LETTERS TO THE EDITOR

APPLICATION OF THE LAW OF CORRESPONDING STATES TO MOLAR SOUND VELOCITY

THE law of corresponding states has been successfully applied earlier to the ultrasonic velocity and density of Carboxylic acids[1]. Since the ultrasonic velocity and density obey this law, it is expected that the molar sound velocity (Rao's constant) which is a function of the above two parameters may also obey this law. With a view to verify this aspect, the present investigation has been taken up.

The ultrasonic velocity and density data of carboxylic acids have been taken from the earlier experimental work[2] and molar sound velocity V_M of different substances has been calculated.

Following the equation of state used by Belinskaya[3], the molar sound velocity V_M can be written as

$$V_M = C^{1/3} \cdot \frac{M}{\rho} = V_c\left[\frac{5}{3}\frac{RT}{M}\left(\frac{V}{V_c}\right)^{\nu} + \frac{RT_c}{\mu(\nu-\mu)}\left\{\mu - \nu\left(\frac{V}{V_c}\right)^{\nu-\mu}\right\}\right]^{1/6} \quad (1)$$

where C is the ultrasonic velocity, M is the molecular weight of the substance with density ρ, V_c is the critical volume, R is the gas constant, T is temperature in degrees absolute, V is the molar volume given by M/ρ, Tc is the critical temperature in degrees absolute and μ and ν are constants. It has been shown that $\nu = 6$ for many liquids by Lependin[4] on the basis of molecular Kinetic theory of matter. We have evaluated from expression (1) the value of 'μ' for one of the liquids, namely lauric acid, making the experimental and theoretical values of V_M at 20° C to coincide and the value of μ so obtained is 2·264. Using this value of $\mu = 2{\cdot}264$ and $\nu = 6$ to all other liquids, the molar sound velocities are theoretically calculated from expression (1) and compared with those determined at 20° C by experiment. The values so obtained are shown in Table I.

The agreement between the values in columns 2 and 3 of Table I is very good in view of many assumptions made in theory for deriving the expression (1) which cannot be realised in experiment.

The reduced molar sound velocity can be written from expression (1) as

$$\frac{V_M}{V_{Mc}} = \left[\frac{5}{2}\frac{T}{T_c}\left(\frac{V}{V_c}\right)^{\nu} + \frac{3}{2}\frac{1}{\nu-\mu}\left\{\mu - \nu\left(\frac{V}{V_c}\right)^{\nu-\mu}\right\}\right]^{1/6} \quad (2)$$

TABLE I

Theoretical and experimental values of molar sound velocity

Name of the Substance	V_M $m^{1/3}$ Sec.$^{-1}$ (Theoretical	V_M $m^{1/3}$ Sec.$^{-1}$ (Experimental)	Symbol used in the graph
Formic acid	424	419	○
Acetic acid	561	599	⊗
Propionic acid	765	788	Δ
Butyric acid	963	979	▼
Valeric acid	1167	1169	▲
Caprylic acid	1734	1739	∇
Pelargonic acid	1922	1922	□
Capric acid	2118	2119	⊞
Lauric acid	2501	2501	⊖
Myristic acid	2893	2883	⊕
Palmitic acid	3280	3268	X
Stearic acid	3666	3643	▀

where

$$V_{Mc} = C_c^{1/3}\, M/\rho_c$$

and is a function of reduced temperature and volume. C_c and ρ_c stand for ultrasonic velocity and density at critical temperature. The graph of the above relationship for various substances is shown in Fig. 1, Curve 2, while curve one gives all the experimental points. It s clear that all points lie on single curve showi g that V_M obeys the law of corresponding states. The maximum scattering of experimental points is not more than 4% from curve 1. This may be due to the arbitrary value of μ chosen.

It may be observed from Fig. 1, that the theoretical curve is lower than the experimental curve and the maximum deviation of points on the two curves is about 2·1%. This may be attributed to the discrepancy between experiment and semi-empirical nature of the theoretical expression.

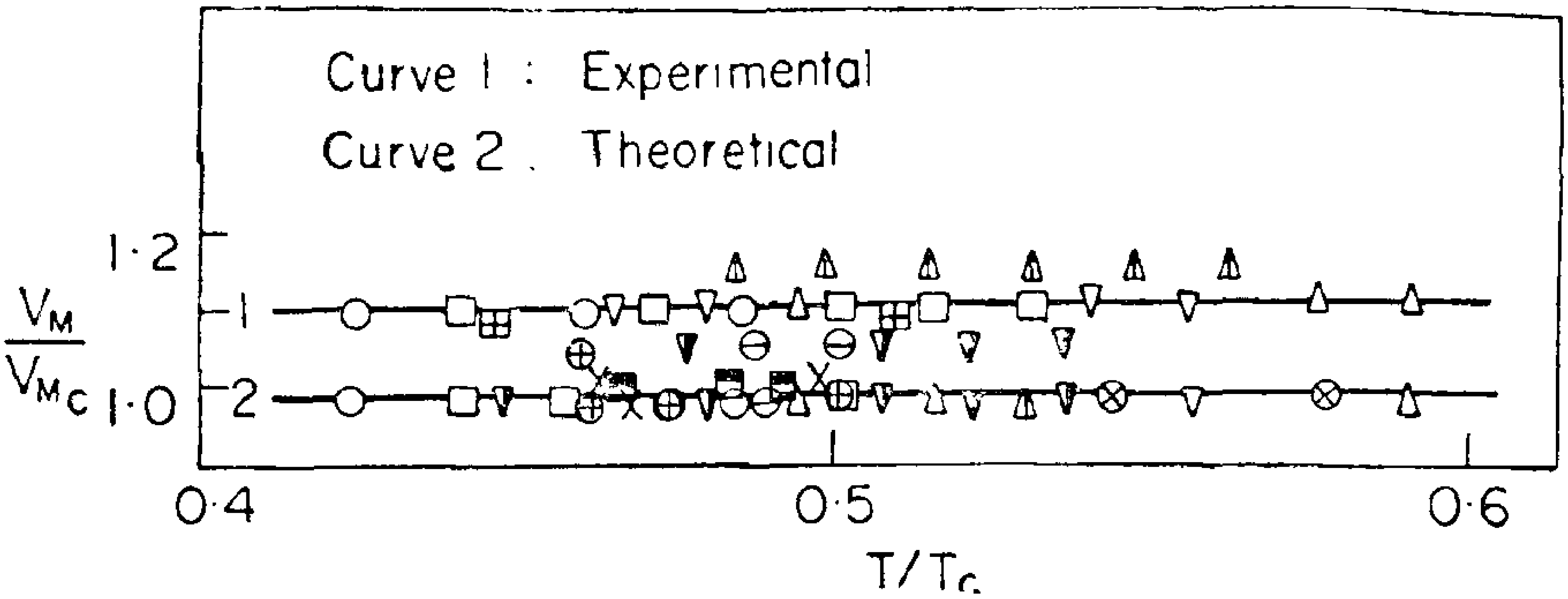

FIG. 1. Test of the validity of Law of corresponding states for molar sound velocities.

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EQUATORIAL GEOMAGNETIC BAYS AND IMF SECTOR POLARITY

Geomagnetic bays at equatorial latitudes, observed during night time as large perturbations in the geomagnetic field components, resembling indentations of coast line of a geographical map, are considered to be manifestations of polar magnetic substorms at the low and middle latitudes. Substantial evidence now exists in literature to show an influence of the north-south component/polarity of the interplanetary magnetic field (IMF) on terrestrial magnetic activity and geomagnetic perturbations in the polar regions[1-6]. Burch[5] found a dependence of the seasonal variation of auroral zone positive and negative bay activity on the sector structure of the interplanetary magnetic field. Very recently, Bhargava and Rangarajan[7] showed a dependence of the seasonal variation in the occurrence of positive bays at equatorial latitudes on the IMF sector polarity. They also noticed a difference in the local time variation of bay events associated with the passage of 'A' (away) and 'C' (toward) sectors, but only in the equatorial region. The earlier work of Gupta[8] showed a positive relationship between the rise time and amplitude of bays in the equatorial region. In this brief communication, the results of an analysis to point out an influence of the polarity of IMF on the degree of association between the rise time and amplitude of bays in the equatorial region are presented.

The present study is based on positive bays observed in the normal run magnetograms at the equatorial station, Kodaikanal (dip 3·5° N), over the ten year period 1962–1971. A total number of 350 basys has been identified at Kodaikanal over this period. For each bay, the rise time (defined as the time in minutes reckoned from the undisturbed H-trace to the point where H reaches the maximum value) and ampiitude (defined as the value of H in nT, $n\mathrm{T} = 10^{-5}$ Gauss, from the undisturbed H-trace to the maximum value attained during the course of the bay) have been obtained. As the rise time of bays is quite large (of the order of several minutes), evaluation rise time from normal run magnetograms is considered to be adequate. Only these bay events, with both the amplitude and the rise time greater than or equal to 10 nT and 10 min respectively have been taken into consideration. Data on IMF sector polarity are taken from Svalgaard[9]. It is to be mentioned that in the recent past some workers have pointed out a strong geomagnetic bias of the sector polarity inferred by Svalgarrd prior to 1962 (pre-satellite era) in that 'toward' days were twide as active as 'away' days[10-12]. The sector polarity however was comparatively free from such bias from 1962–1971. The use of Svalgaard index is therefore quite adequate