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The Water Absorption Effect on the Hardness of Composites Polyester

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Abstract. Unsaturated polyester resin (UPE) was used as the matrix .The iron woven wire and E-glass fiber type (0 – 9°), were used as a reinforcements additives of weight percentage (5, 10, 15) respectively. Samples were prepared by the hand lay- up method for (UPE), (UPE -Fe) and (UPE- Glass). Chemical analysis was used to identify the composition of Fe wire. Water immersing at room temperature for all samples were done at (2, 5, 7, 9, 12) days. Hardness test (Brinell) showed decreasing with increasing in immersion time for (UPE) from (67) HB to (95) HP after adding the reinforcement Fe fibers, with increasing in the water absorbed content especially in the days (2, 5). The water content of absorption was found to be either decreasing or increasing depending on the number of reinforcing layers added.

Keywords: Composites polyester; Water absorption; Hardness.
PACS: 72.80.Tm, 62.20.Qp

INTRODUCTION

In recent years composites polymer containing fiber has obtained considerable attention is interest in fiber reinforced polymer arises rabidly due to the high performance in its mechanical properties, significant processing advantages, low coast and low density [1]. A composites are formed by different materials (long or short fiber), its homogenous examined macroscopically. Another phase of the composites is the matrix, which has an agglutinant function and causes the reinforcement to work in an integrated manner supporting the mechanical structure [2]. Composites polymer were widely used in structural applications, because of their high modulus as strength so, its useful to predict their degradation service loads and environment [3]. The hardness of the surface mechanical task which can be define as the resistant of material for stiches and to be able to keep its surface tact under the influence of external loads property.

MATERIALS and METHOD

The material used in this work was polyester resin as a matrix. Polymer polyester resin where manufactured by "Saudi Industrial Resins Company Limited" with hardener was mixed in ratio 1:11. The reinforcement iron (Fe) woven wire and E-glass fibers materials have been used respectively. The Fe fiber was examined and shown in Table 1.

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Table 1. The chemical analysis of Fe metal wire.

Elements	Wt.%
Fe	89.635
Ti	5.863
Cr	3.251
Mn	0.749
W	0.318
Cu	0.101
Mg	0.079

The unsaturated polyester added to tempered Methylenthyl KetonePeroxide (MEKP) at room temperature as hardener of amount 2 Wt.% of polyester resin to becomes hardened temperature. The added materials used to prepare the composites are iron fibers and E-glass fiber respectively by molding and cold hand pressing (Hand-Layup Molding). Seven specimens were prepared according to (ASTM) as shown in table 2. The hardness test were done to all samples using Brinell's hardness by a hydraulic piston type (6700-D) processor from WOLPERT Germany Company.

Table 2. The UPE and UPE – Composites samples.

Sample type	Polyester Wt.% + Fiber Wt.%
UPE	Polyester 90%+ Fe 10%
UPE+1 layer of woven Fe	Polyester 80% +Fe 90%
UPE+2 layers of woven Fe	Polyester 70% +Fe 80%
UPE+3 layers of woven Fe	Polyester 90% +E glass
UPE+1 layer of woven E-glass	Polyester 80% + E glass
UPE+2 layer of woven E-glass	Polyester 70% +E glass
UPE+3 layer of woven E-glass	Polyester 100%

The water absorption were done at 14 hours immersed for all samples, test of the developed at ambient temperature [4]. These samples were taken out from the water bath and water was wiped off by tissue paper on both sides of the surfaces and reweighed by electrical sensitive balance. The hardness test were done for all samples using Brinell's hardness at (15) sec period, using standard load, by a hydraulic piston type (6700-D) processor from WOLPERT Germany Company.

RESULTS and DISCUSSION

Figures 1 and Figure 2 showing the water absorption of polyester samples (UPE) and its composites (UPE/Fe), (UPE/E-glass) respectively with respect to time immersion in water. The pure polyester absorbed the water molecules du to the attractive of the polarity groups of water molecules which increase the absorption with increases the numbers of polarity groups having lowest value at one day of immersing while the increasing gradually started after the one day immersing to reach its maximum value at the day 13 (0.02%) . For the UPE –Fe wt.% composites, the water absorption increasing as the number of layer increasing (10, 20, 30) reaching its

maximum value of (0.035%) at the days (8 – 13) .This because of the action conducts the water molecules to the material and fills in the voids [5]. In the composites, UPE – E- glass wt.% , the same behavior was observed, but with much water absorption of (0.07 %) at the days (8 – 13) . This may be due to formation of micro-channels, which contribute to the higher water absorption and also provide a way for water to pass through pores on the surface [6]. Figures 3 and Figure 4 shows the hardness behavior, which is in consistently with the results got in Figure 1 and Figure 2. The UPE shows maximum hardness of (67 BH) before immersion in water, but after the immersion it value decreasing to reach (38HB) at the day 13. While the UPE –Fe composites showing the hardness decreasing as the number of increasing layers (10, 20, 30) reaching its lowest value of (90 HB) at the day 13.The same behavior was achieved for the UPE –E- glass composites. The lowest value conducted was (78HB) at the day 13. This is related to the softening and decrease the hydrogen bonding between polymer chains which is reflected by platization of the resin [7]. The resulting data generally reflect the improvement in the hardness after adding the Fe and E –glass respectively before and after immersing in water comparing with those obtained in pure UPE. And the batter improvement was noticed for the UPE –Fe wt.%. We can attribute this to reinforced polyester by hybrids containing woven with angle (0-90°) of fiber, which has a higher resistance to scratch and stitches because of symmetry properties on both sides as well as the high hardness and durability [8].

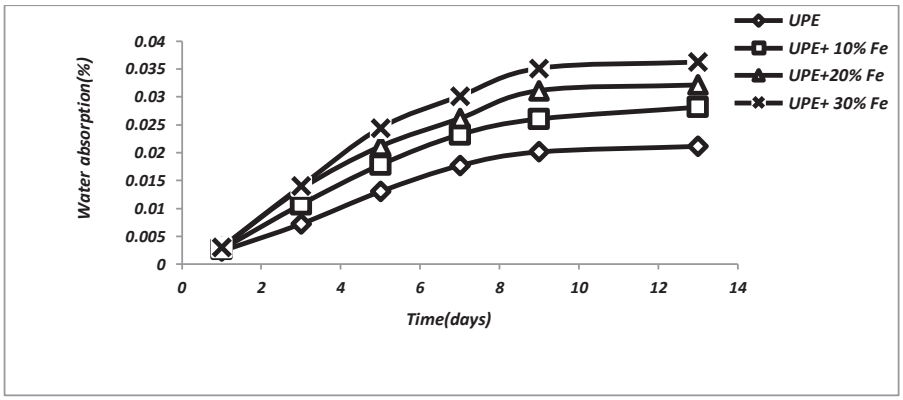

Figure 1. The room temperature water absorption for UPE & UPE – Fe wt.% composites.

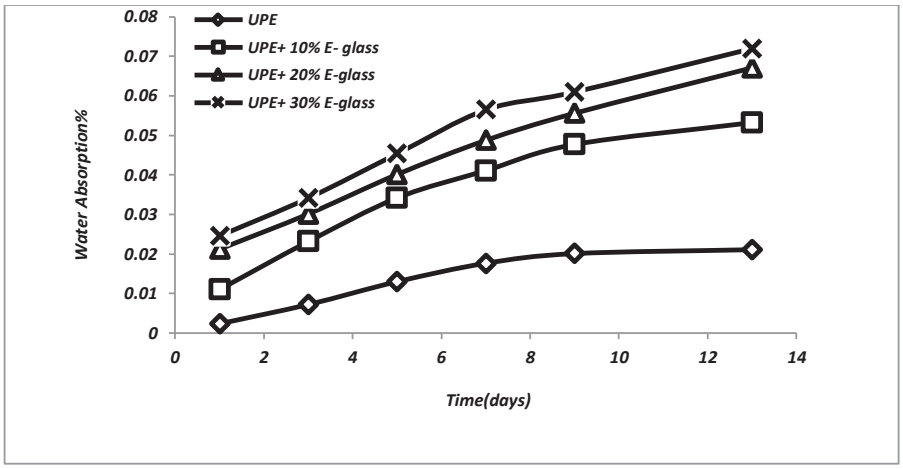

Figure 2. The room temperature water absorption for UPE &UPE– E- glass wt.% composites.

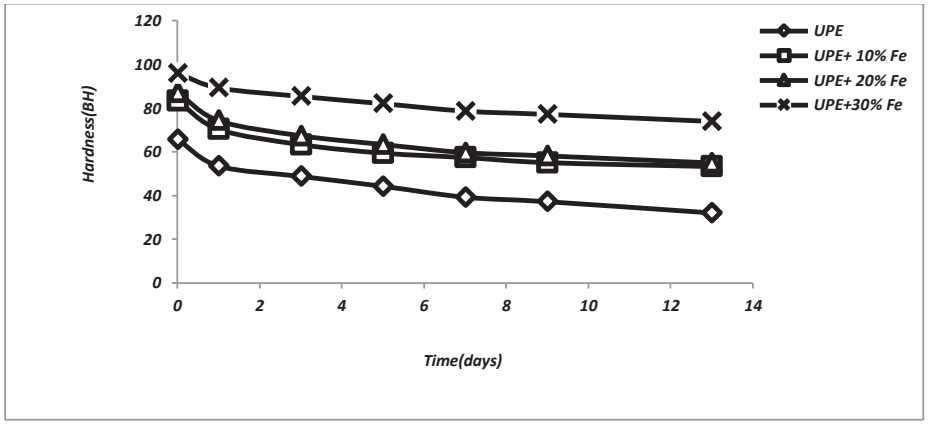

Figure 3. Brinell hardness for UPE & UPE –Fe wt.% composites before and after water immersed.

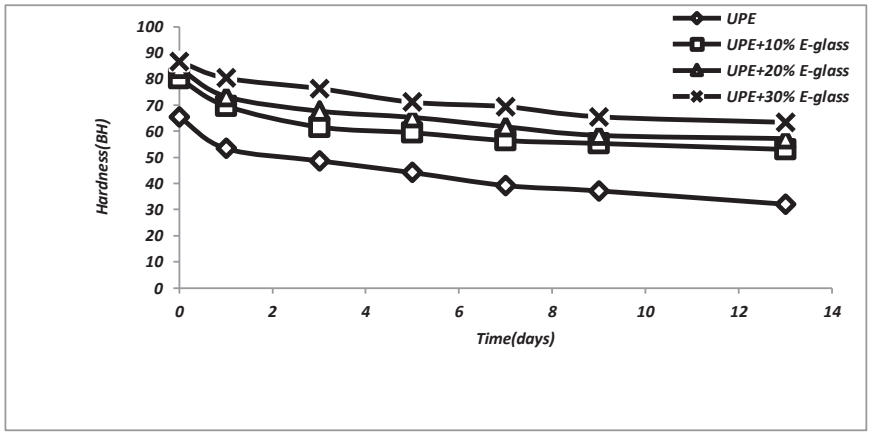

Figure 4. Brinell hardness for UPE & UPE - E-glass composites before and after water immersed.

CONCLUSIONS

The quantity of absorbed water increases with increasing the time of immersion in water and with increasing the number of layers of fiber. UPE samples absorb water less than the composites samples.

Hardness decreases with increasing the time of immersion in water at room temperature for UPE, (UPE/Fe) and (UPE/E-glass) (0 – 90°). While the improvement in hardness noticed for the UPE –Fe wt.% composites comparing with both UPE and UPE – glass composite.

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