DESIGN AND DEVLOPMENT EXPERIMENTAL SETUP OF THERMAL CONTACT RESISTANCE

Design and Development

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Abstract: Paper consists of design and fabrication of a test rig for measurement of conductivity of SS and aluminium slab which consists of a heater sandwiched between two sets of slabs. Two types of slabs are provided on either sides of heater, which forms a structure. Main aim of project is to calculate thermal resistance of slab. Thermal resistance is a bulk property that describes the ability of material to transfer heat. Thermal conductivity plays an important role where cooling is required. Thermal conductivity for slab is calculated in current report.

***Keywords*: Thermal Resistance, Composite Wall, Contact Resistance, Band Heater**

I. INTRODUCTION

Heat transfer occurs at a rate across materials of lower thermal across 'materials of high thermal conductivity'. Correspondingly, materials of high thermal resistance are widely used in heat sink application and materials of high thermal resistance are used as thermal insulation.to quantify the with which a particular medium conducts engineers employ the thermal resistance also known as the conduction coefficient k. Thermal resistance is a material property that is primarily dependent on the materials phase, temperature, density, and molecular bonding. Heat is energy in transition from a region of higher to one of lower temperature in such a way that the region reach the equilibrium. In other word heat is transferred by conduction when adjacent atoms vibrate against one another or electron moves one atom to another. Conduction is most significant means of heat transfer within a solid or between solid objects in thermal contact. Junction is to be form by pressing two similar or dissimilar metallic materials together, only a small fraction of nominal surface area is in contact because of the non-flatness and roughness of the contacting surface. The heat flux is imposed across, the junction the steady flow of heat is generally restricted in conduction through the contact dot or spots, limited number of the contact spots results in an actual contacting area that is significantly smaller than apparent contact area. This limited contact area causes a thermal resistance. Presence of a fluid or solid and other medium between the contacting surfaces may be contribute to or restrict the heat transfer at junction, depending upon the thermal conductivity, thickness, and hardness (in the case of a solid) of the different medium.

II. METHODOLOGY

Equipment and instrument used
Table 1 Description of Material-

Sr No.	Material	Specification
1	M.S plate	10mm thick
2.	Aluminum plate	10mm thick
3.	Voltmeter	Up to 300 volt
4.	Ammeter	up to 5amp
5.	Band heater	125 watt
6.	Temp sensor	Measure up to 2 to 100 degree
7.	Relay	230 voltage AC input

Manufacturing process

- Operations used for fabrication

1 .Raw material
A raw material is the basic material used in the basic material used in productions of the goods, finished products. The term "raw material" is used to denote material which is unprocessed.

2. Marking
Marking is the process of making visible impressions on the metal surface so that required operations can be carried out as per the dimensions.

3. Cutting
The raw material cut into the required dimensions using a grinding wheel cutter. Metal cutting is done by a relative motion between the work and piece and the hard edge cutting tool, which is multi point cutting tool.

4. Welding
The assembly of base table is done by the process of welding. In this case the process is done by "Arc Welding". Arc welding is

Parameter	*Description*
Heat load (W)	Up to 125 W
Source temperature	25 to 99 C

one type of welding that uses a welding power supply to make an electric arc between an electrode and the base material to be melt the metal at the welding point. They can use either direct or AC, and consumable or non-consumable electrode.

5. Drilling
Drilling is easily and the most common machining process. Drilling involves the making of holes that are right circular cylinders. This is accomplished most typically by using the twist drill. The chip through the flutes to the outside of the tool. The cutting front is embedded within work piece, making cooling difficult. The cutting area can be cover, coolant spray mist-can be applied, coolant can be delivered through the drill bit shaft.

III. EXPERIMENTAL SETUP

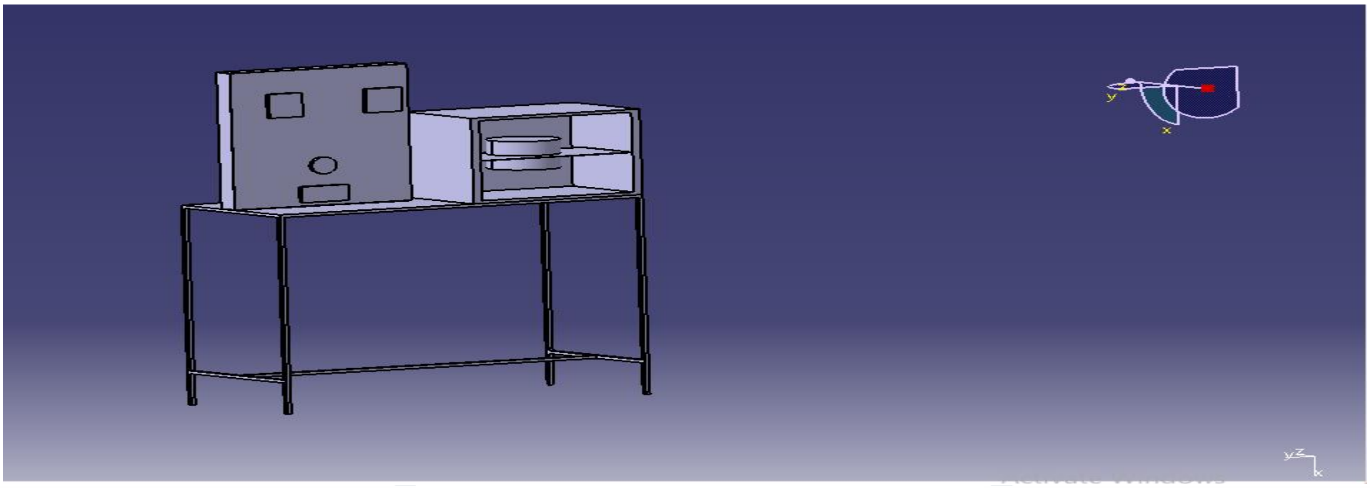

Fig. 1 Basic 3D-CAD Model of Experiment Setup

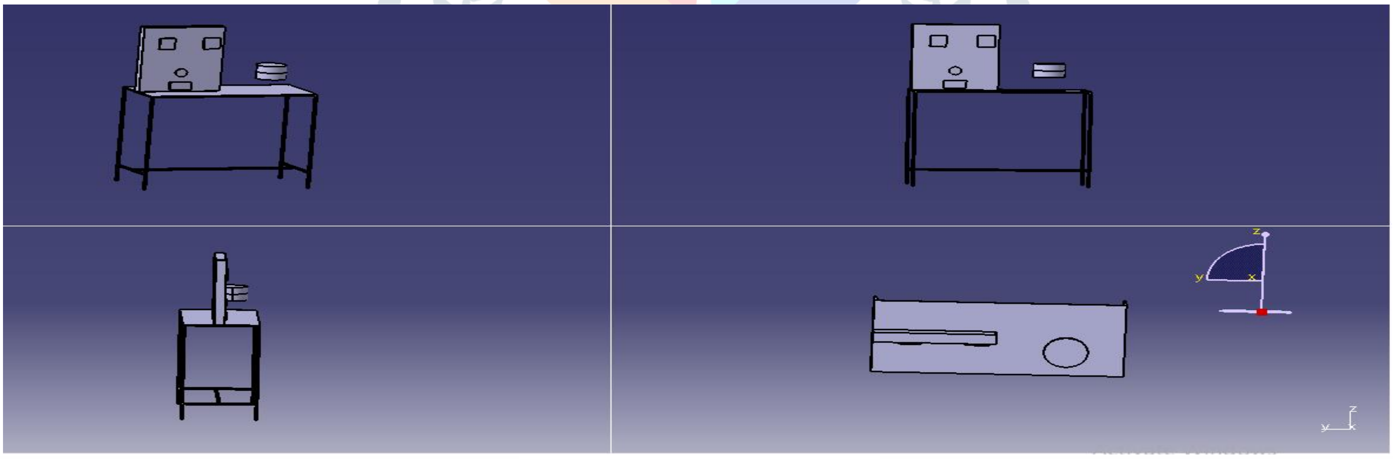

Fig. 2 Different Views of Setup

- Experimental Procedure-

a) Slabs are heated with the help of heater which increases temperature of wall.
b) The corresponding voltmeter and ammeter readings are noted and power supplied to electrical heater is calculated.
c) Temperature is measured at each face of slab so that heat transfer can be measured.
From the readings thermal conductivity and thermal contact resistance can be calculated.

- Test Parameters-

Experimentation was carried on the T PCT HRHX. Working fluid is important parameter in the experimentation. BN/H20 nano-fluid was used as a working fluid. Other parameters and its description as follows.

The heat input, effectiveness of heat exchanger is calculated by the following equations.

Heat Input
(Qin) = V x I(W)
Where, V= Voltage, I=Current

All the necessary components were assembled and experimental set was developed. The necessary instruments were attached at correct configuration and the set-up is ready for the experimentation.

IV. RESULTS & CALCULATIONS

- Observation Table-

Table 2. Observation Table

Voltage	Current	Temp T1	Temp T2	Temp T3	Temp T4	Time
10	0.571	41.8	40.3	45.6	32.9	10 min
10	0.571	41.6	40.5	45.4	32.9	10 min
11	0.721	57.5	55.9	61.7	32.9	10 min
11	0.721	57.1	55.8	61.3	32.9	10 min
12	0.829	68.6	64.1	74.5	32.9	10 min
12	0.829	68.4	64.3	74.4	32.9	10 min

- Calculation

1. For 10V

Voltage	Current	Temp T1	Temp T2	Temp T3	Temp T4	Time
10	0.571	41.8	40.3	45.6	32.9	10 min
10	0.571	41.6	40.5	45.4	32.9	10 min

Q=Voltage X Current

=10×0.571

=5.71

Stainless Steel

$$K_1=\frac{Q}{A(t3-t1)}$$

$$=\frac{5.71}{0.02986\times(45.6-41.8)}$$

= 0.50322 watt/m℃

Aluminum

$$K_1=\frac{Q}{A(t3-t1)}$$

$$=\frac{5.71}{0.02986\times(45.4-41.6)}$$

= 0.375 watt/m℃

2. For 11 Volt

Voltage	Current	Temp T1	Temp T2	Temp T3	Temp T4	Time
11	0.721	57.5	55.9	61.7	32.9	10 min
11	0.721	57.5	55.8	61.3	32.9	10 min

Q=Voltage X Current

=11×0.721

= 7.931

Stainless Steel

$$K_1=\frac{Q}{A(t3-t1)}$$

$$=\frac{7.931}{0.02986\times(61.7-57.5)}$$

= 0.64 watt/m℃

Aluminum

$$K_1=\frac{Q}{A(t3-t1)}$$

$$=\frac{7.931}{0.02986\times(61.3-57.5)}$$

= 0.4742 watt/m℃

V. CONCLUSION

Thermal conductivity of material are depending on the composition of the material. Here in this experimental setup thermal conductivity of stainless steel and aluminum is measured for different inputs.

- Heat input (Q) taken are 5.71 watt,7.931 watts, and 9.948watts
- For SS plate thermal conductivity for different heat inputs 0.5032,0.64,0.56 watt/m℃

Similarly for aluminum plate it comes out to be 0.375, 0.4742, 0.325 watt/m℃

Hence, we can say that thermal conductivity for SS plate is more than that of aluminum plate.

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