Study of Some Physical Properties for Polyvinyl Alcohol-Polyethylene Glycol Blends

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Abstract

A polymer blends (PVA/PEG) have been prepared at various concentrations(6%, 8%, 10%, 12%, and 14%) g /ml by dissolving different weights from the powders{Pva and Peg}.The behavior of this mixture has been studied utilize some physical properties such as ultrasonic absorption coefficient, relaxation amplitude, specific acoustic Impedance, compression, bulk modulus, shear viscosity, and Reduced viscosity. The outcomes referenced that each of these characteristics increased with increasing concentration of polymeric solutions, "while compressibility decreased with increasing concentration solutions".

Key Words: PEG Polymer, Ultrasound Technique, Reduced Viscosity.

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Introduction

Ultrasound resembles sound waves, "both of which travel through an intermediate". Ultrasound consists of high frequency sound waves that have not been heard before. Ultrasound frequency usually exceeds{20 kHz}. Ultrasound can be viewed as similar to ultraviolet light in that it distinguishes that region of sound phenomena that cannot be reached by human perception[1]. There are two distinct ways to measure ultrasound. One is called acoustics and the other is known as electro acoustics. They measure completely different parameters. The acoustics are simpler because there is one field the mechanical stress field. Usually the measured parameters are the speed of sound and the attenuation coefficient. The electro-acoustic method is more complicated because it relies on a two-field coupling - electro and mechanical". The measured parameters are the size and phase of the electrical acoustic signal. "Four basic parameters can be used as a footprint of a specific liquid system sound speed, attenuation coefficient, Magnitude of the electroacoustic signal and Phase of the electroacoustic signal"[2]. Ultrasound is an industrial technology widely used to measure thickness and detect defects and to a limited but increasing extent to the characterization of substances[3].

Experimental

In this work, two polymers are adopted

Polyvinyl Alcohol (PVA)

PVA is one of the oldest and most popular polymers," it is widely used in a variety of applications and is currently widely used in semiconductor applications". Water soluble polymer created in the world based on volume [4].

Polyethylene Glycol (PEG)

"Polyethylene glycol is used in many pharmaceutical products. Low molecular weight variants are used as solvents in oral liquids and soft capsules, while solid variants are used as ointment bases, tablet binders, and lubricants. Soluble in water, methanol and ethanol"[5].

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They are used as homogeneous granules, and can be obtained from local market. The main characteristics are recorded for these materials in the list {1}.

List {1}

Melting point	Density	Purity	Molecular formula	Appearance	materials
T_m ^0C	$gm.cm^{-3}$	%			
230	1.31	99.8	$(CH_2CH(OH))_n$	White–to-cream powder	PVA
55-82	1.12	99.5	HO - (CH2 - CH2 - O)n - H	white powder	PEG

Preparation of Polymer Solutions

Powders of polyethylene glycol and polyvinyl alcohol were used in the preparation of polymer mixture solutions (PVA/PEG) and many concentrations were obtained (6%, 8%, 10%, 12%, and 14%) g / ml of solutions (PVA/ PEG) after melting the known weights of the (PVA and PEG) powders in (250 ml) of distilled water and stirring at (70 ° C) for (30 minutes) until obtaining homogeneous solutions. Concentrations of these solutions were calculated from the following relationship [6].

$$\text{Concentration} = \frac{\text{(Mass of solute)}}{\text{(Volume of solution)}} \text{ x } 100\ \%$$

$$\text{Molar Concentration} = \frac{\text{(Mass of solute)}}{\text{(Volume of solution)}} \times \frac{1}{\text{Molecular weight}}$$

Results and Discussion

1-Ultrasound measurements: conducted with pulse-type transmitter receiver type (SV-DH-7A / SVX-7 speed from audio device) at fixed frequency (25 kHz).

- Absorption Coefficient of Ultrasonic Waves

The ultrasonic absorption coefficient (α) value of the polymeric solutions is calculated by the following formula:

$$\alpha = \frac{-\ln A / A_0}{X}$$

Where A_0 : the first amplitude of the ultrasound

A : the following wave amplitude absorption

X : distance between the transmitter and receiver

Ultrasound The amplitude of a wave in a relaxing state after collision with a particle solution and discomfort due to this collision then returns to a state of relaxation called relaxation amplitude (D), given by [7]:

$$D = \alpha / f^2$$

Where { f } ultrasound frequency.

The results show in Figure (1) that the absorption coefficient of the blends increases as the concentration increases, because the absorption coefficient mainly depends on the concentration and also depends on the structural relaxation that occurs between the polymer molecules, which is due to the fact that when the polymer concentration increases, there will be more molecules in the solution this leads to more attenuation against wave propagation and changes in the particle size distribution function rather than the increase in shear viscosity.

Figure (2) note that the amplitude of relaxation increases with increasing concentration of(PVA/PEG) solutions. This is due to the fact that ultrasound energy depends on viscosity and thermal conductivity. So any increase in viscosity leads to an increase in the absorption coefficient and consequently to an increase in relaxation capacity when the frequency is constant.This result is consistent with the behavior obtained by the researcher [8].

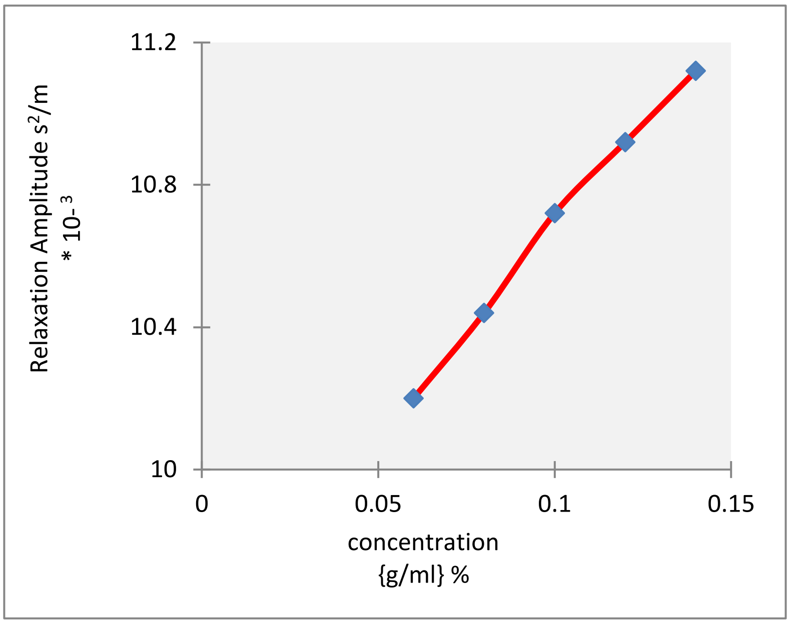

Figure 1.

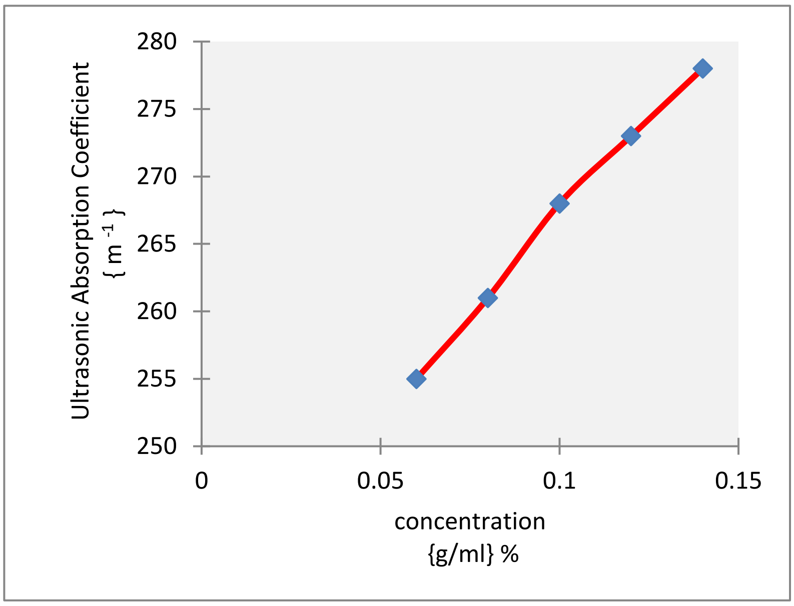

Figure 2.

Density and Ultrasonic Velocity

Density(ρ) is a physical property of matter that expresses the ratio of mass to volume. The density of all solutions was measured at room temperature and the results are shown in Figure (3) which shows that the density increases with increasing concentration of (PVA/PEG) solutions and this is due to the increase in the mass of the solution and the swelling made in polymer chains as a result of solubility in distilled water, especially polymers of high molecular weight[9].

Ultrasound velocity(v) was determined by dividing the distance traveled by the wave inside the polymer solution by the delay time and Figure (4) shows the relationship between ultrasound velocity and focus. This figure exhibits that ultrasound speeds remain constant with the increase of the (PVA / PEG) polymer blends concentration,these results are similar to those of the researcher[10].

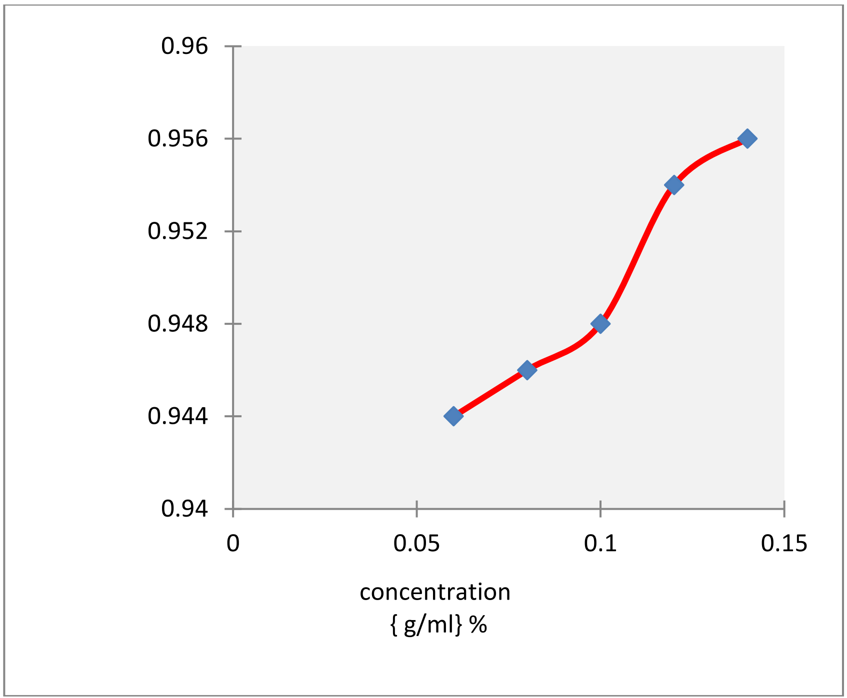

Figure 3.

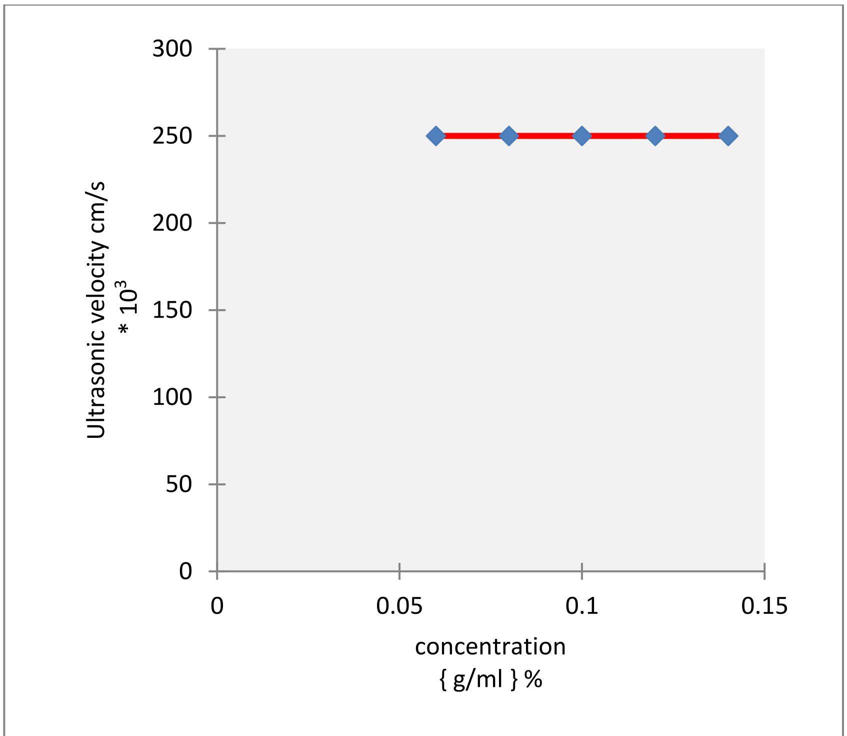

Figure 4.

Specific acoustic impedances . The acoustic impedance (Z) is calculated using the formula:

$$Z= \rho V$$

Figure (5) shows an increase in acoustic impedance with increasing concentration of the polymeric blends solutions due to the interaction between the polymer and solvent molecules, which increases the distance between the particles, opens a relatively wide gap between the particles and becomes the main cause of ultrasound resistance.

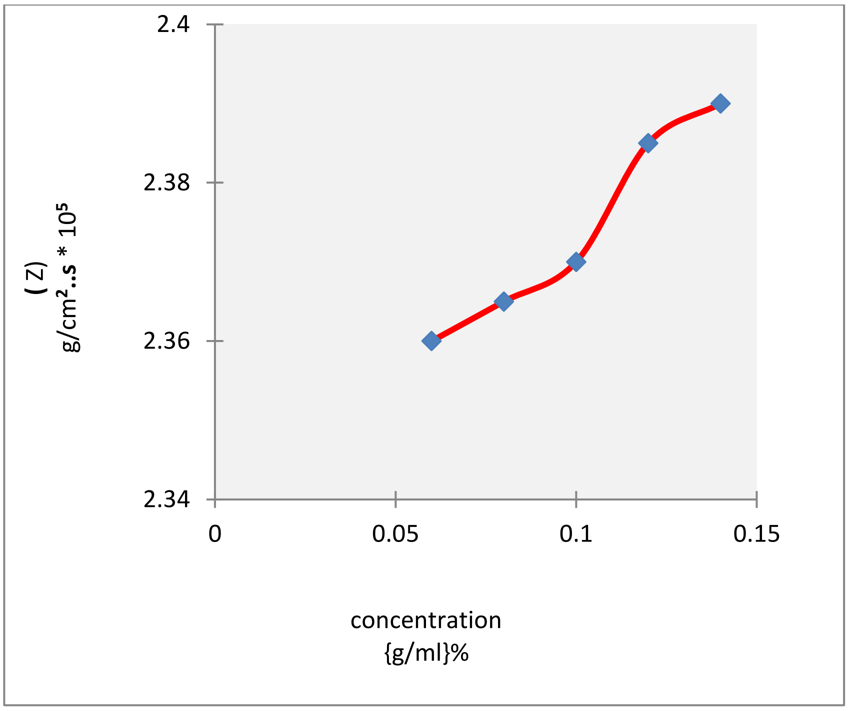

Figure 5.

a. Compressibility and Bulk Modulus

compressibility(β) calculate from the speed of sound (v) and the density of the medium (ρ) using the equation:

$$\beta = (\rho v2) -1$$

The bulk modulus(Y) is defined as the pressure increase necessary to reduce the volume, and is calculated by [11]:

$$Y = \frac{1}{\beta}$$

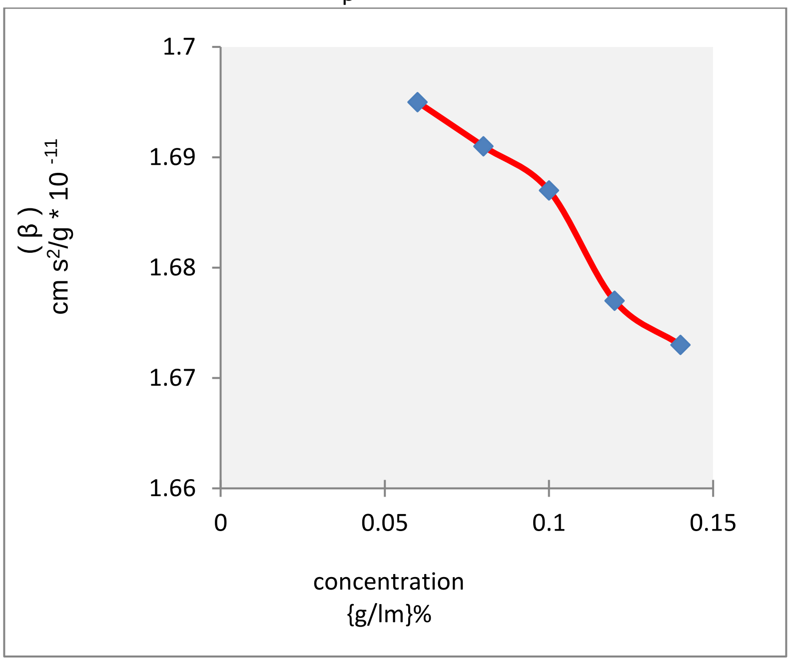

Figure 6.

Fig.(6) display that the compressibility lower with increasing concentration of solutions, this is imputed to the reality that the polymer molecules ionize in dilute solutions. whilst the Bulk modulus in Figure (7) increases with increasing concentration of the polymeric blends. Because it is inversely attached to compressibility, when compression minimize, the volume coefficient should rise specially, This is consistent with the researcher's results[12].

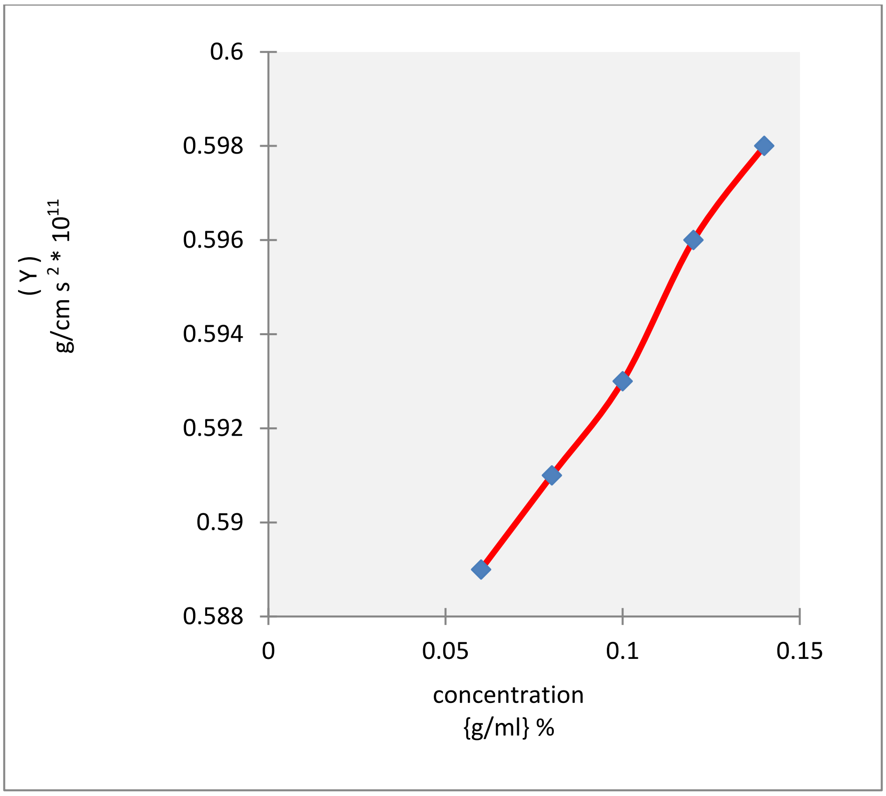

Figure 7.

Shear, Relative, and Reduced Viscosities

Shear viscosity of all concentrations was measured using

Digital viscometer type (Rheocalc V3.3 Bulid 49-1: Rheometer 1) fabricated by Germany.

Newton knows the shear viscosity (ηs) as the proportion amongst the shear stress and shear rate (dυ / dx) [13].

$$n_s = s/(^{dv}/_{dx})$$

Where {s} represents shear stress

The relative viscosity (ηrel) of the polymer solutions and the reduced viscosity (ηred) are found using the following equations:

$$\eta_{rel} = \frac{\eta_s}{\eta_o}$$

$$n_{red} = \frac{n_{sp}}{c}$$

Where η_o=viscosity of solvent

η_{sp}= Specific Viscosity

C= Concentration of material

The shear viscosity of all solutions was measured at room temperature, and the results in Figure (8) show that the shear viscosity increases with increasing concentration of mixtures (PVA / PEG).The reason is due to the attractive forces between the solution molecules, and this leads to the particles being separated in mixing and filled with a larger volume. This increases the shear viscosity values[14].

Other types of viscosity, such as relative and reduced viscosity, take the same shear viscosity behavior as derived from them, as shown in figures (9,10),These results are similar in behavior to those of researcher [15].

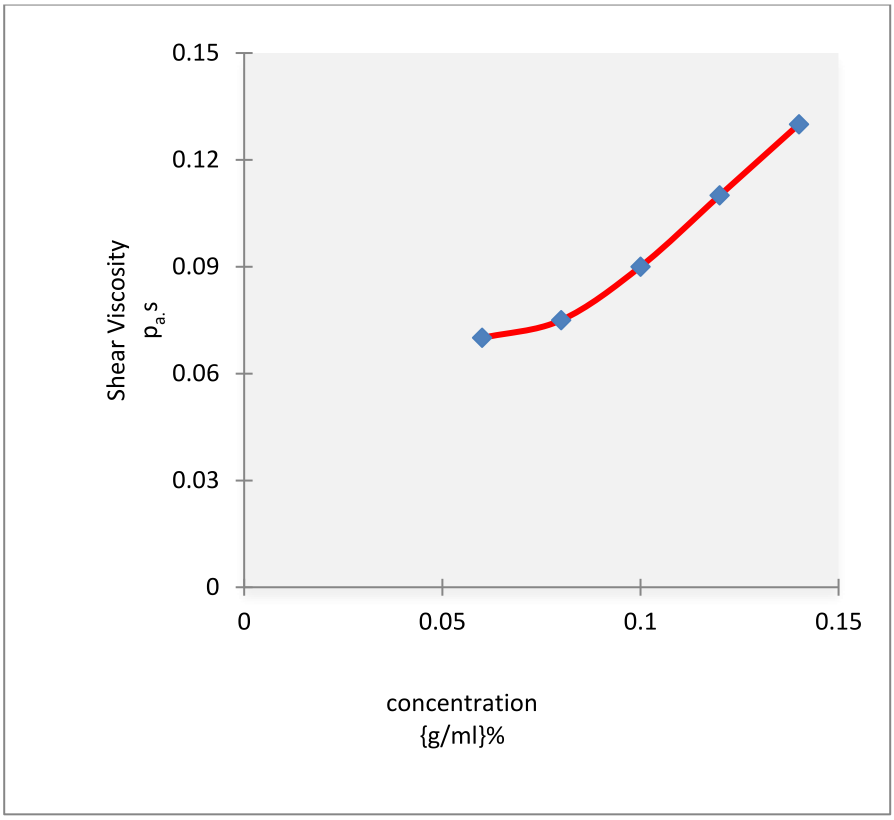

Figure 8.

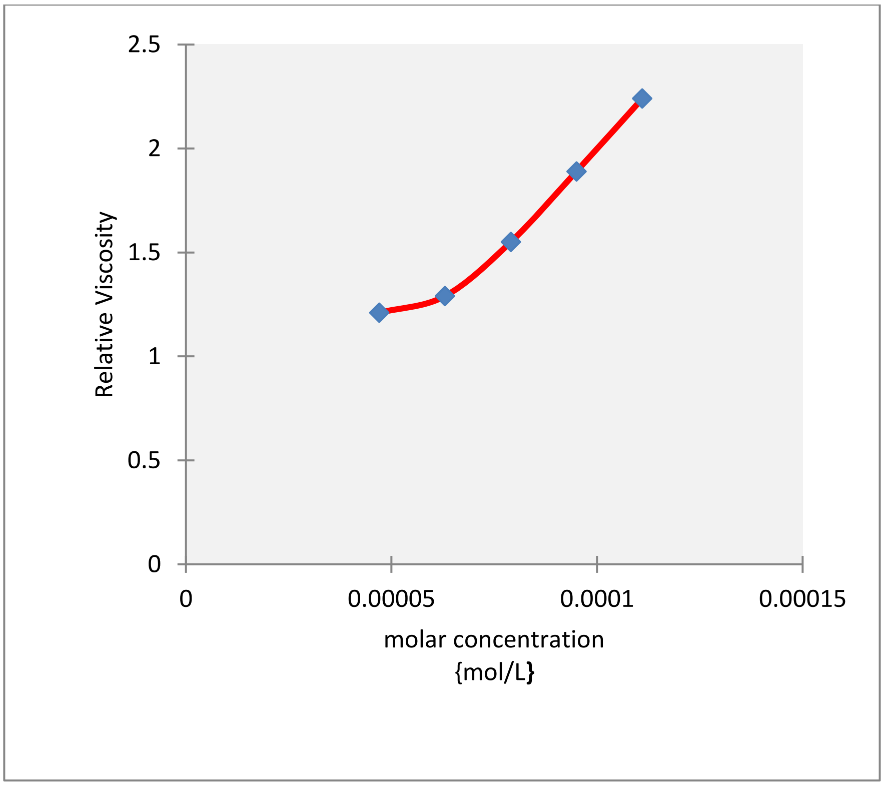

Figure 9.

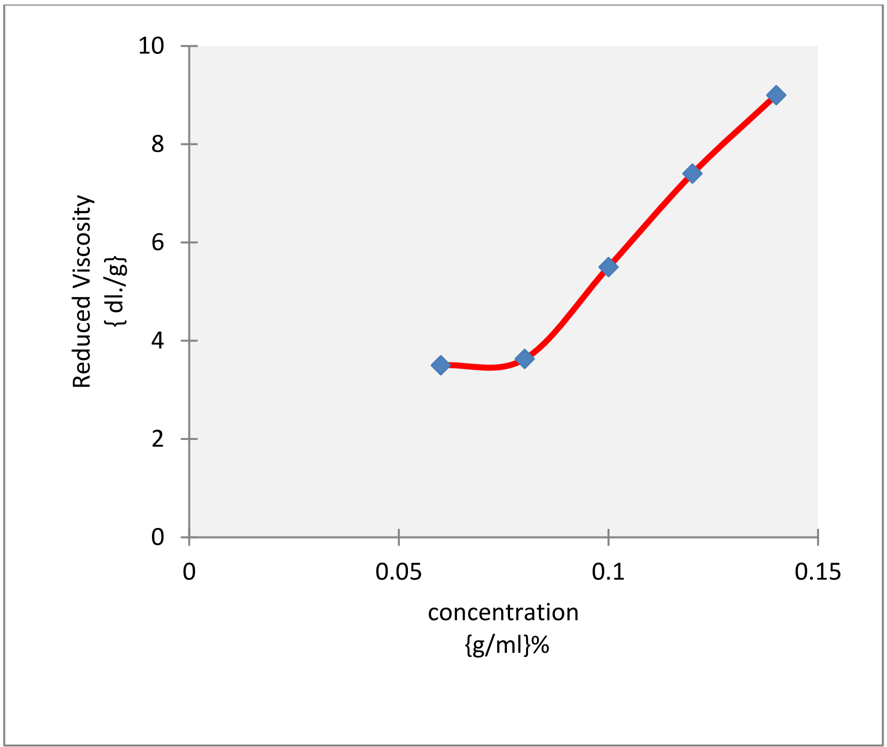

Figure 10.

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