STEFAN BOLTZMANN'S LAW OF RADIATION WITH AN AMPLIFIER (KCHT-182-IIT/R)

Foreword

Welcome to the fast growing family of K.C. product owners. We appreciate your interest in us and thank you for buying our product.

You have chosen the finest quality product in the market which is produced using latest techniques and has underwent strict quality control tests. It is a product that we are proud to build and you are proud to own it.

Our products are easy to understand and operate. They are excellent for students who are trying to gain practical knowledge through experiments.

However your comfort and safety are important to us, so we want you have an understanding of proper procedure to use the equipment. For the purpose, we urge you to read and follow the step-by-step operating instructions and safety precautions in this manual. It will ensure that your favourite product delivers reliable, superior performance year after year.

This manual includes information for all options available on this model. Therefore, you may find some information that does not apply to your equipment.

All information, specifications and illustrations in this manual are those in effect at the time of printing. We reserve the right to change specifications or design at any time without notice.

Customer satisfaction is our primary concern. Feel Free to contact us for any assistance. So what are you waiting for, roll up your sleeves and let us get down to work!

K.C. Engineers Pvt. Ltd.

Important Information About This Manual

Reminder for Safety

Modification on Equipment:

This equipment should not be modified. Modification could affect its performance, safety or disturbance. In addition damage or performance problems resulting from modification may not be covered under warranties.

Precautions and Maintenance:

This is used to indicate the presence of a hazard that could cause minor or moderate personal injury or damage to your equipment. To avoid or reduce the risk, the procedures must be followed carefully.

Contents

STEFAN BOLTZMANN'S LAW OF RADIATION WITH AN AMPLIFIER

1. OBJECTIVE:

To study the Stefan Boltzmann's Law of Radiation.

2. AIM:

To verify the Stefan Boltzmann Law of Radiation.

3. INTRODUCTION:

All substances at all temperature emit thermal radiation. Thermal radiation is an electromagnetic wave and does not require any material medium for propagation. All bodies can emit radiation and have also the capacity to absorb all or a part of the radiation coming from the surrounding towards it.

4. THEORY:

The most commonly used law of thermal radiation is the stefan boltzmann law which states that thermal radiation heat flux or emissive power of a black surface is directly proportional to the fourth power of absolute temperature of the source and is given by:

$$E_b \alpha T^4 \quad \ldots (1)$$

Taking natural log of both side

$$\ln E_b \sim 4 \ln T + \ln C \quad \ldots (2)$$

Where,

E_b = Emitted radiation,

T = Absolute Temperature of the source &

C = Constant.

5. DESCRIPTION:

The apparatus consists of a thermopile with shielding tube mounted on a slider, Tungsten filament halogen lamp with holder mounted on the second slider, optical bench

which provide sliding platform to the thermopile and lamp, power supply, digital millimeters, measuring amplifier, connection box and connection cords.

6. UTILITIES REQUIRED:

6.1 Electricity Supply: Single Phase, 220 V AC, 50 Hz, 5-15 Amp combined socket with earth connection. Earth voltage should be less than 5 volts.

6.2 Bench Area Required: 1.0 m x 0.75 m.

7. EXPERIMENTAL PROCEDURE:

7.1 STARTING PROCEDURE:

7.1.1 Ensure that switches given on the panel are at OFF position.

7.1.2 Connect electric supply to the set up.

7.1.3 Switch ON the mains ON / OFF switch.

7.1.4 Set thermopile and lamp at 30 cm apart from each other.

7.1.5 Open the protective cover of the shielding tube.

7.1.6 Connect lamp with DC power supply.

7.1.7 Supply a current of 0.1 Amp to the lamp at room temperature via variac and measure the voltage.

7.1.8 Raise voltage (at an interval of 1 volt) to lamp via variac and record voltage, current and thermopile output.

7.1.9 Calculate absolute temperature of the filament and plot a log-log graph of Thermopile output and absolute temperature. It will be linear now find the slop of this line and compare it with the slop of equation (2).

7.2 CLOSING PROCEDURE:

7.2.1 When experiment is over set variac to zero position.

7.2.2 Switch OFF the Mains power supply.

7.2.3 Close opening of shielding tube with the protective cover.

8. OBSERVATION & CALCULATION:

8.1 DATA:

Temperature coefficient of resistivity of Tungsten(α) = 0.0045 K^{-1}

8.2 OBSERVATIONS:

T_R = …. ºC

V_R = …. V

I_R = 0.1 Amps

8.3 OBSERVATION TABLE:

Sr. No.	V (Volts)	I (Amps)	E_b (mV)

8.4 CALCULATIONS:

$$R_R = \frac{V_R}{I_R} \ (\Omega)$$

$$T_{Rabs} = T_R + 273.15 \ (K)$$

$$R = \frac{V}{I} \ (\Omega)$$

$$T_S = \frac{R - R_R}{\alpha R_R} + T_{Rabs} \ (K)$$

8.5 CALCULATIONS TABLE:

S.No.	E_b (mV)	T_S (K)	Ln (E_b)	Ln (T_S)

Plot the graph of Ln T_S vs Ln E_b and find the slope.

Slop ~ 4

9. NOMENCLATURE:

Nom	Column Heading	Units	Type
α	Temperature coefficient of resistivity of Tungsten	K^{-1}	Given
T_R	Room Temperature	^oC	Measured
V_R	Voltage at room temperature	Volts	Measured
I_R	Current at room temperature	Amps	Measured
V	Supply Voltage	Volts	Measured
I	Supply Current	Amps	Measured
E_b	Radiant Energy (Thermopile output)	mV	Measured
R_R	Filament Resistance at room temperature	Ω	Calculated
T_{Rabs}	Absolute Temperature of disc at time t	K	Calculated
R	Filament Resistance	Ω	Calculated
T_S	Absolute Temperature of Source (Filament)	K	Calculated

10. PRECAUTION & MAINTENANCE INSTRUCTIONS:

10.1 Never run the apparatus if power supply is less than 200 volts and more than 230 volts.

10.2 Don't operate the equipment Beyond 10 Volts.

10.3 Select care fully the mode of operation (AC or DC)on control panel as well as on Multimeter.

10.4 Never switch ON mains power supply before ensuring that all the ON/OFF switches given on the panel are at OFF position.

10.5 Always keep the apparatus free from dust.

10.6 Always keep the shielding tube protective cover.

11. TROUBLESHOOTING:

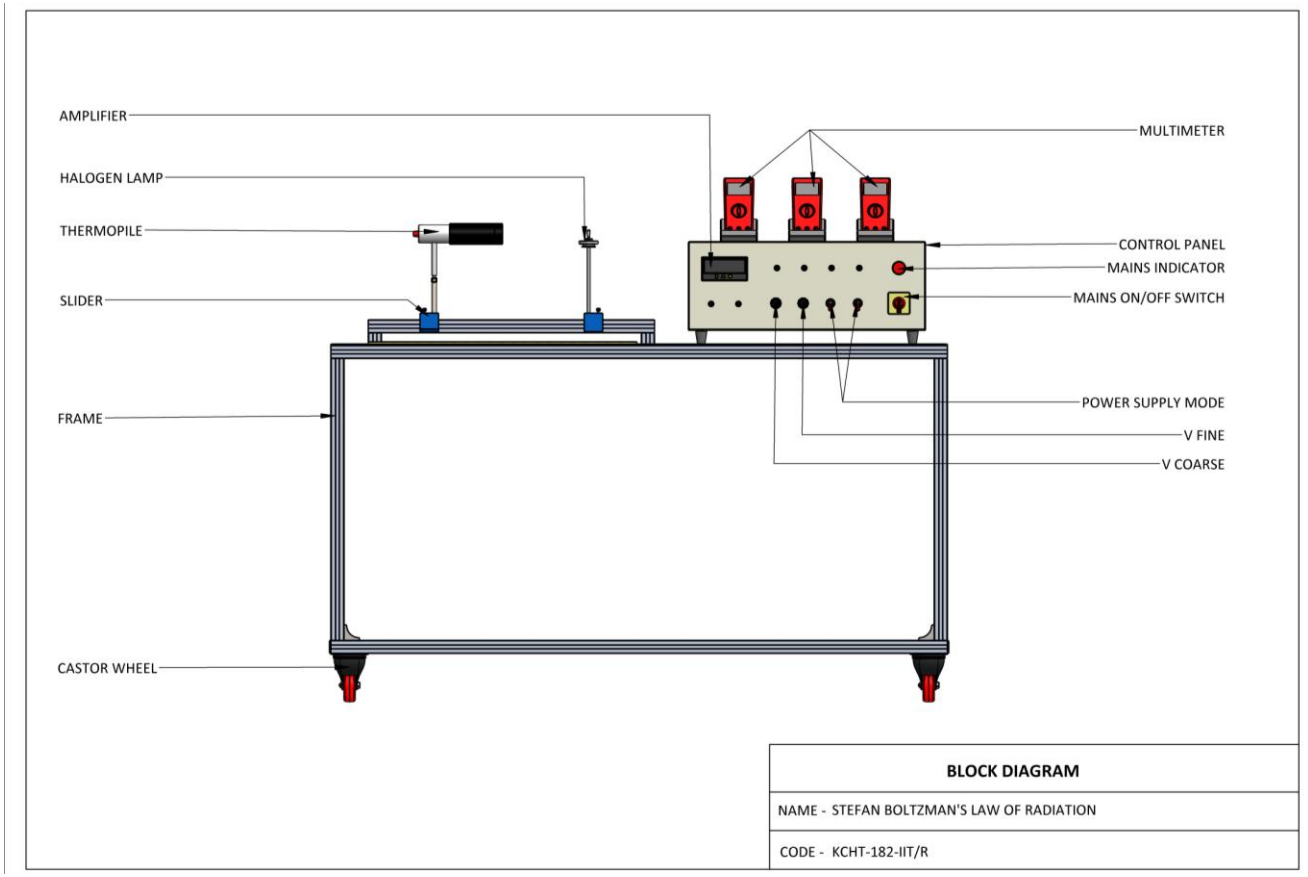
11.1 If electric panel is not showing the input on the mains light, check the main supply.

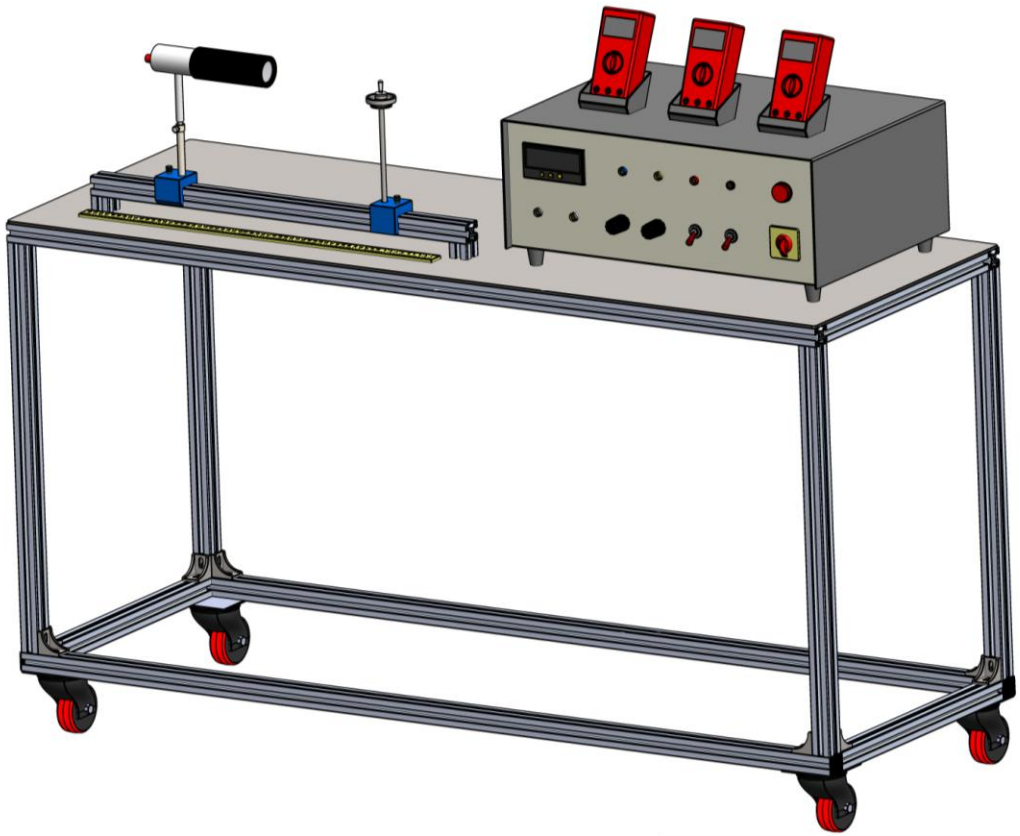
12. REFERENCES:

12.1 Holman, J.P (2008). *Heat Transfer*. 9th Ed. ND: McGraw Hill. p 372.

12.2 Cengel, Y.A (2007). *Heat and Mass Transfer*. 3rd Ed. ND: Tata McGraw Hill. pp 28, 667-671.

13. BLOCK DIAGRAM:





BLOCK DIAGRAM
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CODE - KCHT-182-IIT/R