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Research Article

Rheological Properties of NBR-PVC Blend

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Abstract

Effects of reinforcing by (30,50,70 pphr) PVC particles on rheological properties of Nitril butadiene rubber were studied. Oscillating disk rheometer was used to measure scorch time, cure time and viscosity by specifying the behaviour of master batch through scorch time. The obtained results shown that the rheological properties of Nitril butadiene rubber will increase with PVC addition.

Keywords: *Rheological properties; PVC particles; Nitril butadiene rubber*

Introduction

High elastic polymer composites are very important in the applications of rubber industries, such as tires, transportation belts, pipes for fluids and oil transmission, damping and support parts in the mobiles as well as diaphragm as mentioned above. Rubber composite materials with different type of rubber are used in dampers and supports application [1]. Fillers is one of the major additives used in rubber compound and has marked effect and influence on rubber materials. Filler functions to modify the physical and, to some extent, the chemical properties of vulcanization. In rubber industry, filters that are commonly in tuse are carbon black, china clay and calcium carbonate [2]. For engineering applications, not only mechanical properties, but also dynamic mechanical properties at a sensible range of temperature and rheological properties, must be taken into account [3]. Rheological properties, which have important implications in many and diverse applications often, an additive is used to impart the desired flow behaviour. Among these, organoclay products, formed by the reaction of organic cations with smectite clays, are the most widely used additives for solvent-based coatings [4].

The often used cation, usually a quaternary ammonium salt, influences the performance of the resultant organoclay. Criteria to consider in the choice of a cation are molecular size, compatibility with the fluid in which the organoclay is to be used, stability and reactivity [5]. Applications of rheology are important in many areas of industries involving metal, plastic, and many other materials [6]. The results from rheological investigations provide the mathematical description of the viscoelasticity behaviour of matter. An understanding of the rheology of a material is important in the processing of composites, whether the task is designing an injection molded part or determining the cure cycle for a prepregs [7]. For many years, rheology has been used as semi-quantitative tools in polymer science and engineering [8]. The relationship between the structure and rheology of a polymer is of practical interest for two reasons: firstly, rheological properties are very sensitive to certain aspect of structure and they are simpler to use than analytical methods, such as nuclear magnetic resonance [9]. Secondly, it is the rheological properties that govern the flow behaviour of polymers when they are processed in the mol-ten state. Considering the structures of polymers by means of the size and shape of molecules and the distribution of these characteristics among the molecules, structure formation and controlled assembly are the focus of joint simulations and various experiments [10].

Experiment

Materials

There are two types of materials employed in this study: Nitril butadiene rubber (NBR), Poly vinyl chloride (PVC).

Mixing process

Defined in ASTM D 1566 as a homogeneous mixture of rubber mixing process for materials used in rubber batch is done by the laboratory milling type (Comerio Ercole Busto Avsizo), which contains a double rollers with diameter (150 mm) and length (300 mm) and roller speed is (24 rpm) [5]. Table.1 represents the materials content in the master batch.

Materials	Content pphr %
PVC	0, 30, 50, 70
NBR	30, 50, 70, 100
Carbon black 660	40
MBTS	0.7
Sulfur	1.5
Zinc oxide	3
Stearic acid	1

Samples Preparing

Samples were prepared as slices of 6 mm in thickness and were divided as discs of 40 mm in diameter and 6 mm in thickness by using hydraulic mould in order to vulcanize them and study their cure time and scorch time.

Measuring of Rheological Properties

The test is carried out according to (ASTM D1646-68) by using oscillating disc Rheometer. The samples were held upper and lower jaws clutch under 3.5 bar pressure and 185°C for 6 min .

Figure 1: *Oscillating disc Rheometer.*

Results and Discussion

Figure 2 shows the relation between the scorch time (This period of time before vulcanization starts is generally referred to as scorch time) and the PVC percent in the recipe, we notice that the scorch time increases with the increase in PVC percent, , this is due to the interference between PVC and NBR chains which inhibit vulcanization by sulphur and such increasing in scorch time will give a chance for product forming before vulcanization which results in decrease in energy required for recipe forming.

Figure 3 shows the relation between the cure time and the PVC percent in the recipe, it is noticed that increase in cure time causes increase in PVC percent this is due to the increasing of scorch time and this improvement in the vulcanization time gives a chance for the recipe to take the required time to complete forming before any partial vulcanization takes place which results in a defect in the product [11].

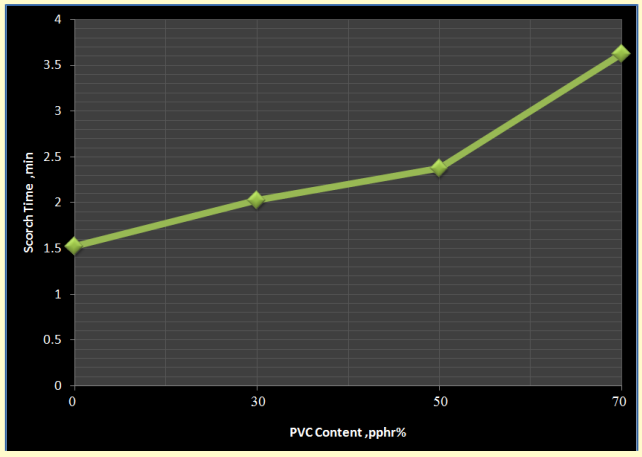

Figure 2: *Relationship between scorch time and PVC content.*

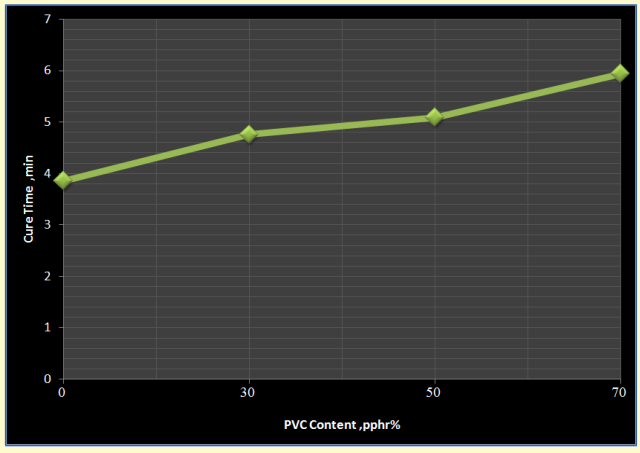

Figure 3: *Relationship between cure time and PVC content.*

Figure 4 represents the relationship between viscosity and PVC content. By using REO-METER apparatus, the viscosity of NBR/PVC blend increases exponentially with PVC percentage in the blend because of the PVC restricts the molecular chains movement of NBR by forming C-CL bonds with NBR, therefore the entanglements increased and the flexibility decreased, for these reasons the Viscosity increased [5].

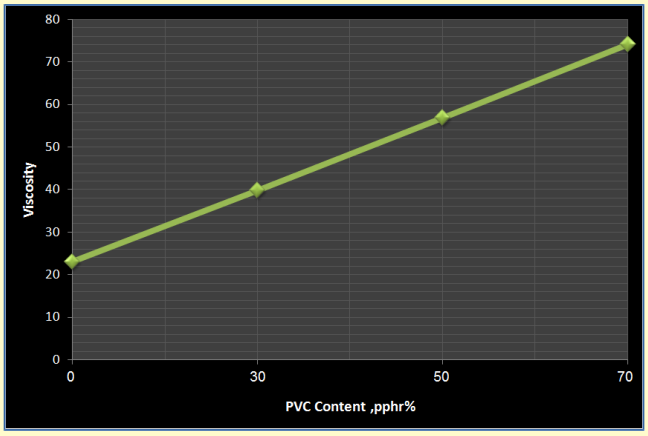

Figure 4: *Relationship between Viscosity and PVC content.*

Conclusion

From the results obtained that when adding PVC the resultants blends will be stiffer. Increasing scorch and cure time after adding PVC powder and this thing will continue with increased powder percentage. Viscosity of this blend increases with increasing PVC content due to PVC restrict the movement of NBR molecular chains.

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