Chemical and Other Properties of Unsaturated Polyester under Various Environmental Conditions

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Abstract – This work study the effect and improvement of the chemical , physical , electrical and mechanical properties of unsaturated polyester under different environmental conditions e.g. [dry – wet – sodium chloride (NaCl 40 % wt) – hydrochloric acid (HCl 40 % wt) – nitric acid (HNO_3 40 % wt)] and to the chemical , physical , electrical and mechanical properties of the unsaturated polyester resins using inorganic fillers e.g. [Mica 40 % wt – aluminum tri hydrate $Al(OH)_3$ (ATH) 40 % wt – calcium carbonate 40 % wt] by preparation unsaturated polyester resin using Trans esterification reaction of mixing 1-2 propylene glycol , maleic anhydride and phathalic anhydride , then curing the prepared viscous polyester in cured in the oven at 35 ºC for half an hour the temperature was increased by 5 º C every half an hour until reached to a total curing time is 4 hours .Filler is added to polyester pre polymer using 70 / 30 wt % polyester/styrene , 2 % of Methyl ethyl keton peroxide as initiator and 0.5 % of Co-naphthenate as accelerator , using five cylindrical thermoset polyester resin with varying lengths of filled and un filled (blank) polyester samples (5 , 10 , 15 and 20 mm). Also , in this study , the physical properties such as water absorbency was found to decreases with mica filler than the other fillers (ATH and $CaCO_3$) . The electrical properties (Flashover voltage values) increase by using ATH filler rather than Mica and $CaCO_3$ fillers . While the Mechanical properties (Compressive Index Terms ***Index Terms***strength) increase by using Mica filler rather than ATH and $CaCO_3$fillers . .

Index Terms—Unsaturated Polyester , Environmental Conditions , Chemical Resistance , Apparent Porosity , Flashover Voltage , Compressive Strength , Mica , Calcium Carbonate , Aluminum tri Hydrate .

1 INTRODUCTION

Results showed that the unfilled polyester is affected by strong corrosive substance e.g. (HNO_3 40 % wt) by weight loss while has a quite resistance against other chemicals (water – NaCl 40 % wt – HCl 40 % wt) by weight gain , The addition of Mica , ATH and $CaCO_3$ fillers decreases the weights values of the unfilled polyester samples . A comparison between the inorganic fillers with different environmental condition showed that chemical resistance of samples containing Mica filler is more than of samples containing ATH and $CaCO_3$ fillers even in corrosive substance , at 20 mm sample the weight values reaches for 2.05 gm for samples without filler , 2.16 gm for samples containing Mica 40 % wt , 2.20 gm for samples containing ATH 40 % wt and 1.56 gm for samples containing $CaCO_3$ 40 % wt in nitric acid condition .

Polymers are extremely large molecules that are essential to our very existence are formed by a chemical process Knowing as polymerization which is the process of linking thousands of repeated units called monomers. it leads to an increased molecular mass , higher melting point and boiling point temperatures and greater viscosity of the product .(1-2)

Polymers are classified in several ways – by how the molecules are synthesized, by their molecular structure, or by their chemical family. For example,

Linear polymers consist of long molecular chains, while the branched polymers consist of primary long chains and secondary chains that stem from these main chains. However, linear does not mean straight lines. The better way to classify polymers is according to their mechanical and thermal behavior. Industrially polymers are classified into two main classes – elastomers and plastics. (3)

Elastomers: known as rubbers, these are polymers which can undergo large elongations under load, at room temperature, and return to their original shape when the load is released. There are number of man-made elastomers in addition to natural rubber. These consist of coil-like polymer chains those can reversibly stretch by applying a force. (4)

Plastics are moldable organic resins. These are either natural or synthetic, and are processed by forming or molding into shapes. Plastics are important engineering materials for many reasons. They have a wide range of properties, some of which are unattainable from any other materials, and in most cases they are relatively low in coast (5).

The most important properties of plastics , light weight, wide range of colors, low thermal and electrical conductivity, less brittle, good toughness, good resistance to acids, bases and moisture, high dielectric strength (use in electrical insulation) . (6)

The unsaturated polyesters backbone is generally composed of structural units, which are saturated acids, unsaturated acids and glycols. In case of the general purpose polyester

these components usually consists of phthailcacid, maleic acid and propylene glycol , to which diethylene glycol is occasionally added in small amounts . Such as composition has the characteristic of low coast and good quality. (7- 8)

Unsaturated polyester resins are produced by the formation of monoesters or ring-opening of the anhydrides in the first reaction step which reacts to form di-esters after the temperature is increased. These diesters react further through poly condensation to produce the final polyester and water as by-product (10)

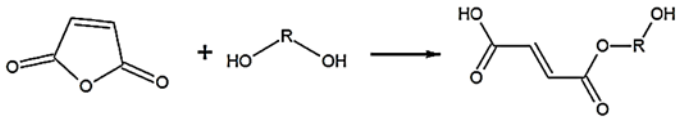

Figure (1) Ring opening step (Monoester formation): (R= alkyl group)

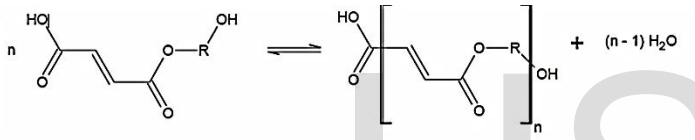

Figure (2) Poly esterification step

2 CHEMICAL PREPARATION OF SAMPLES

This part presents the experimental arrangement and different types of fillers circuits such as (mica – ATH – $CaCO_3$) used during the present study , the preparation of polyester depend on different parameters such as type of material , types of fillers that affect on prosperities of the base material and final product, this chapter discusses the preparation of the test circuit and the effect of different environmental conditions applied during the present study ,the investigation of chemical resistance , porosity test , flashover voltage , and mechanical test (compressive strength) .

2.1 Materials of Polyester and Fillers

Preparation of polyester resin based on poly – 1, 2 – propylene – maleate – phthalate:

A mixture of (1.25 moles) 1,2 Propylene glycol (PG), (0.5 moles) Phthalic anhydride (PA) 0.2% p- Toluene sulfonic acid (PTSA) (as acid catalyst) and Xylene as solvent, was charged in a three-neck reaction kettle equipped with stirrer, thermometer, nitrogen-gas introducing tube (for eliminating presence of oxygen inside the flask) , separator and water condenser. The mixture was mechanically stirred and heated at 120 ºC under nitrogen gas stream. When reaction mass becomes clear, it was allowed to cool to 80 ºC and then (0.5 moles) Maleic anhydride (MA) was added and continues heating at 150-200 ºC until an acid number of 20 was reached. During esterification reaction, water formed as by product and was continuously removed from the reaction mass as it inhibits the rate of reaction .

The Xylene was completely distilled out and reaction product was allowed to cool. When the temperature reached to 160 ºC, 20 mg of hydroquinone was added as inhibitor.

2.2 Preparation of Polyester Composites

Three different type of base polymer loading of different level of fillers such as Mica, ATH and calcium carbonate are used in this work.

All specimens have been cured in the oven at 35 ºC for half an hour the temperature was increased by 5 º C every half an hour until reached to a total curing time is 4 hours .

Filler is added to polyester pre polymer using 70 / 30 wt polyester/styrene, 2 % of Methyl ethyl keton peroxide (MEK) as initiator and 0.5 % of Co-naphthenate (Co-naph) as accelerator. That is again stirred slowly until particles have been uniformly mixed with the resin and air bubbles have escaped. The mixture is then poured carefully into a glass tubes and left at room temperature (25 ºC ± 1) until curing occurs according to the methods indicated above .

3 EXPERIMENTAL SETUP AND TECHNIQUES

The Acid Number of polyester composites is determined The acid number is determined by titrating polyester with known grams dissolved in solvent with solution of potassium hydroxide (KOH) with Known normality and phenolphthalein (Ph. Ph) a color indicator. The acid number was calculated by this equation :

$$Acid\ Number = \frac{\text{Volume of used KOH} \times \text{N} \times 5.61}{\text{Wt of sample resin}}$$

The prepared polyester was examined by infrared spectrometry measurements were made on a PU .9712 infrared spectrometer .the temperatures wasthermostatically controlled at 25 ºC by small air conditioning unit.

Specimens have been prepared from polyester. It made of cylindrical rods have 10 μ m diameter and 100 μ m length, powder inorganic fillers with particles size ranging from 61 – 74 μ m have been added to polyester .

3.1 Types of Test

Four identical sets of samples have been prepared and tested in atmospheric air using ac (50 Hz) was supplied from single phase autotransformer (100 kV – 15 kA) ,the parameters affecting the chemical, physical , electrical and mechanical properties are sample length, type of fillers , types of environmental conditions , the different testing conditions are classified as follows :-

3.1.1 Chemical Resistance Test

This method includes provisions for reporting changes in appearance and strength properties using different standard specified reagents. Provisions are made for given exposure times (24 hours) and constant exposure temperature (30 ± 1ºC) .Theeffect of chemical reagents on the properties of the final forms was determined by performing measurements on 4 standard species before and after immersion. The standard reagents used are (distilled water - NaCl 40 % wt –HCl 40 % wt – HNO_3 40 % wt) .

3.1.2 Apparent Porosity Test

the test specimen was dried at constant weight at (30 ± 1ºC) , the specimen then placed in water for 24 hours and each specimens was blotted lightly with a moistened smooth linen or cotton cloth to remove all drops of water from the surface , then we calculate the following :

Weight dry (W_{dry}) , Weight of water displaced (W_{wtr}) , Saturated weights (W_{sat}) ,

Exterior Volume (V) $=W_{sat}–W_{wtr}$

$$The\ apparent\ porosity\ (P) = \frac{Wsat - W\ dry}{V}$$

3.1.3 Flashover Voltage Test

Flashover test, which shows electrical properties, illustrates the behavior of sample insulation to with stand the voltage applied and this flashover test was studied at faculty of engineering in Aswanuniversity, two similar copper electrodes have a half cylindrical shape with rounded edges , it is vital to ensure that the electrodes had very smooth without any irregularities to avoid the non-uniform electric filed according to ASTM D-2303-64T .

3.1.4 Compressive Strength Test

Compressive test is used to give the ability of sample to with stand the compressive force (M Pa) . it has been done to evaluate the mechanical performance of composite insulators according to ASTM D 695 and ASTM D 638 for compressive strength , all virgin specimens have been measured andtested using (dynamic testing machine) under different environmental condition (dry – wet – NaCl 40 % wt – HCl 40 % wt – HNO_3 40 % wt) .

4 Results and Discussion

The prepared polyester is a pale yellow viscous resin, soluble in chloroform and insoluble in benzene has an acid number 20.

The IR spectra showed a strong band centered at 3433.64 cm^{-1} characteristics of the stretching frequency of an OH group of glycol . The group of bands at 2924.52 cm^{-1} and 2865.7 cm^{-1} may stand for the CH stretching frequencies of CH_3 , CH_2 , aromatic and olefinic groups .The intense broad band at 1886.04 cm^{-1} characteristics of the the stretching frequency of carbonyl groups of esters .The sharp intense band at 1612.2 cm^{-1} is quite indicative of carbonyl group of aromatic and unsaturated acids and esters, While The broad bands at 1509.03 cm^{-1} and 1455.03 cm^{-1} are probably due to the stretching frequency of aromatic and olefinic C = C , the broad bands at 1295 cm^{-1} , 1244 cm^{-1} and 1179 cm^{-1} are due to bending frequencies of CH_2 and CH_3 groups ,the strong bands at 875.52 cm^{-1} , 829.24 cm^{-1} , 560.22 cm^{-1} and 470.54 cm^{-1} are indicative of the presence of aromatic residues in the polyester chain .

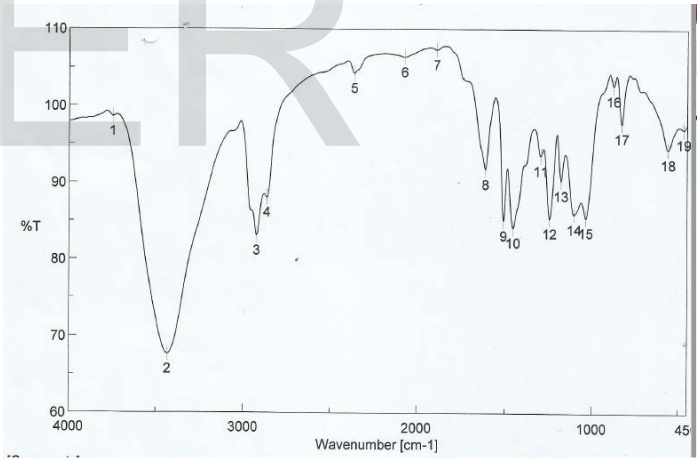

Figure (3)IR Spectra for Unsaturated Polyester resins

4.1 Chemical Resistance

The increment percentage in Table (1) illustrates that pure polyester samples has a quite resistance against (water ,40% NaCl , 40% HCl) in which the chemicals does not make cracks or deterioration or weights loss, that means the chemicals just affect on physical properties of samples by increasing the weight of samples and swelling sample , the decrement percentage illustrates that exposure of pure polyester samples to nitric acids 40 % causes loss weights of samplesit can be noticed that as thesample length increases , the weights of the samples increases .

TABLE (1)

EFFECT OF CHEMICAL ENVIRONMENTS ON POLYESTER COMPOSITES WITHOUT FILLERS

Samples of Polyester	Lengths (mm)	Weights (gm)				
		Chemical Environments				
		Dry	Wet	NaCl	HCl	HNO_3
Blank (without fillers)	5	0.92	0.93	0.97	1.00	0.87
	10	1.33	1.35	1.42	1.46	1.25
	15	1.72	1.78	1.87	1.93	1.65
	20	2.11	2.21	2.29	2.40	2.05

The results in Table (2) illustrate that polyester / mica 40 % samples has weight values less than the weight values of the pure poly ester sample at all environmental conditions in different lengths also in nitric acid 40 % that means mica makes samples homogenous and compact , and fills the open pores that exist in the sample which permit to the chemical penetrate the samples and make change in the physical properties by increasing in weights , swelling , formation of pits and make it having a weak resistance against chemicals and this is may be mica consists of silica and it has a good resistance against acids and weak resistance against bases .

It can be noticed that the differences in the weight values between short samples is low, while the differences in long samples is higher.

TABLE (2)

EFFECT OF CHEMICAL ENVIRONMENTS ON POLYESTER COMPOSITES WITH MICA FILLERS

Samples of Polyester	Lengths (mm)	Weights (gm)				
		Chemical Environments				
		Dry	Wet	NaCl	HCl	HNO_3
Mica 40 % wt	5	0.52	0.52	0.52	0.53	0.53
	10	0.97	0.97	0.98	1.00	1.01
	15	1.50	1.52	1.55	1.57	1.58
	20	2.02	2.06	2.11	2.14	2.16

It can be noticed that from Table (3) that the weight values of polyester / ATH 40% samples is higher than the weight values of polyester /mica 40% samples but less than weight values of pure polyester samples in all different lengths samples with different environmental conditions , and this is because aluminum tri hydrate consists of hydroxyl groups which employed this filler as flame retardants in polymers not as reinforced filler .

TABLE (3)

EFFECT OF CHEMICAL ENVIRONMENTS ON POLYESTER COMPOSITES WITH ATH FILLERS

Samples of Polyester	Lengths (mm)	Weights (gm)				
		Chemical Environments				
		Dry	Wet	NaCl	HCl	HNO_3
(ATH) 40 % wt	5	0.58	0.58	0.60	0.63	0.63
	10	1.06	1.07	1.10	1.13	1.14
	15	1.70	1.73	1.77	1.80	1.82
	20	2.04	2.07	2.12	2.16	2.20

The results in Table (4) illustrate that calcium carbonate 40 % filler make decrement in the weight of the pure poly ester sample and less than at aluminum tri hydrate and lower than mica filler , and it makes loss in sample weight at hydro chloride and nitric acid condition .That means calcium carbonates makes samples has a weak resistance against acidic chemicals .

TABLE (4)

EFFECT OF CHEMICAL ENVIRONMENTS ON POLYESTER COMPOSITES WITH $CaCO_3$ FILLERS

Samples of Polyester	Lengths (mm)	Weights (gm)				
		Chemical Environments				
		Dry	Wet	NaCl	HCl	HNO_3
$CaCO_3$ 40 % wt	5	0.44	0.48	0.53	0.42	0.40
	10	0.79	0.85	0.93	0.76	0.72

	15	1.35	1.43	1.55	1.31	1.26
	20	1.69	1.80	1.93	1.63	1.56

Comparing previous results showed that The un filled poly ester specimens have a higher weight values than its values of samples containing (mica , aluminum tri hydrate , calcium carbonate) ,this is due to the fillers fills the pores in the pure poly ester and make it easily handling and has light weight with low coast , in the filled polyester specimens aluminum tri hydrate 40 % fillers weight value is higher than mica 40 % filler weight value than calcium carbonate 40 % fillers . The weight values of un filled and filled polyester samples at dry condition is lower than the weight values un filled and filled polyester at wet condition in, but unfilled polyester has higher weight values than filled polyester because water can penetrate the un filled polyester and occupy the open pores , the open pores which will be blocked and filled by the applied fillers . In the filled polyesters ,polyester/ calcium carbonate 40 % wt samples has lower weight value than polyester/ mica carbonate 40 % wt samples and polyester/ aluminum tri hydrate 40 % wt samples ,so polyester/ aluminum tri hydrate 40 % wt samples has thehighestweight value in wet conditions and the polyester/ calcium carbonate 40 % wt samples has the lowest weight value at wet condition . The same case occurs in sodium chloride 40 % wt conditions and hydro chloride acid 40 % wt in un filled an filled polyester samples except for calcium carbonate 40 % wt which shows a decrement in weight values when exposed to hydrochloric acid 40 % wt conditions that means it has a weak resistance against acids .

The weight values of unfilled polyester in nitric acid 40 % wt is less the weight value of unfilledpolyester in dry conditions that means a chemical attack occurs in the pure polyester and it has a weak resistance against. But in filled poly ester the weight value at nitric acid 40 % weight condition is higher than the weight value of filled poly ester at dry condition, except for calcium carbonate 40 % wt filler , the weight value of polyester / calcium carbonate 40 % wt at nitric acid 40 % wt conditions is less than at dry conditions .

4.2 Apparent Porosity

The water absorbency values in Figure (4) in unfilled polyester is higher than the water absorbency values in filled polyester, this because fillers blocks the open pores and limit penetration of water molecule to polymer lattice. The decrement percentage in water absorbency in polyester /mica 40 %occurs only in two sample lengths (15 and 20 mm) lengths with a decrement percentage (57.56 and 61 %) the other lengths (5 and 10 mm) . The decrement percentage in water absorbency in polyester /ATH 40 %occurs in three sample lengths (10 , 15 and 20 mm) lengths with a decrement percentage (66.40 , 82.07 and 81.65 %) in (5 mm) length does not have open pores in presence of ATH 40 % wt filler .

The decrement percentage in water absorbency in polyester /$CaCO_3$ 40 %occurs only in two sample lengths (10 and 15 mm) lengths with a decrement percentage (66.40 and 82.07 and) in (5 mm) length does not have open pores in presence of $CaCO_3$ 40 % wt fillerbut in 20 mm sample lengths an increment occur in the water absorbency with an increment percentage = 12.80 % .

From the previous results it can be noticed that mica 40% wt has a low water absorption much lower than aluminum tri hydrate 40 % wt and calcium carbonate 40% wt. .This is because aluminum tri hydrate belongs to hydroxidespolymer families that mean it is hydrophilic fillers and tends to absorbs water.

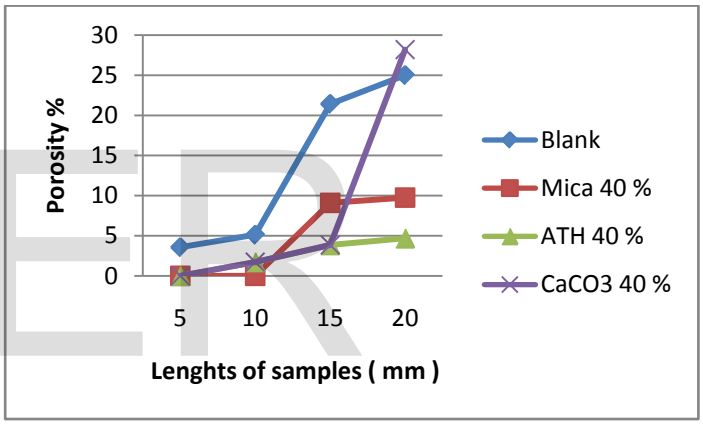

Figure (4) Comparison of Porosity values betweenUN filled and filled polyester samples

4.3 Flashover Voltage

The decrement percentage of unfilled polyester in Figure (5) illustrates that the flashover voltage is affected by the different environmental conditions ,in 5 mm sample length at wet condition the flashover voltage value = 11 kV , at sodium chloride 40 % wt condition the flashover voltage value decreases to = 10 kV this because water along with pollutant accumulated on the surface from a conducting layer which allows the flow of leakage current affecting on its flashover performance . the conductive contamination dissolved within the water . This condition results in leakage current flow and arc formation. This true at The different environmental conditions in all sample lengths (10 , 15 and 20 mm) On the other hand , it can be noticed that as the sample length increases , the flashover voltage values increases .

From the results in Figure (6) it can be noticed that the flashover voltage values of polyester / Mica 40 wt composites is more than the flashover voltage values of unfilled polyester composites that means mica improves the flash over voltage of the polyester and make it compact and homogenous .The decrement percentage between different lengths at different environmental conditions illustrates that the flashover voltage in polyester / mica 40 % wt is affected by this environmental conditions, but this decrement percentage in the flashover voltage values of polyester / mica sample is higher than the decrement percentage in unfilled polyester samples.

In Figure (7) the flashover voltage values of polyester / ATH 40 % wt composites is more than the flashover voltage values of polyester / Mica 40 % wtcomposites that means aluminum tri hydrate 40 % improves the flash over voltage of the polyester than mica 40 % wt .

The flashover voltage values of polyester / $CaCO_3$ 40 % wt composites in Figure (8) is less than the flashover voltage values of polyester / Mica 40 % wtand lower than theflashover voltage values of polyester / ATH 40 % wt composites that means calcium carbonate 40 % wt does not improves the flash over voltage of the polyester .

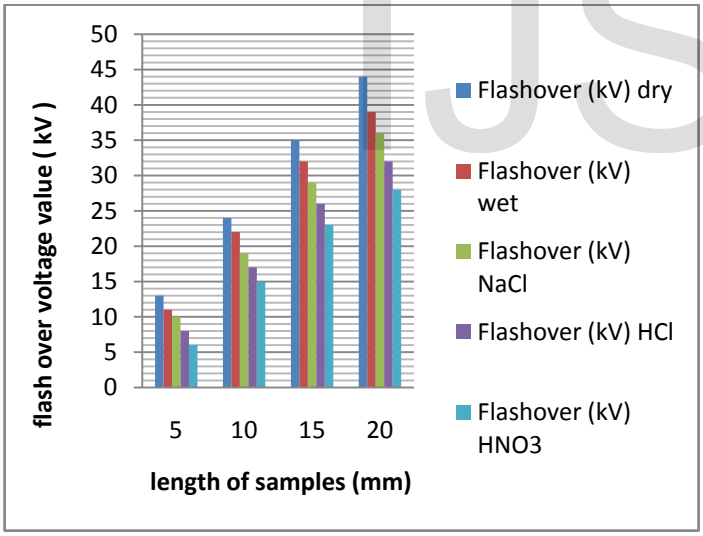

Figure (5) Flash over voltage under different condition in unfilled polyester composite

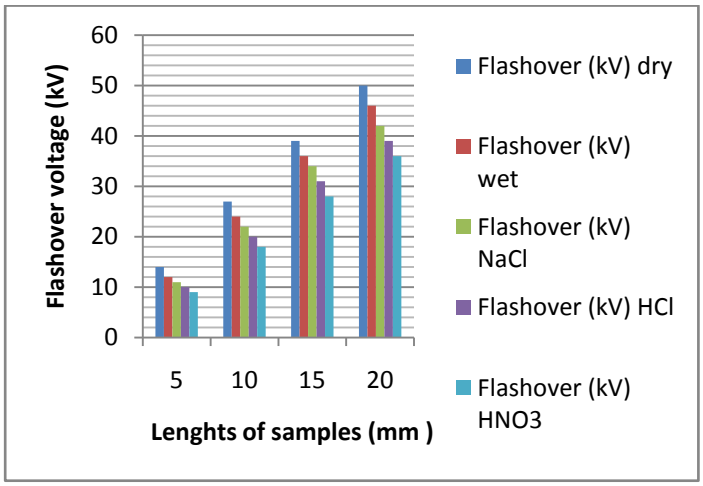

Figure (6) flash over voltage under different condition in polyester / Mica 40 % wt composite

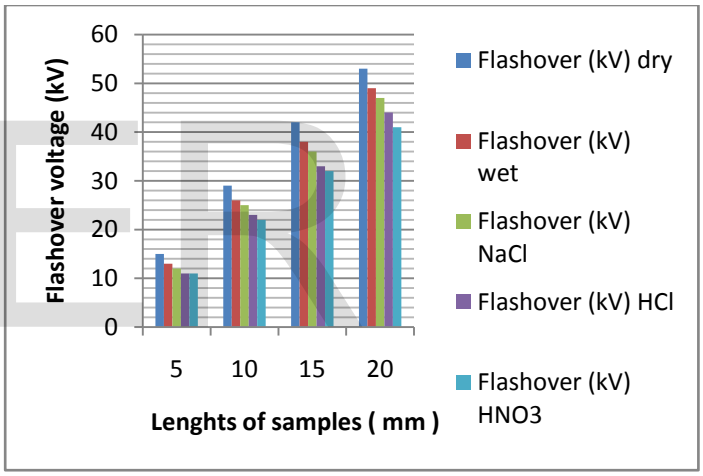

Figure (7) flash over voltage under different condition in polyester / ATH 40 % wt composite

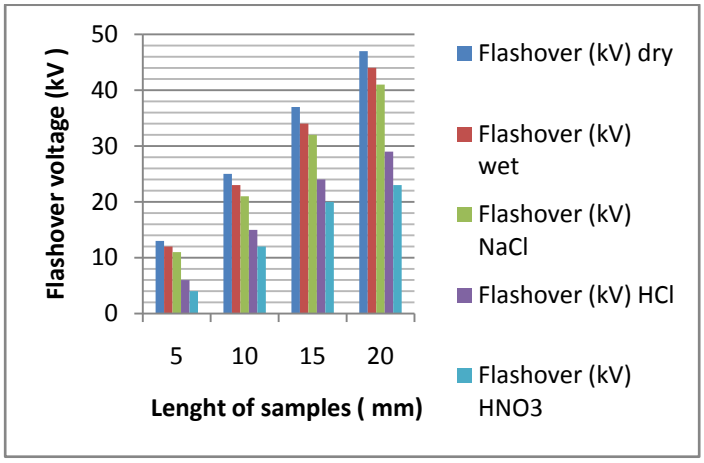

Figure (8) flash over voltage under different condition in polyester / $CaCO_3$ 40 % wt composite

The un filled poly ester specimens have a lower flashover voltage value than its value of samples containing (mica , aluminum tri hydrate , calcium carbonate) ,this is due to the fillers fills the pores in the pure poly ester so the surface of the sample becomes smooth and this improves the flash over voltage because the leakage current egged path for passage , while in the unfilled polyester sample the surface is rough which makes leakage current pass easily , the best value of flash over voltage at dry condition is in polyester / aluminum tri hydrate 40 % wt .The flashover voltage values in wet condition in both (filled and un filled polyester samples) is lower than the flashover voltage values at dry condition this may be due to in wet condition hydrophobic nature of polymer materials makes conductive water tend to beads rather than to form filaments along the surface . These beads under electric stress consistswater film results in leakage current flow , which in turn causes flash over faster than dry condition .

In dry condition there is no contamination so , this condition results in lower leakage current flow and the probability of arc formation , which in turn requires a higher voltage to cause flash over .In nitric acid condition there is large surface leakage current consists between two electrodes results from nitric acid.This leakage current lead to faster flashover at small values if it compared to condition without contamination. The flashover voltage values of aluminum tri hydrate 40 % wt is higher than flash over voltage values by mica 40 % wt , and highest than flashover voltage values by calcium carbonate 40 % wt , that mean the lowest flashover voltage values is in calcium carbonate 40% wt .

4.4 Compressive Strength

The compressive strength is calculated by dividing the maximum compressive load carried by the specimen during the test by the original minimum cross section area of the specimen. Express the result in (MPa)as shown in the following equation :

$$Compressive\ strength = \frac{\text{Pmax}}{\text{A}}$$

Where:(F) applied force &(A) cross section

The decrement percentage of unfilled polyester in Figure (9) illustrates that the compressive strength is affected by the different environmental conditions. On the other hand, it can be noticed that as the sample length increases, the compressive strength increases.

It can be noticed from Figure (10) the compressive strength values of polyester / Mica 40 % wt composites is more than the compressive strength values of unfilled polyester composites that means mica improves the compressive strength of the polyester and make it compact and homogenous .the differences between the compressive strength values in short samples is small , while in long sample is large , this is because in short samples such as (5 mm) the filler is nonhomogeneous in the sample, so its effect to improve compressive strength value is small , while in long sample (2.5 mm) the filler is homogeneous and compact , so its effect is apparent improving compressive strength values .

The compressive strength values of polyester / ATH 40 % wt composites in Figure (11) is less than the compressive strength values of polyester / Mica 40 % wt composites but more than the compressive strength values of unfilled polyester composites ,that means aluminum tri hydrate 40 % improves the compressive strength of the polyester but not as mica 40 % wt .

In Figure (12) it can be noticed that the compressive strength values of polyester / $CaCO_3$ 40 % wt composites is less than the compressive strength values of polyester / ATH 40 % wt composites and lowest than the compressive strength values of polyester / Mica 40 % wt , but more than the compressive strength values of un filled polyester composites , that means calcium carbonate 40 % improves the compressive strength of the polyester but not as mica 40 % wt and aluminum tri hydrate 40 % wt .

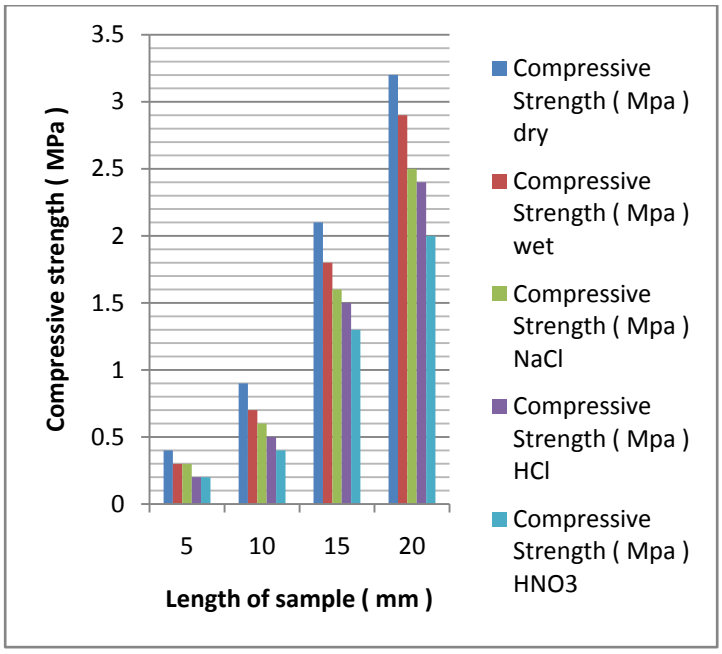

Figure (9) Compressive strength under different condition in unfilled polyester composite

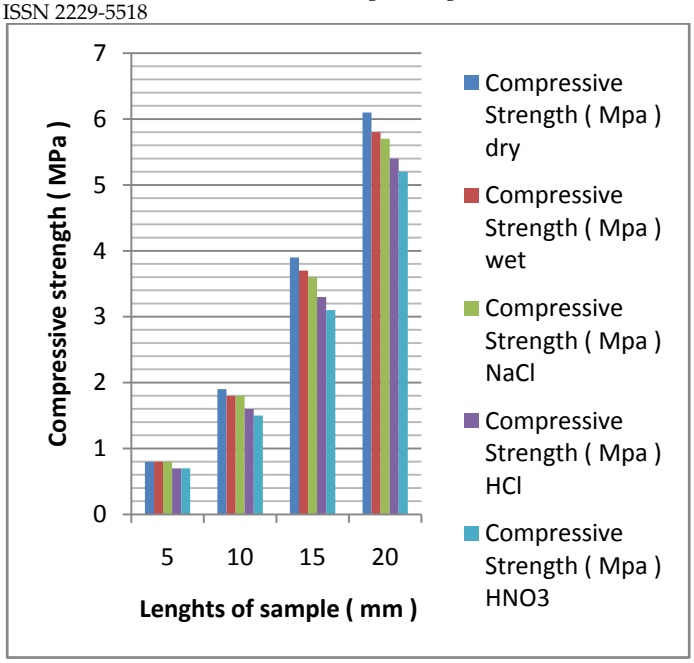

Figure (10) Compressive strength under different condition in polyester / Mica 40 % wt composite

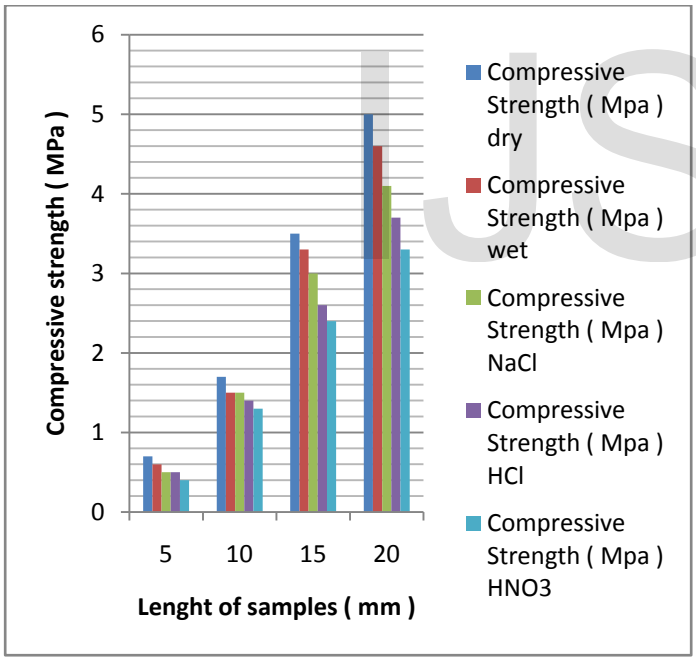

Figure (11) Compressive strength under different condition in polyester / ATH 40 % wt composite

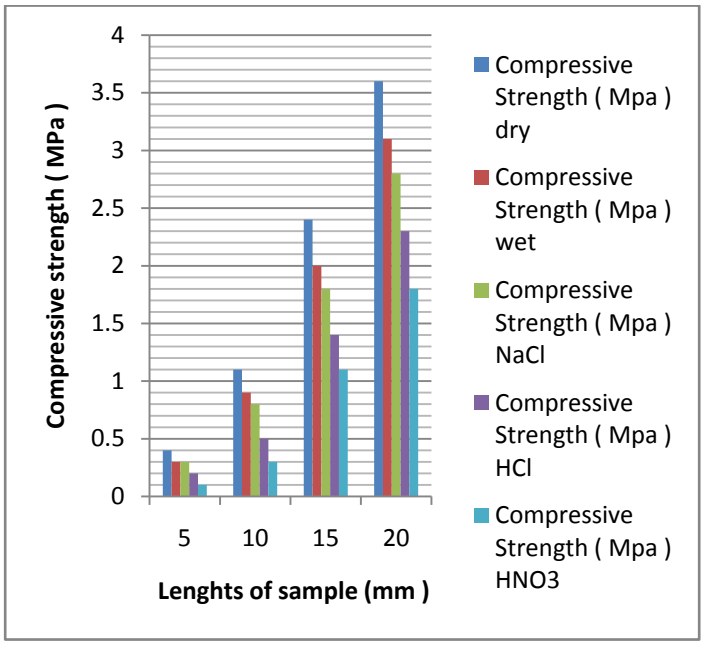

Figure (12) Compressive strength under different condition in polyester / $CaCO_3$ 40 % wt composite

5 Conclusion

This analytical and experimental investigation on polyester composites samples has lead to the following conclusions:

1- Unfilled polyester samples has a quite resistance against (water ,40% NaCl , 40% HCl) in which the chemicals does not make cracks or deterioration or weights loss , while exposure of unfilled polyester samples to nitric acids 40 % causes loss weights of samples . as the sample length increases , the weights of the samples increases.

2- Addition of inorganic fillers (Mica , ATH and $CaCO_3$) decrease the weight values of the un filled polyester samples but increasing the weight values at different environmental condition even at corrosive mediums except for incorporation calcium carbonate $CaCO_3$ fillers 40 % wt which make polyester composites has a weak resistance against (HCl 40 % wt and HNO_3 40 % wt)

3- Mica is the best chemical resistance and reinforcing filler because it decrease the weight value of the pure polyester and this is necessary in polymer`s manufacture and has a good resistance against chemical specially corrosive substance and does not make changes in the structure of the polyester.

4- The water absorbency values in unfilled polyester are higher than the water absorbency values in filled polyester. Mica 40% wt has alow water absorption much lower than aluminum tri hydrate 40 % wt and calcium carbonate 40% wt .So Mica is the best fillers to minimize water absorption by polyester samples.

5- Flashover voltage values and compressive strength values are affected by different environmental conditions , at dry condition the un filled poly ester specimens have a lower flashover voltage value than its value of samples containing (mica , aluminum tri hydrate , calcium carbonate) .
6- The best fillers that improves the flashover voltage values is ATH fillers this is due to aluminum tri hydrate fills the pores so the surface become smooth and the leakage current egged path for passage . while in unfilled condition the surface of the samples is rough which make a leakage current passes easily .
7- The compressive strength values of un filled poly ester specimens lower than its values of samples containing (mica , aluminum tri hydrate , calcium carbonate) .
8- The best compressive strength value is for Mica fillers 40 % wt better than other fillers (ATH and $CaCO_3$) loaded to the pure polyester samples .

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