MedCrave
Step into the World of Research

Journal of Analytical & Pharmaceutical Research

Research Article

Open Access

Physicochemical study of potassium dichromate ($K_2Cr_2O_7$) in10% sucrose-water at different temperature

Abstract

The knowledge of ion-solvent interaction by the help of volumetric and other fundamental properties has great importance and data generated from these experiments used for industrial applications. The experimental data of densities at 313.15K and 323.15K have been obtained for potassium dichromate ($K_2Cr_2O_7$) in 10% sucrose-aqueous solution measured as a function of their concentration. Experimental data of density evaluates the values of apparent molar volume, limiting apparent molar volume, experimental slope, molar volume and excess molar volume. The results were interpreted in the light of ion–ion and ion–solvent interactions and of structural effects of the solutes in solutions. These data give valuable information about interaction of compounds with carbohydrate which can be used for designing industrial and pharmaceutical applications.

Keywords: molar volume, excess molar volume, sucrose

Volume 5 Issue 3 - 2017

Ajita Dixit, Pushpkant Sahu, Vidya Rani Singh, Vivek Dhruw

Center for Basic Sciences, Pt. Ravishankar Shukla University, India

Correspondence: Ajita Dixit, Center for Basic Sciences, Pt. Ravishankar Shukla University, Raipur (C.G.), Pincode: 492001, India, Email ajita.dixit@gmail.com

Received: May 19, 2017 | **Published:** June 29, 2017

Introduction

Carbohydrate chemistry is a sub discipline of chemistry primarily concerned with the synthesis, structure and function of carbohydrates. Potassium dichromate ($K_2Cr_2O_7$) is a crystalline ionic solid with a bright, red-orange color most commonly used as an oxidizing agent in various laboratory and industrial application. Basic and fundamental data are less available as far as carbohydrates are concern. The main objective is to provide data in binary system because substances interact differently then single system. Study in water-organic system not only important for industrial application as many chemical interact with both during processing and production which can affect the quality of products. It is also helpful in study of breakdown of carbohydrate which may help in research of drugs for many diseases like diabetes, obesity etc. Density is an example of an intensive property, a property in which the value is solely dependent upon the identity of the material, and not the amount present. Knowledge of volumetric properties to study in binary solvent system is useful for engineering design of new applications.[1] Sucrose solution plays an important role in biological and food industries. Sucrose has been the subject of structural and theoretical investigations for long time and research is still lively.[2] Since intensive properties are an inherent characteristic of the material they can be used to identify the material. Density data are required for many chemical engineering calculations involving fluid flow, heat and mass transfer.[3] The density of potassium dichromate ($K_2Cr_2O_7$) is studied in binary organo-aqueous solvent of sucrose-water. Potassium dichromate is used in cleaning, leather industries, photography and for construction purpose.[2] This study is done to investigate the interaction of potassium compound with sucrose solution because of biological importance of sucrose. Data of densities of potassium dichromate in sucrose-aqueous solution are scarce. The data of densities is used to analyse of apparent molar volume (fv), limiting apparent molar volume ($ø_v$), experimental slope (S^*_v), molar volume (V) and excess molar volume (VE).

Materials and methods

A stock solution of 0.10M of each of potassium dichromate is prepared in 10% (w/v) sucrose-aqueous solvent by direct weighing. Mass dilution technique is used for preparation of other concentrations. The concentration of the solutions involved in the experiment was taken in range from 0.01M to 0.10M. Densities of solutions of the potassium dichromate in sucrose-aqueous solvent are determined using 10cm3 double armed pycnometer at temperatures 313.15K and 323.15K. The pycnometer was calibrated at these temperatures with distilled water and benzene. The estimated accuracy of density measurement of solution was 0.00003g cm-3.

Table 1 Densities of potassium dichromate in 10% sucrose-water at 313 .15K and 323.15K

Concentration (mol.L^{-1})C	Density at 300K (Kgm^{-1})r	Density 315K (Kgm^{-1})r
0.01	1.0467	1.0498
0.02	1.0473	1.0561
0.03	1.0506	1.0563
0.04	1.0573	1.0677
0.05	1.0661	1.075
0.06	1.0734	1.0824
0.07	0.9889	1.0898
0.08	1.0756	1.0501
0.09	1.0841	1.0951
0.1	1.0886	1.0969

Results and discussion

Density of potassium dichromate ($K_2Cr_2O_7$) is determined using equation,[4]

$$\rho / \rho_1 = W / W_1 \quad (1)$$

Where, W and W_1 are weight potassium dichromate solution and weight of sucrose-aqueous solution respectively. r is density of potassium dichromate solution and r1 is density of sucrose-aqueous solution. Densities of dichromate solution are determined as a function of their concentration at 313.15K and 323.15K.

The densities of solute were obtained as an intercept of plot between concentration and density of solutions (using Microsoft Excel). The data is reported in Table 1. Apparent molar volume, Φ_v, is calculated by following the equation,[5,6]

$$\phi_v = (\rho_1 - \rho)/c\rho\rho_1 + M/\rho \qquad (2)$$

Where, c is molarity of the solution, M is molar mass of the solute, r and r1 are density of solvent and solute. The result of fv of potassium dichromate is reported in Table 2.The apparent molar volume at infinite dilution (fov) were calculated by the method of least square and fit to plot of □fv vs $c^{1/2}$ in accordance with the Masson's empirical relation,[7]

$$\phi_v = \phi_v^0 + S_v^* c^{1/2} \qquad (3)$$

Where, S_v^* is experimental slope. The slope is calculated by the extrapolation of the plots to zero concentration (using Microsoft excel). The positive values of experimental slope are generally associated with the solutes showing an overall hydrophilic character as in the present investigation. The values of apparent molar volume are reported in Table 2.

The molar volumes of solutions are derived from the following expression,[8,9]

$$V = (X_1 M_1 + X_2 M_2)/\rho \qquad (4)$$

Where, X1 and X2 are mole fraction of mixed solvent and mole fraction of solute. M1 and M2 molecular weight of solvent and molecular weight of solute r is density of solution respectively. The data of molar volume of solution is reported in Table 3. The molar volume of 10% (w/v) sucrose solution is 22.2116. The molar volume of potassium dichromate ($K_2Cr_2O_7$) is 280.9370 and 283.1376 at 313.15K and 323.15K respectively.

Knowledge of the excess molar volume is of important property in design and storage and handling facilities of mixtures .The excess molar volume (VE) for these solutions are obtained by the given expression,[10,11]

$$V^E = V - (X_1 V_1 + X_2 V_2) \qquad (5)$$

Where, V, V1 and V2 are the molar volume of solution, mixed solvent and solute respectively. Negative excess molar volume arises due to increased interaction between the unlike molecules. The data of both the compounds are reported in Table 4.

Table 2 Apparent molar volume, apparent molar volume at infinite dilution and experimental slope of potassium dichromate in 10% sucrose-water at 313.15K and 323.15K

Concentration (mol.L^{-1}) C	Apparent Molar Volume (fV)	Apparent Molar Volume Infinite Dilution (f*$_v$)	Experimental Slope (S*$_v$)
Temperature: 313.15K			
0.01	164.4971		
0.02	221.6376		
0.03	240.489		
0.04	249.724		
0.05	255.174	198.7691	841.446
0.06	258.8573		
0.07	264.3206		
0.08	263.8105		
0.09	265.2754		
0.1	266.5352		
Temperature: 323.15K			
0.01	160.9407		
0.02	219.2388		
0.03	239.1181		
0.04	248.4268		
0.05	254.1932	195.8876	866.8444
0.06	258.0348		
0.07	260.7751		
0.08	264.1818		
0.09	264.674		
0.1	266.0565		

Table 3 Molar volumes of potassium dichromate in 10% sucrose-water at 313.15K and 323.15K

Concentration (mol.L^{-1})C	Molar Volume (V) at 313.15K	Molar Volume (V) at 323.15K
0.01	22.7436	22.7435
0.02	22.7628	22.7621
0.03	22.7817	22.7811
0.04	22.8	22.7984
0.05	22.8175	22.8159
0.06	22.8348	22.8329
0.07	22.8778	22.8494
0.08	22.8717	22.8793
0.09	22.8878	22.8844
0.1	22.9048	22.902

Table 4 Excess molar volumes potassium dichromate in 10% sucrose-water at 313.15K and 323.15K

Concentration (mol.L^{-1})C	Excess Molar Volume (V^E) at 313.15K	Excess Molar Volume (V^E) at 323.15K
0.01	-0.0009	-0.001
0.02	-0.0019	-0.0023
0.03	-0.0031	-0.0034
0.04	-0.0047	-0.0054
0.05	-0.0067	-0.0074
0.06	-0.0088	-0.0097
0.07	0.0018	-0.0122
0.08	-0.0121	-0.0084
0.09	-0.0149	-0.0166
0.1	-0.0174	-0.0188

Conclusion

The solutions generally do not behave ideally. The deviation from ideal behaviour is expressed by many thermodynamic properties, particularly by excess or residual extensive properties. Physical properties of liquid mixtures also affect most separation procedures, such as liquid-liquid extraction, gas absorption, and distillation. The data of densities increases as function of concentration. The positive value of fv indicates greater solute-solvent interactions. The values of f0v are large and positive for an potassium dichromate ($K_2Cr_2O_7$) in 10% (w/v) sucrose solution, suggesting the presence of strong solute–solvent interaction. The experimental slope of potassium dichromate is positive showing ion-ion interaction.

Acknowledgments

None.

Conflicts of Interset

None.

References

1. Serheyev V. *Chem & Chem Tech*, 2011. p. 5.
2. Dixit A, Shrivastava S. Volumetric properties of potassium chromate (K2CrO4) and potassium dichromate($K_2Cr_2O_7$) in 15% (w/v)sucrose-aqueous solution at 303.15K. *International Journal of ChemTech Research*. 20113(3):1265–1268.
3. Zhu C, Ma Y, Zhou C. Densities and Viscosities of Sugar Alcohol Aqueous Solutions. *J Chem Eng Data*. 2010;55(9):3882–3885.
4. Xu X, Zhu C, Ma Y.Densities and Viscosities of Sugar Alcohols in Vitamin B6 Aqueous Solutions at (293.15 to 323.15) K. *J Chem Eng Data*. 2015;60(6):1535–1543.
5. Wisniak J, Peralta RD, Infante R, et al. Densities and derived thermodynamic properties of thebinary systems of 1,1-dimethylethyl methyl ether withallyl methacrylate, butyl methacrylate, methacrylic acid, andvinyl acetate at T = (298.15 and 308.15) K. *The Journal of Chemical Thermodynamics*. 2005;37(7):729–736.
6. Bobicz D, Grzybkowski W. Apparent Molar Volumes of Multicharged Cations in Dimethyl Sulfoxide Solutions at 25°C. *Journal of Solution Chemistry*. 2002;31(3):223–234.
7. Monnin C. An Ion Interaction Model for the Volumetric Properties of Natural Waters: Density of the Solution and Partial Molal Volumes of Electrolytes to High Concentrations at 25°C. *Geochimica et Cosmochimica Acta*. 1981;53(6): 1177–1188.
8. Klotz I, Rosenberg RM. *Chemical Thermodynamics, Basic Theory and Methods*. In: Benjanin WA editor. California, USA. 1972.
9. Masson DO. Solute Molecular Volumes in Relation to The Solvation and Ionization. *Phil Mag*. 1929;8:218–222.
10. Morávková L, Sedláková Z. Excess Molar Volume of Binary Systems Containing Mesitylene. *Kem Ind.* 2013;62(5-6):159–170 .
11. Mutalik V, Manjeshwar LS, Sairam M, et al. Excess molar volumes, deviations in viscosity and refractive index of the binary mixtures of mesitylene with ethanol, propan-1-ol, propan-2-ol, butan-1-ol, pentan-1-ol, and 3-methylbutan-1-ol at 298.15, 303.15,and 308.15 K. *Journal of Molecular Liquids*. 2016;129(3):147–154.