

Effect of Addition Reclaimed Rubber on Some Mechanical Properties of Unsaturated Polyester

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Abstract:

The aim of this research is the use of Reclaimed Rubber as Reinforcement Material by simple method. The composite Material was prepared by adding different percent from the powder of Reclaimed Rubber (0 – 25) % to study the effect of this material on some properties of polyester. The tests are used in this research (hardness, impact force, bending strength, tensile strength, modulus and strain). The results have showed that decreased hardness (from 34.9 to 28.9) shoreD, and increased impact force (from 0.2 to 0.79) Joule, and also increase bending strength (from 60.1 to 120.7) Mpa, increase tensile strength (from 27.052 to 32.5) Mpa, raised modulus (from 33.73 to 77.38) Mpa and decrease strain (from 0.804 to 0.42)%.

Key words: entanglements, flexibility, tensile strength, modulus

الخلاصة

ان الهدف من هذا البحث هو استخدام مادة الركليم (المطاط المعاد التدوير) كمادة مقوية (Reinforcement Material) وبطريقة مبسطة، وقد تم تحضير مادة مركبة مكونة من البوليمر استر كمادة اساس (Matrix Material) باضافة نسب مختلفة من الركليم % (0 - 25) لدراسة تاثير تلك المادة على بعض خواص البوليمر استر، والفحوصات التي تم استخدامها في هذا البحث (الصلادة، وقوة الصدم، ومقاومة الانحناء، ومقاومة الشد، ومعامل المرونة والانفعال). وقد أظهرت النتائج حصول انخفاض في الصلادة shoreD (من 34.9 إلى 28.9) وزيادة في قوة الصدم (من 0.2 إلى 0.79) Joule، وحصول زيادة في مقاومة الانحناء (من 60.1 إلى 120.7) Mpa، وزيادة في مقاومة الشد (من 27.052 إلى 32.5) Mpa ومعامل المرونة (من 0.804 إلى 0.42)%. وانخفاض في الانفعال % (من 0.804 إلى 0.42).

الكلمات المفتاحية: التشابكات الفيزيائية، المرونة الجزيئية، مقاومة الشد، معامل المرونة

Introduction

Unsaturated polyester resins are one of the most important thermoset material used in composites industry for the preparation of molding compounds, laminates, coatings, and adhesives as having low cost and good mechanical properties (Andjelkovic *et. al.*,2009;Shenoy and Melo,2007). Thermoset resin is defined as a plastic material which is initially a liquid monomer or oligomers or a pre-polymer, which is cured by either application of heat or catalyst to become an infusible and insoluble material (Sinha,2000).

Unsaturated polyester is a viscous transparent liquid at room temperature and its one of solidified polymers by heating and its widely used polymer in both industrial and civil world and it's characterized by low cost, hardness, high resistance compare to its weight and it is used in the manufacture of mechanical parts, pipes and storage tanks.(Kuang and Richardson ,2007;Osman *et. al.*,2012)

The crosslinking reaction between unsaturated polyester resin and styrene allows one polymer chain to connect with other polymer chains and to produce a three dimensional networks, which convert the resin system from a viscous liquid into hard, thermoset solid (Skrifvars,2000). Styrene acts both as a crosslinking agent and as a viscosity reducer so that the resin can be processed. (Lim *et. al.*,2006).

Reclaiming is a procedure in which the scrap tire rubber or vulcanized rubber waste is converted, using mechanical and thermal energy and chemicals, into a state in which it can be mixed, processed, and vulcanized again. The principle of the process is devulcanization (James *et. al.*,2005), (Franta,1989). In devulcanization, it is assumed that the cleavage of intermolecular bonds of the chemical network, such as

carbon–sulfur and/or sulfur–sulfur bonds, takes place, with further shortening of the chains occurring (Rader,1995).

Many different reclaiming processes (Myhre and MacKillop,2002) have been applied through the years in an attempt to solve the problem of rubber recycling. Generally, ground rubber scrap is, in most cases, the feedstock for the devulcanization step. Warner (Warner,1994) and recently Adhikari et al. (Adhikari and Maiti ,2000) and Isayev (Isayev ,2001) presented reviews of the existing literature that is relevant to various methods of devulcanization. The pan process, digester process (either wet or dry), and mechanical or reclaimator processes are currently the common processes used for reclaiming.(James *et. al.*,2005)

Different types of reclaimed rubber are in use and the most important ones are Whole Tyre Reclaim (WTR) , Minimum Staining Reclaim (MSR), Draband Coloured Reclaims,Butyl Reclaim. (Nelson,2003)

Experimental part

A composite material was prepared which consisted of unsaturated polyester polymer as the matrix and particles of reclaimed rubber as the reinforcement material (particles size 600 mesh), hardener was added in percentage of 2%, and the percentage of reinforcement material to the matrix shown in the table (1).

Table (1) shows the percentage of reinforcement material verses the matrix (unsaturated polyester)

The percentage of polyester%	The percentage of reclaimed%
100	0
95	5
90	10
85	15
80	20
75	25

Samples Preparation for (hardness ,impact, Bending and Tensile) Test

1. A mold used in samples pouring has dimensions according to table no.(2)
2. The mold was thoroughly lubricated with Vaseline.
3. The samples poured in the molds as the percentage in table no. (1), the samples left in molds to 24 hours.
4. The samples were taken out of the molds and placed in the oven at 100°C for one hour.

Table (2) shows the name of devise and the dimensions of the samples for all the tests which are used in this research

Type of test	Name of devise	Dimensions of sample (length×width×thickness)mm
impact test	impact tester – charpy-ASTM D256	(55×10×10)mm.
hardness test	shore D	(55×10×10)mm.
Bending test	Microcomputer controlled electronic universal testing machine- ASTM D790	(150 ×10×10)mm
Tensile Test	Microcomputer controlled electronic universal testing machine- ASTM D638	(163×19×3) mm

The result and discussion

figure (1) shows increase the tensile strength with increasing of added reclaim due to reclaim is vulcanized rubber that increases cohesive between polymer chains and also being considered a filler material that increases the toughness of material, from this process we concluded that reclaim with polyester will be a highly cohesive state and the proof is there was no crack occurred nor there was a drop in the tensile strength and this is clear from the drop in strain values from figure (2) where the decline is gradual and there is no sudden drop.

figure (3) it is obvious the modulus increase proportionally but in a non- linear from as its with strain due to the interaction forces among reclaim granules with polyester where the adhesive is very strong (the surface of reclaim granules is rough which increases the wetability between them) which increase physical entanglement (Vander Waals forces) among the rubber chains leading to increase tensile strength and modulus where as a decline in strain values

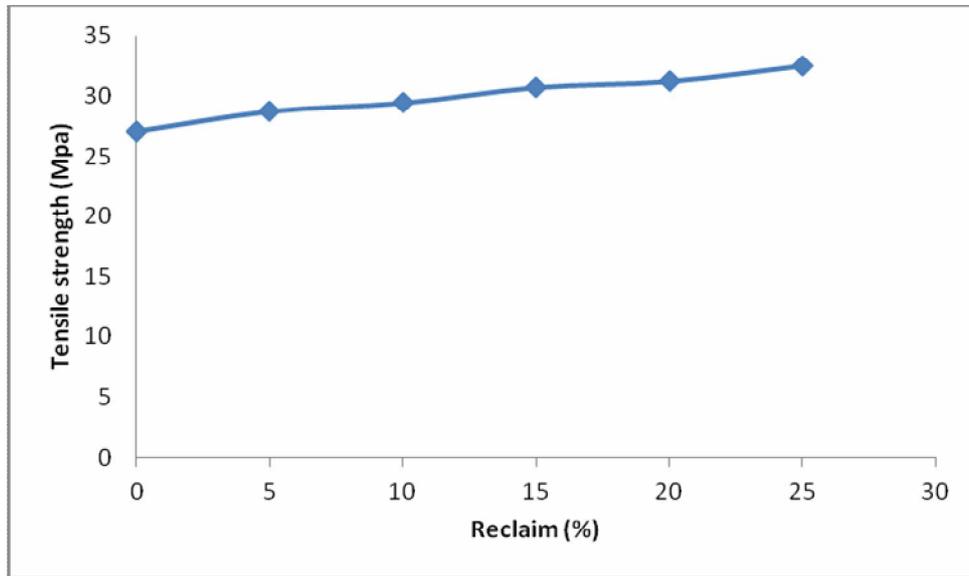


Figure (1) shows the relationship between tensile strength and the percentage of added reclaim

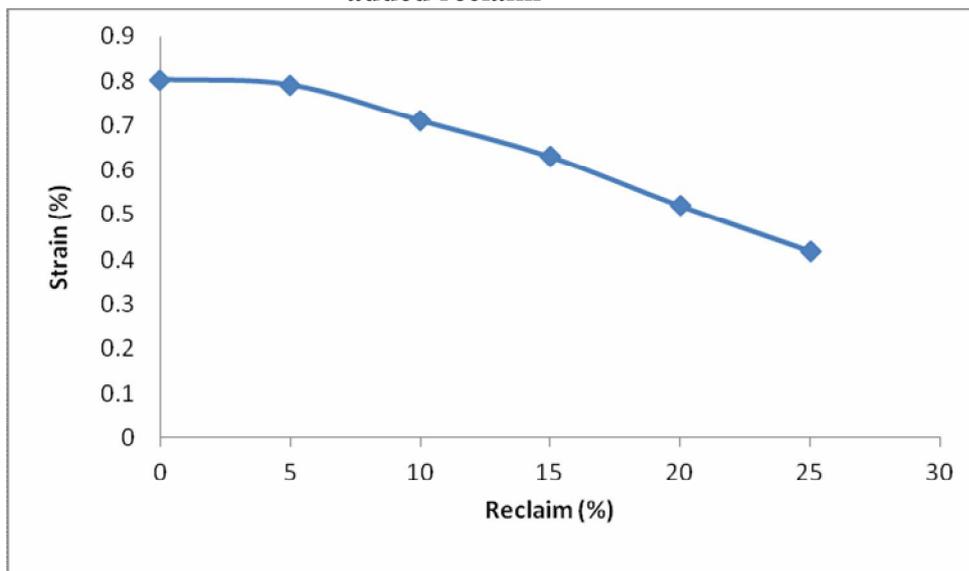


Figure (2) shows the relationship between the strain and the percentage of added reclaim

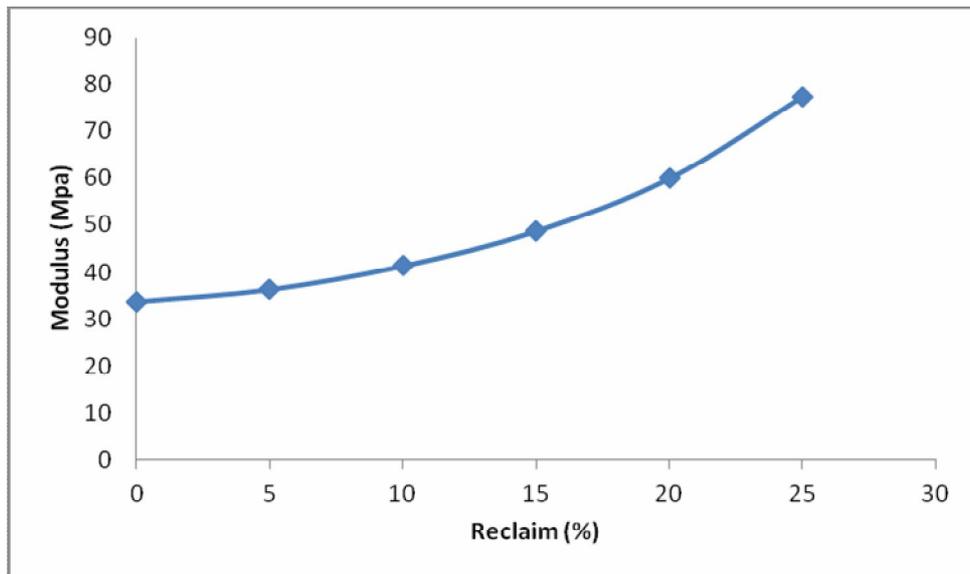


Figure (3) shows the relationship between the modulus and the percentage of added reclaim

figure (4) shows that there is increased in bending strength value with increasing the percentage of added reclaim due to the interaction forces and entanglements among reclaim granules which its surface is winding and rough leading to increase the interaction forces and adhesion with polymer chains causing an increasing in bending strength which agree with result of tensile strength and modulus

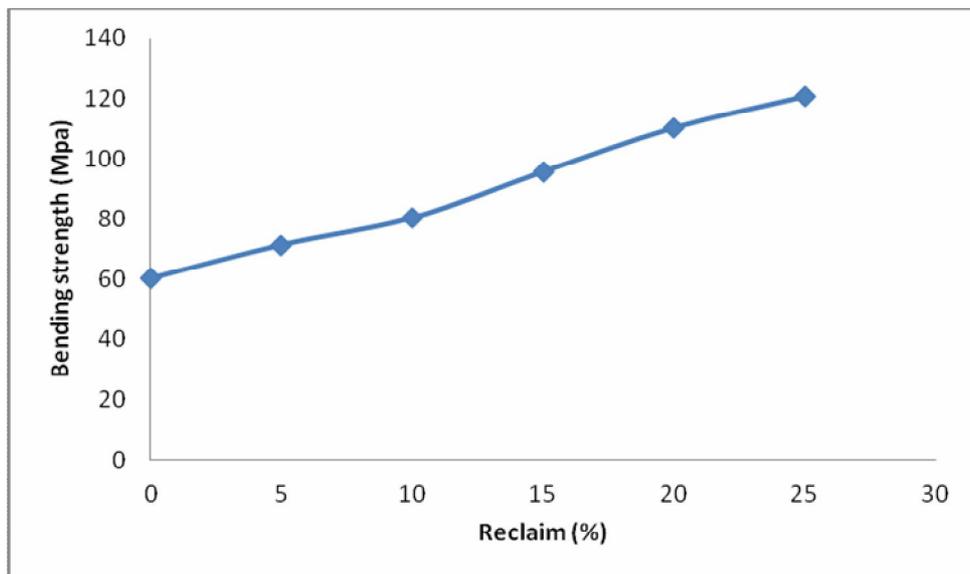


Figure (4) shows the relationship between the bending strength and the percentage of added reclaim

figure (5) shows that there is increased in impact force with increasing the percentage of added reclaim and this is considered normal because the bending strength and modulus (has a good toughness) increased and because reclaim granules have mechanical characteristics which is high flexibility therefore the impact force increased

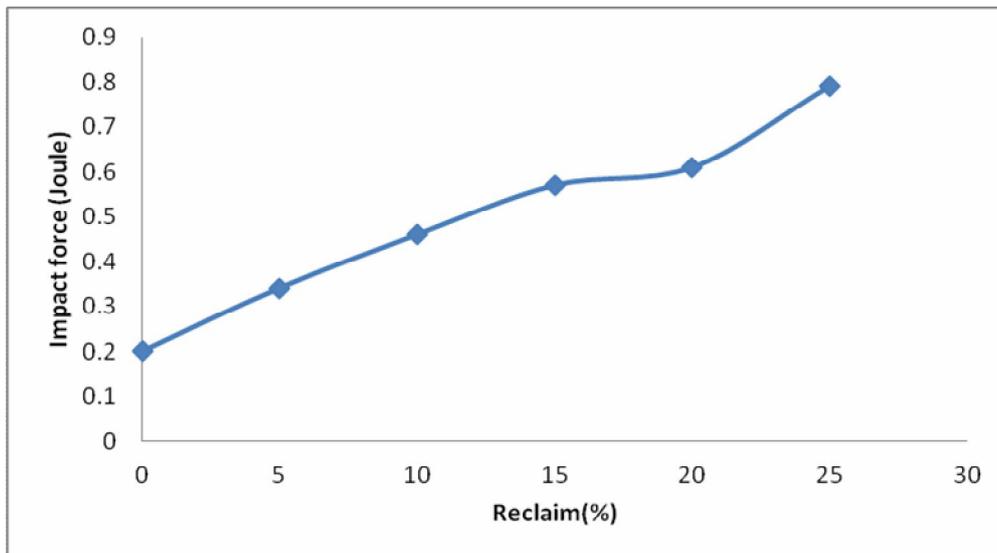


Figure (5) shows the relationship between the impact force and the percentage of added reclaim

figure (6) shows that there is decreased in hardness values with increasing the percentage of added reclaims due to reclaim is being a highly flexible material with hardness lower than polyester and this leads to a decline in material resistance to penetration and causing a decline of hardness eventually.

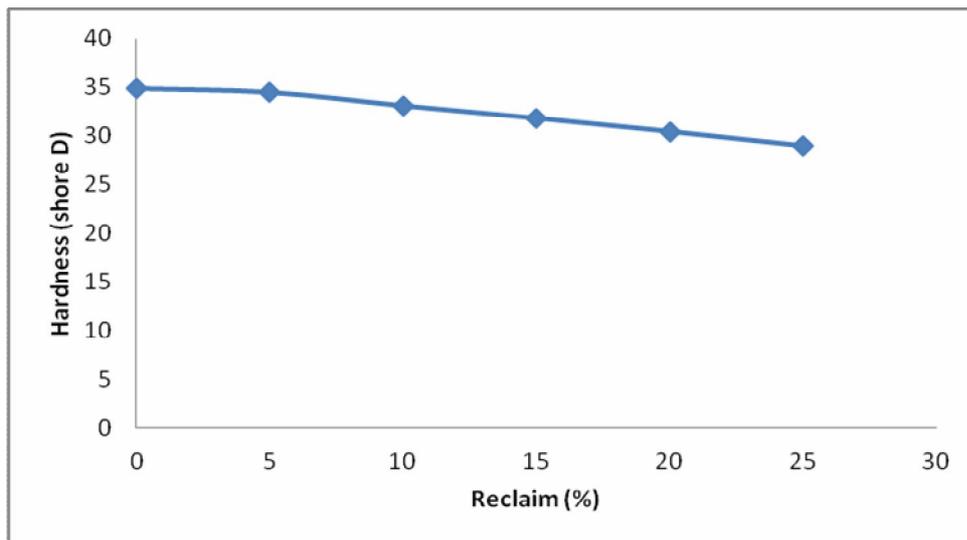


Figure (6) shows the relationship between the hardness and the percentage of added reclaim

Conclusions

1. The Tensile strength and the bending strength rise with increasing the percentage of added reclaim to polyester.
2. The impact force rise with increasing the percentage of added reclaim to polyester.

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