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Experimental Determination of Vapour-Liquid Equilibrium Data for the Binary Mixtures P-Xylene and O-Xylene at 81.3 KPA

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I. INTRODUCTION

Xylenes are aromatic hydrocarbon which are mainly produced from catalytic reforming of dehexanized naphtha as BTX (Benzene, Toluene and Xylene) rich reformate. By the use of extraction and distillation processes, a mixed xylene fraction is produced i.e. ortho, para, & meta - xylene.

Further distillation of Xylene fraction is then done for the separation of all the isomers if desired, but for that several advanced techniques to be used. Usually, o-xylene is separated first by distillation. The meta and para isomers, due to their very near boiling points, cannot allow this type of separation, and on large scale it is carried out by fractional crystallization or molecular sieve adsorption [1]. Equilibrium data for xylenes are required for the accurate design of the distillation columns and condensers.

The main emphasis of this paper is to produce vapor liquid equilibrium data required to designing of distillation colum. Aim of equilibrium data at such reduced pressures (81.3 KPa) is to avoid damage of compounds due to high temperature and to get a more effective separation. VLE data have been reported previously for the p-xylene o-xylene system at 6.66 and 26.66 KPa [2].

II. EXPERIMENTAL DETAIL

Chemicals o-xylene and p-xylene were obtained from SRL chemicals.

Chemicals	**Assay (GC)**	**Boiling Range °C**
o-xylene	98%	143-145
p-xylene	98%	137-139

The equilibrated mixtures were analysed using a Bausch and Lomb Abbe refractometer. The equilibrium temperature is measured by means of a thermometer with an accuracy of 0.1 ºC. The mixture is heated in othmer's still, till equilibrium is obtained. This can be ensured by monitoring the temperature i.e. it must be constant. Then the samples from vapor and liquid phases are collected and analyzed in Abb Refractometer to know its mole fraction [4].

III. RESULTS AND DISCUSSION

The vapour pressures for each compound are obtained from the Wagner equation given below [3].

$$\ln P_r = A(1-T_r)/T_r + B(1-T_r)^{1.5}/T_r + C(1-T_r)^3/T_r + D(1-T_r)^6/T_r$$

The activity coefficients were calculated as.

$$y_1 P = x_1 P_1^* \gamma_1$$

$$y_2 P = x_2 P_2^* \gamma_2$$

where x_1, x_2 and y_1, y_2 are the equilibrium mole fractions of components 1 and 2 in the liquid and vapour phases, respectively, P is the total pressure and P_i^* is the vapour pressure of the components.

The activity coefficients were correlated with the Margules and Van Laar equations. The data obtained from the Van Laar equation and Margules equation is in line with the experimental data.

Table I. Vapor-liquid equilibrium data of the P-XYLENE (1) + O-XYLENE (2) system at 81.3 KPA.

Temperature (K)	**X**	**Y***	**ϒ1**	**ϒ2**
401.05	1.00000	1.00000		
401.65	0.8700	0.9010	1.109	1.032
402.2	0.7320	0.7800	1.123	1.052
402.75	0.6050	0.6620	1.136	1.079
402.95	0.5710	0.6270	1.133	1.090
403.1	0.5460	0.6010	1.131	1.097
403.65	0.4420	0.4910	1.124	1.121
403.95	0.3900	0.4290	1.104	1.140
404.25	0.3440	0.3800	1.099	1.141
404.6	0.2860	0.3180	1.096	1.142
404.75	0.2580	0.2870	1.092	1.144
404.9	0.2320	0.2580	1.087	1.145
405.25	0.1480	0.1660	1.085	1.149
405.5	0.0510	0.0570	1.074	1.158
405.65	0.0000	0.0000		

Figure 1, the temperature versus composition plot is drawn for p-xylene and o-xylene at 81.3 KPa, its clear from the plot that no azeotrope formation takes place. Figure 2, shows the thermodynamic consistency of the data that we have obtained. Figure 3, Excess property become zero as either species approaches purity. About 85% of all mixtures exhibit positive G^E so does our mixture. Figure 4, These models provide great flexibility in the fitting of VLE data for binary systems more over they don't incorporate an explicit Temperature dependence for the parameters.

Table II. Activity coefficient of p-xylene & o-xylene by Van Laar model.

Temperature (K)	X	Vanlaar ϒ1	Vanlaar ϒ2
401.05	1.00000		
401.65	0.8700	1.004	1.3429
402.2	0.7320	1.0198	1.2626
402.75	0.6050	1.0486	1.1941
402.95	0.5710	1.0594	1.1768
403.1	0.5460	1.0683	1.1644
403.65	0.4420	1.1161	1.1160
403.95	0.3900	1.1479	1.0939
404.25	0.3440	1.1815	1.0757
404.6	0.2860	1.2329	1.0549
404.75	0.2580	1.2620	1.0458
404.9	0.2320	1.2919	1.0379
405.25	0.1480	1.4115	1.0167
405.5	0.0510	1.6107	1.0021
405.65	0.0000		

Table III. Activity coefficient of p-xylene & o-xylene by margules model.

Temperature (K)	X	Margules ϒ1	Margules ϒ2
401.05	1.00000		
401.65	0.8700	1.0033	1.2087
402.2	0.7320	1.0185	1.1894
402.75	0.6050	1.0493	1.1755
402.95	0.5710	1.0612	1.1213
403.1	0.5460	1.0711	1.0968
403.65	0.4420	1.1245	1.0770
403.95	0.3900	1.1599	1.0547
404.25	0.3440	1.1970	1.0451
404.6	0.2860	1.2528	1.0369
404.75	0.2580	1.2839	1.0156
404.9	0.2320	1.3154	1.0019
405.25	0.1480	1.4375	1
405.5	0.0510	1.6270	1
405.65	0.0000		

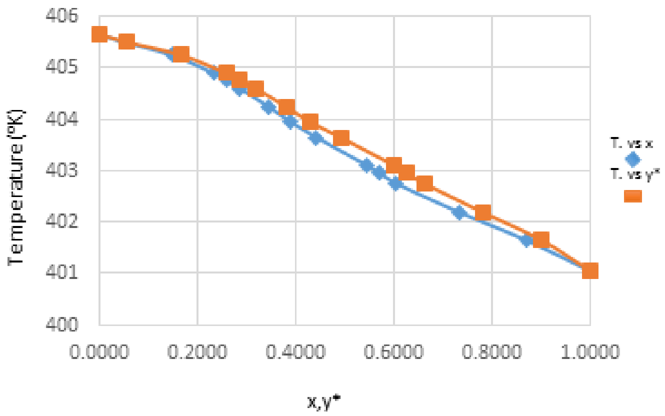

Fig. 1. T vs x,y* plot of p-xylene & o-xylene at 81.3.

IV. CONCLUSION

In this study new VLE data on binary system p-xylene (1) / o-xylene (2) is presented. The new obtained data imposes the isobaric condition of 81.3 KPA. The data are used to determine binary interaction parameters using the Margules, Van Laar model. The values of activity coefficients obtained from Van Laar Equations is very accurate with very less deviations. The result produced by Margules equation shows a modest level of accuracy. The overall deviation is about 15%. The thermodynamic consistency test shows that the error is 2.88% which is acceptable and data is consistent and our result shows small deviation from ideality.

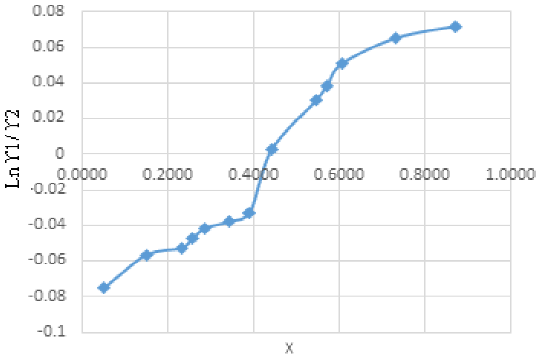

Fig. 2. ln (ϒ1/ ϒ2) vs x plot for p-xylene & o-xylene at 81.3.

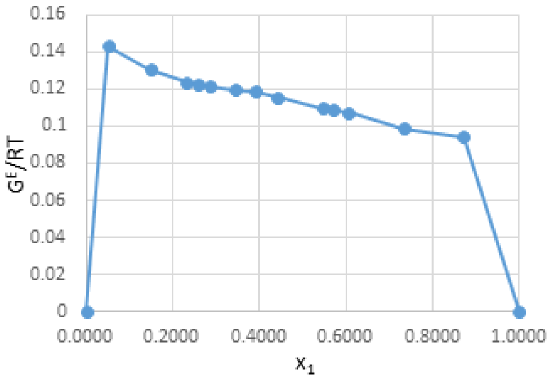

Fig. 3. G^E/RT vs x_1 plot for p-xylene & o-xylene at 81.3 KPA.

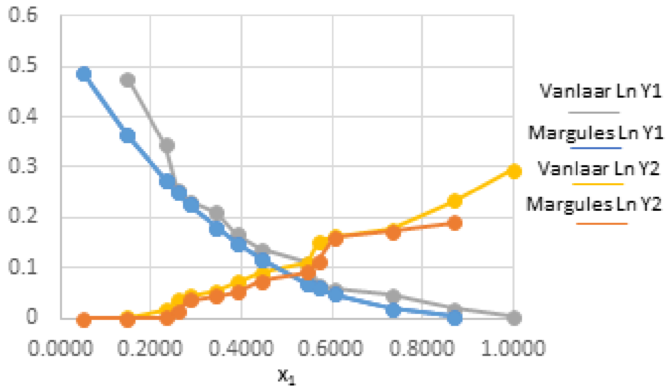

Fig. 4. Comparison of activity coefficient by Van Laar & Margules model for p-xylene & o-xylene at 81.3 KPA.

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