THERMAL CONDUCTIVITY APPARATUS

THEORY

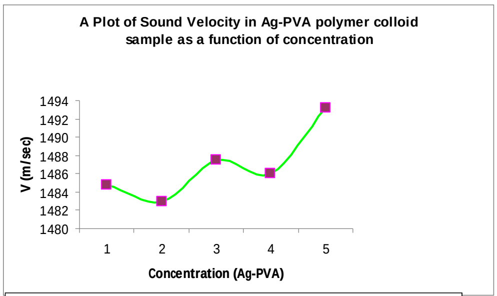
The Apparatus follows widely accepted theory of heat conduction in liquids based on Debye's concept in which the hydroacoustic vibrations (phonons) of a continuous medium(base fluid) are responsible for the heat transfer in liquids. Based on this heat transfer mechanism,Bridgman has obtained a formula,characterized by the direct proportionality between thermal conductivity and sound velocity in pure liquids.

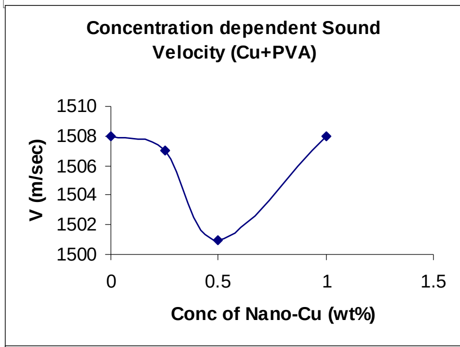
$$k = 3.0\left(\frac{N}{V}\right)^{\left(\frac{2}{3}\right)} K v_s$$

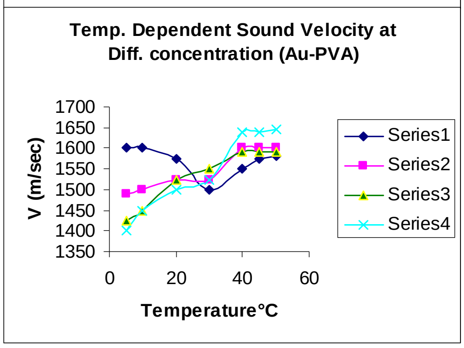
where ν = ultrasound velocity,
N (Avogadro's number) = 6.02×10^{23} and V (molar volume) $= m/\rho$
K= (Boltzmann's constant) = 1.3807×10^{-23} J/K
It is modified by J.Hemalatha for nanofluids as under:

$$k_{bm} = 3\left(\frac{\rho_{nf} N_A}{M_{nf}}\right)^{2/3} k_B v$$

where, k_{bm} is the thermal conductivity value obtained through the modified Bridgman equation, ρ_{nf} is the density of nanofluid, and $M_{nf} = x_{bf} M_{bf} + x_p M_p$ is the molar mass of nanofluid. x_{bf} and x_p are the molar fractions of the base fluid and nanoparticle respectively whereas M_{bf} and M_p are the respective molar masses of the base fluid and nanoparticle.







WORKING PRINCIPLE

Ultrasound waves of known frequency are produced and its wavelength is measured. Then sound velocity in Nanofluids

$$v = \lambda \cdot f$$

After calculating velocity of sound in Nanofluid, one can calculate the thermal conductivity by the formula give above by Bridgman. Error in results is found less than 3%.

Courtesy R.R. Yadav

DESCRIPTION

Thermal Conductivity Apparatus consists of following parts: Electronic unit, Conductivity Cell- 2MHz, Stability Cell 4MHz to increase settling time of the suspension, Temperature Controller Unit - To maintain temperature of nanofluids at desired temp from RT to 90°C

Manufacturer:

Mittal

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References of Papers using our Instrument

- A NOVEL ULTRASONIC APPROACH TO DETERMINE THERMAL CONDUCTIVITY IN CuO–ETHYLENE GLYCOL NANOFLUIDS; *M. Nabeel Rashin, J. Hemalatha;* Journal of Molecular Liquids; Volume 197, September 2014, Pages 257–262

- A COMPARATIVE STUDY ON PARTICLE–FLUID INTERACTIONS IN MICRO AND NANOFLUIDS OF ALUMINIUM OXIDE; *J. Hemalatha , T. Prabhakaran, R. Pratibha Nalini;* Microfluid Nanofluid (2011) 10:263–270

- ON THE THERMAL PROPERTIES OF ASPARTIC ACID USING ULTRASONIC TECHNIQUE; *M. Mohammed Nagoor Meeran, R. Raj Mohammed, P.Indra Devi,M.Sivabharathy and A. Abbas Manthri;* International Journal of ChemTech Research, CODEN (USA): IJCRGG ISSN : 0974-4290, Vol.6, No.7, pp 3685-3689, Sept-Oct 2014

- A PHOTOACOUSTIC AND ULTRASONIC STUDY ON JATROPHA OIL; *G. Krishna Bama and K. Ramachandran*; Journal of Engineering Physics and Thermophysics, Vol. 83, No. 1, 2010

- ULTRASONIC PROPERTIES OF NANOPARTICLES-LIQUID SUSPENSIONS, *R.R. Yadav, Giridhar Mishra, P.K. Yadawa, S.K. Kor, A.K. Gupta, Baldev Raj, T. Jayakumar*, Ultrasonics, 48(2008) 591-593

- THERMAL CONDUCTIVITY & SCATTERED INTENSITY OF ALUMINA (ALPHA) NANO PARTICLES IN ORGANIC BASE SOLVENT ; Dr. N. R. Pawar, Department of Physics, Arts, Commerce & Science College, Maregaon (M.S.); Presentation in NSA-2015 (GOA)

Other properties possible with this Apparatus

- Adiabatic Compressibility
- Acoustic Impedance
- Characterization of Nanofluids/Suspensions
- Characterization of Ferro/Magnetic Nanofluids
- Intermolecular Free Length

Examples:

Adiabatic Compressibility(β_{ad}) $$\beta_{ad} = (\rho v^2)^{-1}$$ where ρ = density Ref: *A. Varada Rajulu and P. Mabu Sab,* Bull. Mater. Sci., Vol. 18 (June 1995), No. 3, pp. 247-253.
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.
Acoustic Impedance $$Z = \rho v$$ where ρ = density, ν = velocity