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Conductance behaviour of material Heterocyclic dichromates in Water-Tetrachloroethylene mixtures.

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ABSTRACT

The paper explores Thermodynamic ion properties of material hetero cyclic Benzimidazolium, Indolenium and Imidazolium dichromates at 278K – 308K in Tetrachloroethylene, water and water-Tetrachloroethylene mixtures of different compositions (v/v). The Modified Kraus-Bray and Advanced Shedlovsky equations are used to calculate molar conductance from conductance data. The limiting molar, Λo, varies depending on the solvent mixture's composition. The preferential / selective conductance of cations by ethanol is interpreted using this method. In line with composition reliance of the Walden product, the effect of diverse solvent composition an ion conductance is studied. "With the help of the 'R'-factor, the influence of the diverse solvent composition on the conductance of ions have been discuss".

KEY WORDS*:* Ion-pair relationship constant, conductance number or R-factor thermodynamic parameter, association and dissociation constant.

GRAPHICAL ABSTRACT: In sample solution, the free hetero and dichromate ions forever in equilibrium through the ion-pairs. It is represent as

$$2OH^{+} + Cr_2O_7^{2-} \underset{}{\overset{K_A}{\rightleftharpoons}} [OHCr_2O_7]^{-} + OH^{+}$$

(OH^+ = Heterocyclic ion (ONH^+))

1. INTRODUCTION

Imidazolium dichromate is a constant oxidant which be arranged and analyzed by Lhim [1]. Imidazolium dichromate, a constant yellow crystalline compound, is create to be a mild selective reagent used for the oxidation of allylic and benzylic alcohols. Conductance behavior of this oxidant in Aq-DMF was accessible in our Manikyamba co-workers paper [2]. Indolenium dichromate is a steady oxidant which was ready and analyzed by Trovev [3]. It is a very useful and versatile oxidant which can be worn in many corey applications [4-9]. Benzimidazolium dichromate is a stable oxidant by Elango [10], which was prepared and analyzed by Isensee [11]. Despite the fact that there is a substantial body of literature on the kinetic elements of these three oxidants, there is no information on the Thermodynamic ion properties of these dichromates. The Thermodynamic ion properties of electrolytes in binary solvent mixtures is influenced by density, viscosity, the medium's dielectric constant, ion-solvent, and solvent-solvent relationships. The ion b is stabilised by ion-solvent relationships Sunil kumar and co workers[12-21]. The present paper details the observations on Thermodynamic ion properties of Imidazolium, Indolenium and Benzimidazolium dichromates in binary solvent mixtures of water- Tetrachloroethylene.

2. EXPERIMENTAL SECTIONS

Chemicals Used, Imidazolium, Indolenium and Benzimidazolium dichromates are prepared on the lines of the references [1,6,11]. The reagent is in a stock solution ready to sample is standardised by dissolving a standard weight of the sample in water and using the iodometric procedure. The conductance of the solution is measured using an ELICO model conductivity bridge with a glass conductivity cell with a cell constant of 1.003 cm-1. A 0.1M KCl solution is used to calibrate the conductivity cell. The solution is made with deionized water that has been distilled.

3. THEORY/CALCULATION

The solutions of Imidazolium, Indolenium and Benzimidazolium dichromates are diluted to different concentrations in the range 0.1M to 2.0×10^{-3} M using different volumes of liquid mixture and it's conductance has measured at 278-308K". The conductance values of the solvent systems used in this research range from 0.019 - 0.0325mS. "The conductance values are found to be reproducible with ±0.005% error. The solvent conductance value is deducted from conductance of it's solution to get the conductance of the solute. Molar conductance is proposed using the relative,

$\Lambda = 1000 \times k / C$ where k: specific conductance & C: morality of the solute in the solution. The same procedure is followed at different compositions of solvent mixtures and at different temperatures".

To find out the limiting molar conductance of Indolenium dichromate two models, they are

1. Modified Kraus- Bray eq. [22],
2. Advanced Shedlovsky eq. [23] have been used. Modified Kraus-Bray derived equation, dissociation constant (K_C) as the limiting molar conductance (Λ^0) and the correlate molar conductance (Λ_m) of the partly dissociated electrolyte

$$\frac{1}{\Lambda_m} = \frac{1}{\Lambda^0} + \frac{1}{K_C \Lambda^{0^2}}(\Lambda_m C) \qquad \ldots \qquad (1)$$

Advanced Shedlovsky derived equation, Eq. 2

$$\frac{1}{S\Lambda_m} = \frac{1}{\Lambda^0} + \frac{K_A}{\Lambda^{0^2}}(S f_\pm^2 \Lambda_m C) \qquad \ldots \qquad (2)$$

Where Λ_m: molar conductance of a solution's solute at a given concentration C,

Λ_o is the limiting molar conductance

K_A is the association constant of the ion-pair,

K_C is the dissociation constant,

$f_\pm$ is the mean ionic activity coefficient,

S is a factor given by

$$S = \left[\frac{\beta\sqrt{C\Lambda}}{4\Lambda^{0\,3/2}} + \sqrt{1+\frac{\beta^2 C\Lambda}{4\Lambda^{0\,3}}}\right]^2 \qquad \ldots \qquad (3)$$

$$\log f_\pm = \left[\frac{-1.8246\times10^6 (C\alpha)^{1/2} / (\varepsilon T)^{3/2}}{1+50.24\times10^8 q (C\alpha)^{1/2} (\varepsilon T)^{1/2}}\right]^2 \qquad \ldots \qquad (4)$$

$$\alpha = \frac{S\Lambda}{\Lambda^0} \qquad \ldots \qquad (5)$$

$$\beta = \frac{8.20\times10^5 \Lambda^0}{(\varepsilon T)^{3/2}} + \frac{82.5}{\eta(\varepsilon T)^{1/2}} \qquad \ldots \qquad (6)$$

Where q: Bjerrum's critical distance q given by

$$q = \frac{e^2}{2\varepsilon kT} = \frac{Z_+ Z_- e^2}{2\varepsilon kT} \qquad \ldots \qquad (7)$$

"E: dielectric constant of solvent medium and η: viscosity of solvent, Z_+e and Z_-e are charges on the ions. K: Boltzmann's constant, T: temperature in K. S has been calculated using Λ^o obtained from the Modified Onsager model using the plot of Λ_m against √C. The least square analysis of the data (Λ_m and C) using the above two eqs.(1), (2) is satisfactory with linear correlation coefficients in the range 0.955-0.976".

4. RESULTS AND DISCUSSION

The values of Λ^o have been evaluated from equation 1 and 2 and were given in Table 1. Temperature value increases the present investigated values also increases

It is attributed to increase in mobility of the ions due to increase in the temperature. The Λ^o present values also depend on the composition of the binary in the black mixture. By adding together of Tetrachloroethylene to water decreases Λ_o value. It may be due to decrease in the dielectric constant of the solvent medium.

It is invented that this disparity has to pursue Arrhenius relation similar to rate procedure. So the energy of activation of the conducting progression is obtained from the Arrhenius is given in eqn (8),

i.e., $\Lambda^0 = A\ e^{-Ea/RT}$ … (8)

E_a were obtained by correlate $\log\Lambda^0$ standards with 1/T by earnings of linear least square analysis. The values have been included in Table 2. These values specify that they are extremely dependent on amount of organic solvent in the medium .These values are maximum in 60% Tetrachloroethylene for Imidazolium dichromate and in 20% Tetrachloroethylene for Indolenium dichromate. For Benzimidazolium dichromate the maximum E_a is observed in pure water.

4.1 RADII OF SOLVATED IONS:

"The effective ionic radii(r_i) of the cation and anion in every one solvent system used are calculated by using Stoke's radius equation modified by Gill [24]"

$$r_i = \frac{0.820|Z|}{\Lambda_+ \eta_o} + 0.0103\in + r_y \qquad \ldots \qquad (9)$$

"Where r_y is a parameter equal to 0.95 A^0 for non associated solvents and 1.12 A^0" for associated solvents. Table 3 summarizes these values. These values, which are the radii of solvated ions, change with the solvent composition, implying that ion-solvent interactions are at work.

4.2 SOLVATION CONDUCTANCE NUMBER:

S_n, the conductance number, which "is the number of solvent molecules in the solvent cover around the species, is calculated from the" consequence of dielectric constant (Є) on Λ^0 . This is based on the equation

$$\log \Lambda^0 = \log \Lambda^{01} - \frac{Z_A Z_B e^2}{\in d_{AB}\, k_B T} \qquad \ldots\ldots\ldots \qquad (10)$$

where, Λ^{01} is the limiting molar conductance within a solvent of unlimited dielectric stable

Z_Ae, Z_Be are the ionic charges,

k_B is Boltzmann constant,

T is the temperature,

d_{AB} is the distance linking the centers of the two ions.

The plot of log Λ^0 against 1/Є is linear with negative slope from which, d_{AB} is intended. S_n is compute using the relation.

$$S_n = \frac{d_{AB} - r_i}{r_{solvent}} \qquad \ldots\ldots\ldots\ldots\ldots \qquad (11)$$

"Where r_i is the Stokes radius of the ion calculated using Stoke's equation" [25]

$$r_i = \frac{0.820|Z|}{\Lambda_o \eta_o} + 0.0103\in + r_y \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (12)$$

"Where r_y = 0.85 $\overset{0}{A}$ for dipolar unassociated solvents and 1.13 $\overset{0}{A}$ for protic and related solvents. These r_i values are tabulated in Table 3".

In order to understand the extent molecular interactions occurring in the solutions, conductance number was calculated.

Conductance numbers thus determined at 288K&298K are presented in Table 4.

The variable conductance number indicates that the ion-pair is solvated to diverse extents depending on the composition of the solvent which reflect variable ion-solvent interactions.

4.3 IONIC CONDUCTANCES:

"As suggested by Amira [25] the ionic conductances Λ_+^0 and Λ_-^0 of the Heterocyclic ion and the dichromate ion are computed in all the solvent systems used and presented in Table 3. Λ_+^0 is maximum in 100% water and decreases due to the addition of Tetrachloroethylene attaining a slight higher value in 100% Tetrachloroethylene. The ionic conductance of the anion slightly increases due to the initial addition of Tetrachloroethylene and gradually decreases attaining a minimum value in 100% Tetrachloroethylene. This variation in the ionic conductance suggests that the specific conductance of the anion is by water while Tetrachloroethylene from the solvent mixture selectively solvates the cation. The conductance behavior of the ions in diverse solvent systems can be better understood in terms of the ionic Walden products, $\eta\Lambda_\pm^0$, of the electrolytes. Figure 1 shows the calculated values of these ionic Walden compounds (A,B). These values are highest in water and gradually decrease as organic components are added to each system. According to Amira and coworkers [25] the ratio (R), $R = \frac{\eta\Lambda_\pm^0(solvent)}{\eta\Lambda_\pm^0(water)}$ can be used to obtain information on the nature of conductance of an electrolyte and its constituent ions in water solvent mixtures. The calculated values of these factors for both the ions are shown in Table 3. This ratio for the cation is less than one and decreases sharply with the increase in the proportion of organic component. According to Amira [25] this is a strong indication of selective conductance of the ion by the Tetrachloroethylene. As a result, the cation may be concluded to be more solvated by acetone from the solvent system. The dichromate ion's R factor rises to up to 80% (v/v), suggesting that the anion is selectively hydrated from the water solvent mixture. By combining organic solvents, the structure of water is broken, allowing water molecules to be available for anion hydration".

TABLE 1 – Limiting molar conductance (Λ^o) values in S cm^2 mol^{-1} of Imidazolium , Indolenium and Benzimidazolium dichromates in aqueous mixtures of Tetrachloroethylene at different temperatures.

IMIDAZOLIUM DICHROMATE

T (K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	1	2	1	2	1	2	1	2	1	2	1	2
278	121.56	122.17	101.13	10.614	80.35	80.14	64.29	64.27	76.91	77.32	45.73	44.53
288	143.79	138.12	128.11	126.94	109.25	108.73	98.16	98.21	92.56	93.17	46.86	48.64
298	154.56	154.83	146.81	139.55	125.62	139.40	115.84	116.73	98.54	98.52	49.49	49.33
308	196.57	196.30	159.85	160.56	167.57	154.61	156.57	147.41	124.84	123.67	55.48	55.14

INDOLENIUM DICHROMATE

T(K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylen	
	1	2	1	2	1	2	1	2	1	2	1	2
278	205.45	205.67	126.06	132.50	108.5	108.41	95.50	95.35	75.05	78.58	69.61	69.85
288	221.48	222.80	176.88	175.56	140.35	137.35	112.05	112.25	95.70	90.65	72.08	71.63
298	253.32	259.61	225.31	226.66	159.52	158.32	122.84	123.24	104.34	98.19	76.24	76.61
308	303.53	307.27	252.51	254.71	219.78	219.19	158.39	159.57	128.85	121.30	85.32	84.81

BENZIMIDAZOLIUM DICHROMATE

T(K)	0% Tetrachloroethylene		20% Tetrachloroethyene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	1	2	1	2	1	2	1	2	1	2	1	2
278	127.77	127.27	115.03	113.14	98.45	97.24	84.19	84.17	79.91	79.32	48.31	47.86
288	154.66	154.93	138.21	136.94	119.15	118.83	108.06	108.31	99.66	97.07	55.56	55.75
298	173.71	179.40	156.76	155.53	145.52	139.30	123.94	123.83	104.76	104.56	60.24	60.35
308	199.66	198.50	169.59	169.57	158.67	158.51	151.51	154.84	124.42	132.56	67.11	67.24

1 = Kraus-Bray Model 2 = Shedlovsky model

TABLE 2. K_A and K_C values of Imidazolium, Indolenium and Benzimidazolium dichromates in aqueous-Tetrachloroethylene mixtures

IMIDAZOLIUM DICHROMATE

T (K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C
278	54.67	0.02	31.60	0.03	21.12	0.05	35.33	0.04	35.57	0.03	61.65	0.02
288	70.07	0.01	22.03	0.06	20.55	0.04	21.39	0.09	29.69	0.03	54.90	0.02
298	28.24	0.02	13.56	0.04	19.90	0.05	16.20	0.13	29.86	0.05	45.61	0.02
308	21.89	0.05	45.14	0.23	19.41	0.05	18.70	0.16	29.10	0.04	44.91	0.02

INDOLENIUM DICHROMATE

T (K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C
278	7.58	0.13	4.07	0.21	19.10	0.05	7.00	0.14	8.76	0.13	13.89	0.03
288	15.20	0.11	6.73	0.15	19.88	0.05	6.59	0.16	10.29	0.12	7.73	0.03
298	37.65	0.28	8.91	0.11	12.66	0.08	38.09	0.26	8.40	0.15	31.08	0.03
308	38.61	0.27	4.77	0.21	19.23	0.08	50.00	0.19	10.64	0.12	36.11	0.03

BENZIMIDAZOLIUM DICHROMATE

T (K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C	K_A	K_C
278	11.95	0.059	10.98	0.091	11.33	0.077	9.09	0.11	10.98	0.092	17.30	0.057
288	10.78	0.091	11.24	0.081	12.00	0.088	8.89	0.12	15.87	0.082	32.80	0.031
298	12.77	0.077	12.55	0.079	8.75	0.113	15.43	0.066	12.55	0.079	30.19	0.033
308	5.76	0.174	6.34	0.15	12.01	0.084	11.33	0.088	13.16	0.075	33.82	0.030

K_A = Association constant from Shedlovsky equation. K_C = Dissociation constant from Kraus-Bray equation

TABLE 3. Computed Values of E_a for Imidazolium, Indolenium and Benzimidazolium dichromates at different compositions (v/v) of aqueous-Tetrachloroethylene mixtures.

IMIDAZOLIUM DICHROMATE

	0% Tetrachloroethylene	20% Tetrachloroethylene	40% Tetrachloroethylene	60% Tetrachloroethylene	80% Tetrachloroethylene	100% Tetrachloroethylene
E_a	9.12	11.06	17.68	19.74	10.75	4.77

INDOLENIUM DICHROMATE

	0% Tetrachloroethylene	20% Tetrachloroethylene	40% Tetrachloroethylene	60% Tetrachloroethylene	80% Tetrachloroethylene	100% Tetrachloroethylene
E_a	9.12	17.06	16.12	11.83	10.08	4.88

BENZIMIDAZOLIUM DICHROMATE

	0% Tetrachloroethylene	20% Tetrachloroethylene	40% Tetrachloroethylene	60% Tetrachloroethylene	80% Tetrachloroethylene	100% Tetrachloroethylene
E_a	9.12	14.03	15.44	17.01	12.37	8.45

TABLE 4. Computed change in free energy (ΔG_a) and transfer (ΔG_t) Imidazolium, Indolenium and Benzimidazolium dichromate in aqueous mixtures of Tetrachloroethylene at different temperatures in kJ mol^{-1}

IMIDAZOLIUM DICHROMATE

T (K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t
278	-4.76	-	-3.89	0.87	-5.73	-0.18	-4.92	-0.030	-4.51	0.05	-5.34	0.58
288	-4.03	-	-5.15	1.47	-10.08	0.09	-5.21	0.25	-4.73	0.34	-5.69	-0.17
298	-9.15	-	-5.39	3.76	-6.54	2.61	-5.68	0.60	-5.21	0.68	-5.44	0.64
308	-9.51	-	-5.92	3.59	-6.89	2.62	-5.89	0.61	-5.86	0.61	-6.38	0.52

INDOLENIUM DICHROMATE

T (K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t
278	-4.94	-	-8.03	-0.16	-8.05	-3.02	-8.46	-2.69	-13.05	9.27	-9.41	-1.94
288	-8.07	-	-7.74	-3.86	-8.06	2.30	-6.94	-2.69	-8.95	-1.41	-8.68	-1.68
298	-7.99	-	-7.48	-2.01	-7.18	-1.22	-7.37	-1.03	-7.51	-0.89	-7.18	-1.22
308	-8.74	-	-7.24	-2.60	-5.77	-2.24	-7.07	-2.14	-7.90	-0.12	-10.23	2.21

BENZIMIDAZOLIUM DICHROMATE

T (K)	0% Tetrachloroethylene		20% Tetrachloroethylene		40% Tetrachloroethylene		60% Tetrachloroethylene		80% Tetrachloroethylene		100% Tetrachloroethylene	
	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t	ΔG_a	ΔG_t
273	-4.760	-	-5.52	-0.758	-8.17	-2.65	-8.24	-2.54	-8.24	-3.48	-5.57	-0.81
283	-4.032	-	-9.13	-5.10	-8.59	-4.56	-8.51	-3.27	-8.51	-4.48	-5.88	-1.85
293	-9.151	-	-10.25	-1.10	-8.57	+0.58	-9.33	-0.18	-9.90	-0.75	-5.91	+3.24
308	-9.513	-	-9.63	-0.12	-6.70	+2.81	-9.21	+0.30	-8.91	+0.60	-8.91	+0.60

TABLE 5. Ionic conductances and radii of solvated ions of Imidazolium, Indolenium and Benzimidazolium dichromate in aqueous-Tetrachloroethylene mixtures

Imidazolium dichromate

T = 288K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^{2}mol^{-1})	Λ^0_- (S cm^{2}mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	48.98	94.94	3.11	2.71	5.82
20%	44.87	82.07	3.83	2.36	6.19
40%	32.43	76.72	3.67	2.57	6.24
60%	31.32	66.74	3.99	1.42	5.41
80%	29.72	62.94	5.27	1.38	6.65
100%	10.63	36.32	2.07	0.95	3.02

T = 298K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^{2}mol^{-1})	Λ^0_- (S cm^{2}mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$

0%	59.74	94.92	3.09	2.82	5.83
20%	50.60	88.17	2.99	2.52	6.23
40%	37.52	87.99	3.62	2.24	5.86
60%	33.33	82.65	3.38	2.24	7.07
80%	33.78	64.76	5.06	3.20	5.87
100%	3.91	45.59	7.31	2.95	10.36

INDOLENIUM DICHROMATE

T = 288K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^2mol^{-1})	Λ^0_- (S cm^2mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	126.64	94.94	2.52	2.71	5.23
20%	94.91	82.07	2.53	2.36	6.33
40%	60.63	76.72	2.61	2.57	4.89
60%	45.51	66.74	3.15	1.42	4.57
80%	27.71	62.94	1.65	1.38	3.03
100%	35.41	36.32	1.85	0.95	3.68

T = 298K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^2mol^{-1})	Λ^0_- (S cm^2mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	164.69	94.92	2.14	2.82	4.96
20%	137.24	88.17	2.07	2.52	4.59
40%	60.32	87.99	2.62	2.24	4.86
60%	33.59	82.65	3.08	2.24	5.32
80%	33.33	64.76	1.57	3.20	4.77
100%	30.65	45.59	1.96	2.95	4.91

BENZIMIDAZOLIUM DICHROMATE

T = 288K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^2mol^{-1})	Λ^0_- (S cm^2mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	59.72	94.94	1.02	2.71	3.73
20%	54.14	82.07	1.23	2.36	3.59
40%	42.43	76.72	1.32	2.57	3.89
60%	52.09	66.74	1.66	1.42	3.08
80%	45.12	62.94	1.69	1.38	3.07
100%	19.24	36.32	2.02	0.95	2.97

T = 298K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^{2}mol^{-1})	Λ^0_- (S cm^{2}mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	78.79	94.92	2.03	2.82	4.85
20%	68.59	88.17	1.64	2.52	4.16
40%	57.53	87.99	1.61	2.24	3.85
60%	41.29	82.65	1.55	2.24	3.79
80%	40.00	64.76	1.17	3.20	4.37
100%	14.65	45.59	1.05	2.95	4.00

T = 298K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^{2}mol^{-1})	Λ^0_- (S cm^{2}mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	164.69	94.92	2.14	2.82	4.96
20%	137.24	88.17	2.07	2.52	4.59
40%	60.32	87.99	2.62	2.24	4.86
60%	33.59	82.65	3.08	2.24	5.32
80%	33.33	64.76	1.57	3.20	4.77
100%	30.65	45.59	1.96	2.95	4.91

BENZIMIDAZOLIUM DICHROMATE

T = 288K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^{2}mol^{-1})	Λ^0_- (S cm^{2}mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	59.72	94.94	1.02	2.71	3.73
20%	54.14	82.07	1.23	2.36	3.59
40%	42.43	76.72	1.32	2.57	3.89
60%	52.09	66.74	1.66	1.42	3.08
80%	45.12	62.94	1.69	1.38	3.07
100%	19.24	36.32	2.02	0.95	2.97

T = 298K

Composition (v/v) Tetrachloroethylene	Λ^0_+ (S cm^{2}mol^{-1})	Λ^0_- (S cm^{2}mol^{-1})	$r_+(A^0)$	$r_-(A^0)$	$r_+ + r_-(A^0)$
0%	78.79	94.92	2.03	2.82	4.85
20%	68.59	88.17	1.64	2.52	4.16
40%	57.53	87.99	1.61	2.24	3.85
60%	41.29	82.65	1.55	2.24	3.79
80%	40.00	64.76	1.17	3.20	4.37
100%	14.65	45.59	1.05	2.95	4.00

TABLE 6 – Conductance number values of Imidazolium, Indolenium and Benzimidazolium dichromates in aqueous-Tetrachloroethylene mixtures at 288 and 298K.

IMIDAZOLIUM DICHROMATE

T(K)	0% Tetrachloro ethylene	20% Tetrachloro ethylene	40% Tetrachloro ethylene	60% Tetrachloro ethylene	80% Tetrachloro ethylene	100% Tetrachloro ethylene
288	5.02	4.78	4.48	4.38	4.34	3.19
298	5.93	5.83	5.31	4.70	4.63	2.59

INDOLENIUM DICHROMATE

T(K)	0% Tetrachloroethylene	20% Tetrachloroethylene	40% Tetrachloroethylene	60% Tetrachloroethylene	80% Tetrachloroethylene	100% Tetrachloroethylene
288	6.34	5.86	5.44	5.36	4.52	3.63
298	6.15	5.84	5.62	4.65	4.42	3.72

BENZIMIDAZOLIUM DICHROMATE

T(K	0% Tetrachloroethylene	20% Tetrachloroethylene	40% Tetrachloroethylene	60% Tetrachloroethylene	80% Tetrachloroethylene	100% Tetrachloroethylene
288	0.79	1.06	1.01	1.49	1.23	1.02
298	1.64	1.39	1.90	1.78	1.37	1.32

TABLE 7. Computed change in free energy of conductance ($\Delta G_{i\text{-}s}^{+}$) and ($\Delta G_{i\text{-}s}^{-}$) for Imidazolium, Indolenium and Benzimidazolium dichromate in aqueous-Tetrachloroethylene mixtures at 288, 298K in kJ mol^{-1}.

IMIDAZOLIUM DICHROMATE

T(K)	0% Tetrachloro ethylene		20% Tetrachloro ethylene		40% Tetrachloro ethylene		60% Tetrachloro ethylene		80% Tetrachloro ethylene		100% Tetrachloro ethylene	
	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	ΔG_{is}^{+}	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$
288	3.1	3.2	2.6	4.3	3.3	4.7	3.9	10.8	3.9	14.8	30.8	18.0
298	3.0	3.2	3.7	3.9	3.6	4.3	4.8	5.9	4.4	7.3	4.7	16.4

INDOLENIUM DICHROMATE

T (K)	0% Tetrachloro ethylene		20% Tetrachloro ethylene		40% Tetrachloro ethylene		60% Tetrachloro ethylene		80% Tetrachloro ethylene		100% Tetrachloro ethylene	
	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$	ΔG_{is}^{+}	$\Delta G_{i\text{-}s}^{-}$	$\Delta G_{i\text{-}s}^{+}$	$\Delta G_{i\text{-}s}^{-}$
288	3.4	3.2	4.0	4.3	4.7	4.7	4.9	10.8	6.9	14.8	17.8	18.0
298	4.2	3.2	5.2	4.3	5.0	4.7	5.3	10.9	14.0	14.8	17.6	18.0

BENZIMIDAZOLIUM DICHROMATE

T (K)	0% Tetrachloro ethylene		20% Tetrachloro ethylene		40% Tetrachloro ethylene		60% Tetrachloro ethylene		80% Tetrachloro ethylene		100% Tetrachloro ethylene	
	ΔG_{i-s}^{+}	ΔG_{i-s}^{-}	ΔG_{i-s}^{+}	ΔG_{i-s}^{-}	ΔG_{i-s}^{+}	ΔG_{i-s}^{-}	ΔG_{i-s}^{+}	ΔG_{i-s}^{-}	ΔG_{i-s}^{+}	ΔG_{i-s}^{-}	ΔG_{i-s}^{+}	ΔG_{i-s}^{-}
288	4.1	3.20	5.95	4.30	7.30	4.74	11.67	10.80	20.03	14.80	32.42	17.98
298	4.4	3.89	6.64	4.27	8.04	5.79	10.50	7.30	18.75	16.40	33.00	11.71

CONCLUSIONS

Among three Hetero-dichromates studied superior conductance integer is experimental for Indolenium ion compared to Imidazolium and Benzimidazolium ions. This might be ascribed to lesser size of the Indolenium ion which increase the charge density.

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