Discussion of Some Electrolytic properties of o, p-nitrophenol in polar solvents

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Abstract :
It has been shown in recent research that electrolysis of some solvents in polar and non-polar solvents can have significant physical and solvolytic consequences. Phenols are aromatic alcohols, and their reactive substituted o, p-nitro compounds. As a result, their electrolytic qualities require additional effort when placed in reactive liquids. Here, we used 40 degrees Celsius of o, p- nitrophenol in chloroform at a steady temperature. Other acoustic and thermodynamic parameters, such as adiabatic compressibility, lowering deformability, specific flowability, lowered flowability, specific attenuation coefficient, molar sound velocity, relative connection, different chain length, apparent molal compressibility, and solvation number, are calculated at varying molar concentrations based on the measured density, viscosity, and ultrasound velocity. As described in relation to the aforementioned variables, the quantity and character of molecular interaction.
Key Word : Solvation number, Molar Sound Velocity, p-nitrophenol

INTRODUCTION:

Since the molecules in binary non-aqueous liquid mixes are so loosely packed that there are some open inter spaces between them, the cell model theory of the liquid has been utilised to examine their interaction. Intermolecular free length, isentropic compressibility, molar volume, accessible volume, shear's relaxation time, and acoustic impedance, as well as their dependent properties, provide useful criteria for interpreting molecular contact and molecular association in organic liquid mixtures. These variables are useful for coordinating the acoustic behaviour of compound organic liquids.

Using the collision factor theory and the free length theory, Jaju et al.[1] have tried a quantitative investigation of the ultrasonic velocity in a binary liquid combination. Binary mixtures of o-cresol with aniline and phenoline have been studied by Adgaonkar et.al[2], who interpreted the results by looking at the variation of ultrasound velocity and adiabatic compressibility. There have been a number of workers[3-6] who have documented the correlation between temperature and the speed of sound.

EXPERIMENTAL:

A multi frequency ultrasonic interferometer, model F-81, produced by m/s Mittal enterprises New Delhi, was used to measure the ultrasound velocities of the solutions. Quartz crystals vary in frequency and are accurate to within +/-.05%. Ten different measurements were taken, and the mean was used as the final figure for the Ultrasound Velocities. The water temperature was maintained within 0.01k by a thermostat made by Scientific instrument Company limited, which was circulated around the cell. Specifically, it has a D.B.S. voltage of 230 and a power output of 2000 watts. Included in this package is a motor by Rami Udyog of Bombay, India, rated at 230 volts, type 183, 1800 revolutions per minute. A temperature gauge from western Germany that reads to within 0.010 degrees Celsius.

A Bicapillary pyknometer with known calibration standards was used to re-evaluate the previous density readings. The density readings were precise to within + 0.0001 g/cm3 for the whole volume. An ubbelohde-type Capillary viscometer was used to measure the viscosities. It we then called calibrated with de-ionized water that had been distilled twice. An electronic watch accurate to the nearest 0.01 seconds was used to time the outflow. The final efflux time was based on an average of four or five repeatable readings within 0.15. It was determined that the measured viscosities had a margin of error of + 0.005 cp.

RESULTS AND DISCUSSION :

A table displaying the outcomes of ultrasonic velocity, density, and viscosity measurements (1-4). A variety of other acoustic and thermodynamic parameters are tabulated as a function of molar concentration, including isentropic compressibility, decreasing ductility, reduced viscosity, particular attenuation coefficient, mole ratio pulse width, relative affiliation, diffusion path length, apparent molal compressibility, and solvation number (1-4). Solvents such as formaldehyde and dioxane at 40 degrees Celsius are used to discuss the states of o- and p-nitrophenol.

The equations show how the density and isentropic compressibility of a homogeneous non-dissipative fluid system affect its compressional acoustic wave speed. –

$$v = (\rho\ \beta_s)^{-1/2}$$

Therefore, the concentration derivatives of and determine how velocity (v) varies with concentration (c) in electrolytic solution: —

$$dv/dc = -\frac{v}{2}\left[\frac{1}{\rho\left(d\rho/dc\right)} + \frac{1}{\beta_s\left(d\beta_s/dc\right)}\right]$$

The quantity $\frac{d\rho}{dc}$ always positive while $\frac{d\beta_s}{dc}$ seem to be unfavourable for ionic solutions like this one. Given the fact that the signs of these variables are opposite. Possible acceleration through focused effort.

In the molecular free length is given by $\sqrt[k]{\beta_s}$ where k is a constant that varies with temperature1. While specific acoustic impedance was found to increase with increasing molar concentration, compressibility was found to decrease with concentration (tables 1-4).

The molar sound velocity R of a solution is given by the equation: where M1 and M2 are the molecular weights of the solute and solvent, respectively.

$$R = \left(\frac{\bar{M}}{\rho} \right) v^{2/3}$$

Where $\bar{M} = \sum \frac{M_i n_i}{n_i}$ and ρ solutions density Increasing the molar concentration of solutions was found to increase the molar sound velocity in all four electrolytic solutions.

Compressibility exists for the ions in the initial solvation zone. If we let V be the volume of the solution containing n2 moles of solution and Vo be the molar volume of the solvent, then we have Passynsky's modified expression, in which the compressibilities of the solvent and solution are represented by and respectively. 2-3 The equation for salt's primary solvation number is

$$S_n = \frac{n_1}{n_2} \left(1 - \frac{v \beta_s}{n_1 V_o \beta_{s,o}} \right)$$

Both chloroform and dioxane have concentration effects on their solvation numbers.

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Table - 1

O-nitrophenol + Chloroform at 40° C

Isentropic Compressiblity of Chloroform = 71.68 x 10^{-12} dynes/cm^2

Molar Concentraion of O-nitrophenol Mole/litre	Density ρ (gm/ml)	Ultrasound Velocity (m/sec.)	Isentropic Compressibility β_s (cm^2/dyne.10^{12})	Lowering Compressiblity $\beta_{so} - \beta_s$ (cm^2/dyne.10^{12})	Viscosity (C.P.)	Specific Viscosity η_{sp} (C.P.)	Reduced Viscosity η (C.P.)
0.0236	1.0756	1140	71.54	0.14	0.9066	0.9023	38.2335
0.0472	1.0777	1142	71.15	0.53	0.9087	0.9046	19.1659
0.0708	1.0798	1144	70.76	0.92	0.9108	0.9070	12.8101
0.0944	1.0819	1146	70.38	1.30	0.9129	0.9093	9.6322

0.1180	1.0840	1148	70.00	1.68	0.9150	0.9116	7.7254
0.1416	1.0861	1150	69.62	2.06	0.9171	0.9139	6.4542
0.1652	1.0882	1152	69.24	2.44	0.9192	0.9162	5.5463
0.1888	1.0903	1154	68.87	2.81	0.9213	0.9186	4.8653
0.2124	1.0924	1156	68.50	3.18	0.9234	0.9209	4.3356
0.2360	1.0945	1158	68.13	3.55	0.9255	0.9232	3.9119

Molar Concentraion of O-nitrophenol Mole/litre	**Specific Acoustic Impedance** $Z \times 10^{-5}$	**Molar Sound Velocity** R **(m/sec.)**	**Relative Association** R_A	**Solvation Number** S_n	**Intermolecular Free Length** L_f **(A°)**	**Apparent Molal Compressibility** (φ_k) **Cm²/dyne.(10)¹²**
0.0236	1.2262	1213.34	1.0020	0.0200	0.5430	-6.0188
0.0472	1.2307	1216.42	1.0045	0.0749	0.5415	-3.6605
0.0708	1.2353	1219.50	1.0070	0.1294	0.5401	-2.8705
0.0944	1.2399	1222.59	1.0096	0.1835	0.5386	-2.4725
0.1180	1.2444	1225.67	1.0121	0.2372	0.5371	-2.2313
0.1416	1.2490	1228.76	1.0147	0.2905	0.5357	-2.0686
0.1652	1.2536	1231.85	1.0172	0.3435	0.5342	-1.9508
0.1888	1.2582	1234.94	1.0198	0.3961	0.5328	-1.8610
0.2124	1.2628	1238.03	1.0223	0.4482	0.5314	-1.7898
0.2360	1.2674	1241.13	1.0249	0.5001	0.5299	-1.7318

Table – 2

O-nitrophenol + Dioxane at 40° C

Isentropic Compressiblity of Chloroform = 76.56 x 10^{-12} dynes/cm²

Molar Concentraion of O-nitrophenol Mole/litre	**Density** ρ **(gm/ml)**	**Ultrasound Velocity (m/sec.)**	**Isentropic Compressiblity** β_s **(cm²/dyne.10¹²)**	**Lowering Compressiblity** $\beta_{so} - \beta_s$ **(cm²/dyne.10¹²)**	**Viscosity (C.P.)**	**Specific Viscosity** η_{sp} **(C.P.)**	**Reduced Viscosity** η **(C.P.)**
0.0244	0.8411	1251	76.19	0.37	1.1456	0.0020	0.0839
0.0488	0.8436	1253	75.94	0.62	1.1481	0.0042	0.0857
0.0732	0.8460	1255	75.70	0.86	1.1505	0.0063	0.0863
0.0976	0.8485	1257	75.46	1.10	1.1530	0.0084	0.0866
0.1220	0.8509	1259	75.22	1.34	1.1554	0.0106	0.0868
0.1464	0.8533	1261	74.98	1.58	1.1578	0.0127	0.0869
0.1708	0.8558	1263	74.75	1.81	1.1603	0.0149	0.0870
0.1952	0.8582	1265	74.51	2.05	1.1627	0.0170	0.0870
0.2196	0.8607	1267	74.27	2.29	1.1652	0.0191	0.0871
0.2440	0.8631	1269	74.04	2.52	1.1676	0.0213	0.0871

Molar Concentraion of O-nitrophenol Mole/litre	**Specific Acoustic Impedance** $Z \times 10^{-5}$	**Molar Sound Velocity** R **(m/sec.)**	**Relative Association** R_A	**Solvation Number** S_n	**Intermolecular Free Length** L_f **(A°)**	**Apparent Molal Compressibility** (φ_k) **Cm²/dyne.(10)¹²**
0.0244	1.0492	796.51	1.0009	1.2326	0.5604	-0.2986
0.0488	1.0509	796.93	1.0015	2.0349	0.5595	-0.0128
0.0732	1.0526	797.35	1.0020	2.8334	0.5586	0.0841
0.0976	1.0542	797.78	1.0025	3.6280	0.5577	0.1337
0.1220	1.0559	798.20	1.0030	4.4189	0.5568	0.1644
0.1464	1.0576	798.62	1.0036	5.2060	0.5559	0.1856
0.1708	1.0593	799.04	1.0041	5.9894	0.5550	0.2015
0.1952	1.0610	799.47	1.0046	6.7690	0.5542	0.2139
0.2196	1.0626	799.89	1.0052	7.5450	0.5533	0.2241
0.2440	1.0643	800.31	1.0057	8.3173	0.5524	0.2327

Table – 3

p-nitrophenol + Chloroform at 40 ^{o} C

Isentropic Compressiblity of Chloroform = 71.68 x 10^{-12} dynes/cm^2

Molar Concentraion of p-nitrophenol Mole/litre	Density ρ (gm/ml)	Ultrasound Velocity (m/sec.)	Isentropic Compressibility β_s (cm^2/dyne.10^{12})	Lowering Compressiblity $\beta_{so} - \beta_s$ (cm^2/dyne.10^{12})	Viscosity (C.P.)	Specific Viscosity η_{sp} (C.P.)	Reduced Viscosity η (C.P.)
0.0236	1.0759	1142	71.27	0.41	0.9069	0.0025	0.1059
0.0472	1.0782	1144	70.87	0.81	0.9092	0.0051	0.1082
0.0708	1.0806	1146	70.47	1.21	0.9116	0.0077	0.1090
0.0944	1.0829	1148	70.07	1.61	0.9139	0.0103	0.1094
0.1180	1.0853	1150	69.67	2.01	0.9163	0.0129	0.1096
0.1416	1.0877	1152	69.28	5.40	0.9187	0.0155	0.1098
0.1652	1.0900	1154	68.89	5.79	0.9210	0.0182	0.1099
0.1888	1.0924	1156	68.50	3.18	0.9234	0.0208	0.1100
0.2124	1.0947	1158	68.12	3.56	0.9257	0.0234	0.1100
0.2360	1.0971	1160	67.74	3.94	0.9281	0.0260	0.1101

Molar Concentraion of p-nitrophenol Mole/litre	Specific Acoustic Impedance $Z \times 10^{-5}$	Molar Sound Velocity R (m/sec.)	Relative Association R_A	Solvation Number S_n	Intermolecular Free Length L_f (A°)	Apparent Molal Compressibility (φ_k) Cm^2/dyne.$(10)^{12}$
0.0236	1.2286	407.87	1.0028	0.0384	0.5420	-7.2344
0.0472	1.2335	409.00	1.0056	0.0764	0.5404	-4.3414
0.0708	1.2383	410.14	1.0084	0.1140	0.5389	-3.3727
0.0944	1.2432	411.27	1.0111	0.1514	0.5374	-2.8851
0.1180	1.2481	412.41	1.0139	0.1885	0.5359	-2.5901
0.1416	1.2530	413.54	1.0167	0.2254	0.5344	-2.3913
0.1652	1.2579	414.68	1.0195	0.2619	0.5329	-2.2475
0.1888	1.2628	415.82	1.0223	0.2982	0.5314	-2.1381
0.2124	1.2677	416.96	1.0251	0.3342	0.5299	-2.0516
0.2360	1.2726	418.09	1.0279	0.3699	0.5284	-1.9812

Table – 4

p-nitrophenol + Dioxane at 40 ^{o} C

Isentropic Compressiblity of Chloroform = 76.56 x 10^{-12} dynes/cm^2

Molar Concentraion of p-nitrophenol Mole/litre	Density ρ (gm/ml)	Ultrasound Velocity (m/sec.)	Isentropic Compressibility β_s (cm^2/dyne.10^{12})	Lowering Compressiblity $\beta_{so} - \beta_s$ (cm^2/dyne.10^{12})	Viscosity (C.P.)	Specific Viscosity η_{sp} (C.P.)	Reduced Viscosity η (C.P.)
0.0244	0.8410	1250	76.10	0.46	1.1456	0.0020	0.0839
0.0488	0.8435	1252	75.63	0.93	1.1481	0.0042	0.0857
0.0732	0.8459	1254	75.18	1.38	1.1505	0.0063	0.0863
0.0976	0.8484	1256	74.72	1.84	1.1530	0.0084	0.0866
0.1220	0.8508	1258	74.27	2.29	1.1554	0.0106	0.0868
0.1464	0.8532	1260	73.82	2.74	1.1578	0.0127	0.0869
0.1708	0.8557	1262	73.38	3.18	1.1603	0.0149	0.0870
0.1952	0.8581	1264	72.94	3.62	1.1627	0.0170	0.0870
0.2196	0.8606	1266	72.50	4.06	1.1652	0.0191	0.0871
0.2440	0.8630	1268	72.07	4.49	1.1676	0.0213	0.0871

Molar Concentraion ofp-nitrophenol Mole/litre	Specific Acoustic Impedance $Z \times 10^{-5}$	Molar Sound Velocity R (m/sec.)	Relative Association R_A	Solvation Number S_n	Intermolecular Free Length L_f (A°)	Apparent Molal Compressibility (φ_k) Cm^2/dyne.(10)^{12}
0.0244	1.0513	798.51	1.0034	1.5310	0.5600	-1.7240
0.0488	1.0560	801.26	1.0069	3.0573	0.5583	-1.6730
0.0732	1.0608	804.00	1.0103	4.5711	0.5566	-16340
0.0976	1.0655	806.75	1.0138	6.0724	0.5550	-1.6080
0.1220	1.0703	809.50	1.0173	7.5613	0.5533	-1.5720
0.1464	1.0751	812.25	1.0207	9.0380	0.5516	-1.5360
0.1708	1.0799	815.01	1.0242	10.5026	0.5499	-15065
0.1952	1.0847	817.76	1.0276	11.9552	0.5483	-1.4991
0.2196	1.0895	820.52	1.0311	13.3960	0.5467	-1.4917
0.2440	1.0943	823.28	1.0346	14.8251	0.5450	-1.4844