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Ultrasonic Velocity and Related Parameters Study of PCE Water-Soluble Polymer

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Abstract: *Density, viscosity and ultrasonic velocity of aqueous solutions of polycarboxylate ether [PCE] superplastiziser polymer at one of a thoughtful concentrations and temperatures (298.15, 303.13, 308.15 and 313.15)K. different interplay parameters were calculated by the investigational values of density, viscosity and ultrasonic velocity of polycarboxylate ether Water-Soluble Polymer. The viscosity of superplastiziser polymer solution will increase with growing awareness of aqueous answers of polycarboxylate ether. The ultrasonic speed increases from 298.15 K to 308.15K, at that time yet again decreases for 313.15K because the temperature will increase, density, adiabatic compressibility and intermolecular free length duration lower and ultrasonic velocities, acoustic impedance, molar volumes and molar sound velocities turned into discovered to will increase. The ultrasonic velocities to start with boom then decreases with growing consciousness of polycarboxylate ether. For 0.05 polycarboxylate ether it indicates most ultrasonic velocities*

Keywords: superplastiziser, polymer, polycarboxylate ether, ultrasonic velocity

I. INTRODUCTION

Polycarboxylate ether superplasticizer polymer display extraordinarily high water discount in concrete with progressed workability and increase in energy by means of nearly 20-30% depending on use. These display excellent workability in concrete at even at water cement ratios as little as 0.23. Polycarboxylate ether superplasticizer (PCE) is widely used within the concrete enterprise because of its notable homes which include high water discount rate, workability, and coffee stoop loss, essential for developing excessive fluidity, energy, and self-compacting concrete [1].

Ultrasonic velocity approach is widely used to take a look at the answer conduct of natural liquids, polymers, surfactants, incredible Plasticizer and their combos in aqueous and non-aqueous solutions. It performs an important role in expertise the physico-chemical conduct of drinks [2-3]. It's far well known that surfactant molecules can organize themselves into aggregates when dissolved in water. PCE has raise to be the fifth aspect of present day concrete, apart from cement, water, coarse mixture, and first-rate aggregate [2]. PCE, which has a comb-like structure, adsorbs on the surface of cement debris via the anionic carboxyl organization on the principle chain, generating electrostatic repulsion and spatial quandary, leading to the dispersion of cement. On the identical time, its side chain stretches between the pore answer and different cement particles, generating a spatial limitation effect [4-5], which brings accurate dispersion of cement, in particular within the case of a low water-cement ratio, and has an splendid retarding effect [6-8].

In this paper the impact of different concentrations and special temperatures of awesome Plasticizer on density, viscosity and ultrasonic velocity has been studied.

II. MATERIAL AND METHODS

Polycarboxylate ether [PCE] superplastiziser polymer was synthesis in laboratory. Calculated its Mol. Wt. is 40,000.) Doubly distilled water was used for preparation of all solutions.

III. EXPERIMENTAL METHODS

Ultrasonic velocity measurements

In the interferometer cell, the experimental solution was filled and connected to the production terminals of the high occurrence producer via the shielded cable. The measuring cell was surrounded by water from the thermostat, which

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was maintained at the required temperature. Once the solution in the cell reached the required bath temperature, the micro-measurement screw was slowly moved until the anode current metered value reached maximum. The crystal frequency F is precisely known. In this case, the crystal frequency is 2 MHz. The ultrasound velocity U was calculated by the following formula: U = λ x f. The observed densities (R) and ultrasound velocities (U) were then used to compute the following thermodynamic parameters [9-10]:

Adiabatic Compressibility (β_{ad}) = $1/\rho U^2$ Intermolecular

free length (Lf) = K (β_{ad}) $^{1/2}$

Molar Sound Velocity (R_m) = ($\bar{M}/\rho$) U $^{1/3}$

Specific Acoustic Impedance (Z)= (ρU)

Molar Volume (V_m) = ($\bar{M}/\rho$)

Where U is the ultrasound velocity, ρ is the density; K is the Jacobson's temperature depended constant.

IV. RESULT AND DISCUSSION

Density

The densities of aqueous solution of polycarboxylate ether superplastiziser polymer were determined for one of a kind concentrations and temperatures [Table 1]. It was found that for a specific attention answer, the density is going on lowering with growing temperature, due to the fact on growing temperature, kinetic energy of debris, thermal agitation and extent of answer will increase. The densities increases of aqueous polymer solution with numerous attentions imply an boom in solvent–solvent and solute–solvent interactions and this could be due to shrinkage in extent attributable to the presence of solute molecules.

Viscosity

The viscosity of aqueous solution of polycarboxylate ether superplastiziser polymer of various concentrations and temperatures [Table 1]. because the attention of superplastizier polymer will increase the viscosities of solution increases indicate more potent solute-solvent interaction because of alkyl side chain. The values of viscosities boom with awareness of polymer and decreases with growing temperature occur for all structures in step with "flickering cluster" version of water, there are big void areas in the hydrogen bonded framework of the water structure, the molecule might also have penetration into the void areas and may have fantastic interplay with water. The boom in viscosity due to growth in ion length, orientation of polar molecules by means of the ionic subject, for the reason that freedom of actions of these molecules is restricted; this normally outcomes in a stiffening of the response [11-13]. Viscosity will increase due to more potent hydrophilic and hydrophobic interactions in aqueous media the hydrophobic gadgets of superplastiziser polymer companion with each other forming hydrophobic area, they play vital role of intermolecular go hyperlinks which could cause a considerable boom in viscosity. The viscosity of superplastiziser polymer solution increases with growing attention [14-15].

Ultrasonic velocities

The ultrasonic velocities of aqueous reply of polycarboxylate ether superplastiziser polymer have been done for density, adiabatic compressibility and intermolecular free length decrease hence ultrasonic velocities, acoustic impedance, molar volumes and molar sound velocities increases in exceptional temperatures (Table1). The ultrasonic pace will increase density, adiabatic compressibility and intermolecular unfastened period decrease subsequently ultrasonic velocities, acoustic impedance, molar volumes and molar sound velocities increases.

The ultrasonic velocities first of all increase with increasing concentration of polymer. For 0.05M polymer it shows maximum ultrasonic velocities may be because of structural rearrangement as a result of hydration. At higher ultrasonic velocities, the superplastiziser molecule aggregated to form massive molecular cluster collectively by using cohesive forces. The lower in ultrasonic velocities with further growth in awareness of polymers due to the formation of durable hydrogen bonds which typically increases the inter proton distance among adjoining hydrogen bonds. This interesting thing carefully connected to the properly- recognised inter polymeric association reactions which occur in polycarboxylate ether superplastiziser polymer because the attention of PCE polymer increases adiabatic

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compressibility (βad) decreases additionally assist the solute and solvent interplay i.e., when ultrasonic velocity will increase Lf and βadvert decreases and vice-versa. The decreases of Lf and βad values with will increase in ultrasonic velocity exhibits that, in answer suggest sturdy solute-solvent interplay with much less near packing molecules. due to the fact variation of βad elucidated as, the minimal compressibility leads to enhancement of bond strength while most compressibility indicates weaker bond power of molecules and adiabatic compressibility values increases due to removal of solvent molecules around ions helping susceptible interplay[16-17]. βad values decreases with growth in attention of polycarboxylate ether superplastiziser polymer. The acoustic impedance will increase with increase in attention of polycarboxylate ether superplastiziser polymer may be attributed to impact of solute-solvent interaction [18-20].

From the beneath desk it is clear that for a given concentration of polycarboxylate ether superplastiziser polymer, the ultrasonic velocity, acoustic impedance, molar quantity, and molar sound velocity increases with increases awareness from 0.01 to 0.05 but adiabatic compressibility and intermolecular loose duration decreases with boom in temperature and polymer attention. This is because of decreases in density with will increase in temperature of polymer [39].

The plot of ultrasound speed vs. attention of PCE at diverse temperatures below fig. shows that the maximum interplay exists at 308.15 K to start with the ultrasound pace will increase as temperature increases from 303.15K to 308.15K and attains a maximum which suggests the strong interaction among the surfactant and polymer. The ultrasonic speed, acoustic impedance and floor concern were increases as much as 0.03% PVP and then decreases with similarly increase in attention of PCE, whilst the adiabatic compressibility and intermolecular free length have been decreased with growth in the attention PCE and then increases with similarly growth in attention of PCE for all the temperatures studied. The decrease in adiabatic compressibility with boom of concentration of PCE indicates the formation of a huge variety of tightly bound structures this may be due to a extra rigid liquid structure associated with hydrogen bonding of PCE with surfactant such discount in compressibility has been located inside the answer due to solvent molecules [40]. The molar quantity and molar sound velocity have been will increase with growth in awareness of PCE for all of the temperatures studied

The reduced compressibility brings the molecules to a closer packing resulting in to a decrease of intermolecular unfastened length, Lf. Inter molecular loose period is a foremost component in determining the version of ultrasonic speed in solutions. whilst intermolecular loose duration decreases, ultrasonic speed increases or vice a versa. The interdependence of intermolecular free duration and ultrasonic speed has developed from a version for sound propagation [41]. The lower in value of adiabatic compressibility and intermolecular loose duration with boom in ultrasonic speed shows that there may be a giant interplay between the polymer and surfactant molecule due to which structural association is considerably affected [42].

Table I :- Velocity (Us), adiabatic compressibility (β s), intermolecular free length (Lf), relative association (RA) and viscous relaxation time (τ), Gibb' s free energy (Δ G) of S1 compound in different concentration and different percentage of DMF – Water at 10^0C (283K).

Conc.	Density (ρ) Kgm^{-3}	Ultrasonic velocity (U) ms^{-1}	Adiabatic compressibility (βad)x10^{-10} $Kg^{-1}ms^2$	Intermolecular free length (Lf) A^o	Acoustical Impedance (Z)x10^6 Kg $m^{-2}s^{-1}$	Molar volume (Vm)x10^{-3} $L.mol^{-1}$	Relative association (RA)	Viscous relaxation time τ x10^{-6} (s)	Molar sound velocity (RM) x 10^{-4} $mmol^{-1}$ $(N/m^{1/2})^{-1/3}$
	298.15K								
0.01	987.26	2038.00	2.3851	0.3998	2.2561	156.1412	1.0526	1.2958	2020.56
0.02	979.72	2056.01	2.5236	0.3698	2.4562	169.1254	1.0321	1.3598	2323.25
0.03	998.83	2122.25	2.6598	0.3568	2.3654	199.1456	1.0141	1.5697	2812.23
0.04	1000.15	2312.23	1.2581	0.3223	2.6548	235.2236	0.9854	1.7845	3126.26
0.05	1000.95	2502.12	2.8789	0.2645	2.8656	298.5623	0.8874	1.8989	3645.45
	303.15K								
0.01	974.21	2118.00	2.1552	0.3542	2.6801	156.1882	1.0226	1.0354	2112.25
0.02	989.52	2147.10	2.6254	0.3152	2.7762	166.1058	1.0221	1.1359	2248.28

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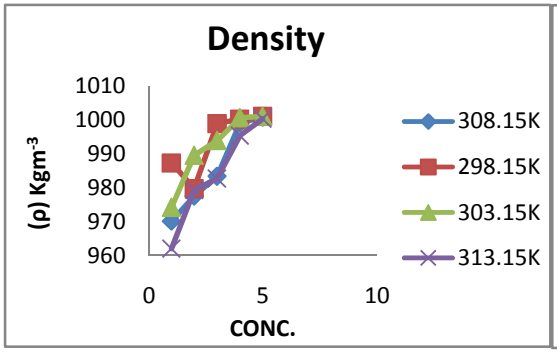
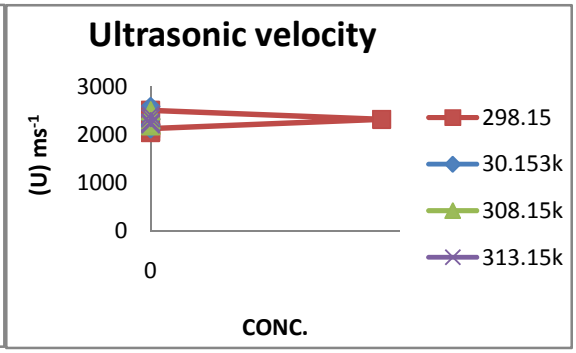
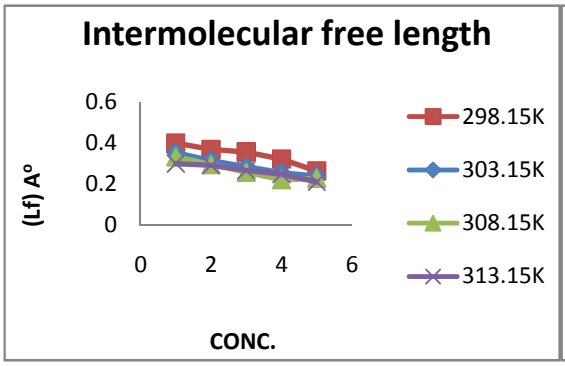
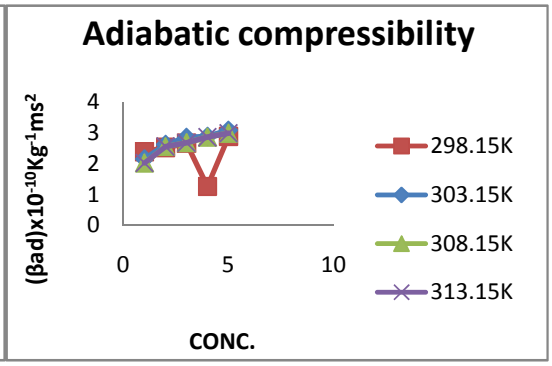
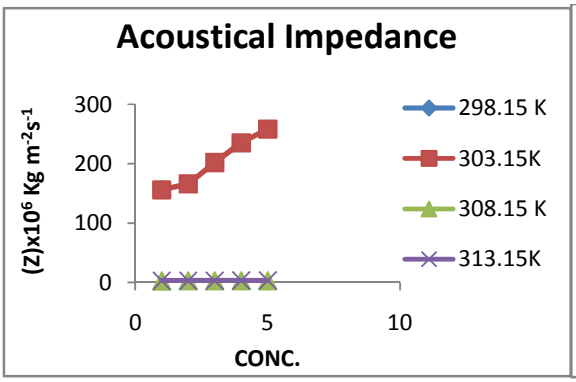
0.03	993.83	2202.05	2.8540	0.2846	2.8065	202.1406	1.0141	1.3569	2522.13
0.04	1000.55	2318.33	2.8847	0.2549	2.8048	235.4587	0.9051	1.5784	2816.58
0.05	1000.99	2582.62	3.0887	0.2389	2.8658	258.5678	0.8549	1.7925	3459.05
	308.15K								
0.01	970.11	2188.09	2.1259	0.3323	2.7554	158.5882	1.0112	1.0034	2218.16
0.02	977.50	2197.28	2.4544	0.2954	2.7998	164.4558	1.0099	1.1152	2288.68
0.03	983.33	2208.25	2.6588	0.2577	2.9587	222.2154	1.0015	1.1902	2492.83
0.04	998.95	2308.08	2.7987	0.2215	3.0125	231.2546	0.9512	1.2514	2696.98
0.05	1000.77	2498.02	2.9889	0.2289	3.1688	244.3125	0.8828	1.5542	3188.02
	313.15K								
0.01	962.02	2212.12	2.0219	0.3003	2.8204	161.0812	1.0002	1.0004	2223.16
0.02	979.25	2237.05	2.5540	0.2914	2.8898	168.4278	0.9082	1.1002	2268.08
0.03	982.63	2254.85	2.6808	0.2671	2.9296	202.2094	0.8510	1.2102	2472.28
0.04	995.24	2338.48	2.8580	0.2485	3.0825	228.2640	0.7782	1.2758	2706.03
0.05	1000.21	2408.82	2.9899	0.2109	3.2588	254.3555	0.6820	1.4549	3008.92

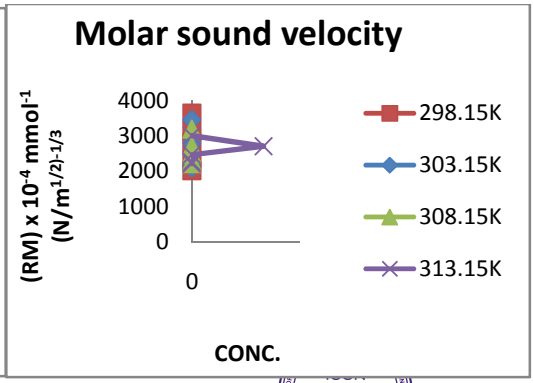












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V. CONCLUSION

The density of polycarboxylate ether superplastiziser polymer solution decreases with increase in temperatures, the density of polymer solution increases with increase in concentration of water-soluble polymers.

VI. ACKNOWLEDGMENT

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