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Innovative Technique for Measurement of Heat Rate of Metal and Alloy

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Abstract:

Thermal conductivity measurement of metals or alloys is necessary in industry for quality control. Heat rate is one of the parameter in measuring thermal conductivity. In laboratory it is difficult to measure Accurate and repeatable heat rate and it takes longer time because of lengthy experimental process also complicated formulas. In order to overcome this we have designed software based heat rate measurement system using Phoneix kit. Combination of hardware and software framework is performed using Phoenix kit. Temperature is measured using IC LM 35 temperature sensor. Software is designed using python programming language with ubuntu operating system. The heat rate observed is 1.60938 ^{0}C/min, 1.615805 ^{0}C/min and 1.66379 ^{0}C/min for Steel, Iron and Brass respectively.

Key words: *Heat rate, Phoenix kit, hardware, software, LM 35, Python Programming Language.*

1.1 Introduction:

To check the quality of material everyone try to maintain proper characteristics of material. There are various physical properties needs to be study. Out of which thermal conductivity is one of the most important property of material. Two types of conductivities occur in material electrical and thermal related with each other shown by *Weidman-Franz law*. At a certain 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 behaviour is well quantified in the Weidman-Franz Law.[1-2] Thermal conductivity is the property of a material's ability to conduct heat. It appears in Fourier's Law for heat conduction. The unit of Thermal conductivity is watts per kelvin-meter (W·K−1·m−1, i.e. W/(K·m). There are a number of ways to measure thermal conductivity of metals or alloys. Each of these is suitable for a limited range of materials, depending on the thermal properties and the medium temperature.[3] The thermal conductivity of metals and alloys is of two-fold interest. In coincidence with other properties of conductivity, particularly electrical conductivity, which focus on the fundamental interaction processes which occur within metallic systems, so that the study of thermal conductivity has played an important role in our understanding of the physics of metals.[4] Advance technology plays important role in the field of temperature measurement due to having a huge variety of sensors and measuring instruments now being available for making accurate measurements at relatively low costs. The Large amount of heat generated in metal during heating process. Manually the high temperatures measurement is difficult in laboratory.[5-7] To measure thermal conductivity most important is to find heat rate of metal or alloy. In laboratory it is difficult to measure Accurate and repeatable heat rate and it takes longer time because of lengthy experimental process also complicated formulas. In order to overcome this we have designed software based heat rate measurement system using Phoneix kit and computer. The python programming language used for design software. Present pare focus on measurement of heat rate through steel, iron and brass.

1.2 LM 35:

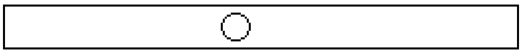
Highly accurate temperature measuring instruments are now widely available at very less costs for making temperature measurement easy. When most people have a requirement to measure a temperature, their first reaction is to purchase the highest specification, most expensive sensor and measuring instrument they can afford.[8] The temperature sensor used for in this work is an LM35 temperature sensor. The LM35 is an integrated circuit sensor that can be used to measure the temperature with an electrical output proportional to the temperature (in°C) and the main property of this sensor is that it is very sensitive to heat, therefore, it is used in various electronic appliances for monitoring temperature. This type of monitoring is very important because the amount of heat need to manage properly.[9]

1.3 Phoenix Kit:

It is an electronic device which is used for computer interfaced science experiments without getting into the details of electronics or computer programming. For performing experiments it acts as intermediate part between computer and sensible circuits. It consist power supply, data acquisition and processing. Phoenix-M can also function like a micro-controller development system helping embedded system designs. Phoenix-M is developed by Inter-University Accelerator Centre 1. IUAC is an autonomous research institute of University Grants Commission, India.

The aim of Phoenix is to make easy way of laboratory experiments than lengthy process. Experimental learning should be the interested thing for students while learning of science subjects. Students at the college level do the traditional lab experiments by following a given steps to take some measurements. Limitations of the apparatus does not allow taking sufficient data points involving fast changing parameters like position of a moving body or a fluctuating temperature. Phoenix provides microsecond level accuracy for timing measurements but the present version gives only 0.1 % resolution for analog parameters, limited by the 10 bit ADC used. [10]

2. Experimental:



As shown in above figure a small hole of dimension of LM 35 sensor is made on metal or alloy rod. LM 35 is mounted at particular place and analog output is given to CH0 of Phoenix kit during experimental work. ADC in Phoenix kit converts analog output into digital form. This digital data is processed according to sensor equation and is converted into its equivalent temperature and it is recorded for calculation of heat rate.

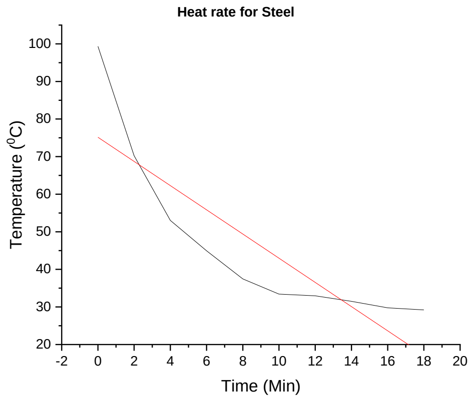
The python program to calculate heat rate.

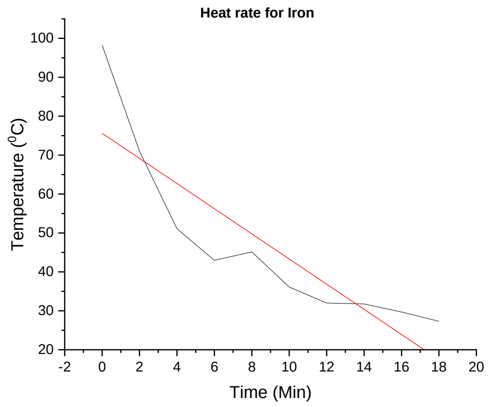
```
import phm, time
p=phm.phm()
f=open('heat.dat','w')
for t in range(120):
        p.select_adc(0)
        ch0=p.get_voltage()
        t1=ch0/10
        print t,'%5.2f'%(t1)
        time.sleep(10)
        f.write('%5.0f\t'%(t))
        f.write( '%5.2f\n'%(t1))
f.close()
```

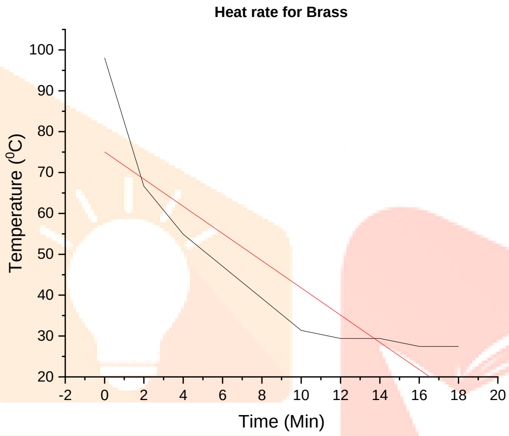
3. Observation table for heat rate:

Sr. No.	Time In min	Temperature In ^{0}C		
		Steel	**Iron**	**Brass**
1	0	99.35	98.27	98.04
2	2	70.24	71.02	66.67
3	4	53.02	51.10	54.9
4	6	44.93	42.96	47.06
5	8	37.47	45.14	39.22
6	10	33.43	36.12	31.37
7	12	32.97	32.01	29.41
8	14	31.49	31.76	29.41
9	16	29.76	29.69	27.45
10	18	29.21	27.32	27.45

4. Graphs:







5. Result and Conclusion:

From above observations the graphs are plotted with the help of origin 8 software. From slope heat rate is calculated. The values of heat rate for Steel 1.60938 ^{0}C/min, Iron 1.615805 ^{0}C/min and Brass 1.66379 ^{0}C/min are observed. We can use these values for measurement of thermal conductivity of metal or alloy using the same technique of phoenix kit and computer. This technology based method is time consuming, useful to reduce human efforts and it will minimize errors in performing experiments.

6. Acknowledgment:

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