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Research Article

EXPERIMENTAL INVESTIGATION OF TEMPERATURE DISTRIBUTION IN DIFFERENT FOOD GRADE METALS

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ABSTRACT
In this experiment, the longitudinal temperature distribution of different food grade metal pipes is evaluated for the heat conductivity performance and it is analysed by varying the voltages at different ranges. A typical heat pipe consists of a sealed pipe or tube made of a food grade material that is compatible with the working fluid (water). Typically a vacuum pump is used to remove the air from the empty heat pipe. The heat pipe is partially filled with a working fluid and then sealed. The working fluid mass is chosen so that the heat pipe contains both vapour and liquid over the operating temperature range. Water heat pipe are sometimes filled by partially filling with water, heating until the water boils and displaces the air, and then sealed while hot. When the heater starts heating, the pipes begin to transfer the heat through by the pipes. Rapid rise of temperature of water and the heat pipe, demonstrates the apparent temperature distribution of pipe calculated. And the result is analysed by plotting the graph between heat sink in water with temperature rise up to 30 minutes and longitudinal temperature distribution with different pipes.

Keywords: *Heat Pipe, Temperature Distribution*

INTRODUCTION

The heat pipe is an interesting technology which is used to transfer heat from one point to another. It work's with the help of evaporation and condensation of liquid, which acts as sink at the lower end of pipes. The heating oil is connected to the heat the pipes for transfer of heat up to appropriate temperature. All the pipes have same physical in dimensions and mounted with a band heater at middle end.

The heat pipe employs evaporative cooling to transfer thermal energy from one point to another by the evaporation and condensation of a working fluid or coolant. Heat pipes rely on a temperature difference between the ends of the pipe and cannot lower temperature at either end beyond the ambient temperature (hence they tend to equalise the temperature within the pipe). When one end of the heat pipe heated the working fluid inside the pipe at that end evaporative and increases the vapour pressure inside the cavity of the heat pipe. The latent heat of evaporation absorbed by the vaporisation of the working fluid reduces the temperature at the hot end of the pipe. The vapour pressure over the hot liquid working fluid at the hot end of the pipe is higher than the equilibrium vapour pressure over the condensing working fluid at the cooler end of the pipe and this pressure difference drives a rapid mass transfer to the condensing end where the excess vapour condenses releases its latent heat and warms the cool end of pipe. Non-condensing gases (caused by contamination of gases) in the vapour impede the gas flow and reduce the effectiveness of the heat pipe, particularly at low temperature, where vapour pressure are low. The speed of molecules in a gas is approximately the speed of sound, and in the absence of non-condensing gases. This is the upper limit to the velocity with which they could travel the heat pipe. In practice the speed of the vapour through the heat pipe is limited by the rate of condensation at the cold end and far lowers the molecular speed. The condensed working fluid then flows back to the hot end of the pipe. In the case of vertically oriented heat pipes the fluid may be moved for the force of gravity. In the case of heat pipes containing wicks, the fluid is returned by capillary action. When making heat pipes, there is no need to create a vaccum in the pipe. One simply boils the working fluid in the heat pipe until the resulting vapour has purged the non-condensing gases from the pipe, and then seals the end.

An interesting property of heat pipes is the temperature range over which they are effective. Initially, it might be suspected that water charged heat pipe only works when the hot end reaches the boiling point (100^0c) and steam is transferred to the cold end. However, the boiling point of water depends on the absolute pressure inside the pipe. In an evacuated pipe, water vaporizes from its melting point (0^0c) to its critical point (373^0c), as long as the heat pipe contains both liquid and vapour. Thus a heat pipe can operate at hot end temperature as low as just slightly warmer as the melting pint of the working fluid, although the maximum power is low at temperature below (25^0c). Similarly, a heat pipe with water as a working fluid can work well above the boiling point (100^0c). The maximum temperature for long term water heat pipes is (270^0c), with heat pipes operating up to (300^0c) for short term tests. The main reason for the effectiveness of heat pipes is the evaporation and condensation of the working fluid. The heat of vaporization greatly exceeds the sensible heat capacity. Using water as an example of energy needed to raise the temperature of that same one gram of water by 1^0c. Almost all of that energy is rapidly transferred to the cold end when the fluid condenses there making a very effective heat transfer system with no moving parts.

MATERIALS AND METHODS

It consists of 3 identical cylindrical conductors. One end of these is heated electrically while there is small capacity tanking acting as heat sinks at the other end. The unit consists of Stainless Steel pipe (SS 304), Aluminium Alloy pipe (AA 1050), Brass pipe (IS 4822: 1981) and thermocouples are embedded along the lengths to measure the temperature distribution and heat transfer rate is noted in terms of the temperature rise.

The performance of heat pipe as super conducting device could be studied well in terms of the temperature distribution along the length at a given instant and could be compared with the other two numbers. Nearly isothermal temperature distribution and test rise of temperature in heat sinks tanks reveals the heat pipe superiority over the conventional conductors.

Fill up sufficient amount of water in the heat sinks. Ensure proper earthing to the unit put the thermometer at the top of heat sinks. Keep dimmer stat zero position and start the electric supply to the unit. Slowly increases the dimmer, so the power is supplied to heaters. As same dimmer stat supplies power to all heaters and all heaters are of same capacity, power input to the entire heater remains same. This makes the comparison simpler. Go on noting down readings, the temperature of water in heat sinks in every 5 minutes. After 30 minutes, note down the readings of longitudinal temperature distribution of the pipes from the temperature indicator. Repeat the procedure at different heat inputs.

Observation

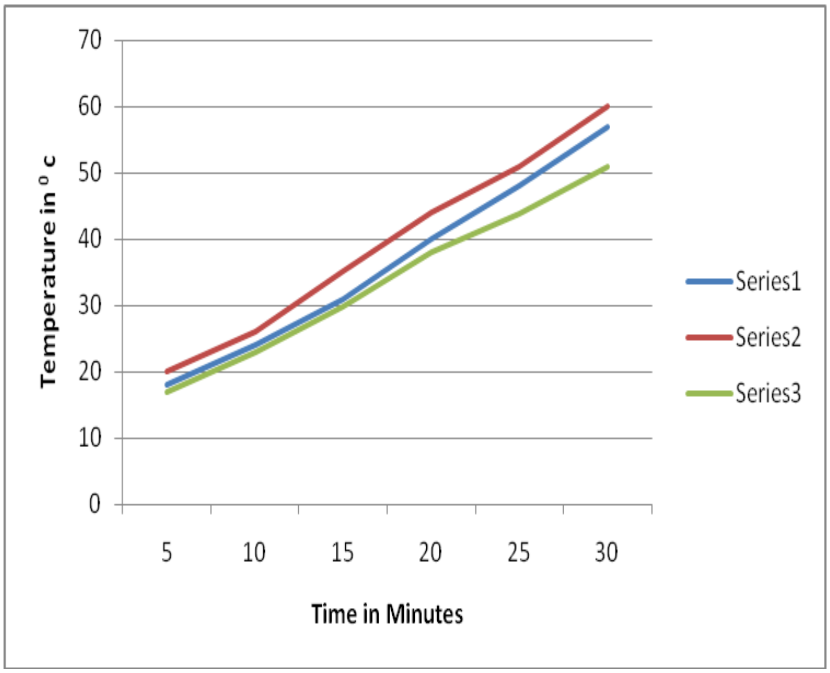
Table 1: Water Temperature at Sink at 220V

S. no	**Time (Minutes)**	**Heat sink in Water for SS 304**	**Heat sink in Water for AA 1050**	**Heat sink in Water for IS 4822 : 1981**
1.	5	18	20	17
2.	10	24	26	23
3.	15	31	35	30
4.	20	40	44	38
5	25	48	51	44
6.	30	57	60	51

If the experiments are conducted for more time, it is merely to raise the water temperature and ultimately evaporation of water.

1. Provide the necessary electrical connection and then switch on system.
2. Switch on the heater and set the voltage (say 150V to 220V) using heater regulator and the digital voltmeter.
3. Wait for sufficient time to allow temperature to reach steady values.
4. Note down the Temperatures 1 to 5 using the channel selector and digital temperature indicator.
5. Note down the ammeter and voltmeter readings.
6. Calculate the axial heat flux for all the pipes.
7. Compare the different heat inputs and compare the results.

Graphical Data for Temperature Distribution of Pipe's Vs Time

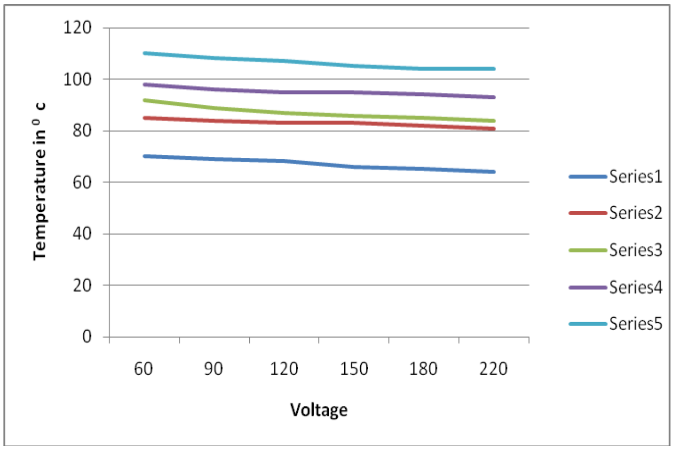


Graph 1
Series 1: SS 304, Series 2: AA 1050, Series 3: IS 4822: 1981

Table 2: Longitudinal Temperature Distribution for SS 304

S. no	Voltage	Ammeter	Temperature ^{0}c for SS 304					
			T1	T2	T3	T4	T5	T6
1.	90	1.0	70	69	68	66	65	64
2.	120	1.0	85	84	83	83	82	81
3.	150	1.0	92	89	87	86	85	84
4.	180	1.5	98	96	95	95	94	93
5.	220	2.0	110	108	107	105	104	104

Graphical Data for Various Voltage Vs Temperature Distribution of SS 304

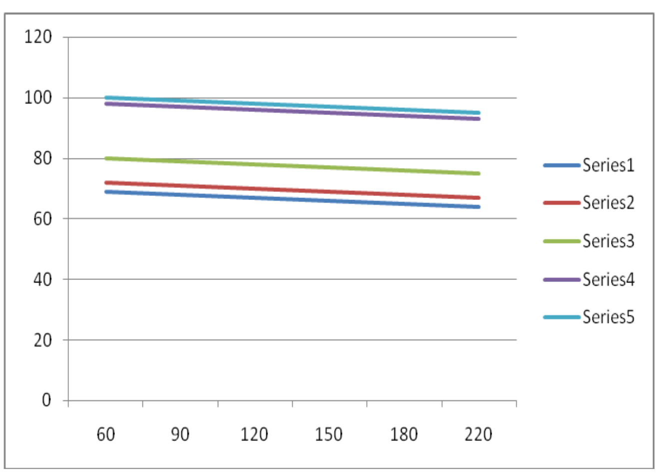


Graph 2
Series 1: 90V Series 2:120V Series 3: 150V Series 4: 180V Series 5: 220V

Table 3: Longitudinal Temperature Distribution for AA 1050

S. no	Voltage	Ammeter	Temperature ^{0}c for AA 1050					
			T1	T2	T3	T4	T5	T6
1.	90	1.0	69	68	67	66	65	64
2.	120	1.0	72	71	70	69	68	67
3.	150	1.0	80	79	78	77	76	75
4.	180	1.5	98	97	96	95	94	93
5.	220	2.0	100	99	98	97	96	95

Graphical Data for Various Voltage Vs Temperature Distribution of AA 1050

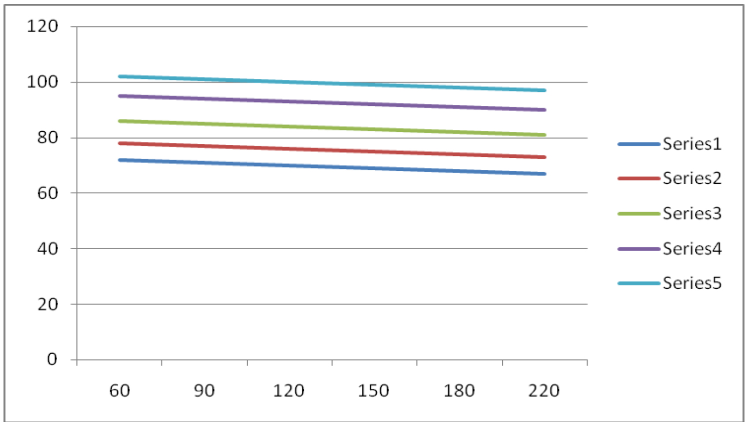


Graph 3
Series 1: 90V Series 2:120V Series 3: 150V Series 4: 180V Series 5: 220V

Table 4: Longitudinal Temperature Distribution for IS 4822:1981

S. no	Voltage	Ammeter	Temperature ^{0}c for IS 4822 : 1981					
			T1	T2	T3	T4	T5	T6
1.	90	1.0	72	71	70	69	68	67
2.	120	1.0	78	77	76	75	74	73
3.	150	1.0	86	85	84	83	82	81
4.	180	1.5	95	94	93	92	91	90
5.	220	2.0	102	101	100	99	98	97

Graphical Data for Various Voltage Vs Temperature Distribution of IS 4822:1981



Graph 4
Series 1: 90V Series 2:120V Series 3: 150V Series 4: 180V Series 5: 220V

RESULTS AND DISCUSSION

Thus the studies, issue the data on the heat conductivity of different materials through by heat pipe demonstrator. And the performance of the heat pipe's as a super conducting devices could be studied well in terms of the temperature distribution along the length at a given instant and could be compared with the other two numbers. Nearly isothermal temperature distribution and test rise of temperature in heat sink tanks reveals the heat pipe superiority over the conventional conductors. Hot pipe is a latest development in the field of heat transfer and finds its applications from space craft to kitchen. It is a superconducting devices and transfer of heat by boiling and condensation of fluid and hence transfer of heat takes place.

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