Volumetric properties of Acesulfame K in presence of 0.6m D(+) Glucose at 298.15, 303.15, 308.15 and 313.15 K temperatures.

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Abstract

Densities of Acesulfame K in water and 0.6m D- Glucose solution at different temperatures (298.15K, 303.15K, 308.15K and 313.15K) have been measured. Molality range of Acesulfame K was (0.02, 0.04, 0.06, 0.08, 0.10) mol. Kg^{-1}. From experimental values of densities apparent molar volume, partial molar volumes, expansion coefficients have been calculated. Results show strong solute – solute and solute – solvent interaction, these values are used to get the information about taste quality of Sweetener Acesulfame K in D- Glucose.

KEYWORDS: Acesulfame K, D- Glucose, Density, apparent molar volumes, partial molar volumes.

INTRODUCTION

In food and pharmaceutical industries blending sweetener in sugars is a common practice. Blending sugar and sweetener user can take advantage like lowest cost and improve test. Water is important solvent and play significant roll in the sweet response. Partial molar volume provided useful information regarding solute – solute (Acesulfame K and D- Glucose) and solute – solvent (Acesulfame k and water and D- Glucose and water) interactions[1]. To study thermodynamic properties and such solute – solute and solute – solvent interactions is very significant and useful in biological, pharmaceutical and food industries. The partial molar and apparent specific volumes of various solutes have been used in assessing drug potency and in sweet taste chemoreception[2].

The paper reports the density study of the Acesulfame K in water and in aqueous 0.6 m D- Glucose solution at 298.15, 303.15, 308.15 and 313.15K temperatures. The apparent molar volume, partial molar volumes and expansion coefficients constants have been calculated from experimental values of densities. Acesulfame K is of special interest because of its pronounced solubility in water in comparison with other sweetener.

MATERIALS AND METHODS

Acesulfame K (Sigma Aldrich >99.0%) and D (+) Glucose (Sigma Aldrich ≥ 99.5%) were used without further purification for this study. Triply distilled water was used for preparation of solutions by weight by weight method. Masses were recorded on single pan Dhona balance. Densities of the solution were measured by using bi-capillary pycnometer. Pycnometer was calibrated with triply distilled water. Temperature bath was used to control the temperature (± 0.01K).

RESULTS AND DISCUSSION

The experimental values of densities of Acesulfame K in water and in 0.6 m D (+) Glucose are presented in Table 1. Figure 1, Figure 3 show the variation of density and molarity. From table 1 and Figure 1 and 3 it is confirming that density of aqueous solutions of Acesulfame K varies linearly with molality. Apparent molar volume provides useful information regarding solute and solvent interaction. Apparent molar volume increases with increasing concentration of Acesulfame K.
Following equation[1] was used for calculation of apparent molar volume

$$V_{\emptyset} = \frac{M}{\rho} - \left\{\frac{(\rho - \rho_0)}{(m\rho\rho_0}\right\}$$

Table 1. Densities (ρ) and apparent molar volume (V_φ) of Acesulfame K in water and 0.6 m D(+) Glucose at different temperatures

m (mol.Kg^{-1})	ρ (Kg.m^{-3})				$V_\varphi \times 10^{-6}$			
Acesulfame K in water								
	298.15K	303.15K	308.15K	313.15K	298.15K	303.15K	308.15K	313.15K
0.00000	997.04	995.64	994.08	992.25	-	-	-	-
0.02007	998.92	997.51	995.92	994.07	107.70	108.41	109.30	110.50
0.04053	1000.81	999.39	997.78	995.91	107.96	108.53	109.65	110.68
0.06008	1002.61	1001.17	999.55	997.65	108.05	108.77	109.71	110.92
0.08001	1004.43	1002.98	1001.34	999.41	108.18	108.85	109.82	111.06
0.10063	1006.30	1004.84	1003.18	1001.23	108.27	108.95	109.92	111.17
Acesulfame K in 0.6 m D(+) Glucose								
0.00000	1035.27	1033.53	1031.79	1029.49	112.28	112.94	113.31	114.23
0.02007	1037.35	1035.60	1033.85	1031.53	97.34	97.71	98.09	98.61
0.04053	1039.16	1037.41	1035.66	1033.33	103.31	103.61	103.91	104.29
0.06008	1040.82	1039.06	1037.31	1034.99	107.50	107.84	108.15	108.72
0.08001	1042.44	1040.68	1038.91	1036.55	110.43	110.68	111.15	111.80
0.10063	1044.06	1042.27	1040.49	1038.16	111.22	111.47	111.71	112.04

Table 2. Partial molar volume (V^0), solute – solute interaction parameter (Vs) and expansion coefficient (E^∞) of Acesulfame K in water and 0.6 m D(+) Glucose at different temperatures

Parameters	298.15K	303.15K	308.15K	313.15K
Acesulfame K in water				
$(V^0) \times 10^{-6}$	107.27	107.93	108.88	109.92
$(Vs) \times 10^{-6}$	03.17	03.22	03.33	03.96
$E^\infty \times 10^{-7}$	0.438	0.441	0.445	0.449
Acesulfame K in 0.6 m D(+) Glucose				
$(V^0) \times 10^{-6}$	85.99	86.30	86.51	87.07
$(Vs) \times 10^{-6}$	08.47	08.48	08.50	08.57
$E^\infty \times 10^{-7}$	0.318	0.566	0.815	1.06

Where M, m, ρ and ρ_0 are molar mass of solute, molality of solution, density of solution and density of solvent. Figure 2, Figure 4, Figure 5 and Figure 6 present the variation of apparent molar volume with square root of molality at 298.15, 303.15, 308.15, and 313.15K temperatures. Plots of V_φ vs $m^{0.5}$ show linear dependence for Acesulfame K in water and in aqueous D (+) Glucose solution. V_φ

increases with apparent molar compressibility also calculated by least square fitting of following equation to the corresponding data.

$$V_{\emptyset} = V_{\emptyset}^{0} + V_s\, m^{0.5}$$

Where V_{φ}, V_s and m are the partial molar volumes solute-solute interaction parameter, and molality.

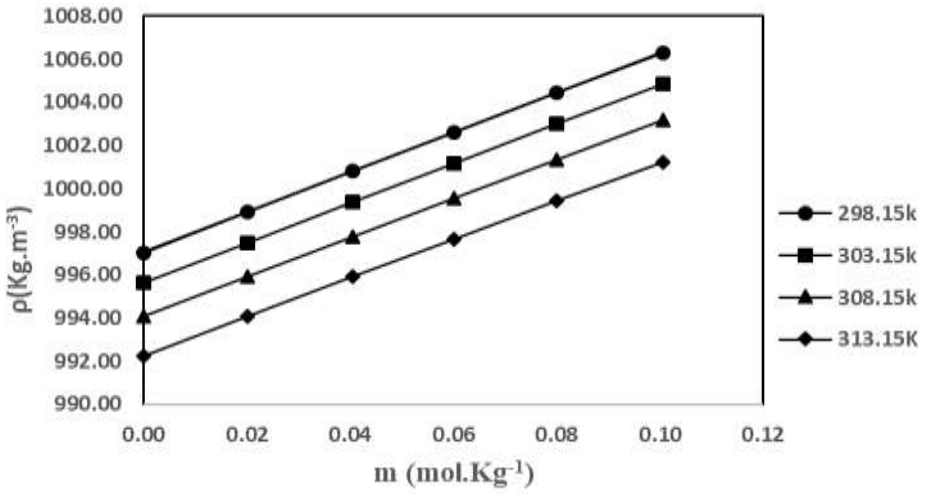

Figure 1. Plot of density (ρ) vs molality (m) of Acesulfame K in water at different temperatures

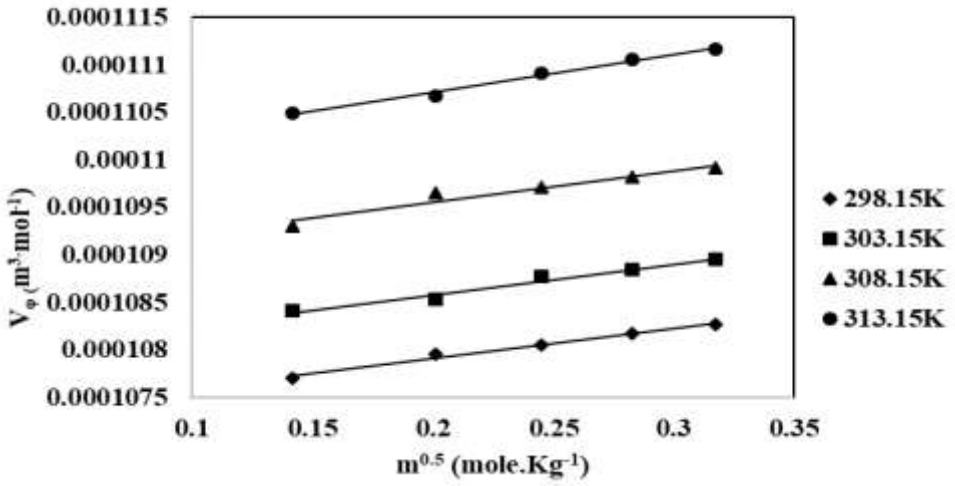

Figure 2. Plot of apparent molar volume (Vφ) vs m $^{0.5}$ of Acesulfame K in water at different temperatures (T)

Partial molar volume provides valuable information regarding the strength of solute solvent interaction. Positive values of partial molar volume indicate strong solute solvent interaction, partial molar volume increases with increase with concentrations of Acesulfame K with temperature.

$$V_{\emptyset}^{0} = a_0 + a_1 T + a_2 T^2$$

Where T is the temperature in Kelvin and a_0, a_1, a_2 are calculated by least squares method.
Differentiating above expression with respect to temperature gives the partial molar expansion (E^{∞})

$$(E^{\infty}) = \left(\partial V_{\emptyset}^{0} \Big/ \partial T\right)_p = a_1 + 2a_2 T$$

Positive value of (E^{∞}) indicates strong solute – solute - solvent interactions.

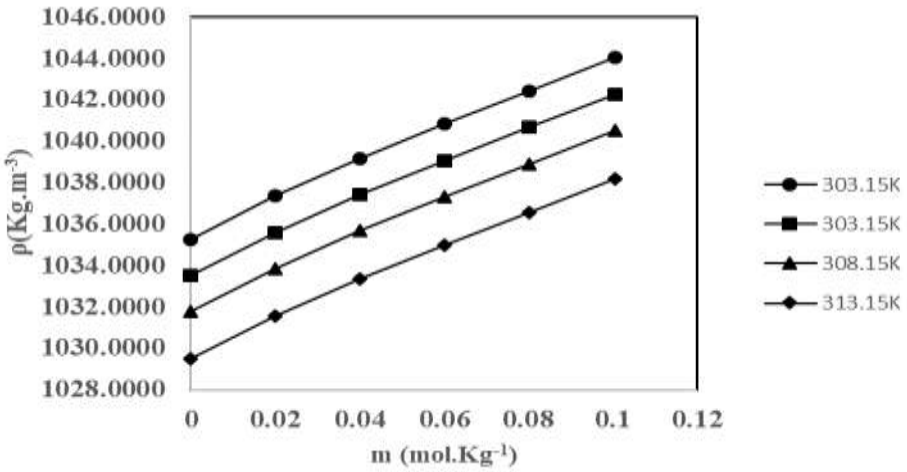

Figure 3. Plot of density (ρ) vs molality (m) of Acesulfame K in 0.6 m D(+) Glucose at different temperatures

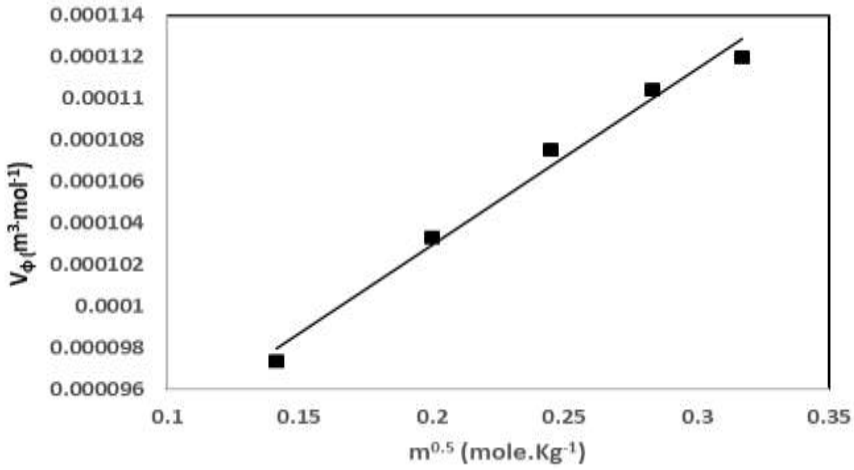

Figure 4. Plot of apparent molar volume (Vφ) vs m $^{0.5}$ of Acesulfame K in 0.6 m D (+) Glucose at 298.15 K.

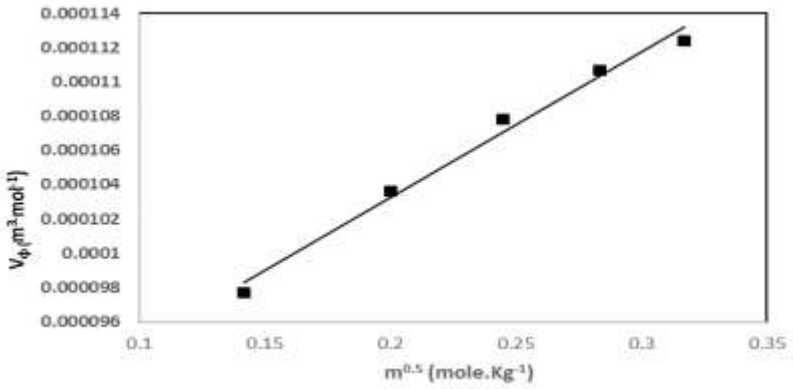

Figure 5. Plot of apparent molar volume (Vφ) vs m0.5 of Acesulfame K in a 0.6 m D (+) Glucose at 303.15 K.

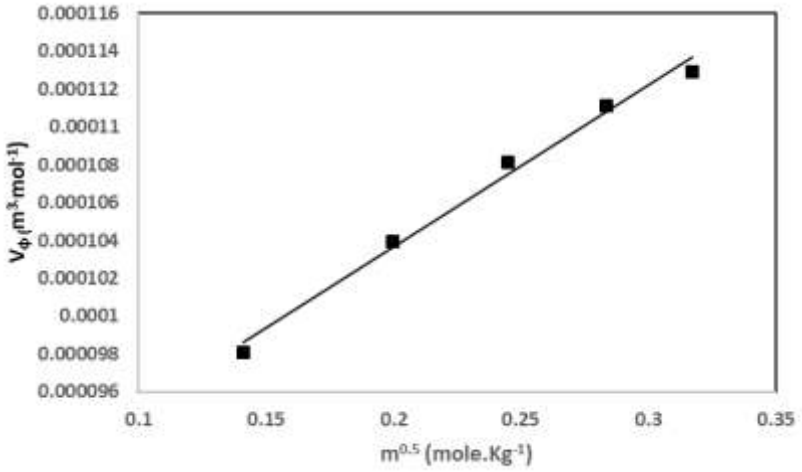

Figure 6. Plot of apparent molar volume (Vφ) vs $m^{0.5}$ of Acesulfame K in a 0.6 m D (+) Glucose at 308.15 K

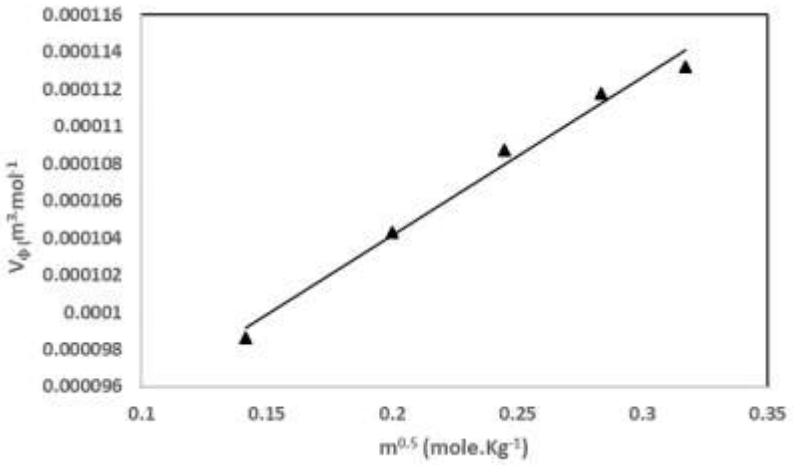

Figure 7. Plot of apparent molar volume (Vφ) vs $m^{0.5}$ of Acesulfame K in a 0.6 m D (+) Glucose at 313.15 K.

CONCLUSION

In summary we extended our knowledge of the volumetric properties of Acesulfame K in water and in aqueous D (+) Glucose solution based on density measurements. Positive values of partial molar volume (V^0) and partial molar expansion (E^∞) suggest strong solute – solute and solute – solvent interactions.

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