Preparation of Poly vinyl Alcohol Solutions in Polar Solvents with Calculation of Activation Energy of Viscous from Arrhenius Equation

Nahla S. salman, Rafid K.Kmal and Nadher D.radhy
Dep. of chemistry / college of education / university of AL-Qadisiyah
Dep. of chemistry pharmaceutical/ pharmacy of education// university of AL-Qadisiyah

الخلاصة

تضمن البحث محاليل بولي فنيل الكحول (PVA) في مذيبات قطبية (الماء ، الايثانول) في درجات حرارية مختلفه ضمن المدى 298.15 K الى 348.15 K .

كما تضمن البحث دراسة تاثير درجة الحرارة على لزوجة هذة المحاليل البوليمرية التي تم الحصول عليها من خلال القيم التجريبية للكثافة في درجات حرارية مختلفة ضمن المدى 298.15 K الى 348.15 K وحساب طاقة التنشيط اللزوجة لهذة المحاليل البوليمرية من خلال تطبيق معادلة ارينيوس الموضحة ادناة :

$$\eta=\eta_0\ \exp^{(Ea/RT)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

ومن خلال النتائج التجريبيه لطاقة تنشيط اللزوجة كانت قيمة طاقة تنشيط اللزوجة لبولي فنيل الكحول في الماء تساوي 17.496 جول وطاقة تنشيط اللزوجة لبولي فنيل الكحول في الايثانول تساوي 18.237 جول .

حيث ان اختلاف طاقة تنشيط اللزوجة بين المحلولين المدروسين يعود الى اختلاف لزوجة المحاليل البوليمرية التي من خلالها تم معرفة طبيعة التداخلات الجزيئية الحاصلة بين محاليل البوليمرات المدروسة.

Abstract

This paper involved, preparation of solution poly vinyl alcohol (PVA) in polar solvents (ethanol , water) from (298.15 to 348.15) K under atmospheric pressure.

The effect of temperature on viscosity present experimental was studied for solutions poly vinyl alcohol that obtained from experimental data densities in the same temperature (298.15 to 348.15) K . and calculate the activation energy of viscosities for these solutions poly vinyl alcohol from arrhenius equation below :

$$\eta=\eta_0\ \exp^{(Ea/RT)} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The values of activation energy of solution poly vinyl alcohol in water was 17.496 J while the values of activation energy of solution poly vinyl alcohol in ethanol was 18.237 J.

The different values of activation energy viscosities of these solution due to intermolecular interaction.

Introduction:

Viscosity is one of the important physical property of liquid metals as well as density, surface tension and refractive indexes and one of the simplest methods to studying the interactions and properties of polymers system in solutions .

When liquid flows layers of liquid molecules slide over each other and intermolecular

Forces cause resistance to flow .Viscosity is a measure of fluids resistance to flow and is affected by several factors such as concentration and temperature .That all the obeyed Arrhenius equation to different degree (1-8) . There are many theoretical dealing with the viscosity temperature relationship in liquid and polymers . Viscosity was correlated with temperature through the Arrhenius equation .

The Arrhenius equation which has already employed to describe the temperature dependence of dilute polymer solutions.

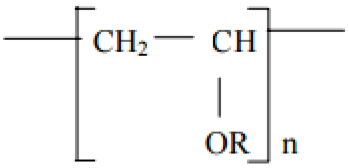
$$\eta=\eta_0\ \exp^{(Ea/RT)} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

where **η** is the relative viscosity (cpoise) .

where **η0** is a pre-exponential constant and **Ea** is the apparent energy of activation (J/mol.k) which is used to represent the stability of the system .

R : is the universal gas constant (8.314 J/mol.k) and **T** is the absolute temperature .

The activation energy which is the minimum energy needed to the molecule to jump to its neighboring hole because of the restriction of other molecules around it (9-17) .Poly vinyl alcohol (PVA) has a relative simple chemical structure with a pendant hydroxyl group. The monomer vinyl alcohol does not exist in a stable from rearranging to its tautomer acetaldehyde . there fore (PVA) is produced by the poly merization of vinyl acetate followed hydrolysis is based on the partied replacement of ester group in vinyl acetate with the hydroxyl group and is completed in the presence of aqueous sodium hydroxide .following gradual addition of the aqueous saponification agent .Polyvinyl alcohol is precipitated washed and dried the degree of hydrolysis is determined by the time point at which the saponification reaction is stopped .The structure of poly vinyl alcohol (partially hydroxyzed) is given below



where R = H or $COCH_3$

Poly vinyl alcohol (PVA) sometimes referred to as (PVA) is a water soluble polymer used widely in adhesives paints , sealants , coatings , textiles , plastics , etc .(18-27). Viscosity of a polymer solution depends on concentration and size (molecular weight) of dissolved polymer .

2. Experimental

2-1 . materials and methods

Materials ; . (PVA) (m.w = 30000 gm/ml) used in this work were supplied by and were used as received with any further purification , distil led water , absolute ethanol (EtOH 99.5 %)
2-2- polymer solution preparation (PVOH) [19-23] (PVA) solutions in water and ethanol
Was prepared by heating and mixing with using standard reflux column / falsic combination . PVA solutions in water and ethanol was prepared by dissolving (20gm from PVA powder in 50 ml deionized water , and heating at 90 ^{0}c after in with magnetic stirring and 20 gm in 50 ml ethanol and heating at 75 ^{o}c after 6 hours , PVA solutions was found (avoid boiling the solutions)

2-3- measurement of Temperature and time [9] ;
In this experiment all temperature were measured by a mercury thermometer with accuracy and proper flow time by stop watch .

2-4- Density

The density of solutions was measured by using single capillary of lmm . Pycnometer or density bottle made of borosil glass having bulb volume of 5 ml , and pycnometer was calibrated with doubly distilled water (24-28) .

2-5- viscosity

The viscosity studied were carried out in an Ubbelohde viscometer and the limiting were measured accurately (0.01) s . The flow time has been measured with an electronic stop watch with a precision of 0.01 sec . Time required for flow from upper mark to lower mark for viscometer . The viscometer was clamped vertically in thermostatically controlled water bath . The viscometer was calibrated with doubly distilled water (7,29) .

3. Result and Discussion

3-1- viscosity temperature Relationship

Viscosity as a function of absolute temperature for polymer dilute solution of PVA in water and ethanol . The experimental values of viscosities of studied polymer dilute solutions of PVA in water and ethanol in different temperatures are listed in table (1) .From table (1) was observed that the viscosities (1,26,29-31) of polymer dilute solutions (PVA + water) and (PVA + ethanol) increased with increasing of temperature , fig (1),The trend in viscosity indicates the intermolecular interaction .The high viscosity can be attributed to the strong forces like hydrogen bond (32)

Table (1) ; Experimental values of viscosities of polymer dilute solutions (PVA + H_2O) And (PVA + Ethanol) at (298.15 – 384) k .

T k	ηcp (PVA + H_2O)	ηcp (PVA + ethanol)
298.15	1.305	1.580
308.15	1.454	1.675
318.15	1.566	1.777
328.15	1.605	1.883
338.15	1.829	2.199
348.15	2.250	2.350

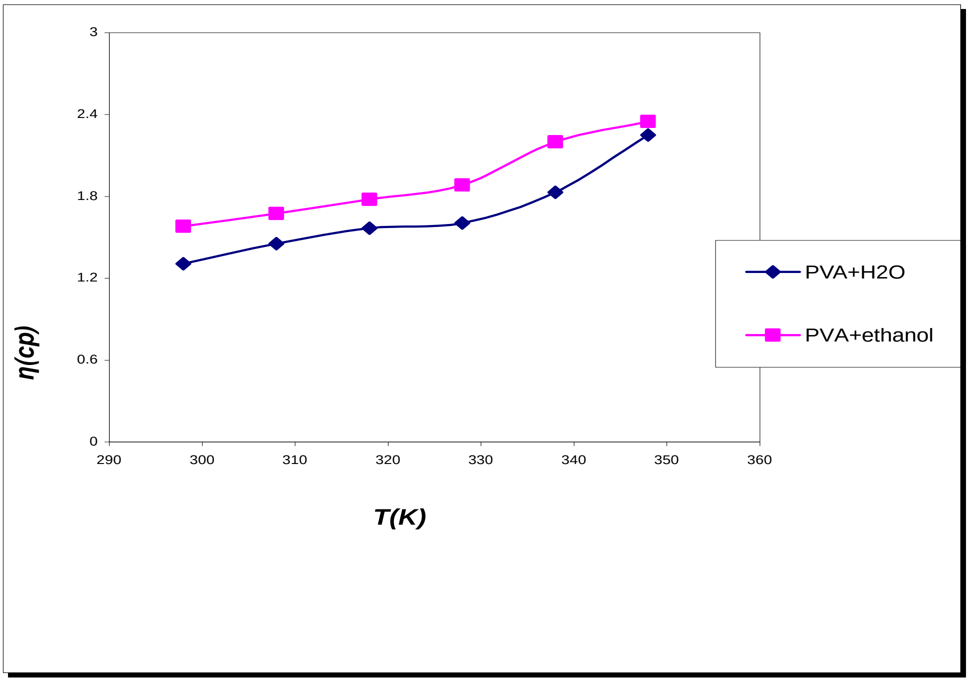


Fig (1) ; show aplot of viscosity versus temperature of polymer dilute solutions of (PVA + H_2O) and (PVA + Ethanol) in (298.15-348.15) k .

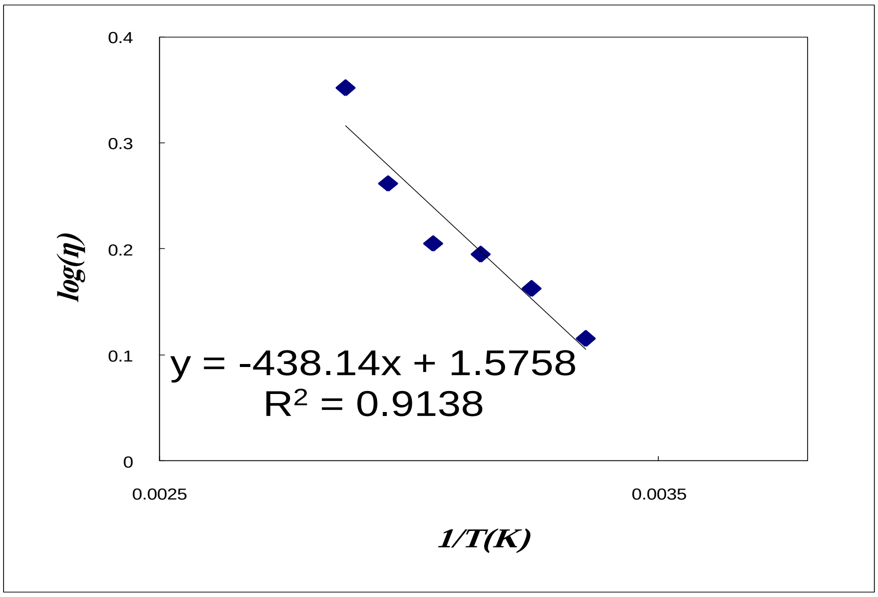
3-2 Activation energy of flow

The activation energy for flow was determined for those polymer dilute solutions by using the Arrhenius equation . **Fig (2) , fig (3)** shows viscosities with versus temperature .

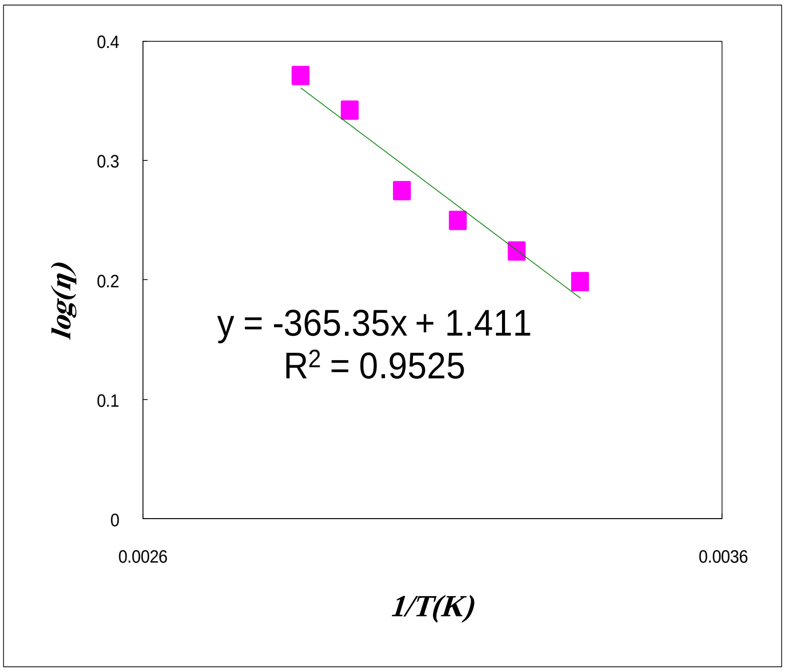
From the experimental values of logarthium viscosities (**η**) and versus temperature (1/T). the activation energies of (PVA+ethanol) and (PVA+H_20) were calculated according to arrhenius eqation and it were 18.237 J, 17.496J respectively.

Increasing in viscosity of solution resulted increasing in activation energy of viscous flow.

The analysis of the results obtained shows that the activation energy decrease with increasing temperature (33-36) .Increasing in viscosity for solution resulted increasing in activation energy.



Fig(2) ; Experimental values of viscosity of polymer dilute solution of (PVA + H_2O) with versus temperature at (298.15) k to (348.15) k .



Fig(3) ; Experimental values of viscosity of polymer dilute solution of (PVA + Ethanol) with versus temperature at (298.15) k to (348.15) k .

Conclusion

The results suggest that the molecular interaction hydrogen bonding between polymer(PVA+ Ethanol) is stronger than of (PVA + H_2O) In The molecular forces in polymer ;

1. intermolecular forces generally covalent bonds (strong) forces between atoms in one chain .
2. Vander wails forces (PE).
3. HYDROGEN BRIGHDES (ps) stronger can become very strong .
4. Enmanagements (physical) Viscosity of a polymer solution depends on concentration and size (molecular weight) of dissolved polymer . Increasing in viscosity and an solution resulted in increased in activation energy of viscous flow . Attractive interaction viscosity of these systems .

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