EFFECT OF PBO ON THE SOME PHYSICAL PROPERTIES OF COMPOUNDING RUBBER

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ABSTRACT

We study the mechanical properties mixture compounding rubber with different ratios concentration of PbO , by using ultrasonic measurements of fixed frequencies (26 kHz) , these properties are ultrasonic velocity, compressibility , specific acoustic impedance , relaxation time, bulk modulus, Results show that all these properties were decreasing with increasing the concentration of PbO in the composite , this reason made these values reduced except that scattering were dominate so we pointed that this composite more effective to reflect and scattered ultrasonic waves.

Keywords: PbO, Compounding rubber, Ultrasonic velocity

INTRODUCTION

The study of composite materials mixtures consisting at least two phases of different chemical compositions has been of great interest from both fundamental and practical stand points , the macroscopic physical properties of such materials can be combined so as to produce materials with a desired average response [1] . Composite materials structural integrity can be compromised via many mechanisms including presence of discontinuities or loss of mechanical properties. Ultrasonic methods are directly sensitive of these changes and can be used to assess the integrity of the composite structure [2]. Ultrasonic velocity measurements are relatively simple to make in bulk solids and can be related to the various elastic modules, especially for isotropic solids. For these bulk solids the sound speed may be weakly related to the crush or abrasion strength of the material [3]. As the sound transmission depends on both the properties of the particles and their configuration, care must be taken to understand the preparation of the sample for measurement. This includes shaking steps to consolidate the powder and prepare as uniform as possible configuration of the powders at measurement [3, 4].

The absorption of ultrasound in polymer composite system is governed by local modes of motion and cooperative because of the existence of strong intermolecular interaction within the polymer [5].

The absorption coefficient (α) was calculated from Beer –Lambert law equation (1) [6].

$$\frac{A}{A_0} = e^{(-\alpha x)} \quad \text{.....(1)}$$

$$\alpha = \frac{\ln(A/A_0)}{x} \quad \text{.....(2)}$$

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Where (A_0) is the initially amplitude of ultrasonic waves (A) is the wave amplitude after absorption, the transmittance (T) is the fraction of incident wave at a specified wavelength that passes through a sample was calculated from the following equation [7]

$$T = \frac{I}{I_0} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The relaxation amplitude of ultrasonic wave (D) was calculated from the following equation where (f) is the frequency [8]

$$D = \frac{\alpha}{f^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The method of measuring the speed of ultrasound was by measuring the thickness of the sample and the time it takes inside the sample [9]

$$V = \frac{x}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where (x) is the sample thickness measured by digital vernier; (t) is the time that the waves need to cross the samples. The wavelength (λ) of the ultrasound waves inside the sample was calculate by the equation [10]

$$\lambda = \frac{V}{f} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The acoustic impedance of a medium (z) is a material property was calculated by this equation where (ρ) is the density [11]

$$Z = \rho v \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The bulk modulus (k) of a substance measures and the substances resistance to uniform compression, it is defined as the pressure increase needed to decrease the volume; its base unit is the Pascal (pa.) was calculated by the following equation [12]

$$K = \rho v^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Compressibility (β) is a measure of the relative volume change of a fluid or solid as a response to a pressure (or mean stress) change, it was calculated by equation (9) [13]

$$\beta = (\rho v^2)^{-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

On the basis that all solid flow to a small extent in response to small shear stress, some researchers has contended that substances known as amorphous solids, such as glass and many polymers may be considered to have viscosity. This has led some to the view that solids are simply "Liquids" with a very high viscosity; the share viscosity of the samples was measured by using the equation (10) [14, 15]

$$\eta_s = \frac{3\alpha\rho v^3}{8\pi^2 f^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

The relaxation time (τ) was calculated by the following equation [16]

$$\tau = \frac{4\,\eta_s}{3\,\rho v^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots(11)$$

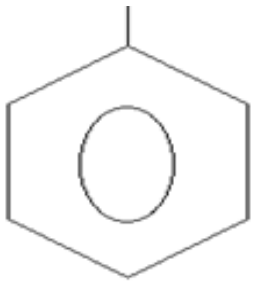
Experiment

We use the ultrasonic pulse velocity method (called also transmission method) is one of the oldest and simplest methods of materials testing. The method consists in the determination of the travel time, over a known path length of longitudinal ultrasonic wave after its transmission through the tested medium as shown in Fig (1a). Both the emitting and receiving transducers are usually placed on the opposite sides of the tested sample (coaxially is possible). Other transducer arrangements are also used by placed on the perpendicular surface (Fig 1b) or on the same side of the tested member (Fig 1c).

All material is used in this research come from Babylon Factory tire Manufacturing Iraq. The structure of material as follows.

Styrene – butadiene rubber (SBR 1502). With styrene content 23.5%. Moony viscosity at 100 C^0 - 50 C^0, specific gravity 0.94, ash content 1 %, there are two type of E-SBR in the market. One of depolymerization can occur at high temoerature. another type of E-SBR , could rubber is using are initiator to lower the polymerization temperature to 5 C^0 and the chain modifier is applied to control the molecular weight , chemical formula of SBR as follows [17]

(CH2 – CH = CH – CH_2 – CH_2 – CH) n



a. Lead oxide : (PbO) semiconductor manoparticles were prepared by chemical synthesis method , the molecular weight is 223.2 , density 9.53gm/cm^2 , melting point 888 C^0 [18]
b. Sulfur : pale yellow powder of sulfur slement , purity 99% , melting point 112 C^0 , specific gravity 2.04-2.06 [19]
c. Zinc oxide : fine powder , purity 99% , specific gravity 5.6
d. Steric acid : melting point 67-69 C^0 , specific gravity 0.838

Table 1. Chemical composition for rubber recipe

Compounding ingredients	*pphr*
Rubber SBR (Babylon Factory Tire Manufacturing Iraq)	100
Zinc oxide	3
Satiric acid	1.5
TMTD	0.6
Sulfur	2

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We take 100 g from these compounds and mix with PbO as far as preparation as follows.

PbO %	*Compound*
0	100
20	80
40	60
60	40
80	20

This mixture transforms to solid state for one hour and the mixture was used as fixed length and thickness (6cm length and 2cm thickness).

Ultrasonic measurements were made by pulse technique of ultrasonic concrete tester (CSI) type (cc – 4 as shown in Figure (2)) velocity of sound instrument with fixed frequency 26 kHz.

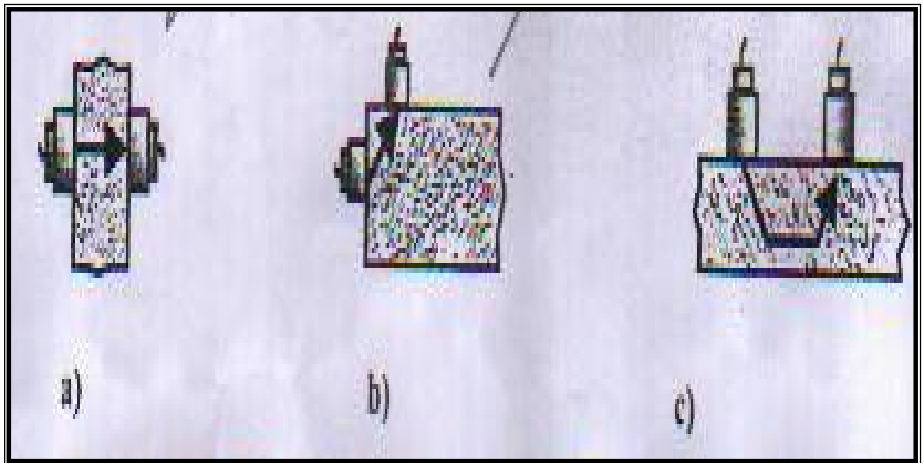

Figure 1. Ultrasonic pulse velocity method:
a) Direct method b) semi-direct method c) indirect (surface) method

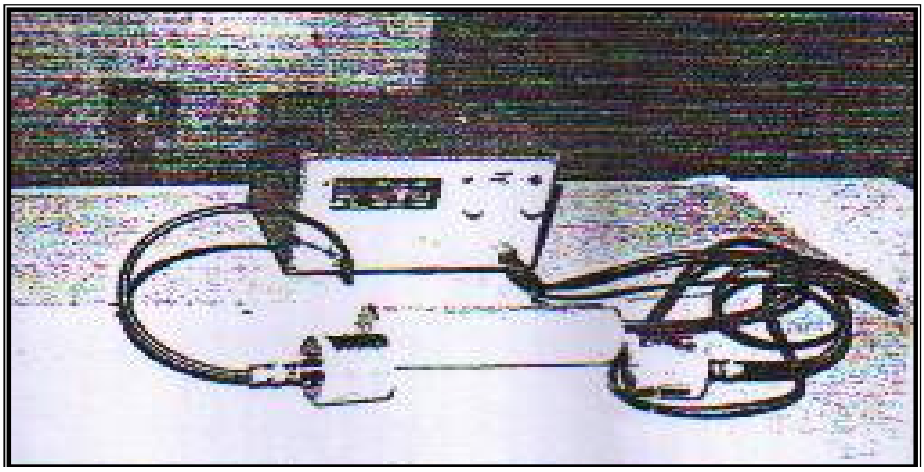

Figure 2. Ultrasonic pulse transit time test

RESULTS

Results show that all these properties were decreasing with increasing concentration of PbO in the composite mixture except acoustic impedence .

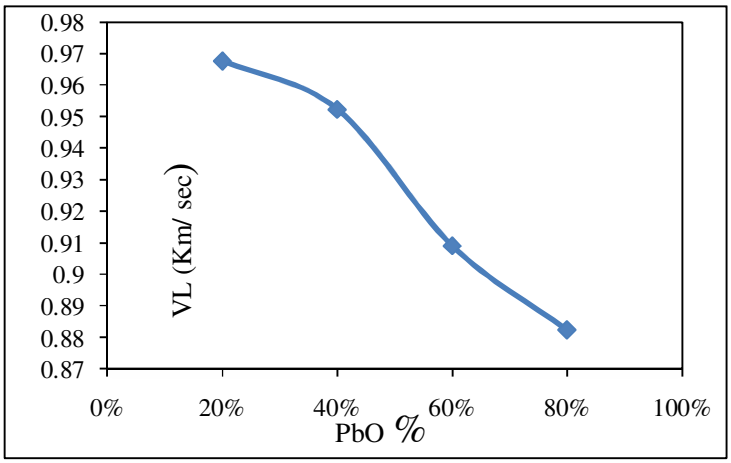

Figure 3. Longitudinal velocity (V_L) due to PbO concentration

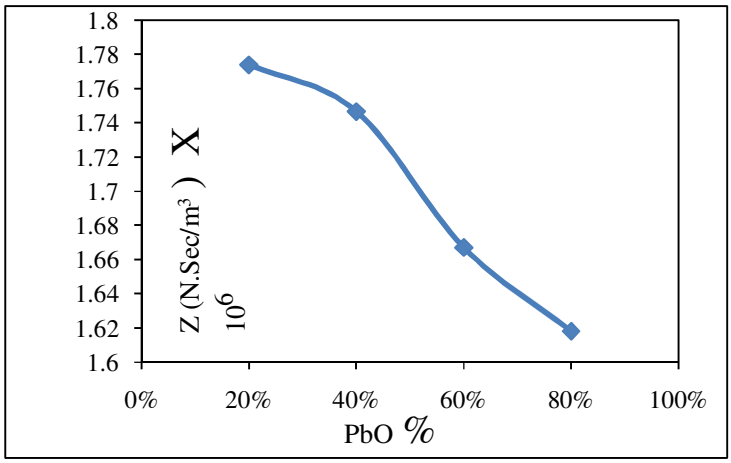

Figure 4. Acoustic Impedance (Z) due to PbO concentration

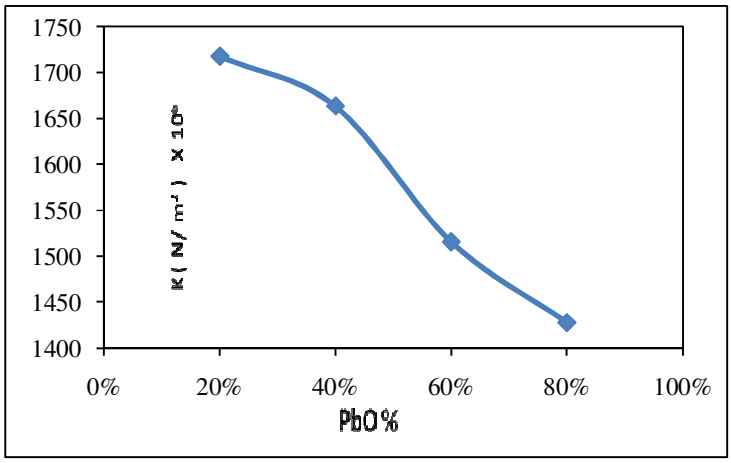

Figure 5. Bulk modulus (K) due to PbO concentration

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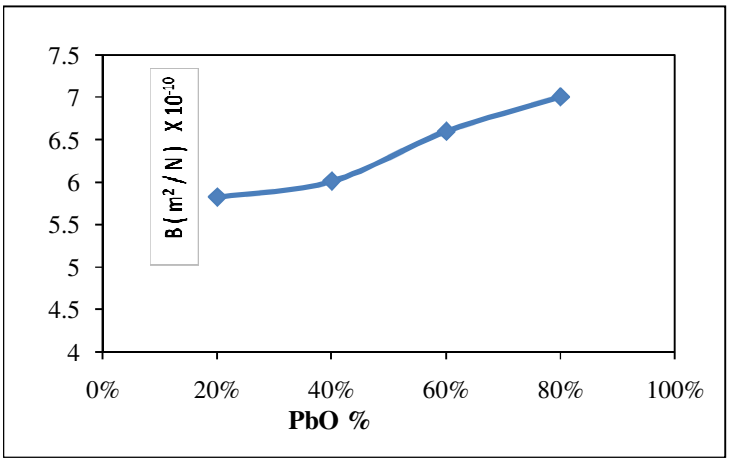

Figure 6. Compressibility (B) due to PbO concentration

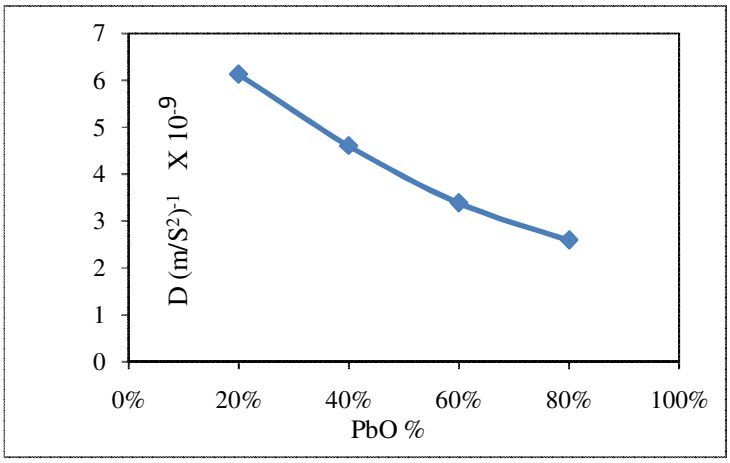

Figure 7. Relaxation amplitude (D) due to PbO concentration

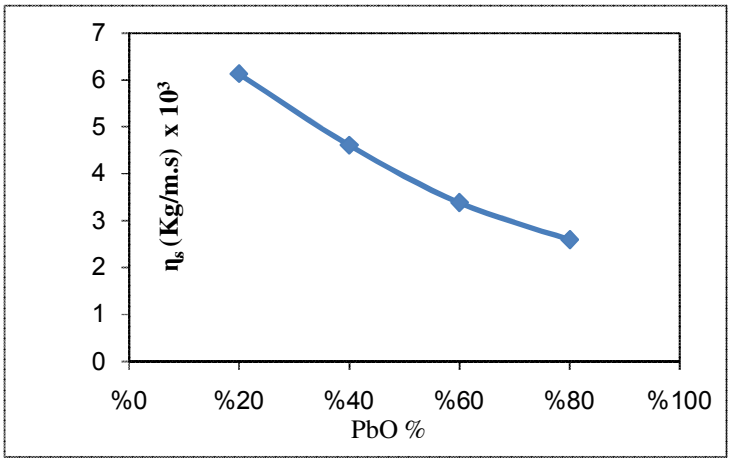

Figure. 8. Share viscosity (η_S) due to PbO concentration

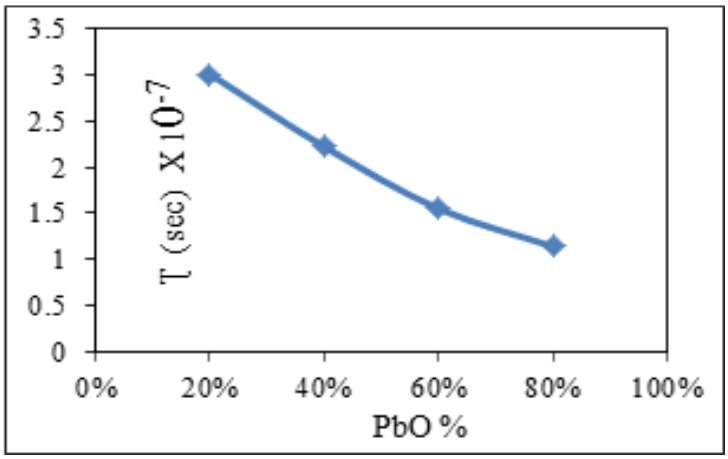

Figure 9. Relaxation time (τ) due to PbO concentration

CONCLUSION

When the thickness of the composite and the frequency of ultrasonic pulse are fixed the variation of the velocity of ultrasonic, Relaxaction amptitude , shar viscosity , bulk modulus , compressibility depends on the concentration of PbO ,which show that all these properties were decreasing with increasing the concentration of PbO in the composite of this mixture, composite is a good reflected medium for ultrasound wave and can applied in different surfaces to be reflected and scattered these wave and it is very important to use composite with PbO concentration as a coat to protect who was working in the application of x-ray field , and this is the best way to protect from Radiation , This which is reached by Mahammad H. AL-Maamori , Oday H. AL-Bodairy and Nehad A. Saleh (Transmission properties X-Rays for SBR) [20] .

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