Study of Physical Properties for Sodium acetate with Water and Water - Acetone mixtures at Different Temperatures

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ABSTRACT

In this study binary and ternary solutions are prepared by using the sodium acetate concentrations (0.1, 0.125, 0.2, 0.25, 0.4, 0.5, 0.8, 1 M) in water and acetone –water mixtures .The important parameters such as apparent molal volume, the partial molal volume transfer, apparent molal compressibility, free energy of activation of viscous flow and thermodynamic activation parameter (enthalpy and entropy) determined of sodium acetate in water , 20%, 40% ,60% and 80% V/V acetone –water mixtures at 298.15K, 303.15K and 308.15 K from density and viscosity measurements espectively. The limiting apparent molal volumes and experimental slopes were derived from the Masson equation, have been interpreted in terms of solute–solvent and solute–solute interactions respectively. The viscosity data were analyzed using theJones–Dole equation and the derived parameter B - coefficient has also been interpreted in terms of solute–solvent interactions in the solutions.

الخلاصة

حضرت في هذه الدراسة محاليل ثنائية وثلاثية المكون باستعمال تراكيز من خلات الصوديوم
(1,0.8,0.5,0.4,0.25,0.2,0.125,0.1) مولاري في الماء ومزيجات الماء-اسيتون ،معاملات مهمة مثل الحجم المولالي الظاهري ،الحجم المولالي الجزئي للانتقال ، الانظغاط المولالي الظاهري ،الطاقة الحرة لتنشيط الانسياب اللزج والمعاملات الثرموديناميكية للتنشيط (الانثالبي والانتروبي) تم تعيينها لخلات الصوديوم في الماء و مزيجات (80,60,40,20)% حجم/حجم ماء-اسيتون عند درجات حرارة (308,303,298) كلفن من قياسات الكثافة واللزوجة تواليا الحجم المولاري المحدد والميل التجريبي المشتقات من معادلة ماسون فسرت مفاهيم تداخلات مذاب- مذيب ومذاب – مذاب تواليا .بيانات اللزوجة حللت من خلال معادلة جونز ودول ومعامل B المشتق منها استعمل في تفسير تداخلات مذاب – مذيب .

NTRODUCTION

The studies on viscosities and densites of electrolyte solutions are usually done to obtain information about structure and properties of solutions. Different types of interactions exist between the ions in the electrolytic solutions and of these, ion – ion and ion – solvent interactions are of current interest. These interactions help in understanding the nature of the solvent as it has been found by number of researchers that the addition of an electrolyte either breaks or makes the structure of the liquid. The making and breaking of the liquids structure have been considered as a measure of solute –solute and solute – solvent interactions [1,2].

The volumetric and viscous behavior of solutes has been proven to be very useful in elucidating the various interactions occurring in solutions and it is an important key thermodynamic properties,so these properties (viscosity and density) of electrolyte solutions were among the earliest studies in the field of solution chemistry and have influenced the developments of our view of the solution process [3,4]

Many recent articles have been written concerning the effect of the salt ions on transport properties of aqueous-non aqueous mixtures [5,6],Thus, the present paper reports acoustical properties of sodium acetate in water and water –Acetone mixtures over a wide concentration range at temperatures under study . The results are interpreted in terms of molecular interactions occurring in the solution.

MATERIALS AND METHODS

Sodium acetate anhydrous of high purity was obtained from Thomas Baker Company, acetone was obtained from Sigma-Aldrich Company. Triply distilled water with a specific conductance of $< 10^{-6}$ S.cm^{-1} was used for the preparation of different sodium acetate solutions at room temperature (25ºC). The precision of balance used was $\pm 1 \times 10^{-4}$g.

Density and Viscosity measurements:

The water –acetone mixtures (20%, 40%, 60%and 80% V/V) were prepared by mixing known volume of solutions in airtight-stoppered bottles. Adequate precautions were taken to minimize evaporation losses during the actual measurements. Mass measurements for stock solutions were done on a kern sohnGmbh electronic balance with a precision of ±0.0001. The

conversion of molarity into molality was accomplished using experimental density values. The uncertainty in molality of solution is estimated to be ± 0.0001 mol. kg^{-1}.

$$C = \frac{1000\, m\rho}{1000 + mM_2} - - - - - (1)$$

where(C) is the molarity, (m)is the molality and (M_2)is the molar mass of sodium acetate.

The density(ρ)was determined by using specific gravity bottle by relative measurement method with accuracy $\pm 1 \times 10^{-4}$ gm/cm^3. The temperature was automatically kept constant within ± 0.01 K.

The viscosity, was measured by means of a suspended Ubbelohde type viscometer, calibrated at the experimental temperatures with doubly distilled water. After attainment of thermal equilibrium, efflux times of flow were recorded with a stop watch. At least three repetitions of each data point were taken to average the flow time. The viscosity of solution (η) is given by the following equation:

$$\eta = ct\rho - - - - - (2)$$

where (c)is the viscometer constant and (t) and (ρ) are the efflux time of flow in seconds and the density of the experimental liquid respectively.

RESULTS AND DISCUSSION

The experimental values of densities of sodium acetate in water and 20%, 40%, 60%and 80% Water-acetone mixtures at 298.15K, 303.15K, and 308.15 K are reported intable(1).

From table (1) we are observed that overall densities of sodium acetate in water and 20%, 40%, 60%, 80% (V/V%) Water-acetone mixtures increased with the increase in concentration of sodium acetate which is attributed to presence of strong ion-solvent interactions.whereas we can be observed that density decrease with increasing temperatures and from water to water-acetone mixtures in the same concentration and temperature.

Apparent molar volumes (ϕ_V) were determined from the solution densities using the following equation[7]:

$$\phi_V = \frac{M}{\rho} - 1000 \frac{(\rho - \rho_o)}{m\rho\rho_o} - - - - - - (3)$$

Where M is the molar mass of the sodium acetate salt, ρ_0 and ρ are the densities of solvent mixture and solution respectively and m is the molality of the solution.The result of (ϕv) of sodium acetate are reported in Table (1).

The apparent molal volume (ϕv) values increases with increase in concentration of sodium acetate in binary mixtures.the (ϕv)values increased with increase ratio of acetone in mixtures which suggests strengthening of solute-solute interactions in mixtures. Upon addition of the solute, resultant change in apparent molal volume becomes more due to weak approach of solvent to solute molecules.These volumes are move in water-acetone than in water. This represents strong and variable

interactions between solute and solutes.And we were observed the same behavior for apparent molal volume which increases with increase in temperature in all system indicates at hiegher concentrations the existence of weak ion-solvent interaction.

Masson found that the apparent molar volumes (ϕ_V) vary with the square root of the molal concentration by the linear equation[8]:

$$\phi_V = \phi_V^\bullet + S_V^\bullet \sqrt{m} - - - - - (4)$$

Where ($\phi_V^\bullet$)is the limiting apparent molal volume and ($S_V^\bullet$) is the experimental slope. The plots of (ϕ_V) against ($\sqrt{m}$) of sodium acetatein water and 20%, 40%,60% and 80% water-acetone at 298.15 K , 303.15Kand308.15K figure (1) .

The values of ($\phi_V^\bullet$) and $S_V^\bullet$)sodium acetate in water and 20%, 40%,60% and 80% water-acetone at 298.15 K , 303.15K and 308.15 K.are reported in table(2).

Table (1): values of molality(m)(mol.kg^{-1}) , density (ρ) (g.cm^{-3})apparent molal volume(ϕ_V)(cm^3.mol^{-1}) of sodium acetate in water and 20%, 40% ,60% and 80% Acetone-water mixtures at different temperatures

Sodium acetate +water								
298K			303K			308K		
m	ρ	ϕ_v	m	ρ	ϕ_v	m	ρ	ϕ_v
0	0.99753	-	0	0.99539	-	0	0.99411	-
0.09197	1.09554	47.98	0.09526	1.05792	28.95	0.09748	1.03402	18.62
0.11511	1.09618	53.34	0.11905	1.06024	38.49	0.12177	1.03675	30.52
0.18456	1.10007	61.17	0.18875	1.07604	51.71	0.19547	1.03958	48.63
0.23084	1.10351	63.62	0.23486	1.08496	55.90	0.24445	1.04320	54.42
0.37189	1.10839	67.36	0.37707	1.09361	62.74	0.39239	1.05220	62.88
0.46741	1.11075	68.56	0.47306	1.09796	64.93	0.49312	1.05497	65.76
0.76308	1.11401	70.40	0.77032	1.10415	68.29	0.80248	1.06254	69.83
0.96757	1.11555	70.98	0.97664	1.10595	69.44	1.01966	1.06276	71.39
Sodium acetate +80% water+20% Acetone								
298K			303K			308K		
m	ρ	ϕ_v	m	ρ	ϕ_v	m	ρ	ϕ_v
0	0.99656	-	0	0.99512	-	0	0.99392	-
0.09993	1.00891	46.77	0.10019	1.00632	32.57	0.10015	1.00673	20.40
0.12477	1.01212	53.39	0.12514	1.00912	42.11	0.12531	1.00778	32.58
0.20033	1.01477	63.61	0.20136	1.00963	56.90	0.20031	1.01486	50.29
0.25103	1.01641	66.96	0.25113	1.01602	61.21	0.25138	1.01501	56.44
0.40311	1.02510	71.46	0.40339	1.02440	67.92	0.40457	1.02152	65.19
0.50580	1.02955	72.86	0.50630	1.02858	70.07	0.50815	1.02499	68.00
0.81891	1.04253	74.47	0.82102	1.04003	72.90	0.82228	1.03853	71.55
1.03735	1.04603	75.10	1.03744	1.04595	73.70	1.04165	1.04205	72.85
Sodium acetate +60% water+40% Acetone								
298K			303K			308K		
m	ρ	ϕ_v	m	ρ	ϕ_v	m	ρ	ϕ_v
0	0.99582	-	0	0.99185	-	0	0.99149	-
0.10124	0.99598	40.90	0.10165	0.99196	1.86	0.10169	0.99158	0.33
0.12680	0.99604	49.26	0.12732	0.99204	18.15	0.12736	0.99175	15.32
0.20410	0.99630	61.77	0.20491	0.99247	42.56	0.20503	0.99187	40.84
0.25615	0.99650	65.94	0.25708	0.99295	50.65	0.25732	0.99207	49.33
0.41484	0.99704	72.16	0.41646	0.99328	62.86	0.41692	0.99223	62.09
0.52293	0.99716	74.24	0.52484	0.99369	66.90	0.52552	0.99245	66.33
0.85866	0.99731	77.37	0.86176	0.99396	73.00	0.86301	0.99261	72.70
1.09086	0.99874	78.29	1.09551	0.99485	74.96	1.09805	0.99274	74.82
Sodium acetate +40% water+60% Acetone								

298K			303K			308K		
m	ρ	ϕ_v	m	ρ	ϕ_v	m	ρ	ϕ_v
0	0.99490	-	0	0.99095	-	0	0.98990	-
0.10132	0.99513	31.84	0.10175	0.99100	-6.98	0.10186	0.98998	-17.31
0.12690	0.99528	42.03	0.12744	0.99109	11.11	0.12758	0.99005	2.88
0.20428	0.99543	57.32	0.20517	0.99120	38.25	0.20538	0.99019	33.17
0.25641	0.99552	62.41	0.25752	0.99130	47.29	0.25778	0.99033	43.26
0.41542	0.99570	70.05	0.41726	0.99144	60.86	0.41770	0.99044	58.40
0.52367	0.99581	72.59	0.52604	0.99151	65.38	0.52658	0.99054	63.44
0.85996	0.99590	76.41	0.86390	0.99166	72.15	0.86486	0.99063	71.01
1.09442	0.99576	77.70	1.09919	0.99179	74.40	1.10047	0.99074	73.53
Sodium acetate +20% water+80% Acetone								
298K			303K			308K		
m	ρ	ϕ_v	m	ρ	ϕ_v	m	ρ	ϕ_v
0	0.99361	-	0	0.98808	-	0	0.98734	-
0.10146	0.99386	19.15	0.10199	0.98872	-35.32	0.10211	0.98750	-42.50
0.12707	0.99395	31.92	0.12774	0.98878	-11.47	0.12789	0.98767	-17.20
0.20457	0.99404	51.09	0.20566	0.98888	24.30	0.20588	0.98782	20.77
0.25676	0.99416	57.47	0.25812	0.98905	36.21	0.25841	0.98795	33.42
0.41603	0.99428	67.05	0.41827	0.98913	54.09	0.41872	0.98812	52.40
0.52445	0.99440	70.23	0.52729	0.98927	60.05	0.52785	0.98826	58.72
0.86124	0.99452	75.02	0.86600	0.98941	68.98	0.86699	0.98836	68.21
1.09570	0.99470	76.60	1.10192	0.98954	71.95	1.10323	0.98846	71.37

Table(2): values of ($\phi_v^\bullet$)(cm³.mol⁻¹) and ( )($S_v^\bullet$ cm³.mol⁻³/².kg⁻¹/²) of sodium acetate in water and 20%, 40% ,60% and 80% Acetone-water mixtures at different temperatures

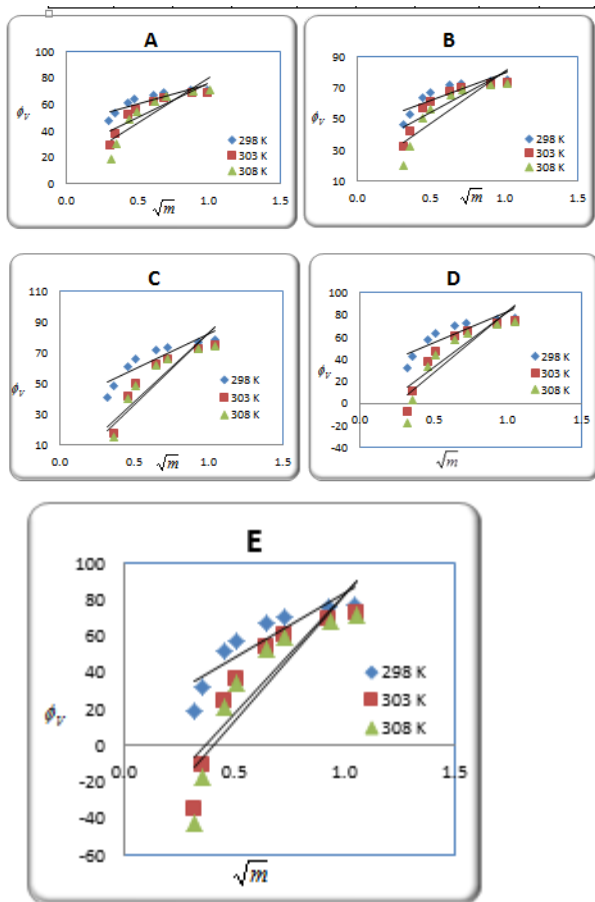| Sodium acetate +water		
T/K	$S_v^\bullet$	$\phi_v^\bullet$
298	29.954	45.316
303	52.871	23.725
308	67.273	12.124
T/K	Sodium acetate +80% water+20% Acetone		Sodium acetate +60% water+40% Acetone	
	$S_v^\bullet$	$\phi_v^\bullet$	$S_v^\bullet$	$\phi_v^\bullet$
298	35.633	43.806	46.004	36.408
303	51.954	27.908	86.720	-6.984
308	66.286	14.105	92.510	-9.905
T/K	Sodium acetate +40% water+60% Acetone		Sodium acetate +20% water+80% Acetone	
	$S_v^\bullet$	$\phi_v^\bullet$	$S_v^\bullet$	$\phi_v^\bullet$
298	56.286	26.294	70.485	12.208
303	99.682	-16.813	131.22	-48.276
308	111.190	-28.284	139.22	-56.265

Figure (1): a plot of apparent molal volume (φv)against ($\sqrt{m}$) fo sodium acetate in   A) water B)20% Water+Acetone   C) 40% Water+Acetone D) 60% Water+Acetone E) 80% Water+Acetone mixtures at different temperatures

($\phi_v^\bullet$) value indicates the extent of solute-solvent interaction. Aperusal of table(2) and figure (1) shows

that ($\phi_v^\bullet$) values for sodium acetate are positive for aqueous solution and become negative with increase percentage of acetone in mixtures and decrease with the increase intemperature which may be due to decrease in hydrogen bonding between water molecules and formed hydrogen bonding between water and acetone with increase in temperature, making less free water moleculesavailable for solvation of sodium acetate and hence solute-solvent interactions decreases with increase in temperature[9].

The parameter ($S_v^\bullet$) is the volumetric virial coefficient that characterizes the pair-wise interaction of solvated species insolution. The sign of ($S_v^\bullet$) is determined by the interaction between the solute species. In the present study ($S_v^\bullet$) valueswere found to be positive and increase with increase intemperature in 20%, 40% , 60% and 80% water-acetone mixtures which may be due to less solvation of sodium acetate with rise intemperature.[10-12]

The volume of transfer ($\Delta\phi_{tr}^\bullet$)(cm³.mol⁻¹)of sodium acetate from water to water-acetone mixtures was calculated by using given relation at different temperatures and is summarized in Table (3).

$$\Delta\phi_{tr}^\bullet = \phi_{v\,(water-acetone)}^\bullet - \phi_{v\,(water)}^\bullet - - - - - (5)$$

The limiting apparent molar expansibilities (φE) can be obtained by the following equation and figure (2):

$$\phi_E = \left(\frac{\partial \phi_v^\bullet}{\partial T}\right)_P = a_1 + 2a_2 T - - - - - (6)$$

Table (3). $(\Delta\phi_{tr}^{\bullet})$ (cm³.mol⁻¹) of sodium acetate in water and water-acetone mixtures at different temperatures

	$(\Delta\phi_{tr}^{\bullet})$ (cm³.mol⁻¹)		
system	298 K	303 K	308 K
Sodium acetate +80% water+20% Acetone	-1.51	4.185	1.981
Sodium acetate +60% water+40% Acetone	-8.908	-30.507	-22.029
Sodium acetate +40% water+60% Acetone	-19.022	-6.91	16.16
Sodium acetate +20% water+80% Acetone	-33.108	24.553	44.141

It is found that value of ($\Delta\phi_{tr}^{\bullet}$) for sodium acetate for all most water-acetone mixtures are negative at 298 K , 303 K and positive at 308 K ,in system negative values of ($\Delta\phi_{tr}^{\bullet}$) (Table 3) decrease with increasing Percentage of acetone and temperature, suggests that the electrostriction first increase and then decrease with increasing temperature. It brings about decrease in volume of the solvent thereby increasing the strong interaction between acetone and water. In sodium acetate-watersystem, hydrophobic interactions are leading at lower percentage, while at higher percentage hydrophilic interactions are leading.

The electrostriction of the neighboring water will be decrease at higher temperature this will lead to decrease in reduction of shrinkage. It brings about increase in volume of the solvent thereby decreasing the strong interaction between acetone and water. This will lead to positive volume transfer or in other words it may be say that there is an increase inelectrostriction. In sodium acetate with acetone-water system hydrophilic interactions are dominating over hydrophobic interactions at higher percentage of acetone. Both negative and positive transfer volume has behavior similar with earliststudy[13].

The values of (ϕ_E) of the sodium acetate solutions study at all temperatures are determined and reported in table (4).
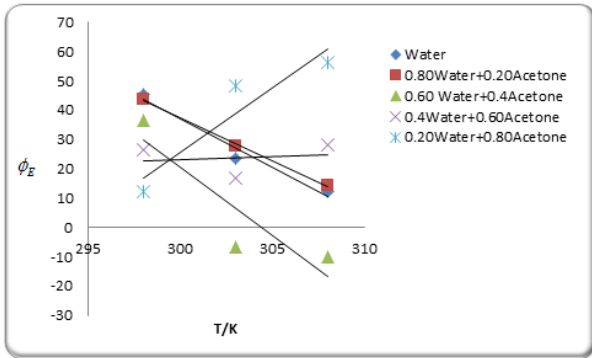

Figure (2): a plot of (ϕ_E) against (T) fo sodium acetate in A) water B)20% Water+Acetone C) 40% Water+Acetone D) 60% Water+Acetone E) 80% Water+Acetone mixtures at 298.15K, 303.15K and 308.15 K

Table(4): values of limiting apparent molar expansibilities of sodium acetate in water and 20%, 40% ,60% and 80% Acetone-water mixtures at different temperatures

system	water	80%water 20% acetone	60% water 40% acetone	40% water 60% acetone	20% water 40% acetone
ϕ_E	-3.31	-2.97	-4.63	0.19	4.40

It is found from table (4) that the values of (ϕ_E)increase with increase of percentage of acetone in mixtures It shows strong electrostatic attractive force in the vicinity of ions. It can be concluded that strong molecular association is found in all systems.On the basis of this expression, it has been deduced that thestructure, making solutes should have positive values whereas structure-breaking solutes should have negative values. In our present investigation, it is evident from table (4) that ϕ_E values are negative for sodium acetate in for solutions (water, 20% water + 80% acetone, 40% water+ 60% acetone) , suggesting thereby that sodium acetate acts as astructure breaker in these solution.whereas that ϕ_E values are postive for sodium acetate infor solutions (40% water+ 60% acetone, 20% water+ 80% acetone)suggesting thereby that sodium acetate acts as astructure maker in these solution.

The experimental values of viscosites ($\dot\eta$) of sodium acetate in water and 20%, 40%, 60%and 80% water-acetone mixtures at 298.15K , 303.15Kand 308.15 K are reported intable (5).

Table(5): Molarity (C), experimental values of viscosites (η)(cp) of sodium acetate in 20%, 40% ,60% and 80% water-acetone mixtures at different temperatures

C/mol.L⁻¹	Sodium acetate +water/η		
	298K	303K	308K
0.000	0.91419	0.81901	0.74578
0.100	0.96977	0.86918	0.77924
0.125	0.98569	0.88763	0.78503
0.200	1.00458	0.90904	0.81087
0.250	1.01832	0.92916	0.82496
0.400	1.05519	0.96719	0.85565
0.500	1.08720	0.99870	0.88829
0.800	1.14075	1.05866	0.94778
1.000	1.17267	1.10152	0.97689

C/mol.L⁻¹	Sodium acetate +80% water+20% Acetone/ η			Sodium acetate +60% water+40% Acetone/ η		
	298K	303K	308K	298K	303K	308K
0.000	1.17497	1.05960	0.93975	1.37918	1.27215	1.09317
0.100	1.20665	1.09044	0.96163	1.40751	1.30462	1.13516
0.125	1.22507	1.10115	0.97150	1.41279	1.31108	1.14409
0.200	1.26643	1.13806	0.98767	1.42470	1.32673	1.16445
0.250	1.29165	1.15867	1.00080	1.43297	1.33850	1.17898
0.400	1.35191	1.20880	1.02152	1.44650	1.36557	1.20853
0.500	1.38742	1.24787	1.03975	1.45746	1.38123	1.22746
0.800	1.48748	1.32749	1.07799	1.49397	1.41380	1.26776
1.000	1.54771	1.38065	1.11166	1.51370	1.43935	1.30962

C/mol.L⁻¹	Sodium acetate +40% water+60% Acetone/ η			Sodium acetate +20% water+80% Acetone/ η		
	298K	303K	308K	298K	303K	308K
0.000	1.38633	1.19905	1.05261	1.10296	0.95646	0.86758
0.100	1.40234	1.23638	1.08620	1.12704	0.99781	0.87809
0.125	1.40851	1.24719	1.09499	1.13111	1.00341	0.87982
0.200	1.42068	1.26199	1.11773	1.14951	1.01974	0.88430
0.250	1.43354	1.27244	1.13095	1.16118	1.03059	0.88718
0.400	1.46208	1.29919	1.15644	1.18121	1.05441	0.89523
0.500	1.47539	1.31514	1.17835	1.19010	1.07316	0.90129
0.800	1.51059	1.35342	1.21847	1.23042	1.10775	0.91681
1.000	1.53068	1.38454	1.25823	1.25451	1.12848	0.92955

From table (5) the viscosity of a sodium acetate solutions under study decrease markedly as temperature is raised [14]. As the temperature increased, more molecules are able to escape from the potential wells provided by their neighbors and so the solution becomes more fluid.

The observed value of viscosity increased with increasing sodium acetate concentration due to the increase of the intermolecular forces which cause to resist in flow process.[15]

The viscosity data has been analyzed using the Jones–Dole equation[16]:

$$(\eta/\eta_{\bullet} - 1)/\sqrt{C} = A + B\sqrt{C} - - - - - - (7)$$

Where ($\eta_\bullet$) and (η) are the viscosities of the solvent mixture and solution, respectively. A and B values as reported in table (6), are the viscosity co-efficients estimated by a least square method.

The A and B values are obtained from the straight line for figure (3) by plotting $(\eta_r - 1)/\sqrt{C}$ against $\sqrt{C}$ for sodium acetate in 20%, 40%,60% and 80% of acetone-water mixtures at 298K , 303.15K and 308.15K respectively.
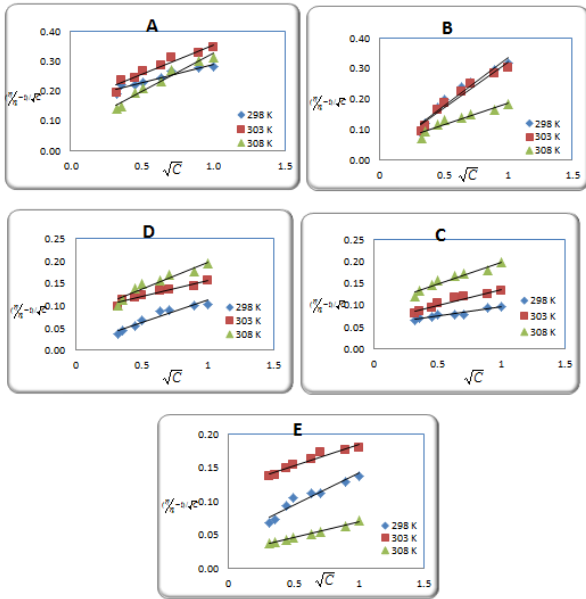

Figure (3):Plots of $(\eta_r - 1)/\sqrt{c}$ $(L^{3/2}.mol^{-1/2})$ vs $\sqrt{c}$ $(mol^{1/2}.L^{-3/2})$ for sodium acetate in A) water B)20% Water+Acetone C) 40% Water+Acetone D) 60% Water+Acetone E) 80% Water+Acetone mixtures at different temperatures

Table (6):Values of A and B coefficients of the Jones – Dole equation for sodium acetate in A) water B)20% Water+Acetone C) 40% Water+Acetone D) 60% Water+Acetone E) 80% Water+Acetone mixtures at different temperatures

T/K	Sodium acetate +water	
	$A(cm^{3/2}.mol^{-1/2})$	$B(cm^3.mol^{-1})$
298	0.167	0.122
303	0.158	0.195
308	0.072	0.253

T/K	Sodium acetate +80% water+20% Acetone		Sodium acetate +60% water+40% Acetone	
	$A(cm^{3/2}.mol^{-1/2})$	$B(cm^3.mol^{-1})$	$A(cm^{3/2}.mol^{-1/2})$	$B(cm^3.mol^{-1})$
298	0.017	0.319	0.052	0.043
303	0.018	0.301	0.064	0.071
308	0.046	0.139	0.099	0.098

T/K	Sodium acetate +40% water+60% Acetone		Sodium acetate +20% water+80% Acetone	
	$A(cm^{3/2}.mol^{-1/2})$	$B(cm^3.mol^{-1})$	$A(cm^{3/2}.mol^{-1/2})$	$B(cm^3.mol^{-1})$
298	0.013	0.099	0.046	0.094
303	0.084	0.070	0.118	0.065
308	0.075	0.121	0.022	0.047

A perusal of table (6) shows that the values of the (A) coefficient decrease with the increase in percentage of acetone in the mixtures under study and decrease with the increase in temperature for water and increase with the increase in temperature for almost water-acetone mixtures . This may be interpreted as more solvation of sodium acetate takes place at higher temperature for water and at lower temperature for almost water-acetone mixtures. The effect of solute–solvent interaction on the solution viscosity can be inferred from the B-coefficient.The viscosity B-coefficient is also a valuable tool to provide information concerning the solvation of the solute in solution.Viscosity coefficient (B), the ion – solvent parameter represents the higher terms of the long – range columbic forces, hydrodynamic or size and shape effect, solvation effect and chemical structural effects.From table(6) and figure(3) it is evident that the values of the B coefficient are positive, thereby suggesting the presence of strong solute–solvent

interactions which are strengthened with the increase temperature for water whereas the (B) values decrease with the increase temperature thereby suggesting the presence of weak solute–solvent interactions .On other hand the (B) values decrease with the increase in percentage of acetone in its aqueous solution.These indicates the structure making nature of sodium acetate for water and the structure breaking nature of sodium acetate for almost water-acetone mixtures, This is agreement with the results obtained from density measurements.[17,18]

using the following relations for calculating $\Delta G_2^\bullet$ contribution per mole of solute to free energy of activation for viscous flow of the solution[19]

$$\Delta G_2^\bullet = \Delta G_1^\bullet + \frac{RT}{\phi_V^\bullet}[1000B - (V_1^\bullet - \phi_V^\bullet)] - - - - - - (8)$$

where $\Delta G_1^\bullet$ the free energy of activation of viscous flow per mole of pure solvent which calculated from relation (9), R is gas constant , h is Planck' s and N is Avogadro Constant respectively , T, is the absolute temperature,($V1^0$) molar volume which calculated from relation (10)

$$\Delta G_1^\bullet = RT \ln \frac{\eta_\bullet \phi_v^\bullet}{Nh} - - - - - -(9)$$

$$V_1^0 = \frac{(x_1 M_1 + x_2 M_2)}{\rho_\bullet} - - - - - -(10)$$

The enthalpy $\Delta H^\bullet$ and entropy $\Delta S^\bullet$ of activation of viscous flow were computed using the equation:

$$\Delta G_2^\bullet = \Delta H^\bullet - T\Delta S^\bullet - - - - - - (11)$$

The values, $\Delta H^\bullet$ and, $\Delta S^\bullet$ are obtained from the intercept and slop of $\Delta G_2^\bullet$ versus T figure (4). The $\Delta H^\bullet$ and, $\Delta S^\bullet$ are summarized in Table (7)
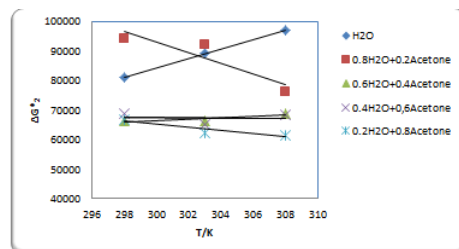

Figure (4): Plots of $(\Delta G_2^\bullet)$ vs (T) for sodium acetate in A) water B)20% Water+Acetone C) 40% Water+Acetone D) 60% Water+Acetone E) 80% Water+Acetone mixtures at different temperatures

Table (7): Thermodynamic parameter for sodium acetate in A) water B)20% Water+Acetone C) 40% Water+Acetone D) 60% Water+Acetone E) 80% Water+Acetone mixtures at different temperatures

system	T/K	ΔG^*_2 (kJ.mol^{-1})	ΔS^* (J.mol^{-1}K^{-1})	ΔH^* (kJ.mol^{-1})
Sodium acetate +water	298	81.06		
	303	89.26	1595.86	-394.43
	308	97.02		
Sodium acetate +80% water+20%Acetone	298	94.08		
	303	92.08	-1803.02	633.72
	308	76.05		
Sodium acetate +60% water+40%Acetone	298	66.45		
	303	66.22	226.87	-1.61
	308	68.72		
Sodium acetate +40% water+60%Acetone	298	68.58		
	303	65.06	-39.53	79.25
	308	68.19		
Sodium acetate +20% water+80%Acetone	298	66.69		
	303	62.33	-534.57	225.56
	308	61.54		

]sodium acetate with water increases with the rise of temperature indicate the association of sodium acetate molecules with water system which be come more interaction. whereas for sodium acetate with water-acetone systems   positive value of ΔG^*_2 for sodium acetate with water decreases with the increase in percentage of acetone and increases with the rise of temperature. This behavior of ΔG^*_2 suggests that the positive work is required to create holes for viscous flow and at higher temperature the solute–solvent and solvent–solvent interactions weaken due to thermal agitation. The negative value of ΔH^* for sodium acetate with water indicates that the association process is exothermic in nature and value of ΔH^* become less negative and positive value with the increase of percentage of acetone indicates that the association process is endothermic in nature . This indicates that to overcome the energy barrier, more positive work has to be done. Thus the viscous flow is favored for all the acetone molecules in solution systems. This might be due to the ground state of the binary and ternary systems is more organized than the transition states[20,21].

The entropy(ΔS^*) of sodium acetate solution for water found positive and found negative and decreases with increasing the percentage of acetone in water-acetone mixtures indicate more order in the water-acetone mixtures than water . The negative values of entropy change of ΔS^*shows that the species are formed at activated stateare more ordered than the initial state [22].

CONCLUSIONS

The data of densities and viscosites increases as function of concentration Due to the values of the limiting apparent molal volume ,viscosity B-coefficient and other parameters   indicate the presence of strong solute– solvent interactions and weak solute– solute interactions with increasing of sodium acetate concentration in water whereas indicate the absence of strong solute–solvent interactions presence of strong solute–solute interactions for sodium acetate in almost water-acetone and solute– solvent interactions decreases with increase in percentage of acetone in its aqueous solution and predominates at higher temperature for water whereas the solute-solute interaction intensifies at higher temperature for almost water-acetone mixtures .

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