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STUDYING THE EFFECT OF TEMPERATURE ON THE DIFFUSIONOF ALKALINE SOLUTION IN POLYESTER REINFORCEMENT BY FIBERSGLASS

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ABSTRACT
In this research have been identified diffusion coefficient of solvents with ratios(0.3salt water) , (0.5sodium hydroxide), (0.5potassium hydroxide), and it was observed melting and mechanisms of moisture in the composite material consisting of fiber glass and polyester it at (70C^{o})and the results were then compared to samples of composite materials with six layers of fiber to take advantage of comparison in determining the impact of the presence of diffuse temperature and without in most in dustrial applications. The samples were composite material used is composed of two types of fiber type I(fibers woven) and type II(fiber woven + random), and through the results was observed that the solvents basal have a clear impact on composite materials and increases this effect with increasing temperature, as observed that diffuse more in the first type of samples(fiber woven) of the second type of samples (fiber woven + random), in addition to the diffuse coefficient varies from one solution to another, when the temperature increase for type 1and 2 .And the results were recorded the largest percentage value of salt water (2.93%,3.02%) for two types of fiber respectively, which means minimum absorption resistance , followed by sodium hydroxide and finally potassium hydroxide (1.292%,1.05%) respectively because of (maximum absorption resistance).
Keywords: diffusion,alkaline solution, polyester, fibersglass

دراسة تأثير درجة الحرارة على الانتشارية للمحاليل القاعدية في البولي استر المقوى بالياف الزجاج

الخلاصة
في هذا البحث تم تحديد معامل الانتشار لنسب المحاليل (0.3 ماء ملحي) ، (0.5 هيدروكسيد الصوديوم) و(0.5 هيدروكسيد البوتاسيوم) ،ومنه تم ملاحظة الذوبان واليات الرطوبة في المواد المركبة المتكونة من الياف الزجاج والبوليستر وذلك عند درجة حرارة (70 م^{o}) ومن ثم تم مقارنة النتائج لعينات المواد المركبة ذات الست طبقات من الالياف للاستفادة من المقارنة في تحديد تاثير الانتشارية بوجود درجة الحرارة وبدونها في معظم التطبيقات الصناعية . وكانت عينات المادة المركبة المستخدمة متكونة من نوعين من الالياف النوع الاول (الياف منسوجة) والنوع الثاني (الياف منسوجة +عشوائية)، ومن خلال النتائج تم ملاحظة ان المحاليل القاعدية لها تاثير واضح على المواد المركبة ويزداد هذا التاثير بزيادة درجة الحرارة ،كما لوحظ بان الانتشارية اكثر في النوع الاول للعينات (الااليا المنسوجة)

من النوع الثاني للعينات (الألياف منسوجة +العشوائية) ، بالإضافة الى انه بزيادة درجة الحرارة يقل معامل الانتشارية. كما يختلف من محلول لاخر ومن نوع لآخر حيث سجلت النتائج أعلى قيمة مئوية للماء الملحي (2.93%,3.02%) على التوالي مما يعني مقاومة قليلة للامتصاص ويليه هيدروكسيد الصوديوم وأخيرا لهيدروكسيد البوتاسيوم (1.292%,1.05%) على التوالي .مما يعني الاكثر مقاومة للامتصاصية .

INTRODUCTION

Many papers discussed the diffusion and solubility characteristics of H,O ,and other molecular species in composite materials have been in , mostly in studies conducted in the last fifteen years .[Sacherand Susko 1979,1981,1982] illustrated the highlighted the limited understanding of the actual solution and transport processes in resins and resin-glass composites, particularly for the role of chemistry and sinks reactions, i.e., chain pits or cavities, in affecting the sorption-description process,[Fonseca, 2011] studied the diffusion Carbon Fibre Reinforced Polymers (CFRP) are being successfully used to repair and renew old and damaged civil engineering infrastructures. In particular, the method of materials involved will be exposed to outdoor environmental conditions, including humidity, water from rain, salt water, There are two fundamental properties may be of interests which lead to an understanding of the phenomena. The first of these is solubility (c), which is related to the partial pressure (P) through Henry's law (c = yP), where y is an activity coefficient. The second property is the diffusion constant (D), which is the ratio of the molecular flux (Q) divided by the gradient of the concentration (dc/dx) of the diffusing species, i.e., Fick's law, Q = Ddc/dx. The process by which permeation occurs for thesematerials are pore-free is activated diffusion. The molecules dissolve in the surface of a polymer, equilibrating with the atmosphere, establish a chemical potential, and diffuse in the direction of the gradient. These parameters can be evaluated as functions of concentration and temperature, [Padmavathi,2006] discussed Fiber-Reinforced Polymer (FRP) composites offer many advantages over conventional materials for applications in the marine and civil infrastructure areas. Their increasing widespread use emphasizes the need to predict their performance over long periods of time after being subjected to exposure to different environmental conditions.

[Areef , 2008] Discussed epoxy composite reinforced with glass fibers (woven and random direction) together as a sandwich with volume fraction (44). The samples were immersed in different solution for equal time at constant temperature (room temperature ±18^{o}C). The result show that the relative mass gain increased with increasing the immersion time till they tend saturation moisture mass (M_∞) after that the relative mass gain decreased. The result shows that the samples immersed in (kerosene) solution had higher mass gain while the samples immersed in distill water had lower mass gain and the samples immersed in other solution (Benzene, HNO_3, KOH, H_2O as received) had relatively mass gain between them.

Polymeric matrix composites differ from other materials in the sense that low- molecular weight substances such as water may easily migrate even at room temperature generating a variation of the material's structure, morphology, and composition [Adamson1980].This phenomenon occurs only in the matrix or at the fiber- matrix interface since water cannot penetrate the fiber. In many cases, it could lead to an irreversible degradation of the material in the so- called humid aging that includes both chemical aging and physical aging. The epoxy matrix show moisture sensitivity due to interactions between some polar groups of the macromolecule and the water molecules, which leads to a reduction of both glass transition (Tg) and mechanical properties. This sensitivity increases with the increasing degree of cross-linking and also with the polarity concentration of the molecular groups[Fuller, and other

1979]. The physical phenomena that simultaneously occur are dissolution, diffusion, swelling, and relaxation, together with deformation and stress build up in the matrix[Apicella and other 1984].

The kinetics of fluid sorption E-glass/vinylester composites was studied widely by using the models diffusion for Fickian and Langmuir . The time and temperature dependence of the rate of diffusion and maximum moisture content are analyzed and moisture kinetics data is assessed is assessed for use in performance predictions.[Bair H.E.,Johnson,G.E., and Memweather,R.1978], the diffusion coefficient normally increases with concentration. This has been discussed as a plasticizing effect and is often accompanied by a decrease in glass transition temperature T,. Although this behavior is exhibited by H,O in some composites, a more common behavior appears to be decrease in the diffusion coefficient with increasing concentration,[Salih,W.M.,2009], discussed the effect of physical properties polyester fiber glass and investigated diffusion test and comprised the diffusion coefficient This paper introduce experimental study of solubility and kinetics of moisture transport mechanisms in type of resin and fibers beside for presence temperature increasing have been investigated the physical tests group comprised the determination of diffusion coefficient (D) of (0.3 Salt water) , (0.5 NaOH) , (0.5 KOH).

EXPERIMENTALPROCEDURES

Unsaturated polyester: It is least expensive polymer resins and most widely utilized,this matrix material is used primarily for glass fiber-reinforced composites. A large number of resin formulations provide a wide range of properties for this polymer. The density of unsaturated polyester used in the present work was 1.19 gm/ cm^3. The hardener used with UP was methyl ethyl ketone peroxide (MEKP) in the ratio (2wt.%) and activated cobalt octate (0.5wt.%) as accelerator.
Table (1) represents the mechanical properties of polyester resin .

Glass Fiber – Reinforced Polymer (GFRP) Composite: Fiber glass is simply a composite consisting of glass fibers, either continuous or discontinuous contained within a polymer matrix, this type of composite is produced in the largest quantities. The composition of the glass is most commonly drawn into fibers, fiber diameters normally range between (3 – 20) μm. Glass is popular as fiber reinforcement material for several reasons,(Ing-Nan Jan et al, 2005) :-
1. It is easily drawn into high – strength fibers from the molten state.
It is readily available and may be fabricated into a glass .
2. Reinforced plastic economically using a wide variety of composite –manufacturing techniques.
3. As a fiber, it is relatively strong, and when embedded in a plastic matrix it produces a composite having a very high specific strength.
Tables (2),(3) represent the mechanical properties of of E-glass, and sample dimensions and standard specimens respectively

The Balances Instruments: The sensitive balance was utilized; an electronic with four digits, which was used to measure the weight of the samples that used for diffusivity test shown in Fig.1. The weight change (%) of the diffusivity samples after each period (for both cases at room temperature and 70Co by using sensitive oven) of immersion is calculated from the relationship:

Weight gain% $=\frac{W_2-W_1}{W_1}$ (1)

Where:
w1: weight of immersed specimen.
w2: weight of dry specimen.

The test specimens: The test specimens were two types the type one from: polyester- woven and random fibers the type two from: polyester –random fibers Fig.2 shows the test specimens in (Salt water, NaOH, KOH) solutions for two types .

Diffusion Coefficient Measurement: Calculate diffusion coefficient in the polymeric to blend and in composite material. The balance is also an electronic type AE 160/4 Digits manufactured by (Meter/England) with four digits. It is used to measure the weight of the samples that are used in diffusivity test as shown in Fig.1.
The diffusion coefficient (D) (m^2/sec) is calculated from the equation (Fick'ssecond law)[Padmavathi 2006] :-

$$D = \pi \left(\frac{KT}{4Mm}\right)2 \qquad (m2/sec) \qquad (2)$$

Where: K: the slope of straight line of the curves, which represent the relations between the weight gain percent (%) and square root of time ($\sqrt{\text{time}}$)
T: the thickness of the specimen.
Mm: the apparent maximum water content (the saturation level).

RESULTS AND DISCUSSION

The percentages of the solutions that are gained by composites with two types of E-glass were observed in Figs. (3 -5). Beside that solution would be absorbed in the first type of composites more than that in second type of composites, From these figures, it is quite clear the effect of temperature increasing leads to decreasing the diffusion characteristics . Because that the fiber/matrix interface plays the role of a channel for a solution to penetrate into the composite; this penetration normally starts at cut edges. This type of channels found in the composites, which means they gained quantity of solution by composites, is more. And the composites which contain glass fibers would undergo stress-corrosion resulting from the leaching out of the network modifier, from the glass structure. This sort of stress corrosion occurs more rapidly in acid or alkaline environments than that in water alone. It is clear, that this phenomenon is confirmed by this work, Both above mentioned two mechanisms looklogical, but it is essential to add, that the existence of micro cracks, flaws, voids or any other in-homogeneity in the blends and composites would enhance the process of penetrating of the solution into those materials, therefore, fewer defects and more homogeneity would definitely lead to reduce the absorbed solution by these materials. In addition Fig.(3 - 5) clearly shows that saltwater, NaOH and KOH solutions into type 1 of composites more than they are drawn into type 2 composites, this is, due to the textural nature of the fibers (woven) or (woven-random), which give addition channels to the solution to permeate into this composites through the fiber itself.

Salt water ,NaOH and KOH in the composites are calculated, according to the second Fick's law. The results are shown in Table (4). From this table, it can be seen, that the diffusivity coefficients of salt water in the materials (under test) has increased compared with that of pure matrices, due to the interface defects or in-homogeneity that exists in the blends and composites. The same idea can be built for NaOH and KOH solutions, due to the same reason. The same table shows that the diffusivities of salt water and NaOH, in composites are more than their identical in KOH because polyester has high resistance to alkine as is known.

in addition to the diffuse coefficient varies from one solution to another, when the temperature increase for type 1and 2.And the results were recorded the largest percentage value of salt water (2.93% and 3.02%)respectively at temp.(70^0C), which means minimum absorption resistance , followed by sodium hydroxide and finally potassium hydroxide (1.292% and 1.05%) respectively at temp.(70^0C) because of (maximum absorption resistance).

CONCLUSION

- Avoid the effect of environment when composites immerse in different solutions.
- Absorbance rate varies and solutions depending on the type of fiber in the composite material.
- Clear effect in diffuseincrease when temperatureincrease
- When the temperature increase the diffusion coefficient decrease because of absorption resistance

Table1: Mechanical properties of polyester resin [Salih,W.M., 2009]

Specific Density	Modulus Elasticity N/mm²	Tensile stress at break N/mm²	Density g/cm^3
1.22	3600	65	1.19

Table2: Mechanical properties of E-glass [Salih,W.M. 2009]

Strength (GPa)	Young of Modulus (GPa)	Diameter (um)	Density g/cm^3
20	76	11	26

Table 3: sample dimensions and standard specimens [Salih,W.M. 2009]

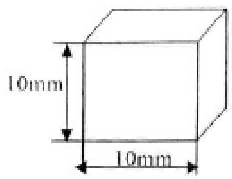
Test	Sample dimensions	Standard Specifications
diffusivity		ASTM-D570

Table (4): Diffusion coefficient of the blends and their composites

Type of solution	diffusion coefficient (D) Polyester resin and E-glass fiber (m^2/sec)			
	Type 1		Type 2	
	At(25^{0}C) [Salih and Ali, 2012]	At (70^{0}C)	At(25^{0}C) [Salih and Ali , 2012]	At (70^{0}C)
0.3 salt water	4.41	2.93	4.84	3.02
0.5 NaOH	2.63	2.191	2.912	2.323
0.5 KOH	1.443	1.293	1.81	1.05

Fig.1 Sensitive balance

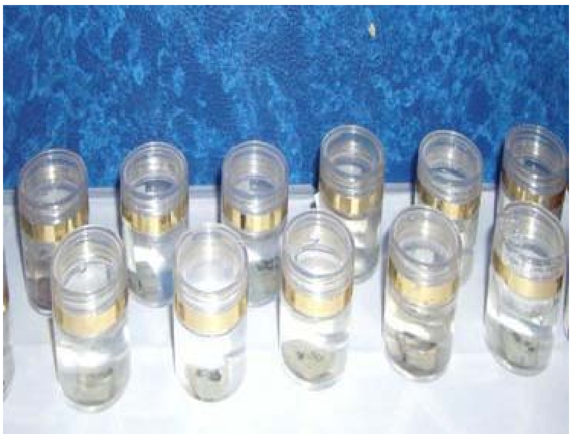


Fig.2 Test specimens

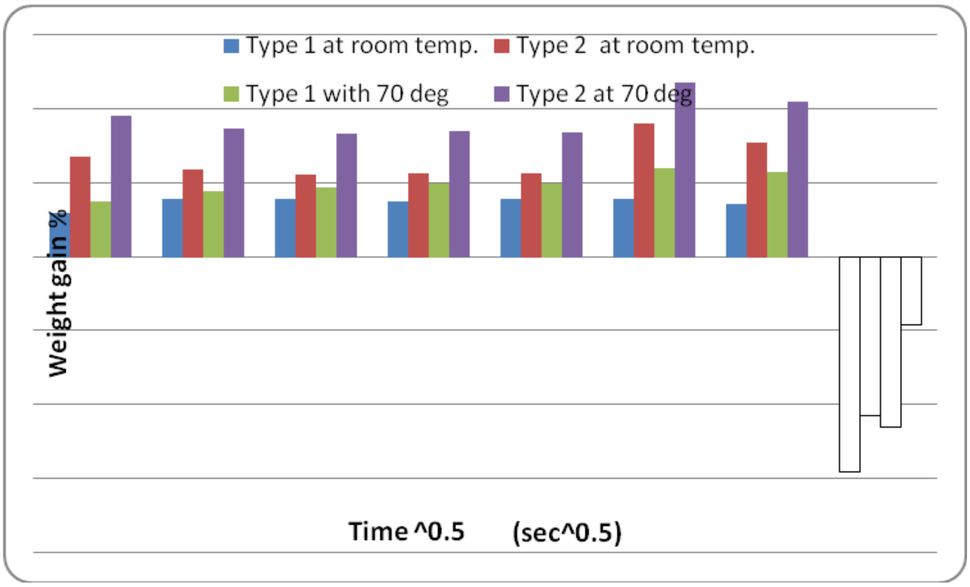


Fig.3: Weight gain% of composites in salt water as a function of time squared root

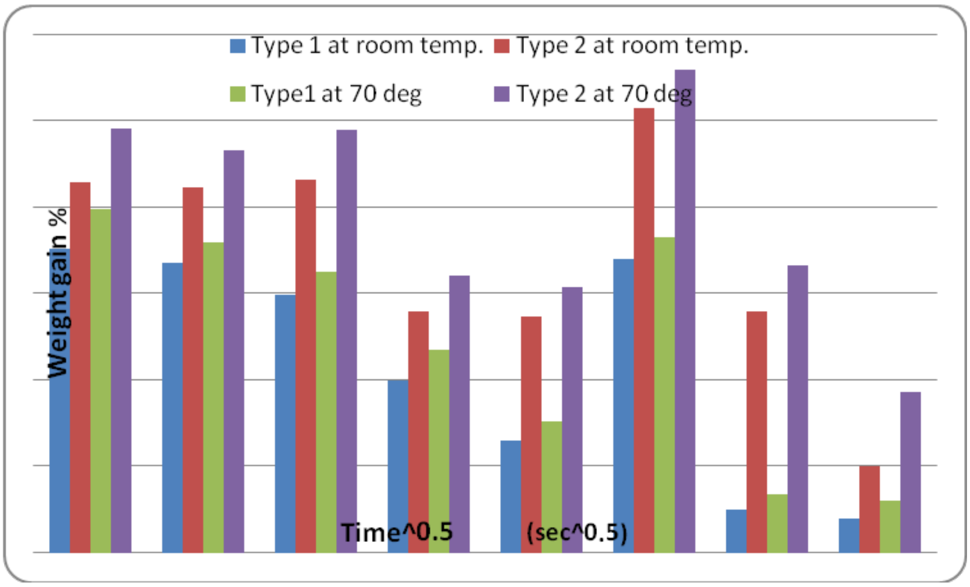


Fig.4: Weight gain% of composites in(KOH) solution as a function of time squared root

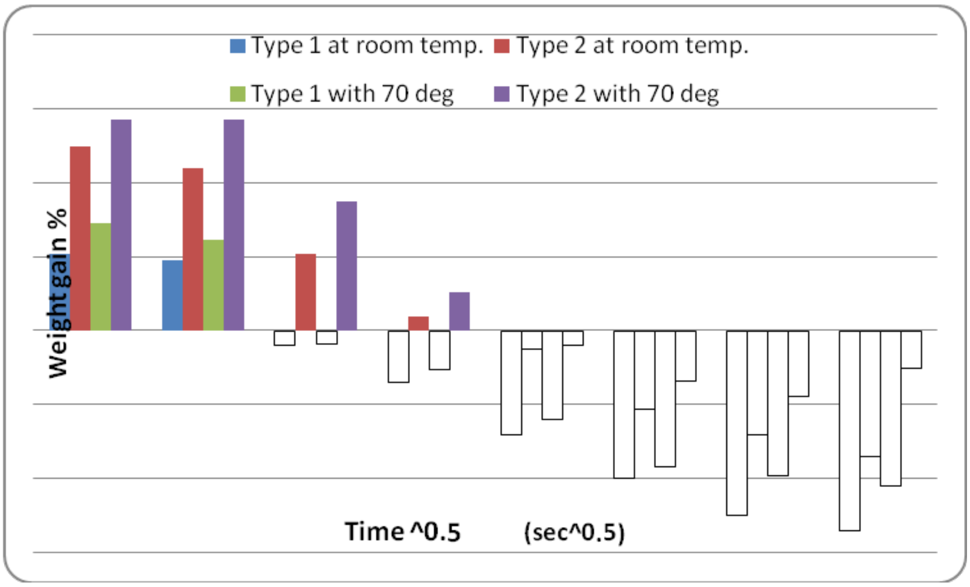


Fig.5: Weight gain% of composites in(NaOH) solution as a function of time squared root

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