1. 各溶液的摩尔分数

Samples	m1	m2	m3	molar_fraction
solution_1	51.254	52.833	85.982	0.05131
solution_2	47.121	49.553	82.231	0.07792
solution_3	40.143	43.291	74.848	0.101744
solution_4	46.274	50.111	81.025	0.123523
solution_5	51.721	56.367	86.282	0.149908

2. 正丁醇、环己烷及各溶液的密度

液体体积为 5 ml

Samples	m1	m2	delta_m	density
C6H12	53.848	57.677	3.829	0.7658
C4H10O	46.291	50.243	3.952	0.7904
solution_1	45.082	48.943	3.861	0.7722
solution_2	49.731	53.577	3.846	0.7692
solution_3	52.315	56.163	3.848	0.7696
solution_4	51.455	55.305	3.85	0.77
solution_5	45.876	49.737	3.861	0.7722

3. 各溶液的介电常数

环己烷的介电常数 (20°C) 为 2.023，根据

$$C^*_{standard} = C_{standard} + C_d$$

$$C^*_0 = C_0 + C_d$$

$$\epsilon = \frac{C^*_X - C_d}{C_0}$$

可以计算出各溶液的介电常数 (见下表)

Samples	1st	2nd	3rd	Average	ϵ
Atmosphere	5.54	\	\	5.54	\
C_6H_{12}	7.93	7.94	7.98	7.95	\
Atmosphere	5.59	\	\	5.59	\
solution_1	8.19	8.24	8.19	8.206667	2.13195
Atmosphere	5.59	\	\	5.59	\
solution_2	8.34	8.36	8.37	8.356667	2.195622
Atmosphere	5.61	\	\	5.61	\
solution_3	8.5	8.51	8.51	8.506667	2.259295
Atmosphere	5.61	\	\	5.61	\

Samples	1st	2nd	3rd	Average	ϵ
solution_4	8.67	8.67	8.67	8.67	2.328627
Atmosphere	5.62	\	\	5.62	\
solution_5	8.92	8.93	8.92	8.923333	2.436162
C_0	2.355816		C_d	3.184184	

4. 摩尔折射度

根据

$$R = \frac{n^2-1}{n^2+2}\frac{M}{\rho}$$

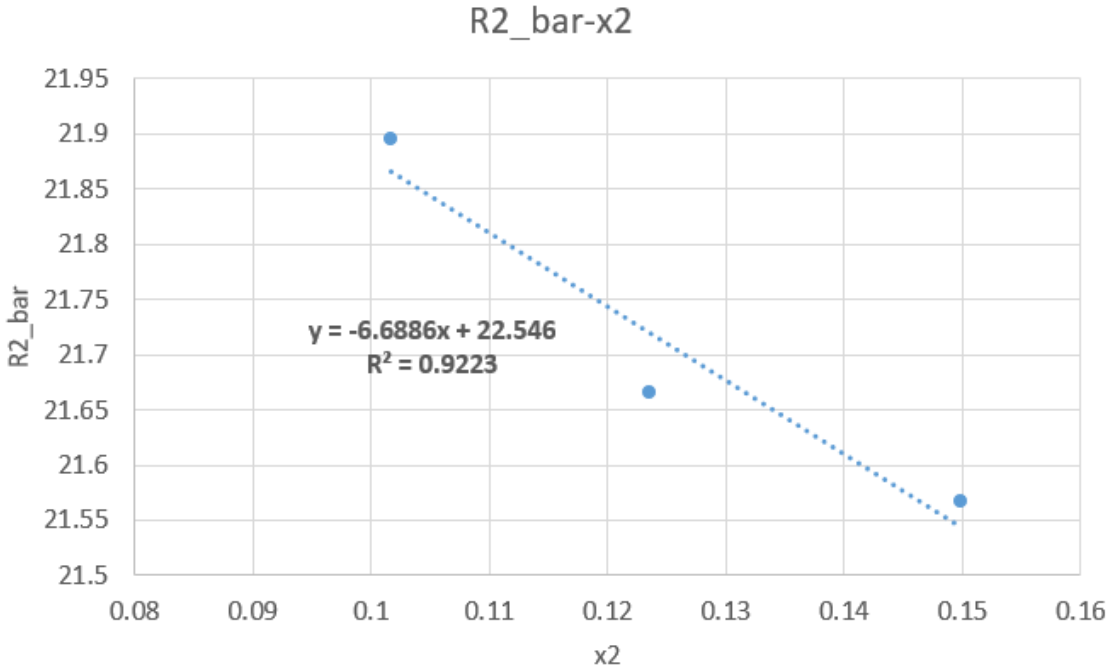
$$R_{1,2} = \frac{n_{1,2}^2-1}{n_{1,2}^2+2} \times \frac{M_1x_1+M_2x_2}{\rho_{1,2}} = x_1\bar{R}_1 + x_2\bar{R}_2$$

$$\bar{R}_1 = R_1^0 = \frac{n_1^2-1}{n_1^2+2}\frac{M_1}{\rho_1}$$

$$\bar{R}_2 = \frac{R_{1,2}-x_1\bar{R}_1}{x_2} = \frac{R_{1,2}-x_1R_1^0}{x_2}$$

可以计算得到每个 x_2 对应的 $\bar{R}_2$ (见下表), 作 $\bar{R}_2 - x_2$ 图，再外推即可求出 $x_2 = 0$ 时的 $\bar{R}_2^{\infty} = 22.546\ cm^3 \cdot mol^{-1}$ (见下图)

x_2	x_1	ϵ	density	$P_{1,2}$	P_1^0	$\bar{P}_2$	n	$R_{1,2}$	R_1^0	$\bar{R}_2$
0.05131	0.94869	2.13195	0.7722	29.67438	27.94576	61.63507	1.4268	27.79986	28.32415	18.10622
0.07792	0.92208	2.195622	0.7692	30.88931	27.94576	65.72245	1.425633	27.75265	28.32415	20.98971
0.101744	0.898256	2.259295	0.7696	31.9394	27.94576	67.19752	1.425833	27.67001	28.32415	21.89495
0.123523	0.876477	2.328627	0.77	33.05373	27.94576	69.29816	1.4244	27.50168	28.32415	21.6657
0.149908	0.850092	2.436162	0.7722	34.65253	27.94576	72.68482	1.423967	27.31129	28.32415	21.56763



5. 摩尔极化度

根据

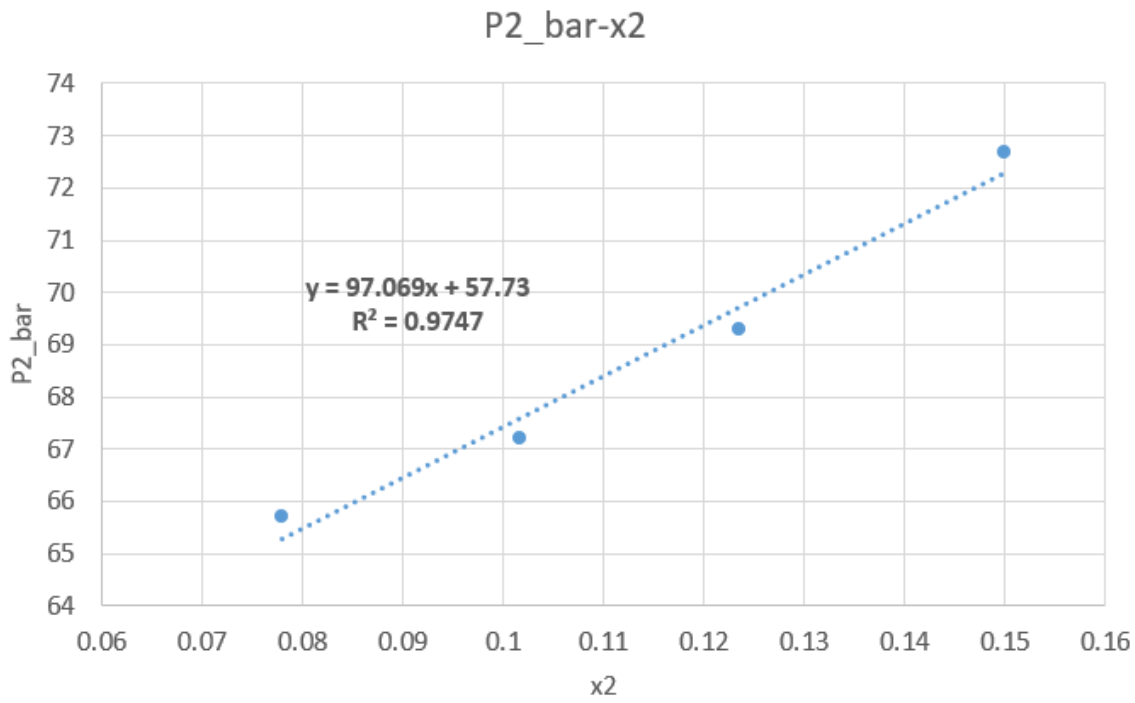
$$P = \frac{\epsilon - 1}{\epsilon + 2}\frac{M}{\rho}$$

$$P_{1,2} = \frac{\epsilon_{1,2} - 1}{\epsilon_{1,2} + 2} \times \frac{M_1 x_1 + M_2 x_2}{\rho_{1,2}} = x_1 \bar{P}_1 + x_2 \bar{P}_2$$

$$\bar{P}_1 = P_1^0 = \frac{\epsilon_1 - 1}{\epsilon_1 + 2}\frac{M_1}{\rho_1}$$

$$\bar{P}_2 = \frac{P_{1,2} - x_1 \bar{P}_1}{x_2} = \frac{P_{1,2} - x_1 P_1^0}{x_2}$$

可以计算得到每个 x_2 对应的 $\bar{P}_2$ (见上表), 作 $\bar{P}_2 - x_2$ 图，再外推即可求出 $x_2 = 0$ 时的 $\bar{P}_2^{\infty} = 57.73\ cm^3 \cdot mol^{-1}$ (见下图)



6. 正丁醇的偶极矩

根据

$$\mu = 12.81\sqrt{(\frac{\bar{P}_2^{\infty}}{m^3 \cdot mol^{-1}} - \frac{\bar{R}_2^{\infty}}{m^3 \cdot mol^{-1}})(\frac{T}{K})} \qquad (D)$$

代入 $\bar{P}_2^{\infty}, \bar{R}_2^{\infty}, T$ 计算得 $\mu = 1.301\ (D)$, 与文献值 1.66[1] 的相对误差为 21.6 %.

误差分析

相对误差较大，可能和有效数据不足有关 (溶液#1的密度测定有误, 趋势和其余四组溶液不符合; 在计算 $\bar{P}_2^{\infty}, \bar{R}_2^{\infty}$ 时也有舍去一些趋势相反的点)，因为实验中溶液的系列摩尔分数差距较小 (要保证是稀溶液), 所以对杂质 (没吹干的液体) 较为敏感，可能是配置或者称量 (计算密度) 的时候有少量外界因素干扰导致测定结果不准确.

参考文献

[1]: W. M. Haynes, ed., *CRC Handbook of Chemistry and Physics, 96th Edition* (Internet Version 2016), CRC Press.