International Journal of Latest Research in Science and Technology **ISSN (Online):2278-5299**
Volume 5, Issue1: Page No142-145, January-February 2016
https://www.mnkpublication.com/journal/ijlrst/index.php

MECHANICAL EVALUATION OF POLYVINYL-ACETATE (PVA)-POLYOL AND KAOLIN SPECIMENS

Thamir Salman Bachari
Polymer Research Centre-Material Science Department-Basrah University,
Iraq

Abstract- Specimens of polyvinyl-acetate (PVA)-polyol blend by percentages by weight 3:1 have been prepared with percentage by weight of kaolin (20wt%) at different particles size (75µm, 212µm, 300µm, 600µm and 2.36 mm.) as dumbbell shape. These are specimens (1, 2, 3, 4 and 5). Tension test of these specimens were measured such as tensile modulus, begin (σlow), tensile modulus, end (σhigh), tensile strength (σM) and tensile strength at break (σB). The measured values of tensile strength (σM) of specimens (1, 2, 3, 4 and 5) are (1.41, 0.731, 0.873, 1.55 and 0.880 MPa), the tensile strength at break is (0.955, 0.461, 0.537, 1.23 and 0.657 MPa). The calculated values of final lengths at break according to the adjustment gauge length of the machine are Lo = 60 mm. at both ends of the specimens are (65.949, 68.304, 66.913, 67.224 and 65.112 mm). These values are investigated.

Keywords: PVA, Polyol, Kaolin, Specimens, Mechanical evaluation.

I. INTRODUCTION

Fiber reinforced composites are certainly widely used. There study and development have largely carried out due to their vast structural potential and also concept and technology of fibre reinforced polymer composites have undergone a sea change with better understanding of the fundamentals like bonding mechanism between the matrix and fiber reinforced, fiber orientation, fiber reinforcement size, distribution and morphological features etc. fiber reinforced polymer composites have steadily gained applications in the fields industry require rubber like materials composites. This appeal is due to primarily to their high strength-to-weight ratio, tailorable mechanical behavior and fatigue resistance. Polymeric composites are susceptible to mechanical damages if they are subjected to efforts of compression, tension and flexural, these can lead to interlayer delaminating [k. G. Satish et al (2010)]. Many of our technologies require materials with unusual combination that cannot be met by the conventional constituents. The technique uses reinforced polymer composites use polymers either thermoplastics or thermoset, as matrix and fibers of various types as reinforcement. The purpose of the matrix material is to bind the fibre together [S. A. Altaf et al (2011)]. Fillers are used along with various commodity as well as engineering polymers to improve materials composites and reduce the cost.

In-corporating inorganic filler into plastic resin improves various physical nature of the materials such as mechanical strength, modulus etc. in general the mechanical behavior of particulate filled polymer composites depend strongly on size, shape and distribution of filler particles in polymer matrix. As fillers, mica, kaolin, calcium carbonate and talc are the most often used to reduce both the production cost and to improve nature of thermoplastic, such as rigidity, strength, hardness, modulus, dimensional stability, crystalline, electrical and thermal conductivity. The fillers affect ultimate mechanical behavior in two ways (i) they act directly as harder particles with determined (shape, size and modulus) and (ii) they affect crystallization processes in polymer matrix and ultimate super molecular structure of semi crystalline polymer[S. N. Mustafa, (2012)]. In order to predict their mechanical behavior not only intrinsic of the resin, filler and volume fractions of both constituents are important, but geometrical factors such as filler aspects ratio, particle size and mean particle distance are also important parameters to be taken into account. Many authors have dealt with problem of the existing theories to predict the mechanical evaluations and the effect of the above-cited geometrical parameters on the mathematical behavior of particulate filled resin matrix composites [J. R. M. D, Almeida, et al (1988)]. High strain rate loading is probable in many of the applications that is fiber reinforced polymer composites find use as candidate materials. It has always been a cause for concern that the mechanical behavior of composite materials may be poor at high rates of strain. Hence, study how the mechanical behavior of these composites would change with strain rate is warranted to be able to design structures that would not fail prematurely and unexpectedly at high loading rates. Various test methods have different advantages and limitations and must be chosen appropriately to to produce good and comparable results [G. C. Jacob et al (2004)]. If a polymer deformed, the stress increased with strain. Typically the behavior of these can be related to their stress-strain curves. Test may be performed in shear, flexure, compression, torsion or tension. Typical high elasticity of rubber arises from its molecular structure. The polymer molecule are long, flexible, coiled and take up random configurations under Brownian motion. They are straightened out by deformation under applied force. Either the force is released the spring back to random shapes as fast as their thermal motion allows, or cut is happened at break region [A. K. Bhowmick, (2014)]. The point at is fixed at a

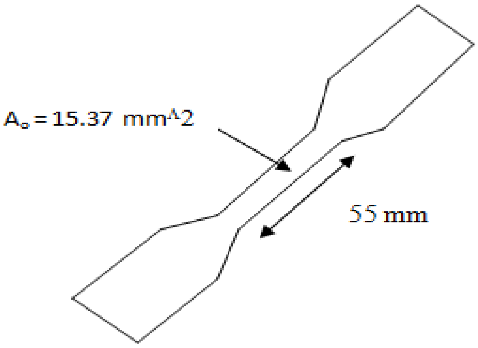
Publication History
Manuscript Received : 12 February 2016
Manuscript Accepted : 20 February 2016
Revision Received : 26 February 2016
Manuscript Published : 29 February 2016

straight line behavior ceases is called the limit of proportionality, beyond this the material will not spring back to its original shape and is said to exhibit some plastic behavior. The stress that the material starts to exhibit permanent deformation is called elastic limit or yield point, if the stress increases beyond the yield point the sample will eventually break. The term ultimate tensile strength is used for the maximum value of the tensile stress that the material can withstand without breaking and is calculated at the maximum tensile force divided by the original cross-sectional area [Hooke's Law (2014)].

II. EXPERIMENT:

Specimens Preparation:

Dumbbell shape specimens has been cut into polyethylene sheet with dimensions 120 mm. in length, 5.3 mm. the width of the neck and 55 mm. the neck length as shown in Figure (1). PVA has been blend with polyol by percentages by weight 3:1 and wt 20% kaolin with different particles sizes were sieved to (75µm, 212µm, 300µm, 600µm and 2.36 mm.) of PVA-polyol weight have been mixed. The mixture has been poured into the specimens and the specimens were left over night to be dried, and the specimens have been taken off from the polyethylene sheet for tension test by using Zwick Roll machine. Table (1) shows the specimen preparation and calculations of change in length of specimens at tension test.



Tension Test:

Tensile strength testing machine sort Zwic Roell serial no. 197735/2011, Germany, has been used for the samples tension test. Tensile test was carried out at crosshead absolute 213.508 [mm]. The results are as shown in Table (2). The results were obtained, referred to tensile modulus (E_t), the tensile strength (σ_M), yield strength (σ_Y), tensile strength at break (σ_B), strain at tensile strength (ε_M), strain at yield (ε_Y) and break (ε_B). The elongation (e) can be determined by using the formula:

$$e\% = (\Delta L/L_o) * 1000 \qquad (1)$$

Where L_o is the initial length of the sample in mm is equal to 60 mm. ΔL the change in length after applied force in mm. is equal to $L-L_{o,}$ L is the final length after applied force in mm.

The maximum force applied is 25 Newton at specimen 4 as shown in Figure (1). The tensile strength (σ_M) can be calculated by the following equation [A. Grujic, et al., (2010)]:

$$\sigma_M = \frac{Fmax}{b.d} \qquad (2)$$

Where Fmax is the maximum force applied on the specimen in Newton. b: is the width of the specimen in [mm]. d: is the thickness of the specimen in [mm]. The tensile modulus E of the investigated composite material can be calculated by the equation:

$$E = \frac{\Delta\sigma}{\Delta\varepsilon} = \frac{\Delta F}{\Delta\varepsilon} \cdot \frac{1}{b.d} \qquad (3)$$

Where the ratio Δσ/Δε is determined by linear regression method from linear portion of stress strain curves.

Table (1) shows the specimens preparations and calculations of specimens change in length.

Sample No.	PVA gm.	Polyol gm	Wt% kaolin	Total weight gm.	Particle size µm.	ΔL mm. break	Lmm. Final at break
1	12	4	20%	19.2	75	5.946	65.946
2	12	4	20%	19.2	212	8.304	68.304
3	12	4	20%	19.2	300	6.918	66.918
4	12	4	20%	19.2	600	7.224	67.224
5	12	4	20%	19.2	2.36	5.112	65.112

Parameters for the report:

Customer :
Job no. :
Test standard :
Type and designation of :
Material :
Specimen removal :
Specimen type :
Pre-treatment :
Tester :
Note :
Machine data :

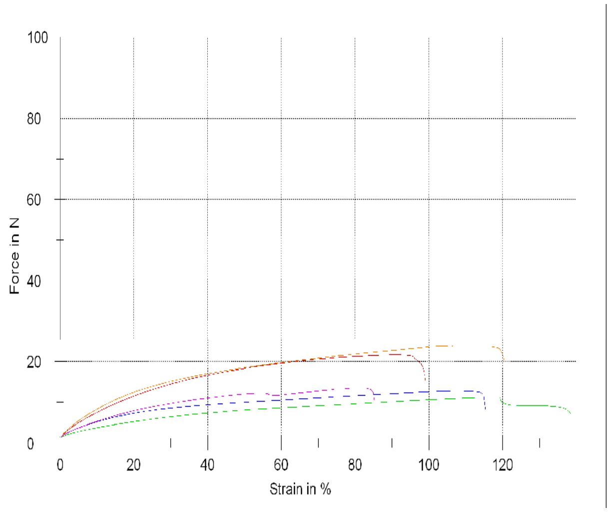
Results Table: (2).

	σ_{low} MPa	σ_{high} MPa	E_t MPa	σ_Y MPa	ε_Y %	σ_M MPa	ε_M %	σ_3 MPa	$\varepsilon_{B\%}$	H mm	b mm	A_0 mm^2
Nr												
1	0.0915	0.0921	0.782	-	-	1.41	91.8	0.955	99.1	2.9	5.3	15.37
2	0.0958	0.0939	-1.07	-	-	0.731	117.6	0.461	138.4	2.9	5.3	15.37
3	0.0944	0.0939	-0.321	-	-	0.837	108.1	0.537	115.3	2.9	5.3	15.37
4	0.0919	0.0937	0.921	-	-	1.55	105.8	1.23	120.4	2.9	5.3	15.37
5	0.0950	0.0943	-0.439	-	-	0.880	80.5	0.657	85.2	2.9	5.3	15.37

Statistics Table:

Series	σ_{low}	σ_{high}	F_t	σ_Y	ε_Y	σ_M	ε_M	σ_D	ε_D	h	B mm	A_0
n = 5	MPa	MPa	MPa	MPa	%	MPa	%	MPa	%	mm		mm^2
x	0.0937	0.0936	-0.0253	-	-	1.08	100.7	0.767	111.7	2.9	5.3	15.37
s	0.00191	0.000872	0.851	-	-	0.371	14.6	0.318	20.4	0.000	0.000	0.00
ν	2.04	0.93	-	-	-	34.33	14.50	41.47	18.28	0.00	0.00	0.00

Curve graph:(2)



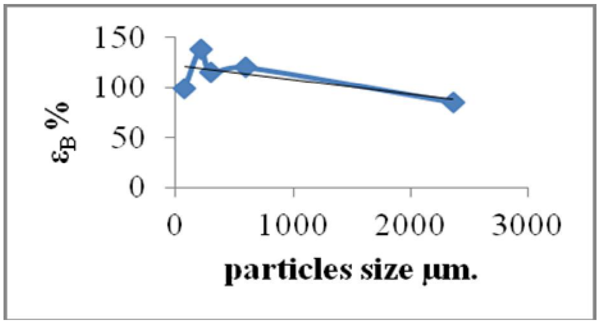


Fig.(3). The relation between εB % at break and particles size of kaolin

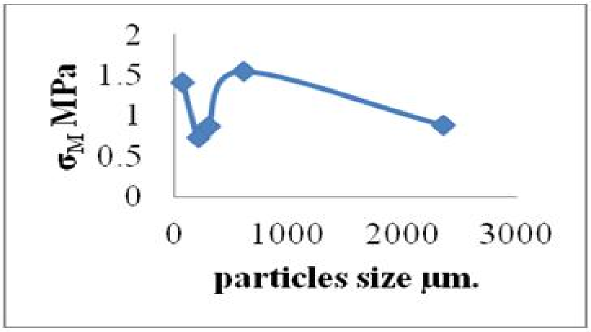


Fig.(4). The effect of particles size on tensile strength σM

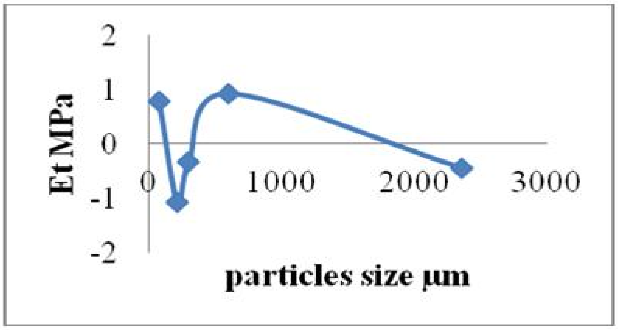


Fig.(5). The dependence of tensile modulus on the particles size of kaolin

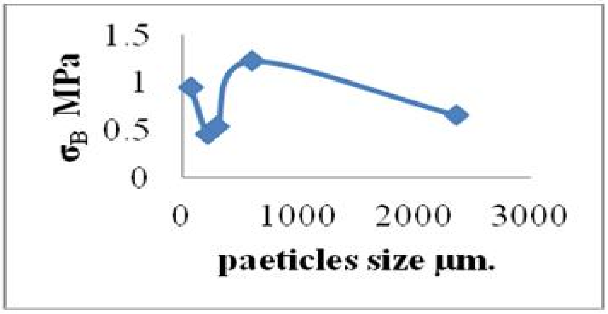


Fig.(6). The relation between tensile strength at break with particles size

III. RESULTS AND DISCUSSION:

Table (1) shows the specimens preparations and the calculations of change in length and the final length at break for particles size of kaolin [(75, 212, 300, 600) µm, and 2.36 mm]. The dumbbell shape specimen in Figure (1) has been used for preparing specimens of PVA-polyol and kaolin mixture, for tension test. Table Results (2) shows the compressions modulus at begin (σ_{low}) and end (σ_{high}) exerted by the machine on the specimens are identical. The calculated values of ΔL in specimens are (5.946, 8.304, 6.918, 7.224 and 5.112 mm.). for specimens (1, 2, 3, 4 and 5) for wt 20% kaolin and particles size are (75, 212, 300, 600 µm, and 2.36 mm), to total weight of PVA and polyol. The curve graph (2) shows the relation between the force applied by the machine on the specimens at different particles size with the percentage of strain, the relation indicates increase in ε_B % with increasing particles size at sample (2) wt 20% kaolin to total weight of PVA and Polyol at particle size 212 µm. to the value 138.4 and sample (4) 600µm of kaolin size particle to the value 120.4% as shown in Figure (3). Figure (4) shows the effect of particles size of specimen on the tensile strength σ_M that is indicated increases in σ_M at sample (1) 75 µm. particle size to the value 1.44 MPa and sample (4) particle size is 600 µm. to the value 1.55 MPa. And minimum value was indicated at specimen (3) particle size is 300 µm., to the value 0.731 MPa. Figure (5) shows that the dependence of tensile modulus on the particles size of kaolin. The positive values were indicated at specimen (1) particle size is 75 µm. to the value 0.782 MPa. And specimen (4) particle size is 600 µm. to the value 0.921 MPa. The negative values were indicated at specimen (2) particle size 212 µm. to the value -1.07 MPa, specimen (3) particle size is 300 µm. to the value -

0.321 MPa. And specimen (5) particle size is 2.36 mm. to the value -0.439 MPa. The tensile modulus for sample (3) -0.321 MPa, indicates that the residual deformation of the specimen is very small [A. M. Bragov, et al., (1994)]. Figure (6) shows the relation between the tensile strength at break σ_B with particles size of kaolin. The maximum value of σ_B is indicated at specimen (4) particle size is 600 µm. to the value 1.23 MPa. And minimum value was obtained at specimen (2) particle size is 212 µm. there is a critical particle size above this particle size there is no effect on composite modulus [T. S. Bachari (2014)]. When the particle size is below this critical value the effect on composite modulus is more significant. The magnitude of this particle size cannot be predicted a prior for depends on the particle matrix and particle matrix adhesion [S. Y. Fu, et al (2008)]. There are three distinct regions were indicated for the entire specimens, these are the linear region that Hooke's Law is applicable was so short and was appeared like end cut with second region the yield region. While the proportional limit is begun at the second region, this is indicated at the deflection in line of the curve. In this region, there is gradually increased in the proportional limit with increasing particle size of kaolin the tensile stress σ_M (1.41, 0.731, 0.837, 1.55 and 0.880 MPa) for specimens (1, 2, 3, 4 and 5) particles size are (75, 212, 300, 600 µm and 2.36 mm) [J. R. M. D' Almeida, et al., (1988)]. The measured values at the third region, the break region, of tensile strength at break are σ_B (0.955, 0.462, 0.537, 1.23 and 0.657 MPa). For specimens (1, 2, 3, 4 and 5) to wt 20% kaolin particles size are [(75, 212, 300, 600 µm. and 2.36 mm) these are the same behavior of σ_M [S. N. Mustafa (2012)]. The dispersion of the particles differs with particle content and particle size that is determining the properties of the composites. For a certain size particle, the dispersion in composite changes with content[S. Zhang, et al (2011)]. The deformation at this region is irreversible, results from the displacement in the molecules in content of PVA-polyol and kaolin mixture and end in cut of specimens. The development of polymer composites have largely carried out due to their vast structural potential and concept of technology of reinforced polymer composites have undergone a sea change with better understanding of the fundamentals like the bounding mechanism between matrix and kaolin size particles and distribution, morphological features etc. Polymer composite are intensively studied for the new concepts, these are given by the combination of both polymer matrix and kaolin and binds together a cluster or fragments of a much stronger material (the reinforcement) respectively[Y. P. Mamunya, et al (2002)].

IV. CONCLUSIONS:

Particles sizes of kaolin mixed with PVA-Polyol have been chosen for determination high performance of ultimate mechanical of polymer composites.

Compression modulus at begin (σ_{Low}) and end (σ_{high}) areidentical. The first region was indicated as end cut with second region. The yield stress σ_Y and elongation at yield ε_Y% are not measurable quantities by the machine, due the flexible specimens have been used to tension test and the quick recorded of the machine. The third region was indicated by the behavior of the curve rather than the measurements of σ_B. Measurements of σ_B and σ_M were showed the same behaviors. Uniform particle distribution and good adhesion between polymer matrixes and filler were obtained, these are crucial for superior mechanical behaviors'.

REFERENCES

[1] K. G. Satish, B. Siddeswarappa and K. M. Kaleemulla, (2010), Characterization of In-Plane Mechanical Properties of Laminated Hybrid Composites, Journal of Minerals& Materials Characterization & Engineering, Vol. 9, No.2, pp.105-114.

[2] S. N. Mustafa, (2012), Effect of Kaoline on the Mechanical Properties of Polypropylene/Polyethylene Composite Material, Diyala Journal of Engineering Sciences, Vol. o5, No.02, pp.162-178.

[3] S. A. Altaf, Dr. V. Pandurangadu and Dr. K. Palanikuamr, (20110, Mechanical Properties of Green Coconut Fibre Reinforced HDPE Polymer Composite, international Journal of Engineering Science and Technology (IJEST), Vol.3 No.11, pp.7942-7952.

[4] J. R. M. D, Almeida and L. H. De Carvalho, (1988), An Investigation on the Tensile Strength of Particulate filled polymer Composites, Journal of Material Science 33, pp. 2215-2219.

[5] G. C. Jacob, J. M. Starbuck, J. F. Fellers, S. Simunovic and R. G. Boeman, (2004), Strain Rate Effects on the Mechanical Propoerties Of polymer composite Materials, Published online in Wiley Interscience (www.interscince.wiley.com), pp.296-301.

[6] A. K. Bhowmick, (2014), Mechanical Propertes of Polymers, Materials Science and Engineering-Vol.1, © Encyclopedia of Life support Systems (EOLSS).

[7] Hook's Law (2014), Mechanical Properties of Metal.

[8] A. Grujic, N. Talijan, D. Stojanovic, J. Stajic-Trosic, Z. Bruzic, Lj. Balanovic and R. Aleksic, (2010), Mechanical and magnetic Properties of composite Materials with Polymer Materix, J. Min. Metall. Sect. B-Metall. 46 (1), pp.25-32.

[9] A. M. Bragov and A. K. Lomunov, (1994), Mechanical Properties of Some Polymers and Composites at Strain Rates of 1000/s, Journal of DE Physique IV, Collogue C8, Supplement au Journal de Physique III, Volume 4, pp. C8-337-C8-342.

[10] S. Y. Fu, X. Q. Feng, B. Lauke and Y. W. Mai, (2008), Effect of particle Size, Particle/Matrix Interface Adhesion and Particle Loading on Mechanical Properties of Particulate-Polymer Composite, Science Direct, composites Part B: Engineering (39), pp.933-963.

[11] T. S. Bachari (2014), Mechanical Propeties of Polyvinyl-Acetate and toluene Diisosyanate and Sulfonated Phenol-Formaldehyde)SPF) Foam Composites, Journal of Natural Sciences Research, IISTE Publisher, Vol.4, No. 21, pp. 59-64. 12- S. Zhang, X. Y. Cao, Y. M. Ma, Y. C. Ke, J. K. Zhang and F. S. Wang, (2011), the effect of Particle Size and Content on the Thermal conductivity and Mechanical Properties of Al2O3/high density polyethylene (HDPE) Composites, eXPRESS Polymer Letters Vol. 5, No. 7, pp.581-590.

[12] Y. P. Mamunya, V. V. Davydenko, P. Pissis and E. V. Lebedev, (2002), Electrical conductivity of Polymers Filled with Metal Powders, Elsevier Science Ltd. European Polymer Journal 38, pp.1887-1897.

[13] Y. P. Mamunya, V. V. Davydenko, P. Pissis and E.

V. Lebedev, (2002), Electrical Conductivity of Polmers Filled with Metal Powders, Elsevier Science Ltd. European Polymer Journal 38, pp.1877-1897.