DETERMINATION OF THERMAL CONDUCTIVITY OF STEEL, IRON AND BRASS USING COMPUTER AND PHOENIX KIT

Yogesh Pathak*

Abstract:

Thermal conductivity of metal or alloy is measured using computer and phoenix kit. The measured value of thermal conductivity of iron metal is 47.38 W/m^{0}K, steel 21.69 W/m^{0}K and brass 121.22 W/m^{0}K and compared with standard values. This technique can be used in industries to check the conductivity of new metal and alloy in the research and development section. Here we learned both hardware and software applied to physics using new technique of computer interface and automation.

Key Words: Phoenix Kit, LM 35, Software, heat rate.

* Department of Physics, Dada Patil Mahavidyalaya, Karjat.

Introduction:

Objective of the research is that to utilize computers in a best manner to teach science and experiments in science. The physical science plays an important role in the study of the physical properties of metals by which one can decide the quality of metal. Out of which thermal conductivity is one of the most important property of material. Generally two types of conductivities observed electrical and thermal related with each other shown by *Weidman-Franz law*. At a given temperature, the thermal and electrical conductivities of metals are proportional, but as temperature increase the thermal conductivity will also increases while decreasing the electrical conductivity. This behavior is quantified in the Weidman-Franz Law [1-3].

$$\frac{k}{\sigma} = LT \quad OR \quad L = \frac{k}{\sigma T} \quad Widemann - Franz\ Law$$

Block diagram:

1. **Transducer :**

Transducer LM 35 is a temperature transducer which converts temperature into its equivalent electrical signal. It is very sensitive to temperature; the scale factor is 0.01v/˚c. That is when temperature is 10˚c then it gives 100mv voltage.

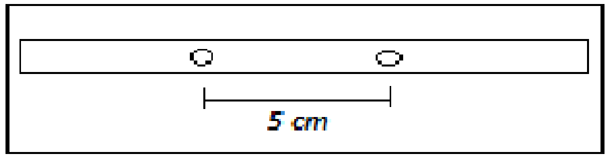
2. **Phoenix kit:**

We can't read electrical signal directly with the help of computer and we don't have the facility to connect the transducers directly to computer. Phoenix kit is used to interface these transducers and convert the electrical signal coming from transducers into digital form and send it to the computer using simple commands. Python programming language is used as a tool for data acquisition, analysis, displays and for writing simulation programs [4-6].

3. Computer:

Computer does the function of reading the data, process data and finally displays the result.

Detail working:



Two transducer's LM 35 fitted in the metal rod which is shown in fig.(b), the distance between these transducer's is 0.05m. The analog output of these transducers is given to CH0 and CH1 of phoenix kit. The ADC converts analog data into digital form. The digital data is taken by the computer through CH0 and CH1 of ADC. This digital data is processed based on transducer's equation and is converted into its equivalent temperature and the temperature from these transducer's displayed on the screen. When we heat the transducer at one end then sensor at that end gets heated up and gives some temperature say T1, at the same time second sensor also show some temperature say T2. There is always some temperature difference between T1 and T2 because to pass heat from one place to other it will takes some time. Here T1 is always greater than T2; By calculating the difference and using following equation thermal conductivity is calculated.

$$lamda = (heatrate * dist)/(area * (T1 - T2))$$

Software to find the heat rate:

```
import phm, time
p=phm.phm()
f=open('heatrate.dat','w')
for t in range(60):
        p.select_adc(0)
        ch0=p.get_voltage()[1]
        t1=ch0/10
        print t,'%5.2f'%(t1)
        time.sleep(30)
        f.write('%5.0f\t'%(t))
        f.write( '%5.2f\n'%(t1))
f.close()
```

Software to find thermal conductivity:

```
import phm, time

p=phm.phm()

area=0.502e-4;
dist=0.05;
heatrate=1.060832;
```

```
sum1=0;
f=open('steel.dat','w')
for t in range(0,20):
        p.select_adc(0)
        ch0=p.get_voltage()[1]
        t1=ch0/10
        T1=t1+273
        p.select_adc(1)
        ch1=p.get_voltage()[1]
        t2=ch1/10
        T2=t2+273
        lamda = (heatrate*dist)/(area*(T1-T2))
        print t,'\t\t%5.2f'%(T1),'\t\t%5.2f'%(T2),'\t\t%5.2f'%(lamda)
        time.sleep(5)
        sum1=sum1+lamda
        f.write( '\t%5.2f\t'%(T1))
        f.write( '%5.2f\n'%(T2))
f.close()
average =sum1/20
print average
```

Observations:

For heat rate of Steel

TIME In min	TEMP In ^{0}C	TIME In min	TEMP In ^{0}C
1	100	16	29.41
2	86.27	17	29.41
3	70.59	18	29.41
4	60.78	19	29.41
5	52.94	20	27.45
6	49.02	21	27.45
7	45.1	22	29.41
8	39.22	23	27.45
9	37.25	24	27.45
10	35.29	25	25.49
11	33.33	26	27.45
12	33.33	27	27.45
13	31.37	28	27.45
14	31.37	29	29.41
15	31.37	30	27.45

For heat rate of Iron

TIME In min	TEMP In ^{0}C
1	100
2	84.31
3	70.59
4	58.82
5	50.98
6	47.06
7	43.14
8	39.22
9	45.1
10	35.29
11	35.29
12	33.33
13	31.37
14	29.41
15	31.37

For heat rate of Brass

TIME In min	TEMP In ^{0}C
1	98.04
2	76.47
3	66.67
4	56.86
5	54.9
6	50.98
7	47.06
8	39.22
9	39.22
10	33.33
11	31.37
12	29.41
13	29.41
14	29.41
15	29.41

Obs. No.	MATERIALS	HEAT RATE In ^{0}C/min
1	BRASS	2.188
2	IRON	2.007
3	STEEL	1.623

Thermal Conductivity of Steel

Time In Sec	T_1 in ^0C	T_2 in ^0C	Thermal conductivity in w/m k
0	363.20	314.18	21.55
1	361.24	314.18	22.45
2	363.20	314.18	21.55
3	363.20	316.14	22.45
4	365.16	314.18	20.73
5	365.16	316.14	21.55
6	363.20	316.14	22.45
7	365.16	316.14	21.55
8	365.16	316.14	21.55
9	365.16	316.14	21.55
10	363.20	316.14	22.45
11	365.16	316.14	21.55
12	365.16	316.14	21.55
13	365.16	316.14	21.55
14	365.16	318.10	22.45
15	365.16	316.14	21.55
16	365.16	316.14	21.55
17	369.08	318.10	20.73
18	365.16	318.10	22.45
19	369.08	318.10	20.73

Average Thermal conductivity= 21.69 w/m°k

Thermal Conductivity of Iron

Time In Sec	T_1 in ^0C	T_2 in ^0C	Thermal conductivity in w/m k
0	322.02	302.41	75.23
1	323.98	304.37	75.23
2	325.94	304.37	68.39
3	327.9	304.37	62.69
4	331.82	306.33	57.87
5	329.86	306.33	62.69
6	333.78	306.33	53.73
7	335.75	308.29	53.73
8	333.78	308.29	57.87
9	337.71	308.29	50.15
10	337.71	312.22	57.87
11	341.63	310.25	47.02
12	341.63	310.25	47.02
13	343.59	312.22	47.02
14	345.55	312.22	44.25
15	347.51	314.18	44.25
16	347.51	314.18	44.25
17	349.47	316.14	44.25
18	351.43	316.14	41.79
19	353.39	316.14	39.59

Average Thermal Conductivity= 53.74 w/m°k

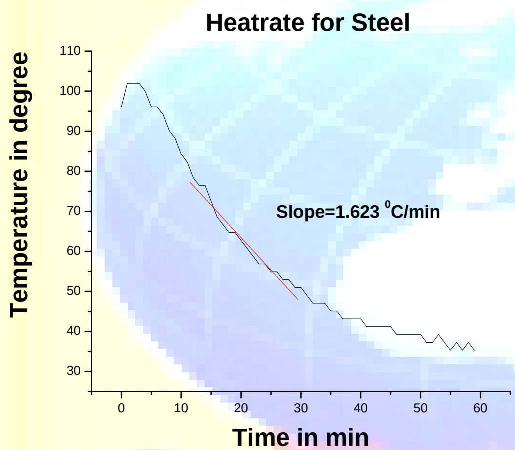
Thermal Conductivity of Brass

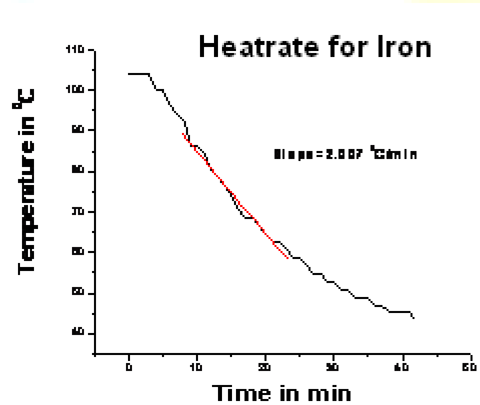
Time In Sec	T_1 in ^0C	T_2 in ^0C	Thermal conductivity in w/m k	Time In Sec	T_1 in ^0C	T_2 in ^0C	Thermal conductivity in w/m k
0	341.63	327.90	92.31	10	339.67	331.82	161.54
1	341.63	331.82	129.23	11	341.63	329.86	107.69
2	341.63	329.86	107.69	12	343.59	331.82	107.69
3	341.63	331.82	129.23	13	341.63	331.82	129.23
4	341.63	329.86	107.69	14	341.63	331.82	129.23
5	341.63	329.86	107.69	15	343.59	331.82	107.69
6	341.63	331.82	129.23	16	341.63	331.82	129.23
7	341.63	331.82	129.23	17	339.67	331.82	161.54
8	341.63	331.82	129.23	18	341.63	331.82	129.23
9	343.59	329.86	92.31	19	343.59	331.82	107.69

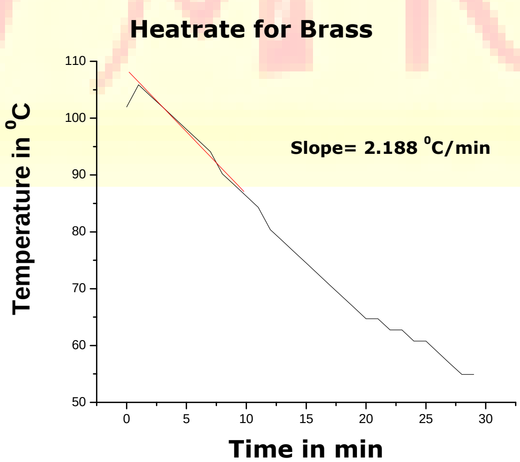
Average Thermal conductivity=121.22 w/m°k

Comparative Chart:

Sr. No.	Metal	Observed value of Thermal Conductivity	Standard Value of Thermal Conductivity[7]
1	STEEL	21.69 W/m^0K	24 W/m^0K
2	IRON	47.38 W/m^0K	55 W/m^0K
3	BRASS	121.22 W/m^0K	121 W/m^0K







Conclusion and Applications:

1. From the above table it can be concluded that Brass has good thermal conductivity than Iron and Steel.
2. All utensils are coated with Brass from bottom since it has good thermal conductivity.
3. This technique can be used in industries to check the conductivity of new metal in the research and development section.

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