ABSTRACT:

This work presents the development of experimental setups to study the thermal properties of elastomers and their blends from 60 to 300K.

A new convenient experimental set up is made with the help of a refrigerator cryostat to study the variation of thermal conductivity on the principle of guarded hot plate method.

A test apparatus for the measurement of heat capacity is also developed on the principle of adiabatic calorimetry with transient heating technique. The apparatus is of liquid cryostat type, made of copper with a stainless steel neck. The calorimeter is a hollow cylinder prepared from copper foil. The adiabaticity is maintained by evacuating the cryostat to 10^{-5} torr and with isothermal shield closely following the temperature of the calorimeter to an accuracy of 0.1K.

These apparatus have been calibrated with the published results on Polytetrafluoroethylene (PTFE).

The measurements on the variation of the thermal conductivity, heat capacity, thermal diffusivity, entropy and enthalpy of poly(butadiene-co-styrene) rubber, poly(butadiene -co-acrylonitrile) rubber, poly(isobutylene-co-isoprene)

rubber, poly(chloroprene) rubber cis-1,4-poly(isoprene) rubber, a thermoplastic elastomer poly(ethylene vinyl acetate) and a series of blends of silicone rubber and poly(butadiene-co -styrene) rubber of different composition are carried out.

The thermal conductivity of gum rubbers increases almost linearly to a peak value upto a temperature which corresponds to the glass transition temperature of the particular elastomer and drops down to a temperature - independent value at 290K. The variations of the thermal conductivity are emperically correlated with the present experimental data by two equations: $K(T) = A_k . T^x$, where A_k and x have different values before and after glass transition temperature. Similarly, the heat capacity also increases with temperature and show a temperature-independent value at 290K. The heat capacity anomaly is found at the same temperature where the peak values of the thermal conductivity is observed. The data of the heat capacity varies as $C(T) = A_c . T^y$ in excellent agreement with the present data except in the transition zone. Theoretical calculation on the basis of established models has also been carried out for the variation of thermal conductivity and heat capacity with temperature and it is observed that except in the glass transtion region the results fit well with the experimental results in a qualitative way. The thermal diffusivity also emperically correlated by two equations, which is in nice agreement with the present experimental data by, $\alpha(T) = A_{d1}.T^{p} + A_{d2}.T^{p+1}$, where A_{d1}, A_{d2} and p have different values.

For poly (ethylene vinyl acetate) (EVA) the thermal conductivity increases with temperature and a deviation is observed in the region of 170 to 210K where it shows a plateau. The variation of thermal conductivities (K) before and after the plateau are expressed by two emperical equations given by $K = A_{k1}.T^{p1}$ with the values of A_{k1} and p1 are different for 60 to 170K and 210 to 300K. The heat capacity also increases with temperature and from 170 to 210K it shoots up and again drops down to match the nonlinear variation of the heat capacity. A maxima is observed at 195K indicating a transition temperature. The change of heat capacity of EVA is well represented by the emperical equation $C = A_{e1}{}^{q1}$.

For silicone rubber-SBR blends it is observed that the experimental values of thermal conductivity for the entire blend composition is emperically correlated by a single polynomial equation for the above temperature zone in the form of $k(T) = A_1.T+A_2.T^2-A_3.T^3$ where the constants A_1, A_2, A_3 are function of composition (F). An approximate calculation of thermal conductivity on the basis of available theory is carried out and compared with the experimental results which shows a qualitative match with the experimental values. The change of thermal diffusivity is also calculated. It is found that these values also match with the existing theoretical propositions.

The heat capacity of blends is showntohave two clear anomalies which correspond to the glass transition temperature region of silicone and SBR. The experimental values of heat capacity for the entire blend composition is emperically correlated by a single polynomial equation for the above temperature zone in the form ; $C(T) = B_1.T + B_2.T^2 - B_3.T^3$ where the constants B_1, B_2, B_3 are function of composition (F). This emperical equation fits well with the experimental values throughout the range except in the transition regions. A theoretical calculation is also carried out to study its variation with temperature. The variation of thermal diffusivity shows an exponential decrease with temperature with reverse peaks near T_g. The change of entropy and the enthalpy thus obtained from heat capacity are also correlated by a similar set of emperical equation of the form S OR $H = X_1.T+X_2.T^2+X_3.T^3+Const.$ These parameters also increase with temperature with a sudden rise near the transition temperature of SBR only. These properties increase with temperature and attain a peak value near the T_g of SBR and then decrease rapidly to an asymptotic value near room temperature.

Key words : THERMAL CONDUCTIVITY ; HEAT CAPACITY ; THERMAL DIFFUSIVITY ; ENTROPY ; ENTHALPY ; MEASURING INSTRUMENTS ; GUARDED HOT PLATE ; ADIABATIC CALORIMETRY ; ELASTOMER ; BLEND