1$
3. Remove the test disc before pouring the water into lower tank.
4. Switch off the heater and open the valve and allow the water into second tank
5. Allow it for steady state.
6. Note down the reading of thermocouple $T_2$ to $T_5$
7. Insert the disc and immediately note down the temperature of $T_6$ at every five seconds
8. Draw the graph of temperature V/s time and calculate dT/dt

## Observation table

| Sr. | Temp. Readings ˚c | | | | Time in sec for which $T_6$ is noted ˚c | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $T_2$ | $T_3$ | $T_4$ | $T_5$ | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |

## Calculations

$T_s$ = surface temperature = $(T_2+T_3+T_4+T_5) / 4 + 273$ K

$T_6$ = Disc Temperature= $T_6 + 273$ K

$A_d$ = Surface area of the disc=0.021 m= $3.46 \times 10^{-2} m^2$
M = Mass of disc = 0.0026 kg
$C_p$ = specific heat of disc =418.68 J/Kg ˚K

Slope of (dT/dt) =

The value of can be obtained by using equation

$$\sigma = \frac{m.\ C_p\ (dT/dt)}{A_d\, x(T_6^4 - T_s^4) x\ 0.86}$$

Where, Temperature of disc D at the instant when it is inserted ($T_6$).

## Conclusion

**Marks Obtained** **Sign of Faculty**