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Rheological and Electrical Behavior of Styrene - Butadine Rubber (S B R)

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Abstract

Styrene – Butadiene Rubber (SBR) with different concentration has been dissolved in toluene
(0.1 – 0.6) g / ml .
The Rheological and Electrical properties were investigated which have shown that the Shear viscosity , relative viscosity , Specific viscosity , and density were affected by increasing their
values as the concentration increase , while the opposite behavior was shown in reduced viscosity
The capacitance and dielectric constant increase as the percentage of concentration increase .

Introduction

Styrene – butadiene rubber is considered as one of the most versatile copolymer rubber compound
in the world due to its unique properties such as, it has good abrasion resistance , better ozone
resistance , weather ability than natural rubber high fracture elongation and low elastic modulus
SBR is known as a non polar rubber , and dose not easily break down [1—3] .
This composite is widely used in car tires where it maybe blend with natural rubber , belt , footwear , sporting goods , moulded and extruded products , sheetings , membranes , wires and
Cables [4 – 8] SBR can be used with conducting filler filled composite which an important

materials suitable for devices [9 – 11] Antonio et al . has studied the effect of solvent absorption
On the electrical properties of SBR / carbon black (C B) for chemical sensor [12] .
This application has been extended to nanotechnology when SBR was used with multi wall
carbon nanotubes (MWCNTs) , to enhance , this conducting elastomeric composite which was
greatly increased by the addition of (MWCNTs) [13] .
In this work we record Some physical properties of this composite and the effect of concentration
of SBR on these parameters .

Experimental procedures

Styrene butadiene rubber composite Supplied from the general company for the manufacture of
Batteries , were dissolve in toluene and has been prepared by the following concentrations
(0.1 – 0.6) g / ml .
The shear viscosity of SBR was measured by (Ostwold viscometer) for all the samples under
Study using the following relation [14]

$\eta_s = \eta_o \times (t_s \rho_s / t_o \rho_o)$ poise …… (1)

Where t_s , t_o Time of the flow quantity of polymeric solution and the Solvent in a certain
length respectively .

ρ_s , ρ_o The density of the polymeric solution and the solvent respectively .
η_s . η_o The shear viscosity of the polymeric solution and the solvent measured by poise
unit .

The relative viscosity could be calculated by the relation :

$\eta_{rel} = \eta_s / \eta_o = t_s \rho_s / t_o \rho_o$ ..... (2)

where the reduced viscosity was calculated from the relation

$\eta_{red} = [(\eta_s / \eta_o) -- 1] / C$ ..... (3)

where C is the concentration of solvent , while the Specific viscosity could be calculated from

$\eta_{sp} = (\eta_s / \eta_o) -- 1 = \eta_{red} -- 1$ ..... (4)

so we can write η_{red} in terms of η_{sp}

$\eta_{red} = \eta_{sp} / C$ ..... (5)

The refractive index of the samples were measured using (Abbe refractometer) .
Measurement of capacitance (C_D) of SBR with different concentration at room temperature
where made by (Digital CM 860 A^+) .
The dielectric constant (D) was calculated from the measured capacitance of the Sample for
Different concentration utilizing the following relation : [15]

$D = C_D / C_o$ ..... (6)

Where C_o is the capacitance in vacuum .

Result and discussion

Rheological calculation
1. Density
Fig (1) show the relation between density and concentration . It is obviously seen that the density

Increase as the concentration increase this behavior could be attributed to the increase of mass solution and the swelling occurs in the polymer molecules as a result of it dissolves in the solvent. As the density increase the refractive index is also increases with the increasing of concentration as shown in Fig (2) . [17]

2 . Viscosity

Shear viscosity was calculated according to equation (1) .

Fig (3) shows the shear viscosity as a function of concentration . We can notice that the viscosity increases with increasing concentration . This might be due to the formation of polymeric chain of big molecules as a result of increase the concentration of polymer in solution and thus

Cause an increase in the rotational and transitional friction force between polymer and solvent[16]

The relative viscosity and the Specific viscosity was calculated using the equations (2) and (4)

respectively .

Figs (4) , (5) show the dependence of relative viscosity and the Specific viscosity on concentration . We can see from these figures that these curves have the same trend as in the

shear viscosity .

Fig (6) shows the variation of reduced viscosity with concentration , it clearly seen that η_{red}

increase with the decrease of concentration this behavior could be attributed to the extended of

polymer chain as a result of strong repulsion between the similar charges [18]] .

Fig(7) and fig (8) shows the variation of capacitance and dielectric constant versus concentration

respectively .

Both of them increases as the concentration increasing , this might be attributed to the increase

occurring in the number of polarized molecules as the concentration increased .[19]

Conclusion

SBR with different concentration has been studied , the result shows that the shear viscosity , relative viscosity and the specific viscosity have the same trend , while the reduced viscosity show behavior contrary to the rest . The capacitance and dielectric constant increase as the concentration increased.

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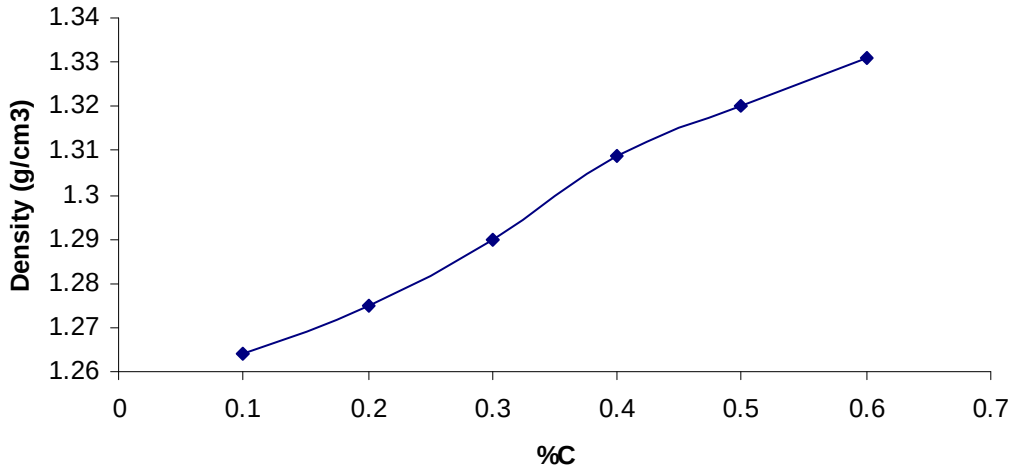

Fig. (1) shows the relation between the density and concentration

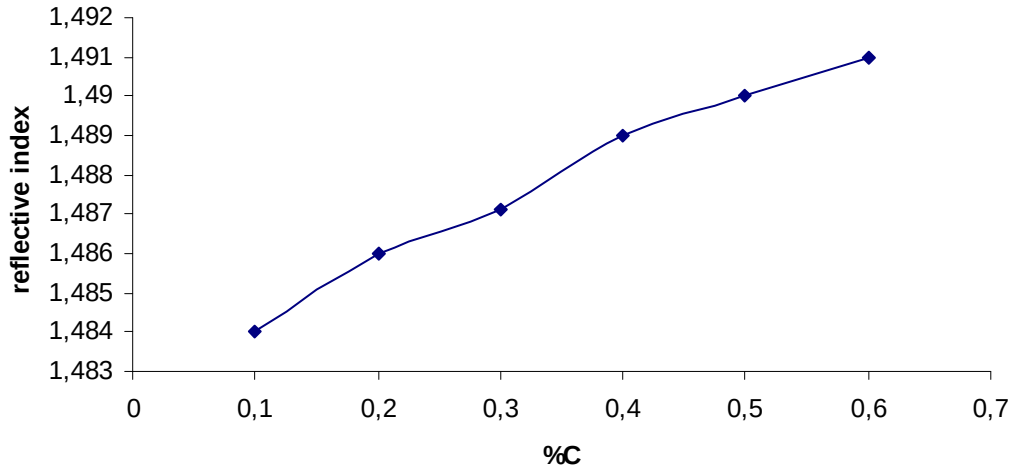

Fig. (2) shows the relation between the refractive index and concentration

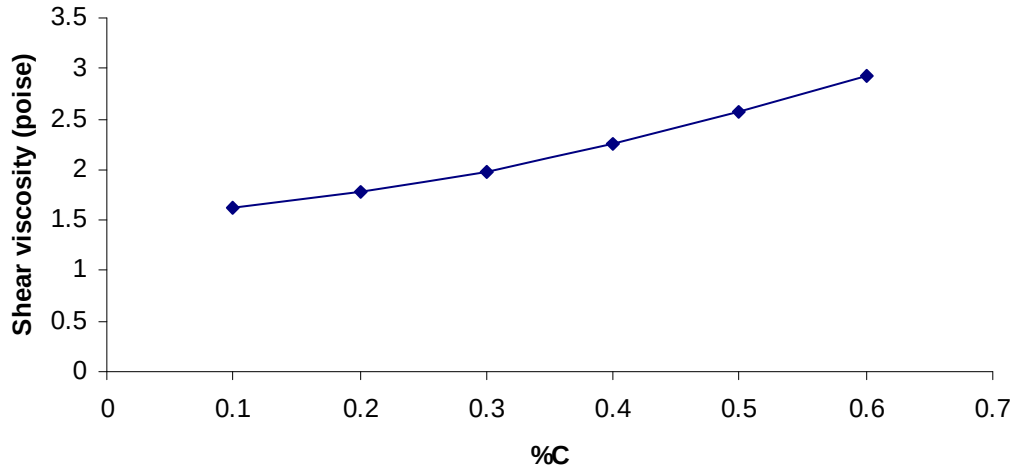

Fig. (3) shows the relation between the shear viscosity and concentration

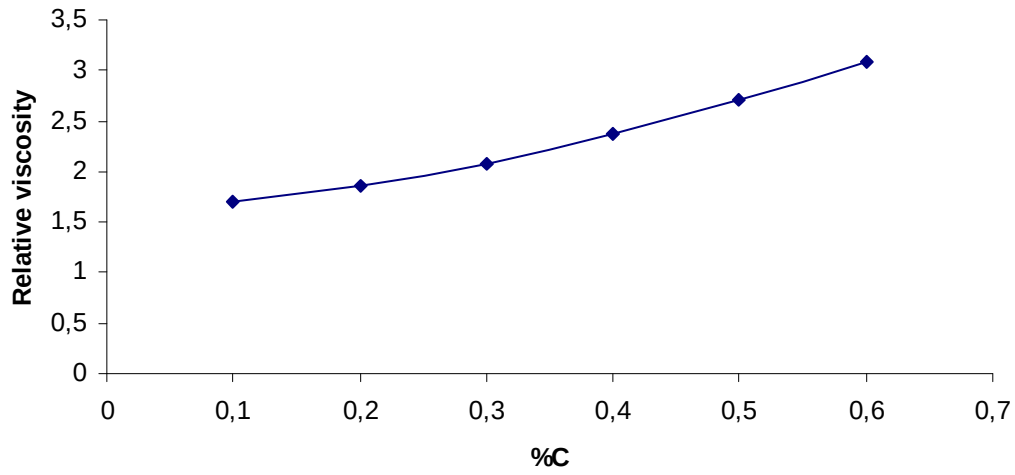

Fig. (4) shows the relation between the relative viscosity and concentration

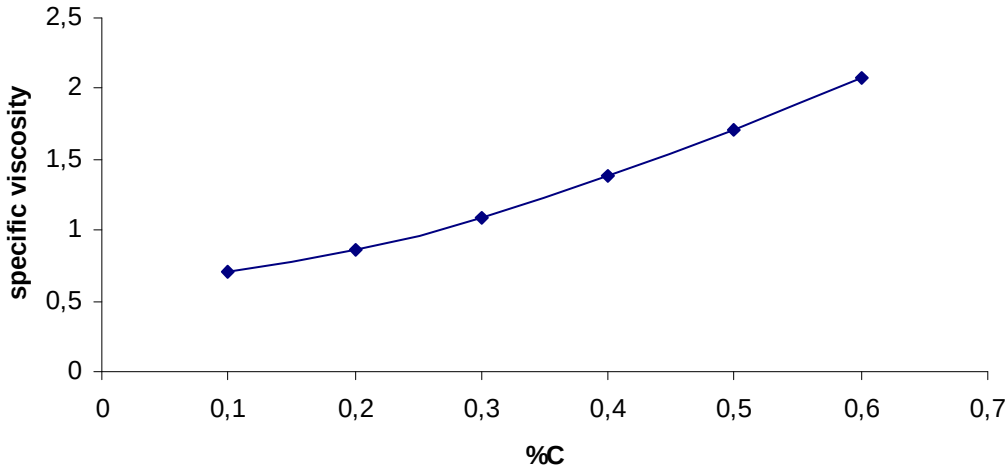

Fig. (5) shows the relation between the specific viscosity and concentration

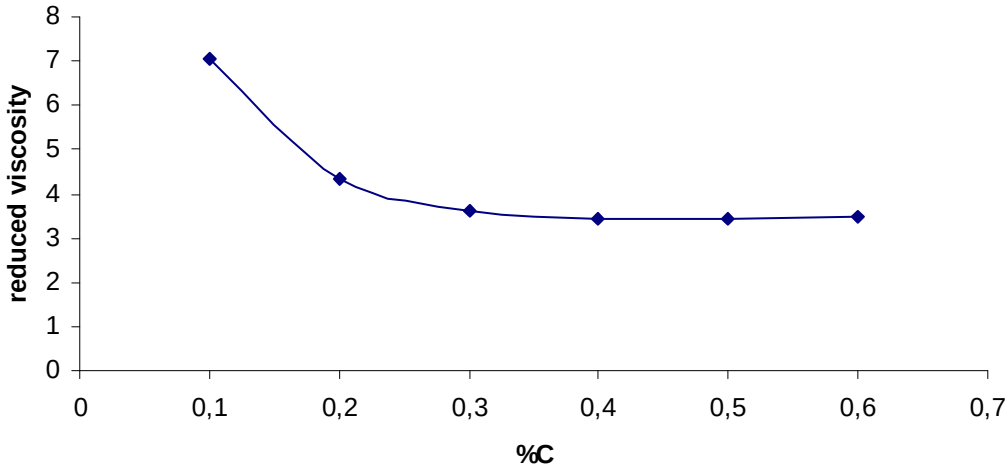

Fig. (6) shows the relation between the reduced viscosity and concentration

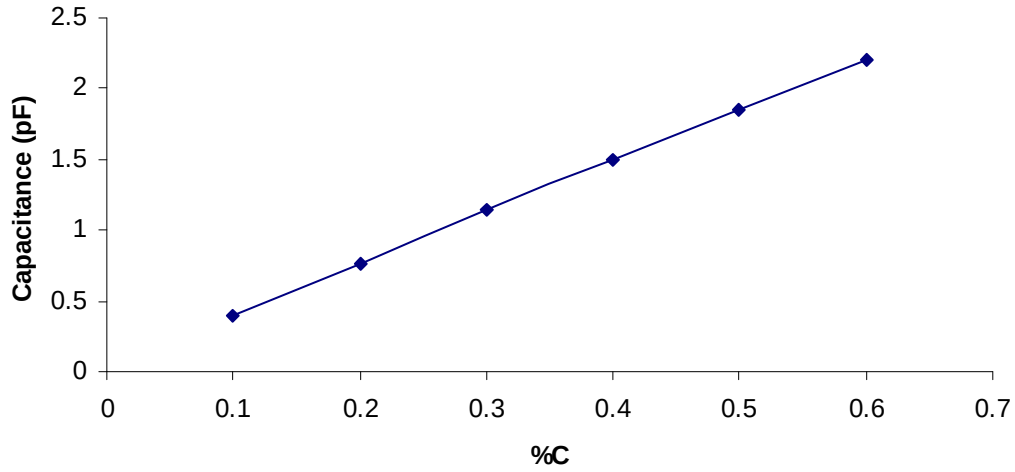

Fig. (7) shows the relation between the capacitance and concentration

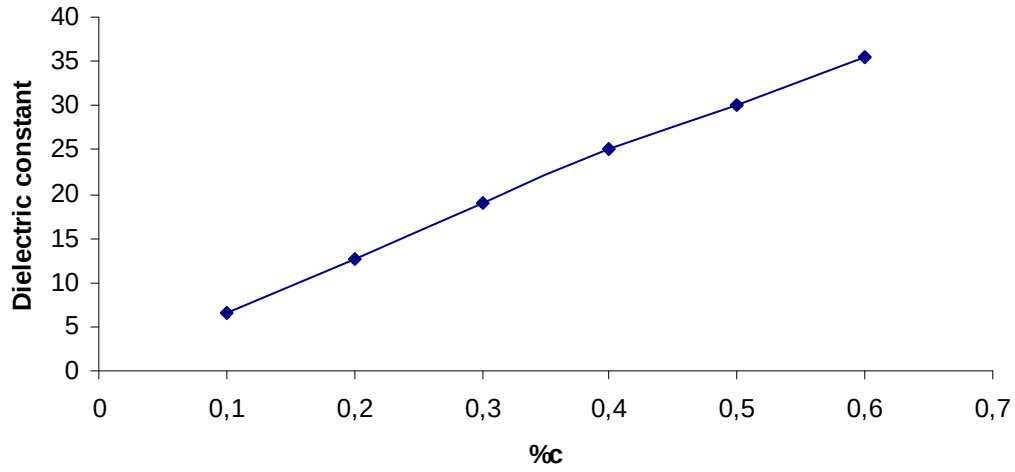

Fig. (8) shows the relation between the dielectric constant and concentration