Acoustic Parameters of Potassium Halides with Variable Normality

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Abstract

Acoustic parameters of chemicals and the relationship among these parameters is the recent, innovative and informative area in interdisciplinary fields of science. In this research acoustic parameters like adiabatic compressibility, acoustic impedance and their relations are observed at 3 M Hz (Ultrasonic) frequencies. Thus comparison of these parameters is made between Potassium halides with variable normality. The said parameters are measured using Ultrasonic interferometer working at 3 M H z. the adiabatic compressibility decreases in potassium halides with increase in normality while acoustic impedance increase with increase in density.

KEYWORDS: Alkali halides, Ultrasonic Interference, Acoustic parameters.

Introduction:

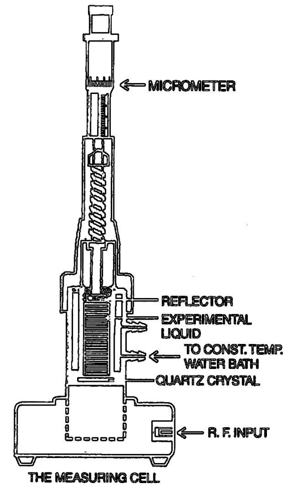
Acoustic study is found to be very effective as it helps in measuring many Thermodynamic parameters (1,3,4) of chemicals. It is also found to be Non destructive technique that is without disturbing or wasting chemicals we can study properties of chemicals. The amount of chemical required is just less than10cc. Using Ultrasonic Interferometer one can determine wavelength of sound in the chemical under study, and since frequency is known velocity at room temperature can be determined. By knowing velocity, density, Molecular weight etc one can determine parameters like adiabatic compressibility (1), Acoustic impedance. It was already observed that adiabatic compressibility and acoustic impedance varies inversely (2).Further relations are observed between these parameters.

Objectives:

1) To measure the thermo acoustic parameters of Potassium halides at different normality using an ultrasonic interferometer (at 3 M Hz).
2) To obtain relation between these parameters.

Materials and Methodology:

The solvent under study is poured in the narrow cylinder and is fitted with acoustic reflector. Ultrasonic waves with constant frequency of 3 MHz are then allowed to pass through, which are reflected back to source forming standing wave pattern. This instrument is connected to supporting sensor device which shows maxima and minima of current, when we moved reflector. These maxima and minima were corresponding to nodes and antinodes formed within the cylinder. By knowing distance between two consecutive maxima one can find the value of half wavelength. By knowing wavelength one can find velocity of ultrasonic sound in that liquid. By knowing density, velocity, and atomic weight, etc one can find various acoustic parameters. The details of apparatus and procedure of measuring wavelength of sound is explained in short note along with schematic diagram of apparatus used for measurement of sound velocity in chemicals. Note that because high accuracy in the measurement of wavelength and précised value of frequency the related values of parameters are determined with good accuracy.



Note: An ultrasonic interferometer is a simple and direct device to determine the ultrasonic velocity in liquids with a high degree of accuracy.
The principle used in the measurement of velocity (v) is based on the accurate determination of the wavelength (λ) in the medium. Ultrasonic waves of known frequency (f) are produced by a quartz plate fixed at the bottom of the cell. The waves are reflected by a movable metallic plate kept parallel to the quartz plate. If the separation between these plates is exactly a whole multiple of the sound wavelength, standing waves are formed in the medium. The acoustic resonance gives rise to an electrical reaction on the generator driving the quartz plate and the anode current of the generator becomes maximum. If the distance is now increased or decreased and the variation is exactly one half wavelength ($\lambda/2$) or multiple of it, anode current again becomes maximum.
Theory: Following properties are observed for potassium halides using Ultrasonic Interferometer along with the given terminology:

1) Adiabatic compressibility $\beta = 1/v^2.d$ where, v = velocity & d = density (1)

   The adiabatic compressibility is the fractional decrease of volume per unit increase of pressure, when no heat flows in or out. If there is no heat flow, the entropy is unchanged, in a reversible process, so that an adiabatic process is one at constant entropy. The compressibility factor is a measure intermolecular attraction. The degree of compressibility of a fluid has strong implications for its dynamics. Most notably, the propagation of sound is dependent on the compressibility of the medium.

2) Specific acoustic impedance (2) Z = v.d

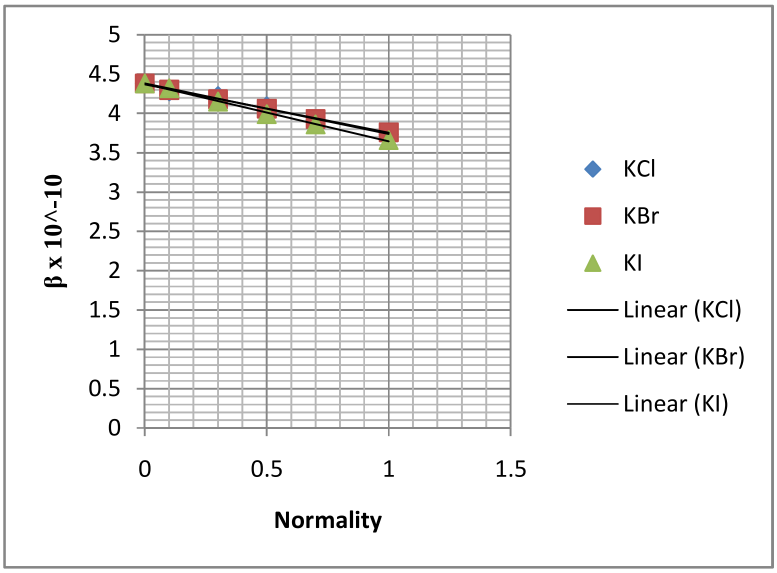
   Specific acoustic impedance is a characteristics property of a medium. The acoustic impedance is analogous to the refractive index of medium. Acoustic impedance indicates how much sound pressure is generated by the vibration of molecules of a particular acoustic medium at a given frequency. The acoustic impedance *Z* (or sound impedance) is frequency (*f*) dependent.

Observations:

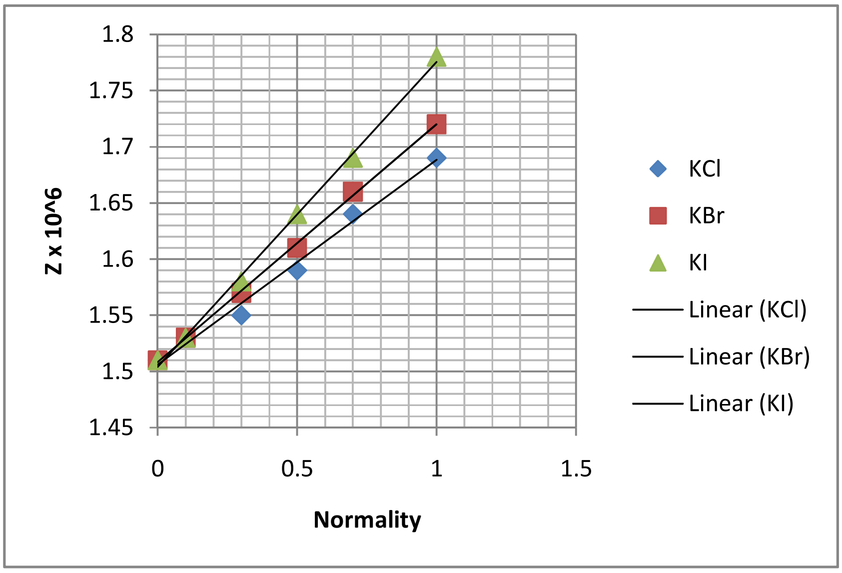
Observations on Potassium Halides at 3 MHz frequency

Normality	KCl		KBr		KI	
	β_{ad} x10^{-10}	Z x 10^6	β_{ad} x10^{-10}	Z x 10^6	β_{ad} x10^{-10}	Z x 10^6
0= Water	4.38	1.51	4.38	1.51	4.38	1.51
0.1	4.28	1.53	4.30	1.53	4.32	1.53
0.3	4.22	1.55	4.18	1.57	4.15	1.58
0.5	4.09	1.59	4.06	1.61	3.99	1.64
0.7	3.91	1.64	3.93	1.66	3.86	1.69
1.0	3.73	1.69	3.76	1.72	3.66	1.78

Variation of adiabatic compressibility with normality is as shown: note that it decreases linearly with increase in normality or so to say concentration of solvent.



Variation of acoustic impedance with normality is as shown: note that it increase linearly with increase in concentration of solvent.



Result and Discussions:

It was observed that adiabatic compressibility (1) decreases with increase in concentration for potassium chloride, potassium bromide and potassium iodide. This change was found to be linear. The adiabatic compressibility was found to be more in potassium iodide at lower concentrations while less at larger concentrations. The acoustic impedance increases with increase in normality in potassium chloride, bromide, iodide, and the change was found to be linear in all. The acoustic impedance was observed to be more in potassium iodide and comparatively less in potassium chloride. It was also observed that as acoustic impedance (2) increases adiabatic compressibility decreases for all cases. This is because as adiabatic compressibility increases the capacity of compression and rarefaction of liquid increases and as a result acoustic impedance decreases.

Conclusions:

1) Adiabatic compressibility decreases with increases in normality in all potassium halide solutions.

2) Acoustic impedance increases with increases in normality in all potassium halide solutions.

3) As adiabatic compressibility decreases acoustic impedance decreases in general.

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