Viscometric and Activation energy study of PEG 6000 in water , and solution of DMSO with water at 298.15k , 308.15 , 318.

Asal Ahmed Al-Jawary Hanaa Ghali Attiya
Zainab Abbas Al-Dulaimy Maida H. Saleem
Department of chemistry , college of education for pure science/ Ibn –Al – Haitham , University of Baghdad

Abstract

on the basis of viscosities of PEG 6000 in water and in mixed aqueous solution of DMSO at 298.15 ,308.15 , 318.15 k , kinematic viscosity and the Activation Energy have been calculated using Erying equation .

The result are discussed in the light of Erying theory and shows that the DMSO solution preferred than water

Key word

Viscosity, kinematic viscosity, Activation Energy

قياسات اللزوجة ودراسة طاقة التنشيط لمادة بولي اثلين كلايكول ٦٠٠٠ في الماء ومحلول ثنائي مثيل السلفوكسيد في الماء بدرجات(٢٩٨.١٥،٣٠٨.١٥،٣١٨.١٥)

الخلاصة

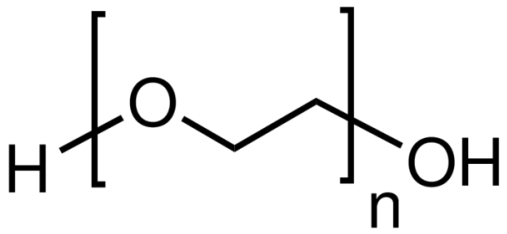
على اساس اللزوجة للبوليمر بولي اثلين كلايكول ٦٠٠٠ في الماء ،و في محلول المائي لثنائي مثيل سلفوكسد بدرجات ٢٩٨.١٥,٣٠٨.١٥,٣١٨.١٥ تم حساب اللزوجة الحركية وطاقة التنشيط بأستخدام معادلة ايرنك .

النتائج نوقشت في ضوء نظرية ايرنك ولوحظ ان محلول ثنائي مثيل سلفوكسيد افضل من المحلول المائي .

Introduction

The kinematic viscosities υ value with the concentration of PEG solution and temperature have been interpreted in accordance of the energy of interaction and frictional forces between the polymer and solvent molecules.[1] [2]

Poly ethylene glycol are synthesized by polymerization of ethylene oxide and are mercantly available over wide range of molecular weights from 300g/md to 10,000,000 g/mol very high purity PEG has latterly been appeared to be crystalline ,allowing characterization of a crystal structure by x-ray diffraction [2]



PEG are liquids or low melting solids depending on their molecular weights, and have different physical properties like viscosity due to chain length effects.[3]

Chemical properties are nearly identical

PEG is a polyether compound with many applications ,from industrial manufacting to medcien

PEG is soluble in water, ethanol, methanol, benzen, acetonitrile, and dichlormethane, while insoluble in hexane, and diethylether. [4]

In addition to hydrophobic molecules to produce non-ionic surfactants [5]

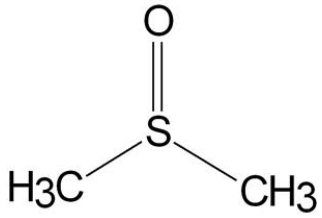
Because PEG is hydrophilic molecule, it has been used to passivate microscope glass slides for avoiding non-specific sticking for proteins in single-molecule fluorescence studies.

It has a low tonicity and is used in a variety of products[6]

DMSO: dimethyl sulfoxide is defined as an organo sulfur compound has formula $(CH_3)_2\ SO_4$. It is an important liquid

polar aprotic solvent has colorless that miscible in a wide range of organic solvent as well as water. This is dissolved both polar and non-polar compound.

DMSO has a comparatively high melting point and unusual property that many individuals sensitive agarlic -like taste in the mouth after contact with the skin [7] [8]



DMSO is a polar a protic solvent and is less toxic than other kinds of this class, such as Dimethyl actamide , HMPA, and N- methyl -2 Pyrrolidone . DMSO is extremely used as a solvent for chemical reactions involving salts, most notably.

Finkelstein reactions and nucleophilic substitutions . It is also widely used as an extraction in cell biology and biochemistry . [9] [10]

Because DMSO is only weakly acidic, it indulges relatively strong bases and as such has been widely used in the study of carbanions.

A set of non-aqueous PKa values (C-H,O-H,S-H and N-H acidities)

Many of organic compounds have been determined in DMSO solution [11] [12]

Experimental:

Viscosity η was measured by using a suspended level ubbelohde viscometer with a flow time of approximately 3305 for distilled water at 298.15,303.15 and 313.15 K . thermostatic control was employed all measurements. [13]

PEG 6000 available product of Aldrich chemical company USA whose number average molecular weight 6000 Kg-mol^{-1} and used without any further treatment . DMSO was dimethyl

sulfoxide (colorless liquid) was obtained from fluka company (purity > 99.7%) and used with out any further treatment .
Water used in these experiments doubly distilled (sp – conductivity – 10^{-6} ohm^{-1} cm^{-1}) .

Result and Discussion:

The experimental data for the molar concentration M and viscosity η and kinematic viscosity υ of PEG 6000 in water and in 2% (DMSO with water) at various temperatures 298.15,303.15 and 313.15 K were summarized in table 1 and table 2
The molar of solutions M was calculated applying the following relation:

$$M=\frac{w}{M.w}\times\frac{1000}{v\,ml} \quad \ldots\ldots\ldots(1)$$

Where M the molarity of solution mol dm^{-3}
M.W the molecular weight of the polymer PEG(6000 g/mol^{-1})
W the weight of PEG g
The calculated values of **υ** kinematic viscosity for all solution at different temperatures was calculated applying the following relation :

$$\upsilon = C\,t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$ [14] [15]

Where C capillary viscometer constant 0.0047
t the time (second)
the calculated values of **υ** for all solution at different temperatures were listed in table 1
table 1 showed that the values of **υ** increase with increase of PEG concentration and DMSO in solvent , and with elevated temperature . it indicated that the solute-solvent interaction decrease with increasing PEG concentration
the activation energy of viscous flow was found by computerized least square fitting to the following equation:

$$\upsilon = Ae^{\frac{Ea}{RT}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$ [16] [17]

$$\ln \upsilon = \ln A + \frac{Ea}{RT} \quad \ldots\ldots\ldots(4)$$

Where **υ** the kinematic viscosity c.St

A pre-exponential factor
Ea the activation energy j/mol

C(g/dm^3)	298.15 k	308.15 k	318.15 k
0.00001	0.188	0.1504	0.141
0.00003	0.1974	0.1551	0.1457
0.00005	0.2021	0.1645	0.1504
0.00007	0.2024	0.1659	0.151
0.00009	0.21	0.1683	0.1512
0.0001	0.2201	0.1706	0.152

R the gas constant 8.3144 j.k^{-1}.mol
T temperature in kelvin
And when we plot ln υ versous $\frac{1}{T}$ we got straight line and from the slope we have the activation energy from the values of table (3) and table (4)
The values of activation energy of viscous flow for the two solvent is shown in table (5) that the values of activation energy of DMSO is lower , we can explain this by Ering theory
This theory interpreted viscosity in mechanical view including the displacement of particles one by one during viscous flow and crossing the energy barrier between neighboring sites. [18][19]
Therefore the solution DMSO is prefer than water because low value of activation energy

Table(1) Values of kinematic viscosity (c.St) ,concentration in molarity at 298.15k,308.15k and 318.15k temperature for PEGin aqueous solution.

0.00013	0.2205	0.171	0.1602
0.00015	0.2207	0.1738	0.1606
0.00017	0.23	0.1747	0.1609
0.00019	0.2306	0.1772	0.1632

Table(2) Values of kinematic viscosity (c.St) ,concentration in molarity at 298.15k,308.15k and 318.15k temperature for PEG in solution of water and DMSO

C(g/dm^{-3})	298.15 k	308.15 k	318.15 k
0.00001	0,282	0,2503	0,2287
0.00003	0,2845	0,255	0,2308
0.00005	0,2901	0,2671	0,2315
0.00007	0,2975	0,2699	0,2362
0.00009	0,3001	0,2721	0,2413
0.0001	0,3158	0,2773	0,2472
0.00013	0,3171	0,2793	0,2489
0.00015	0,3405	0,2804	0,2497
0.00017	0,3638	0,2836	0,2515
0.00019	0,4005	0,2897	0,2522

Table(3) Values of lnυ and 1/T of PEG in aqueous at 298.15k,308.15k and 318.15k temperature

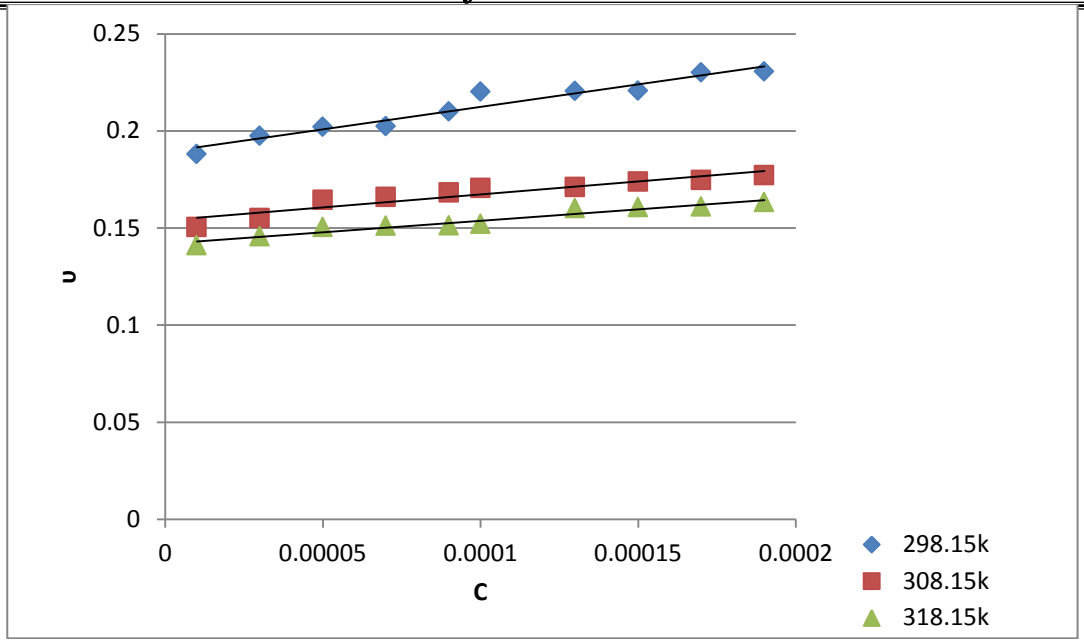
1/T	lnυ
0.00335	-1,45
0.003245	-1,78
0.003143	-1.87

Table(4) Values of lnυ and 1/T of PEG in solution of water and DMSO at 298.15k,308.15k and 318.15k temperature

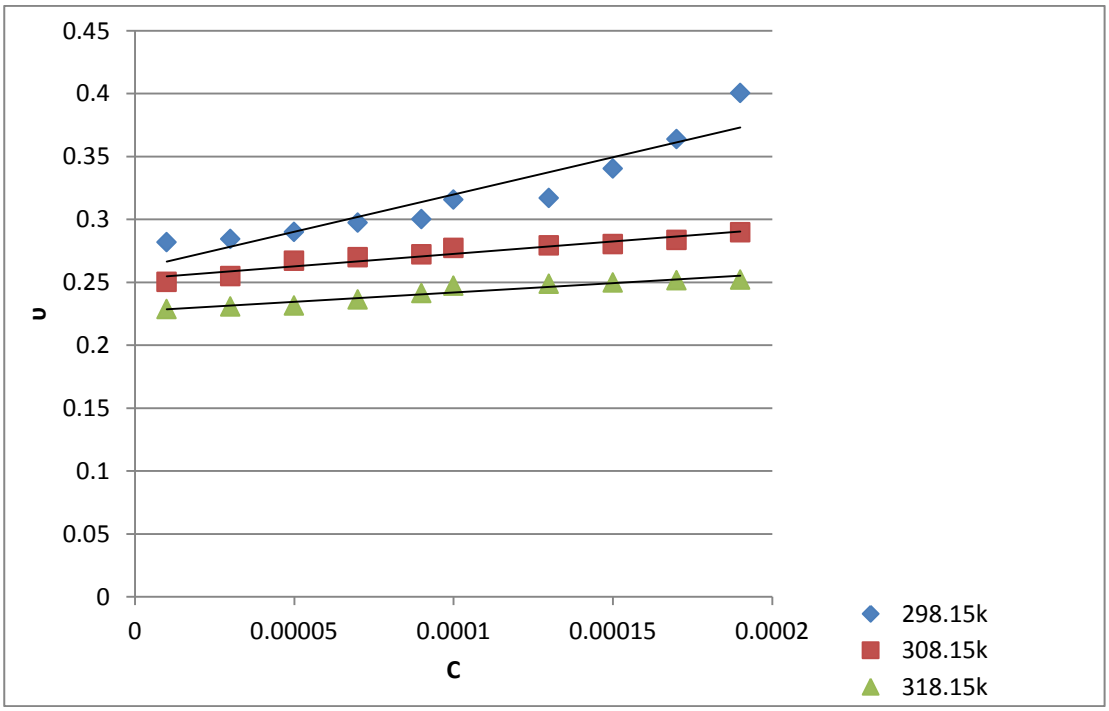
1/T	lnυ
0.00335	-1,1419
0.003245	-1,3
0.003143	-1,4196

Table(5) Values of activation energy of viscous flow for the two solvent

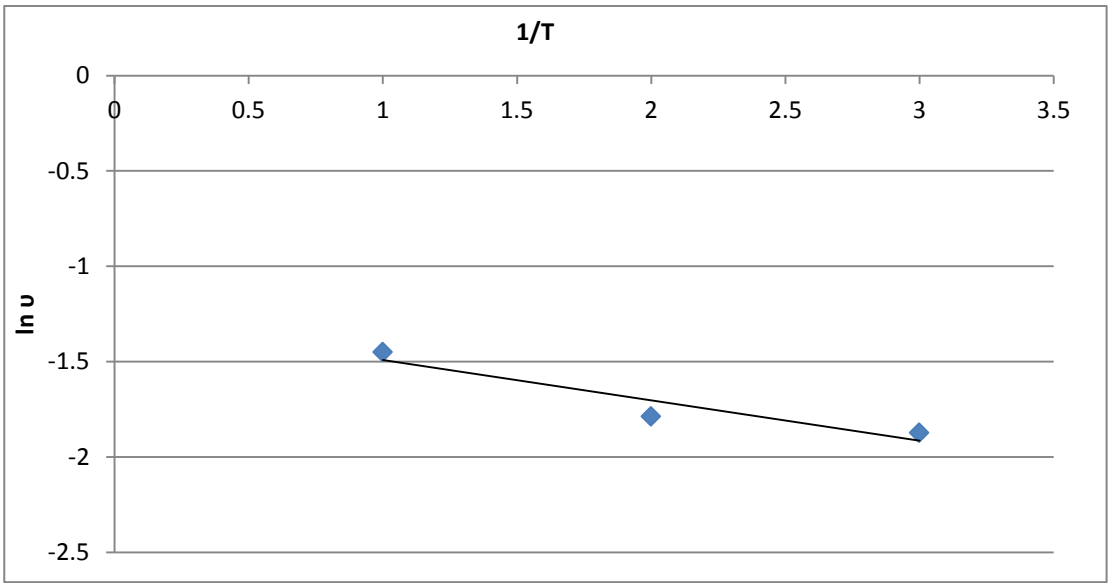
PEG/Solvent	E^a J/mole
water	1280.7
DMSO	1009.5



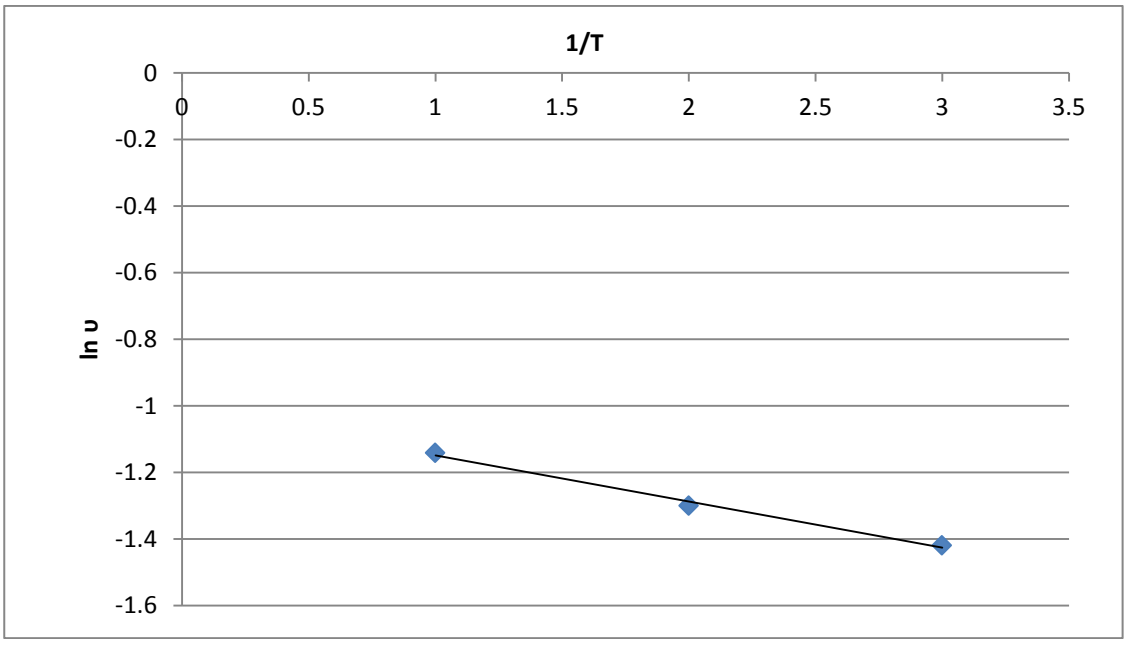
Figure(1) concentration dependence of kinematic viscosity of PEG in aqueous solution at 298.15k,308.15k and 318.15k temperature.



Figure(2) concentration dependence of kinematic viscosity of PEG in DMSO at 298.15k,308.15k and 318.15k temperature



Figure(3) ln υ and 1/T of PEG in aqueous solution at 298.15k,308.15k and 318.15k temperature.



Figure(4) ln υ and 1/T of PEG in DMSO solution at 298.15k,308.15k and 318.15k temperature

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