مختبر انتقال الحرارة

التجربة الاولى

اعداد / مراد خشاشنة

Al-Balqa'a Applied University

Al-Huson University College

Mechanical Engineering Department

Laboratory Name: Heat Transfer

Laboratory Day: Mo - We

Laboratory Time: 8:00 - 11:00 am

Experimental Number: 1

Experimental Name:

Student name: Morad Mohammad Ali Khashashneh

Student number: ------

Specialization: HVAC

Instructor: Prof. Mosa Al-Ajlouni

Supervisor: Ali Al-Oqool

Summer semester, 2014/2015

❖ *Objective*

To investigate the thermal conductivity and thermal resistance of brass in linear direction.

❖ *Theory*

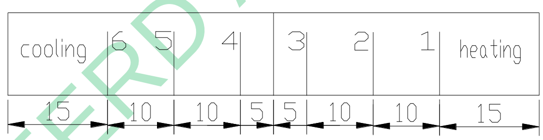
1. Thermal Resistance

$$R_{cond.} = (T_A - T_B) / q_x$$
$$q''_x = q_x / A$$

2. Thermal Contact Resistance

$$R''_{cond} = \frac{T_A - T_B}{q''_x}$$

3. Linear Heat Conduction



Layout for linear Heat Conduction

The rate of linear conduction heat transfer for this system:

$$q_x = -k.A.(dT/dx)$$
$$= k.A(T_A - T_B)/L$$

Where :

K= thermal conductivity

A= cylindrical area

L= heat traveling distance

T_A= temp. Near heater

T_B= temp. Further heater

❖ Equipment (Apparatus Name)

LINEAR AND RADIAL HEAT CONDUCTION APPARATUS LS-17 003-LRH
Stop watch

❖ Procedure

1. Read and follow the apparatus components before conduct the exp..

2. Plug the 3 pin plug to the main power supply 220VAC. Switch ON the main power.

3.connect the cold water supply. Must allow the cooling water to flow continuously throughout the exp..

4. Don't connect the extra 30 mm length of brass or stainless steel in the middle of the apparatus.

5. Apply some heat transfer compound on the surface of the thermocouple to further improve the exp performance.

6. Place the 6 thermocouples into the holes located directly above the linear heat conduction apparatus according to the numberings attached.

7. Tighten the set screws to keep the thermocouples in place. Note: make sure the thermocouples are inserted to the holes on top of brass and don't over tightened.

8. connect the thermocouple to the thermocouple slots according to the number.

9. connect the heater cable to heater supply. Then, make sure the clips properly locked.

10. Then, switch ON the ON/OFF switch.

11. Record the initial temp values for rach measuring point by switching the temp selector switch.

12. switch ON the selector switch to linear and regulate the heater to 40W by turning the heater controller.

13. Wait 30min unitl the temp achieved stable at every measuring point.

14. Observe and record down the respective final temp valuse at every point.

15. Turn OFF the ON/OFF switch after finish the exp..

❖ *Result and Calculation*

... Results Table ...				
Measuring piont	Position	Distance from Heater (mm)	Initial Temperature (ºC)	Final Temperature (ºC)
1	Nearest the heater	15	24.7	44.7
2	↓	25	24.7	42.7
3		35	24.7	41.3
4		45	24.7	36.4
5		55	24.7	33.6
6	Furthest the heater	65	24.7	30.7

... Calculations Table ...			
NO.	K_{th}	K_{exp}	ERORR
12	109	513.13	370.8%
46	109	22.57	79.3%
	http://www.engineeringtoolbox.com/thermal-conductivity-d_429.html		

Q = 40W

A = $\frac{\pi}{4}D^2$ = $\frac{\pi}{4}(25.4 \times 10^{-3})^2$ = 5.067$\times 10^{-4}\ m^2$

Slope$_{13}$ = $\frac{Ta-Tb}{Xa-Xb}$ = $\frac{43.1-41.7}{(23.5-32.6)\times10^{-3}}$ = $-153.85\ °C/m$

K$_{13}$ = $\frac{-Q}{A\times SLOPE13}$ = $\frac{-40}{5.067\times10^{-4}\times-153.85}$ =513.13 W/$m.°C$

ERORR = $\left|\frac{Kth - Kexp}{Kth}\right| \times 100\%$ = $\left|\frac{109 - 513.13}{109}\right| \times 100\%$ = 370.8%

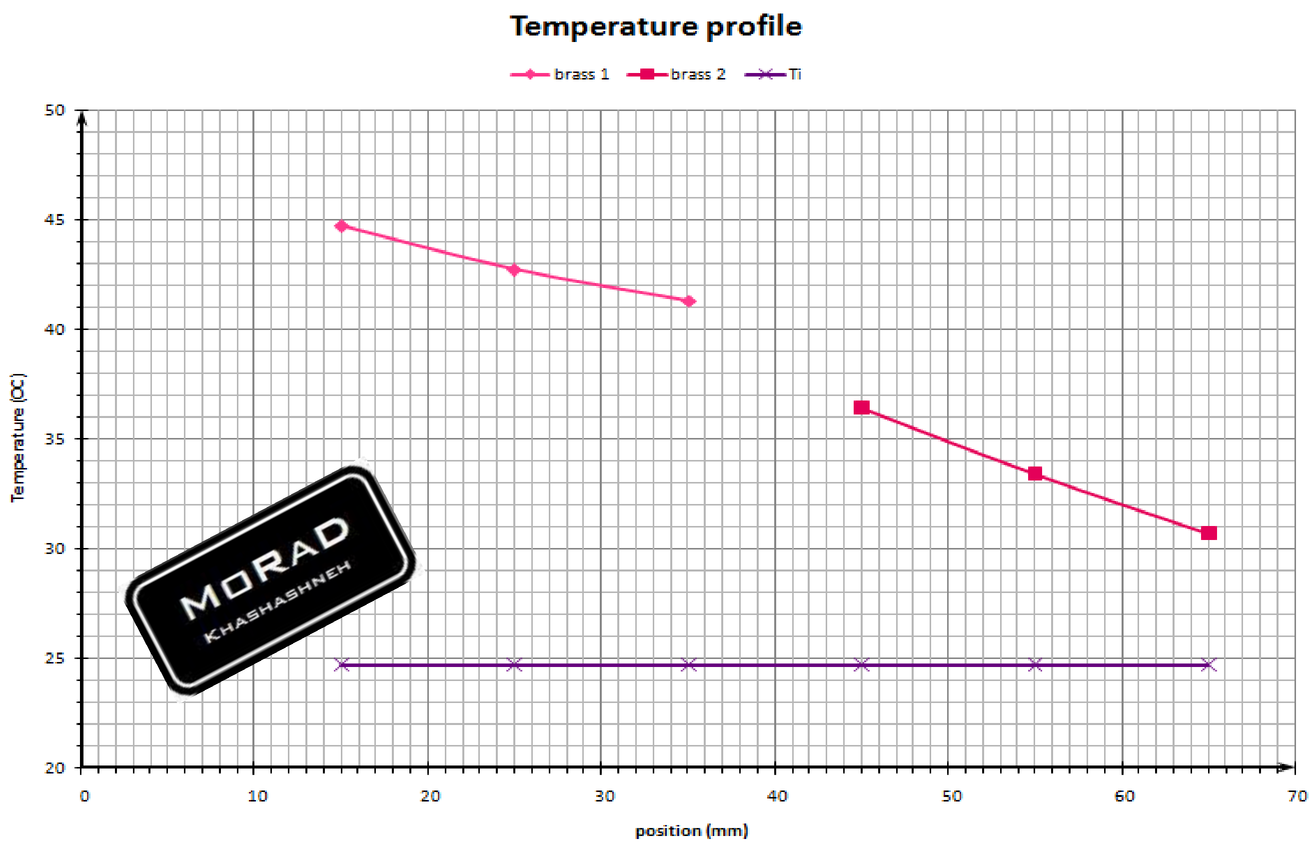
Slope$_{46}$ = $\frac{Tc-Td}{Xc-Xd}$ = $\frac{35-32}{(49.8-59.9)\times10^{-3}}$ = $-3497.03\ °C/m$

K$_{46}$ = $\frac{-Q}{A\times SLOPE46}$ = $\frac{-40}{5.067\times10^{-4}\times-3497.03}$ = 22.57 W/.K

ERORR = $\left|\frac{Kth - Kexp}{Kth}\right| \times 100\%$ = $\left|\frac{109 - 22.57}{109}\right| \times 100\%$ = 79.3%

$q''_x = \frac{q_x}{A} = \frac{40}{5.067\times10^{-4}}$ = 78942.1749 W/m^2

R$_{34}$ = $\frac{T3 - T4}{q''_x}$ = $\frac{41.3 - 36.4}{78942.1749}$ = 6.21 $\times 10^{-5}\ m^2.°C$/W


Temperature profile
brass 1
brass 2
Ti
Temperature (OC)
position (mm)
50
45
40
35
30
25
20
0
10
20
30
40
50
60
70
MoRAD
KHASHASHNEH

❖ *Discussion*

From graphs can be described in two sections. The first section of the graph is in the heater region ranging from 0-40mm, The temperature gradient along these points is decreasing. The second section is in the cooling section ranging from 40-70mm and as expected the temperature along these points also decreasing.

From the calculated thermal conductivity, k, it was found that the error was so great that the Fourier's Law was not found to be valid in this experiment. This may be due to some error which could not be avoided such as a malfunction in the probe that stops us from getting the correct temperature of the sample and due not variable of heat transfer with position(assume constant = 40W).

In general.. The temperature gradient in the linear heat transfer was found decreasing along the material from the hot surface end to the cold surface end. The heat transfer also depended on the area of the sample where the higher the area, the more the heat can be transferred. The temperature gradient of the brass was also found to decrease away from the heat source with position to cold source.

إن الجامعات هي ينبوع المعرفة ...
يأتي البعض إليها لينهلوا منها ...
والبعض لأخذ نفحات ... والبقيّة
للتمسح بها لا أكثر ...

وما تنساني من دعوة ^_^

مراد الخشاشنة