To Observe and Explain the Effect of Heating on a Bi-Metallic Strip

Aim
To observe and explain the effect of heating on a bi-metallic strip.

Apparatus
A bi-metallic strip (made of iron and brass bars), a board with clamp screw on one side and vertical scale on the other side, electric heating arrangement, or a burner thermometer.

Short Description of a Bi-metallic Strip
It is a strip made up of two bars of different metals but same dimensions, put together lengthwise and ripetted at their ends. The strip is straight at room temperature.

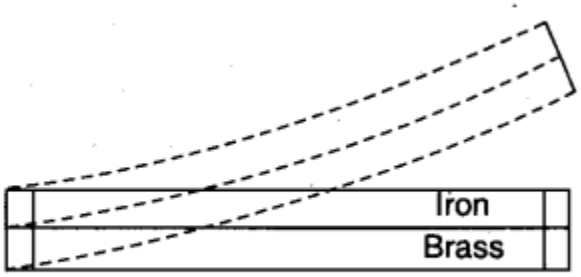

Fig. Bi-metallic strip.

When the bi-metallic strip is heated both bars expand differently. Since they are ripetted at their ends, their ends stay together. The bi-metallic strip bends keeping more expanding bar on its convex side. More is heating, more is the bending.
In case of an iron-brass bi-metallic strip, the bent strip will have brass bar on its convex side.

Theory

If L_1 be the length of a rod (bar) at temperature t_1°C and L_2 be the length at t_2°C, then

$$L_2 = L_1[1 + \alpha(t_2 - t_1)]$$

where α is the coefficient of linear expansion of the material of the rod (bar).

If two rods of different metals have same length L_1 at temperature t_1°C, their length at higher temperature t_2 °C will be different. The rod of a metal having more value of ' coefficient of linear expansion will have more length than the other rod.

Diagram

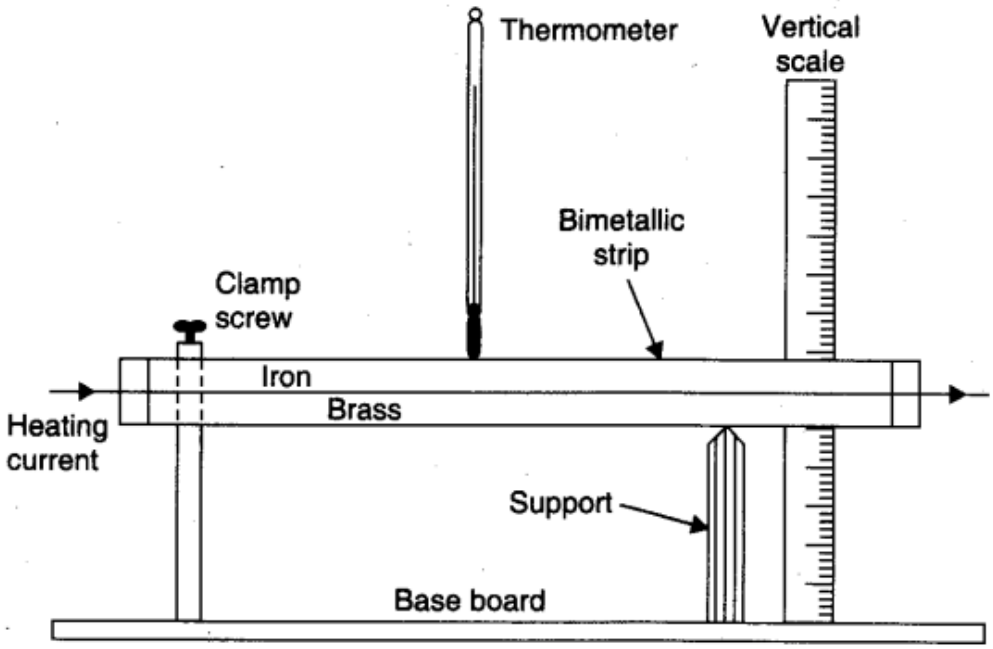

Fig. Bending of a bi-metallic strip.

Procedure

1. Clamp one end of the brass-iron bi-metallic strip, keeping brass bar on the lower side.
2. Keep the strip horizontal rested on a vertical support.
3. Fix a vertical scale near the free end of the bi-metallic strip.
4. Suspend a thermometer with its bulb touching the strip in the middle.
5. Note the initial temperature of the strip.
6. Note the vertical scale division coinciding with the upper edge of the strip.
7. Heat the strip by passing electric current through it or by using a burner. The thermometer will show a rise of temperature.
8. Watch the movement of the free end of the strip. The strip bends upwards (towards iron bar side) and position of upper edge of the strip changes.
9. Note the temperature after each rise of temperature by 2°C and also the position of the upper edge at that temperature.
10. Record your observations as given below.

Observations

Room temperature = 30°C (say)
Least count of vertical scale = 1 mm.

Table for temperature and vertical scale reading

Serial No. of Obs.	*Temperature of bi-metallic strip t (°C)*	*Position of upper edge of bi-metallic strip x (mm)*	*Amount of bending upward (mm)*
1.	30°C	$x_1 =$	$x_1 - x_1 =$
2.	32°C	$x_2 =$	$x_2 - x_1 =$
...	.....	.....	.....
11.	50°C	$x_{11} =$	$x_{11} - x_1 =$

Calculations

1. Find the amount of bending by taking difference of position with initial position.
2. It is found that amount of bending increases as temperature rises.

Result

1. Bi-metallic strip bends more and more as its temperature rises.
2. Since brass bar is on convex side and iron bar on concave side of bent bi-metallic strip, brass bar expands more than the iron bar. Hence brass has larger linear expansion.

Precautions

1. The two bars should be firmly ripetted near their ends.
2. Brass bar should be kept on the lower side.
3. One end of the bi-metallic strip should be screw clamped.
4. Heating of whole bi-metallic strip should be uniform.

Sources of error

1. The ripettes may be loose.
2. Heating of strip may not be uniform.