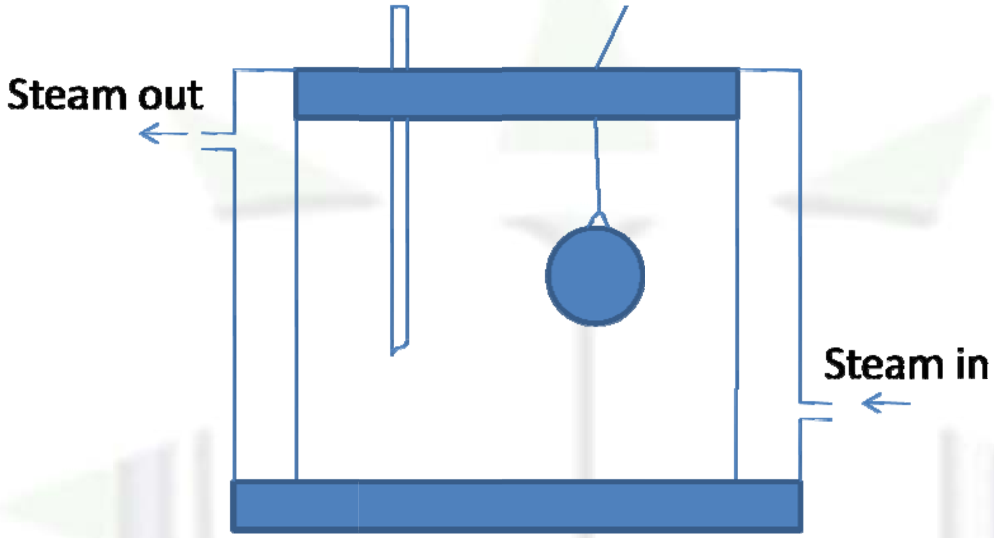
Experimental determination of specific heat capacity of a solid by method of mixture

(1) A copper calorimeter is thoroughly cleaned, washed, dried and weighed along with the stirrer.

(2) About 2/3rd of the calorimeter is filled with water and weighed again to get the mass of water. Temperature of water is recorded.

(3) The experimental solid is heated inside a steam chest. A chest is doubled walled hollow cylinder in which steam is passed through the space between the two walls.



The upper end is closed with a cock, through which a thermometer and the string carrying the experimental solid pass. The lower end is closed with an extra lid, which can be removed. Steam is passed till the reading of the thermometer become constant.

(4) The calorimeter is brought below the steam chest and removing the lid from below, the hot solid is gently lowered into the water in the calorimeter and calorimeter removed.

(5) The water in the calorimeter is stirred well and the final temperature of the mixture in the calorimeter is recorded.

(6) Calorimeter is weighed again to get the mass of the experimental solid.

Calculation: Given

m_1 & s_1 = mass and the specific heat capacity of the calorimeter along with stirrer.

m_2 & s_2 = mass and the specific heat capacity of water in the calorimeter.

Θ_1 = Initial temperature of water in the calorimeter

m = mass of the experimental solid

s = specific heat capacity of experimental solid

Θ_2 = Initial temperature of solid before dropping into the calorimeter i.e. the constant temperature of the steam chest.

Θ =The final temperature of the mixture in the calorimeter.

Heat lost by the experimental solid = $ms(\Theta_2 - \Theta_1)$ Joules

Heat gained by the calorimeter = $m_1s_1(\Theta - \Theta_1)$ Joules

Heat gained by the water in the calorimeter =$m_2s_2(\Theta - \Theta_1)$ Joules

Total heat gained =$(m_1s_1 + m_2s_2)(\Theta - \Theta_1)$

Using principle of calorimetry: Heat gained = Heat lost

$$ms(\theta_2 - \theta) = (m_1s_1 + m_2s_2)(\theta - \theta_1)$$
$$s = \frac{(m_1s_1 + m_2s_2)(\theta - \theta_1)}{m(\theta_2 - \theta)} \text{ Joules Kg}^{-1}\text{K}^{-1}$$

Experimental determination of specific heat capacity of a liquid by the method of mixture:

The experiment is exactly same with the following changes

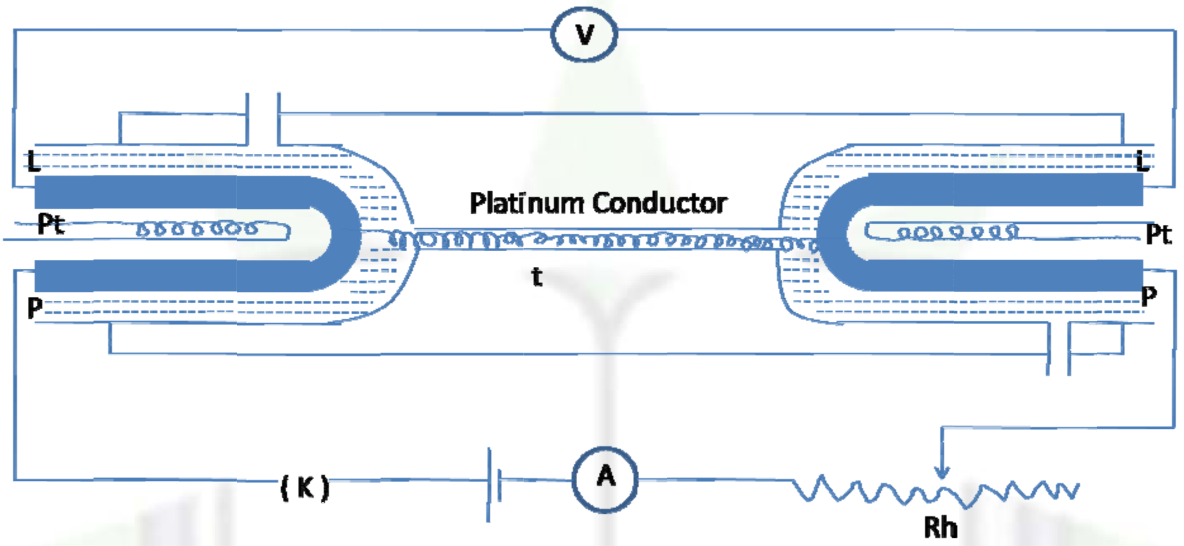
(1) In calorimeter instead of water the experimental liquid is taken

(2) Inside the steam chest the solid of known specific heat which does not react with the experimental liquid is taken.

$$ms(\theta_2 - \theta) = (m_1s_1 + m_2s_2)(\theta - \theta_1)$$
$$\left[\frac{ms(\theta_2 - \theta)}{(\theta - \theta_1)} - m_1s_1\right]\frac{1}{m_2} = s_2$$

Experimental determination of specific heat capacity of liquid by an electrical method

The experimental liquid is made to flow at a steady rate, through a narrow glass tube t about 2 to 3 mm in thickness. The liquid is heated by passing current through a central conductor of platinum, kept in the form of a coil. The temperature of the inflowing and out flowing liquid are measured by two platinum resistance thermometer Pt. The two ends of the conductor are connected to two tick copper tubes which serves two purposes:



(1) Copper being a good conductor of heat keeps the bulb of the thermometers at temperature of adjacent liquids.

(2) Copper tube being thick do not produce any appreciable heat near the bulbs of the thermometer

($R \alpha 1/A$)

The ends PP of the copper tubes are connected in series to a battery, key an ammeter and a rheostat. The ends LL are connected to a voltmeter. The whole thing is enclosed in an evacuated jacket to prevent the loss of heat by conduction and convection.

Experiment: The experiment is done in two parts to cancel out, the heat lost due to radiation which depends on the temperature difference between the system and the surrounding.

Part I: By closing the key (K) a constant current i_1 passed through the coil and the potential difference across the coil V_1 is recorded from the voltmeter.

The temperature of both inflowing and out flowing liquid is recorded. The out flowing liquid is collected in a beaker, time interval and mass of liquid collected is measured.

Given:

I_1 and v_1 = the current through and P.D across conductor.

Θ_1 and Θ_2= Temperature of in flowing and out flowing liquid.

m_1 = mass of the out flowing liquid collected t second.

s_1 = Specific heat capacity of liquid.

Let h = the amount of heat lost per second due to radiation.

Heat produced due to the flow of current in t sec

= i_1v_1t Joule

Heat absorbed by the flowing liquid in t sec

$= m_1s(\Theta_2 - \Theta_1)$

Heat lost due to radiation in t sec = ht Joules

$i_1v_1t = m_1s(\Theta_2 - \Theta_1) + ht \longrightarrow (1)$

Part II: In equation (1) s and h are unknown hence to eliminate h we repeat the experiment changing the current and P.D with the rheostat. But to keep h unchanged $(\Theta_2 - \Theta_1)$ should kept same as in part I, and hence the rate of flow of liquid is changed.

When temperature of the out flowing liquid becomes constant out flowing liquid is collected for the same time interval t sec and the mass of collected liquid is measured.

Given:

I_2 & v_2 = current and P.D respectively

m_2 = mass of the liquid collected in t sec.

$i_2v_2t = m_2s(\Theta_2 - \Theta_1) + ht \longrightarrow (2)$

Subtracting equation (2) from (1): $(i_1v_1 - i_2v_2)\,t = (m_1 - m_2)s(\Theta_2 - \Theta_1)$

$$s = \frac{(i_1v_1 - i_2v_2)t}{(m_1 - m_2)(\theta_2 - \theta_1)}$$