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Studying Some of Mechanical Properties (sawdust/Un Saturated Polyester) Composite in Salt Solution

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Abstract

Commercial sawdust is the most common wood filler used for polyster thermosetting and is produced from graduated particles of different sizes which has in general has a lower aspect ratio than wood and other natural fibers. Wood additives include a mixture of sawdust and short chopped fibers. To study how characteristics of fibers and sawdust influence the mechanical properties of unsaturated polyester composites .Investigations were made by studying the effects of different volumetric fractions from sawdust and fiber fillers (up to limit of 1.4mm), then these results were compared with the properties of sawdust-fiber filled composites immersed for different periods in a salt solution of (2 N) . wood volume fractions {(20, 30, 50) v_f %} selected to be added for un saturated polyester were studied which gave improvement in their selected studied mechanical properties for all reinforced composites -(only impact is decreased)- and particularly at higher values of volume fractions ,were hardness showed an improvement by (15%) , compressive strength gave obvious Improvement by (38%) ,while impact resistance decreased by (16%) with the reinforcement of (50 v_f %) sawdust . The above values were reduced when the items were immersed in asalt solution for (60days).

Keywords: sawdust ,wood fiber, unsaturated polyester, impact resistance ,compression strength ,hardness ,salt solutions.

دراسة بعض الخواص الميكانيكية لمتراكبات (نشارة الخشب /البولي أستر غير المشبع)في المحلول الملحي.

الخلاصة

أن نشارة الخشب التقليدية ،تعد من أكثر الأخشاب التي تستخدم كمالئات للبوليمرات المتصلدة حراريا،يتم أنتاجها بهيئة مزيج متدرج من الحجوم الحبيبية ،وبشكل عام تمتلك نسبة باعية أوطأ من ألياف الخشب والمواد الطبيعية الأخرى ،أن إضافات الخشب تتضمن مزيجا من النشارة والألياف القصيرة المقطعة . ولدراسة تأثير مميزات نشارة وألياف الخشب على الخواص الميكانيكية لمتراكبات البولي أستر ،تم التحقق في تأثير دراسة الكسور الحجمية المختلفة لمالئات من ألياف و نشارة الخشب (ذات حد حبيبي 1,4ملم) على الخواص الميكانيكية لمتراكبات البولي أستر المدعمة ،وبعدها تم مقارنة تلك النتائج مع نتائج لمتراكبات البولي أستر المدعمة بنفس المالئات بعد غمرها لفترات زمنية مختلفة في أوساط ملحية ذات عياريه (2) . تم اختيار كسورا حجميه للمالئات تراوحت بين { (20) , (30) , (50) % } من البوليستر غير المشبع المختار . أوضحت النتائج تطورا واضحا في الخواص الميكانيكية - (ماعدا مقاومة الصدمة) - وبالخصوص عند ارتفاع قيم الكسر ألحجمي حيث حققت الصلادة تطورا بنسبة (15%) , في حين حققت مقاومة الانضغاط تطورا ملحوظا وبنسبة (38%) ،بينما انخفضت مقاومة الصدمة بنسبة (16%) عند التدعيم بنسبة (50) % حجما من نشارة الخشب.أن القيم أعلاه أنخفضت عند الغمر في المحلول الملحي لمدة ستون يوما.

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الكلمات المرشدة : نشارة الخشب،ألياف الخشب،البولي أستر غير المشبع ،مقاومة الصدمة ،مقاومة الانضغاط ،الصلادة ،المحاليل الملحية.

Introduction

Sawdust, along with number of other natural fibers, is being considered as an environmentally friendly alternative of synthetic fibers in fiber-reinforced polymer composites. A common feature of natural fibers is a much higher variability of mechanical properties [1]. The use of natural fibers as additives for plastics has been expanded 50% growth in the use of natural fibers in the plastics industry is forecast [2,3,4]. Natural fibers generally refer to lignocelluloses materials derived from wood or agricultural materials such as kenaf , jute, hemp ,flax ,or other natural resources .Natural fibers are available in many different forms and produce different properties when added to thermoplastics[5,6]. Natural fibers may be used in the form of plastics, fiber bundles, or single fibers, and may act as a filler or reinforcement for plastics [7].

(Osswald and Menges) found sawdust was used as filler for polymer ,which tends to increased the stiffness of composites but did not improve its strength [8].

It is often necessary to include a coupling agent in the composite to ensure a strong bond. A-coupling agent improves the bond between the plastic matrix and the natural fiber by chemical and physical means (Gauthier et.al) [9].

(Yibin et.al), studied the mechanical properties of wood fiber composites under the influence of temperature and humidity, their results indicated more reduction in tensile strength. They believed that because of the thermal mismatch of the aspen fiber and the PP matrix. There are large thermal stresses in the composite from fabrication, temperature/ humidity conditioning, and at the test conditions[10].

Nicole and Robert studied the effect of wood fiber characteristics on mechanical properties of wood polypropylene composites [11].

Manisara and Puriphat studied isotactic poly(propylene) / Sawdust composite containing 30 wt.% of the natural fibers The effect of natural weathering, water immersion, and gamma-ray radiation on mechanical properties of the specimens were studied. By natural weathering, all the tensile properties were improved with the initial increase of the exposure time up to 30 days ,but were decreased afterwards. Similarly, the tensile strength and the Young’s modulus of the composite increased with initial increase in the radiation dosage and decreased afterwards. [12].

Ahmad and Mei studied rubber sawdust filled unsaturated polyester, which was prepared by recycling of PET waste from soft drink bottles, to prepare rubber sawdust /UPR composite. PET wastes were subjected to recycle by glycolysis and depolymerized to its monomer and dimmer. The glycolysed product was used to prepare unsaturated polyester resin. The FTIR analysis has been done on the resin and the glycolysed product. The resin then mixed with rubber sawdust fillers before and after alkali treatment with 10% NaOH. The effect of surface treatment and filler content on the mechanical properties and water absorption of the composite were studied. The tensile fractured surfaces of the composites were studied by Scanning Electron Microscopic (SEM) technique to investigate the interfacial bonding between the matrix and the filler. The results show that the tensile modulus was increased with the increase in filler contents. In addition, the results showed that alkali treatment caused a better adhesion between rubber sawdust and UPR matrix and improved the mechanical properties [13].

The objectives of this study were ***(1)*** investigate the influence of various volume fractions of fillers from sawdust –fiber particles with size (up to 1.4 mm) on the mechanical properties of sawdust composites. , and ***(2)*** studying the variation in mechanical properties of unsaturated polyester filled with sawdust immersed in salt solution after 60 days.

Experimental part:

Materials and procedure:

Jewie wood (sawdust) was screened using designated mesh size to produce specified one distinct (sawdust) particle size samples. The screened Jewie wood with particle size (1.4mm)of (sawdust) was dried and then compounded with (UPS) at (20%, 30%, 50% v_f) by volume, , peroxide methyl ethyl ketone was used as a hardener material in 2% from (UPS) weight **,**The resulting mixtures were poured in a rectangular dies with dimensions (100×10×10) mm. The formed composite materials were compounded at 20% , 30% and 50% by volume (fiber – sawdust/UPS).

Testing:

Impact charpy test was conducted according to ISO -179, compression strength test according to ASTM –(D 695),and shore D hardness ,samples of composite were inspected ,and other groups of samples were immersed in salt solutions with (2N) concentration for a different periods {(10-60,) days}, in order to study the effect of immersion in salt solutions on the mechanical properties .

Results and Discussion:

Effect of (fiber -sawdust) volume fraction

The effect of volume fraction on the mechanical properties of (sawdust) /**(UPS)** composites is shown in fig(1) .

The increment in volume fraction decreases charpy impact strength values from (105Mpa) for unsaturated polyester to (88.5Mpa)for (50%v_f) of (sawdust) /**(UPS)** composites. The decreases in the impact strength is attributed to the poor interface between (sawdust) and **(UPS)**. so the crack propagation occurred at this interface, The sawdust in the unsaturated polyester matrix provides stress concentration, therefore providing sites for crack initiation ,the larger (sawdust) volume fraction ,the larger the stress concentration, along the naturally weak interface of the (sawdust wood) and **(UPS)**, and lowers impact energy [13]. This behavior agrees with the works of (Robert and Rowlands)*[9]*

The effect of increase in volume fraction leads to increased compression strength values from (100 Mpa)for **UPS** to (160 Mpa) for (50% V_f) (sawdust) /**(UPS)** composites ,because of sawdust was used as matrix filler ,which tends to increased stiffness of composites .but does not improve its strength ,fibers increase strength as well as stiffness, because stress is transferred from the matrix to the fiber resulting in stronger composites, this work well agrees with (Osswald) [8] .

The effect of volume fraction of (sawdust) will be increased the shore D Hardness from (82.6) for **(UPS)** to (97) for (50% vf) (sawdust) / **(UPS)** composite. This behavior is attributed to sawdust effect in stiffness increment

Effect of Immersion in Salt Solution on the mechanical properties:

Effect of immersion time in salt solution with (2N) concentration on mechanical properties of (sawdust) / **(UPS)** composite is given in figs. (1), (2), (3). Charpy impact strength ,compression strength ,and shore D hardness were decreased with immersion time.

Impact resistance for **(UPS)** was decreased by (43 %) after immersion for 60 days, this decrease was attributed to weakening effect of salt solution on the bonds of polymer structure ,but for reinforced composite was decreased by (21%) . (17%). (21%) for{(20, 30, 50) % v_f} respectively, this may be attributed to the effect of salt solution which weakens interface between (sawdust) /**(UPS)** composites and increases the crack propagation at this interface ,fig. (2) Illustrates this behavior.

Compression strength for **(UPS)** decreased by (82 %) after immersion for 60 days, but for reinforced composite decreased by (50%). (53 %). (48 %) for {(20, 30, 50) % v_f} respectively, fig. (3) Illustrate this behavior.

Hardness for **(UPS)** decreased by (35 %) after immersion for 60 days, ,but for reinforced composite decreased by (18.3 %) . (18 %). (11 %) for {(20, 30, 50) percentage v_f} respectively, this is attributed to the salt solution effect in weakening of bonds between matrix, fig. (3) Illustrates this behavior .The deterioration behavior in all the selected studied mechanical properties in a good agreement with Ahmad. I. and Mei T.M [13].

Conclusions

1- Adhesion between sawdust and matrix was good

2- Volume fraction represent very important parameter in mechanical properties variation to (sawdust) /**(UPS)** composite.

3- The increase in immersion time in salt solutions decrease the mechanical properties (Impact strength , Compression strength and Hardness)for (sawdust) /**(UPS)** composite.

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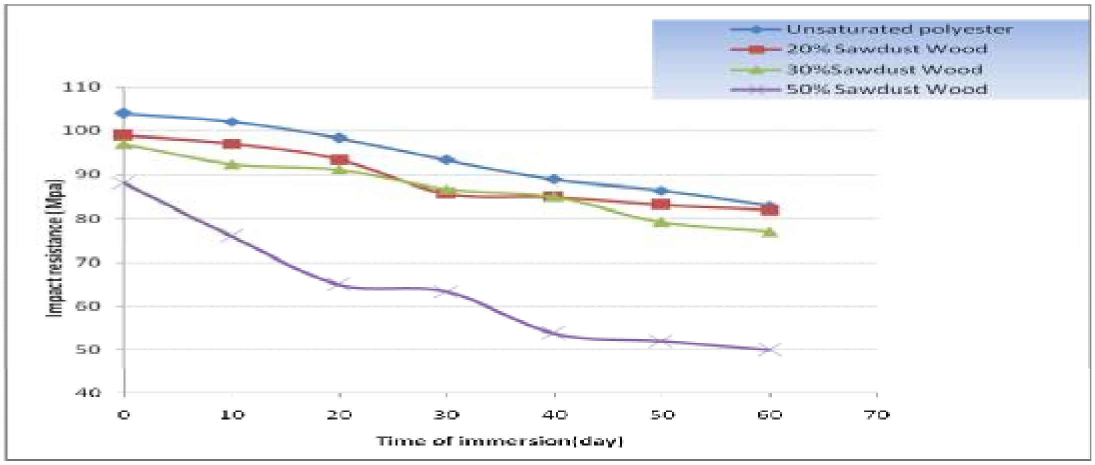

Figure (1) Relation between Impact resistance for (sawdust) filled UPS composite and Time of immersion

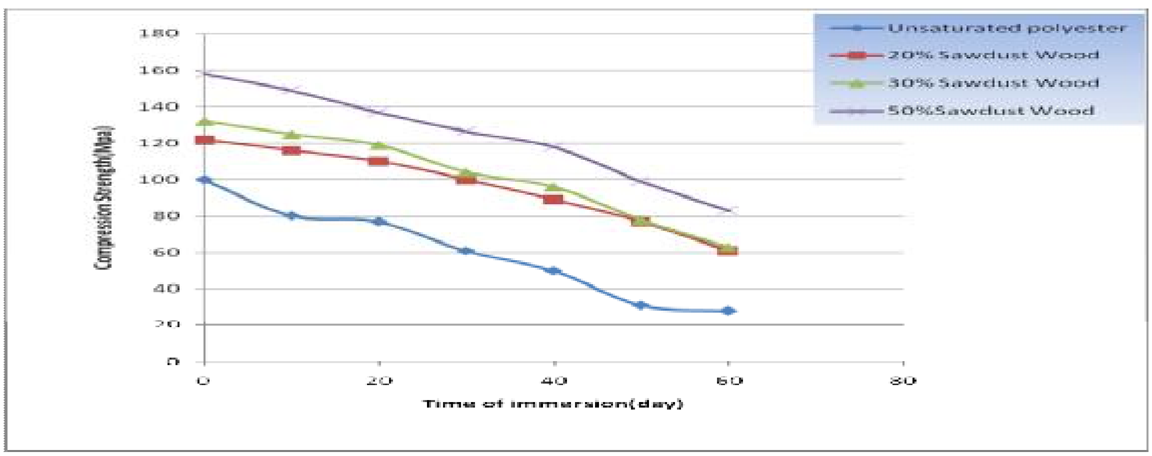

Figure (2) Relation between Compression Strength for (sawdust)/ UPS composite and Time of immersion

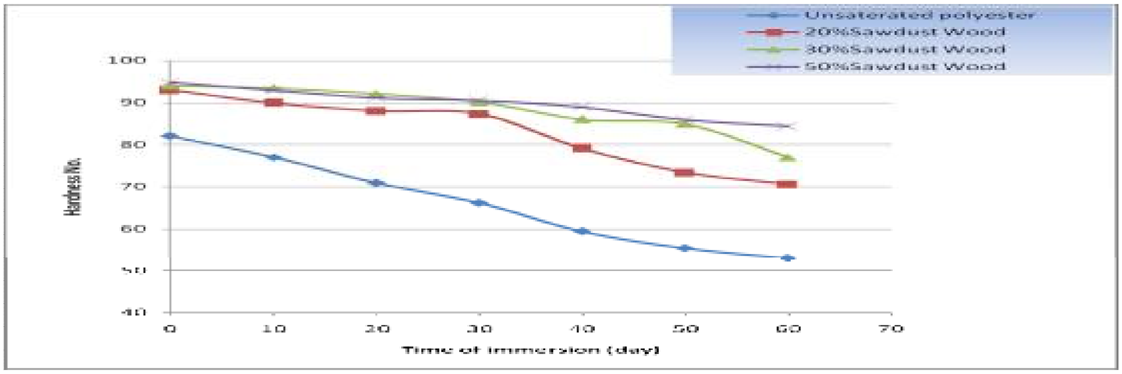

Figure (3) Relation between hardness (shore D) for (sawdust)/ UPS composite and Time of immersion