King Fahd University of Petroleum and Minerals

University Diploma Program
Electronic Equipment Maintenance
Lab Instructor: Muhammad Ajmal Khan

EET-027, Experiment # 4

MATERIAL BEHAVIOR

Objectives:

1. To examine the behavior of thermister when heated.
2. To examine the behavior of nichrome wire when loaded with weight.
3. To examine the behavior of bimetallic strip when heated.

Apparatus:

DC Power Supply

Wheatstone bridge

Multimeter

Thermisters

Bimetallic strip

THEORY:

In this experiment, we will examine the behavior of some materials that affect control in mechanisms. You should already know that most materials are affected by varying environmental conditions. For instance, steel is affected by temperature, stress and strain. The resistance and the length of copper is affected by temperature. The length of wood and hair are affected by humidity. The conductivity of salt is affected by moisture. We use such knowledge in the design of control equipment. This equipment will investigate the effects of temperature, elongation, humidity, conductivity and hysteresis.

The resistance of a wire changes in two ways due to heat. One way is due to the temperature only, and the other way is due to the deformation of the wire when heat is applied. The reason that the resistance of a metal conductor changes when heat is applied is because the heat agitates the electrons, creating movement of electrons, which influences the resistance.

For most conducting materials, the resistance increases linearly with an increase in temperature over normal temperature ranges. Some alloys have been developed which do not increase very much at all with an increase in temperature. Temperature has very little effect on the resistance of this type of material.

There are a few materials that have a negative temperature-resistance characteristic; that is, the resistance decreases as the temperature increases. Carbon is one example. Some materials with high temperature characteristics are used in temperature-measuring devices. These materials often exhibit non-linear resistance characteristics and are known by names like sensitors or thermisters. The resistance of wire also changes with change in length. The change in length can be brought about through effects of temperature, or by stretching.

The coefficient of linear expansion is a term used when dealing with materials whose length changes due to temperature changes, stretching due to strain, etc. The coefficient of linear expansion, C, is defined as the change in length, of each unit length, for a rise of temperature of one degree. The most common example of temperature affecting the length of an object is the mercury tube thermometer. It is well known that a mercury tube thermometer is a good indicator of temperature because of its linear expansion when influenced by small temperature changes. When heated, the mercury column expands and rises, and when cooled, the mercury column contracts and returns toward the bottom.

Another example of a control device utilizing expansion due to heat is the thermostat. The temperature-sensitive part of the thermostat is a bimetallic strip consisting of two dissimilar metals welded together. Each material has a different rate of expansion due to heat. Commonly used materials are brass with a high rate of expansion, and invar, an alloy of nickel and iron, which has a relatively low rate of expansion. As the bimetallic strip is heated, the greater expansion rate of the brass will cause the free end of the strip to bend upward. When cooled, the strip will return to its original position. The amount the strip bends is directly proportional to the temperature.

The thermostat may be used as an indicating thermometer by attaching a pointer to the free end of the strip and permitting it to move over a calibrated temperature scale. It may also be used to activate the control circuit of some heating or cooling system. When the contacts touch, a circuit is closed which in turn energizes the control mechanism.

Another control device which utilizes the principle of temperature affecting the length of a body is the heater thermostat used in the automobile. This device is shown in figure 1. When the water temperature of the automobile is cold, the spring in figure 1 is in compression and restricts the water flow path. Since the water circulation is restricted, it gets hotter and hotter as the engine runs. When a preset temperature is reached, the spring begins to expand, pushing the ballshaped plunger down out of its socket. As the plunger leaves the socket, the water is able to flow more freely through the motor. This thermostat helps keep the engine at a constant temperature, and helps in rapid warming of the heater during the winter months.

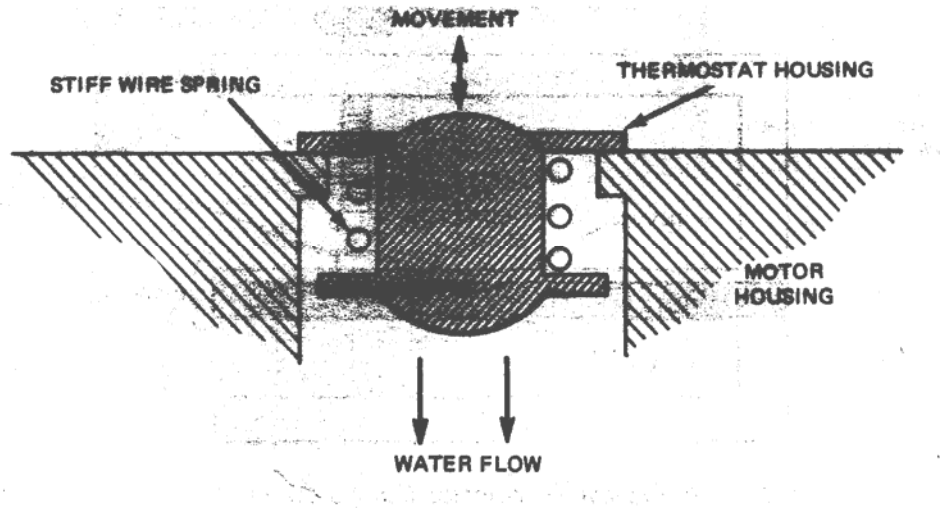

Figure 1: Automobile Thermostate

The length of a metallic conductor also changes when under stress. Here again the change in length affects the resistance of the conductor. Because there are no absolutely elastic materials, none will return to its exact original shape when the deforming force is removed. This is because the molecular material has internal friciton. Steel, glass, copper, brass, and other materials develop only small internal friction when they are only distorted a small amount.

PROCEDURE:

A. Thermister:

1. Measure the resistance of the thermister using wheatstone bridge at room temperature.
2. Now start heating the thermister, then measure the resistance of thermister after heating.
3. Record the results below and then write your conclusions in your own words.

Thermister Resistance at Room Temperature: _____.

Thermister Resistance after Heating: _____.

Conclusions:

B. Bimetallic Strip:

1. You are provided a bimetallic strip.
2. Heat the bimetallic strip, you will observe the small deformation in its shape.
3. Write your conclusions in your own words.

Conclusions:

