STUDIES & FORMULAE OF PROPERTIES USING ULTRASONIC VELOCITY

- AZEOTROPISM
- INTER MOLECULAR INTERACTION
- MISCIBILITY AND COMPATIBILITY
- PHASE TRANSITION
- THERMODYNAMIC PROPERTIES
- TRANSPORT PROPERTIES ETC.

1. Adiabatic Compressibility(β_{ad})

$$\beta_{ad} = \left(\rho v^2\right)^{-1}$$

where ρ = density

Ref: *A. Varada Rajulu and P. Mabu Sab,* Bull. Mater. Sci., Vol. 18 (June 1995), No. 3, pp. 247-253.

2. Isentropic Compressibility(β)

$$\beta = \left(\rho v^2\right)^{-1}$$

where ρ = density

Ref: *D.N. Rao, A.Krishnaiah and P.R. Naidu,* Acta Chim. Acad. Sci. Hung, Vol. 107 (1981), No. 1, pp. 49-55.

3. Isothermal Compressibility(β_T)

$$1. \quad \beta_{T,n-mix} = \frac{17.1\times10^{-4}}{v_{n-mix}^2 T^{4/9} \rho_{n-mix}^{4/3}}$$

where ρ = density.

Ref: *Vimla Vyas*, Physics and Chemistry of Liquids, Vol.42, No.3, June 2004, pp.-229-236.

$$2. \quad \beta_T = \beta_S + \frac{TV\alpha^2}{C_P}$$

where α =Thermal Expansivity, C_P = heat capacity at constant pressure.

Ref: *K.S.Reddy, M.Sreenivasulu and P.R.Naidu,* Zeitschrift fur Physikalische Chemie Neue Folge, Bd. 124, S. 149-154 (1981).

4. Effective Debye Temperature (Q_D)

$$Q_D = \frac{h}{k}\left[\frac{\left(9N/4\pi V\right)}{\left(P\beta_{ad}\right)^{3/2}\left\{\left(\frac{1}{1+\gamma}\right)^{3/2} + 2\left(\frac{4}{3\gamma}\right)^{3/2}\right\}}\right]$$

where h= Planck's constant, k= Boltzmann's constant, N=Avogadro number, V= molar volume, ρ = density, β_{ad}= adiabatic compressibility and $\gamma = \frac{\beta_T}{\beta_{ad}}$ = specific heat ratio.

Ref: *J.D. Pandey, V. Sanguri, R.K. Mishra and A.K.Singh,* J.Pure Application Ultrason, Vol. 26, 2004, pp. 18-29.

5. Gruneisan Parameters (Γ)

$$\Gamma = v^2\alpha / C_p$$

where α = thermal expansion coefficient, C_p= Principal Heat Capacity at constant pressure.

Ref: *B.P. Shukla, L.K. Jha, A.P. Upadhyay, S.N. Dubey and S.N.D. Dubey,* J. Pure Appl. Ultrason., Vol. 11 (1989), pp. 32-33.

6. Intermolecular Free Path Length (L_f)

$$L_f = K\sqrt{\beta_{ad}}$$

where β_{ad}= adiabatic compressibility, K = temperature dependent Jacobson's Constant

Ref: *P.S. Nikam and Mehdi Hasan,* Asian Journal of Chemistry, Vol. 5 (1993), No. 2, pp. 319-321.

7.Internal Pressure (πi)

$$\pi i = bRt\left[\frac{K\eta}{v}\right]^2 \frac{\rho^{2/3}}{M^{7/6}}$$

where b=(packing factor), R=universal gas constant, K=temperature independent constant, η=viscosity of liquid, ρ = density and M= molecular weight.

Ref: *C.V. Suryanarayana and P. Pugazhendhi,* Indian Journal of Pure & Applied Physics, Vol. 24 (Aug. 1986), pp. 406-407.

8.Free Volume (V_f)

$$V_f = \left(\frac{Mv}{K\eta}\right)^{3/2}$$

where K=temperature independent constant, M= molecular weight, η=viscosity of liquid,

Ref: *N. Prasad and H. Rajendra,* J. Pure Appl. Ultrason., Vol. 25 (2003), pp. 25-30.

9. Rao's Constant (R)

$$R=V\,(v)^{1/3}. \quad \text{or} \quad R=(M\ /\rho)\,v^{1/3}$$

where ρ = density, V = molar volume and M= Molecular Weight.

Ref: *R. Paladhi and R.P. Singh,* Acustica, Vol. 72, (1990), pp. 90-95.

10.Surface Tension (S)

$$v = \left(S/6.3\times10^{-4}\rho\right)^{2/3}$$

where ρ = density.

Ref: *Anwar Ali and Mohd Tariq,* Physics and Chemistry of Liquids, Vol. 46, No.1, pp. 47-58.

11. Mean Square Thermodynamic Fluctuation

Mean square fluctuations of pressure, $\overline{(\Delta P)^2} = \left(kT\rho v^2\right)/V$ (1)

Mean square fluctuations of Temperature, $\overline{(\Delta T)^2} = \dfrac{kT^2\gamma}{C_p}$ (2)

Number of molecular in a given volume, $\left(\dfrac{\Delta N}{N}\right)^2 = kT\gamma/\rho v^2 V$ (3)

Correlation function of pressure and temp. fluctuations, $\overline{\Delta P.\Delta T} = \dfrac{a\rho v^2 kT^2}{C_p}$ (4)

where k = Boltzman's constant, T = temperature in K, ρ = density, γ = ratio of specific heats, C_p= specific heat at constant pressure and α = coefficient of expansion.
(1)-(4). Ref: *R. Sabesan, R. Varadarajan and S. Srinivasan,* Jour. Acoust. Soc. Ind., Vol. XII (July 1984), No. 3, pp. 38-40.

12.Van der Waal's Constant (b)

$$b = \frac{M}{\rho}\left[1 - \frac{RT}{Mv^2}\left(\sqrt{1 + \frac{Mv^2}{3RT}} - 1\right)\right]$$

where M= Molecular Weight, ρ = density and R=8.3143 $JK^{-1}mol^{-1}$.

Ref: *A. Varada Rajulu and P. Mabu Sab,* Bull. Mater. Sci., Vol. 18 (June 1995), No. 3, pp. 247-253.

13.Wada Constant (W)

$$1. W = \frac{M}{\rho^{6/7}} V^{2/7} = M^{1/7} R^{6/7}$$

where ρ = density, M= Molecular Weight and R= Gas Constant.
Ref: *R.P. Singh, G.V. Reddy, S. Majumdar and Y.P. Singh,* J. Pure Appl. Ultrason, Vol. 5(1983), pp. 52-54.

$$2. W = (M. \beta^{-1/7}) / \rho$$

where ρ = density, β = adiabatic compressibility and M= molecular Weight.
Ref: *P.A.K. Ekka, G.V. Reddy and R.P. Singh,* Acustica, Vol. 46, (1980), No. 3, pp-341-342.

14. Space Filling Factor (r)

$$r = v / U$$

whereU = represents the sound velocity when the entire volume of space is filled with molecules.
Ref: *A. Varada Rajulu, K. Chowdji Rao and S. Venkata Naidu,* Acustica, Vol. 75 (1991), pp. 213-216.

15. Relative Association (R_A)

$$R_A = (\rho / \rho_0)\ (v_0/v)^{1/3}$$

where ρ_0 = density of solvent, v_0 = ultrasonic velocity of solvent

Ref: *Anwar Ali and Anil Kumar Nain,* Acoustics Letters, Vol. 19 (1996), No. 9, pp. 181-187.

16. Optical Refractive Index(n)

$$v = [10(s/h)]n^{1/X}$$

where s/h = ratio of surface tension to the coefficient of viscosity,

$X = l / L_f$

where l is mean free path of the molecule and L_f is intermolecular free length

Ref: *S. Durai and P Ramadoss*, Indian Journal of Pure and Applied Physics, Vol. 42 (2004), pp. 334-337.

17. Solvation Number (S_n)

$$S_n = \frac{M}{M_o}\left(1 - \frac{\beta}{\beta_o}\right)\left(\frac{100 - x}{x}\right)$$

where M and M_o are molecular weight of Solvent and Solution respectively, β and β_o are adiabatic compressibility of Solvent and Solution respectively and x is the number of grams of salt in 100g of the solution.

Ref: *R Ezhil Pavai, P Vasantharani and A N Kannappan,* Indian Journal of Pure and Applied Physics, Vol.42, , pp.934-936.

18. Attenuation (α/f^2)

$$\alpha/f^2 = 8\pi^2\ \eta / 3\rho v^3$$

where α is absorption coefficient, f is frequency, η is shear viscosity, ρ is density and ν is speed of sound in dispersion.

Ref: *A.Varada Rajulu, G.Sreenivasulu and K.S.Raghuraman,* Indian Journal of Chemical Technology, Vol.1, Sept 1994, pp.302-304.