Good report on heat pipes

Health & Medicine, Addiction

Objectives

The aim of this experiment is to study the effective thermal conductivity of a heat pipe. This is achieved by measuring the difference in temperature across the heat pipe and another conductor made of the same material and size. The temperature measurement for both the pipe and conductor is done under identical thermal conditions.

Apparatus

- Copper-water heat pipe – The specimen whose thermal conductivity is to be found. It is represented in Figure 1.
- Solid Copper Wire – The reference material of same size.
- Thermocouple (quantity – 3) – Temperature measuring instrument (analogue).
- Multi-channel digital thermometer – Temperature measuring instrument (digital) capable of reading more than one temperature at a time; particularly useful for simultaneous monitoring of temperatures.
- Vernier Caliper – Instrument used to measure length (diameter of the specimens in this case); it has a least count of 0. 01 cm.
- Ring stand with clamps (quantity – 2).
- Glass beaker (quantity – 2).
- Hot plate.

Figure 1: Heat Pipe

Results

Beaker 1 contains the copper wire, and beaker 2 contains the heat pipe.

Fourier’s law of Conduction

This law, which is also popularly known as the law of heat conduction states that the rate of change of heat transfer in a material is directly proportional to the area and the negative gradient of temperature. The area considered is at 90 degrees to that gradient. Mathematically, it can be represented in 2 ways: 1) differential form and 2) integral form.

Data

Calculations

The thermal conductivity of the copper wire is given as K = 287 w/mK.

Further, the length of both the specimens is given to be equal. Then, using the Integral Form of Fourier’s Law, we have:

(-KA dT/dx) copper wire = (-KA dT/dx) heat pipe

Here, dx is the same on both sides; therefore,

287 x (0. 0029)2 x (61. 5-54. 3) = K x (0. 0033)2 x (58 – 34. 2)

Implies K = 67. 05 w/mK.

Conclusions

A heat pipe is a heat transfer device. It combines the principles of phase transition and thermal conductivity in order to efficiently maintain the process of heat transfer at two solid interfaces.

They make use of evaporative cooling for the transfer of thermal energy between different points, by the processes of evaporation and condensation respectively, of a coolant or working fluid. They rely on the difference in temperatures at the ends of the pipe. Thus using a fairly accurate temperature sensor is essential.

The heat of vaporization is an important parameter that decides the effectiveness of a het pipe. This is because the processes of evaporation and condensation depend on it; it is much greater than the sensible heat capacity. For example, the energy required to evaporate exactly one gram of water is about 540 times the energy required to increase the temperature of the same amount of water by 1 degree Celsius.

As explained in the results, beaker 1 in the experiment contained the copper wire, and beaker 2, the heat pipe. From calculations, the effective thermal conductivity of the latter is found to be 67. 05 w/mK. The accuracy of this estimation depends on the accuracy of the accuracy of the thermocouples used. The value of thermal conductivity indicates how quickly heat is transferred within the material; it is higher in the heat pipe, as expected.