Asian Journal of Chemistry; Vol. 31, No. 7 (2019), 1473-1475

ASIAN JOURNAL OF CHEMISTRY

https://doi.org/10.14233/ajchem.2019.21775

Unsaturated Polyester Composite Filled Clam Shells (*Anadara granosa*): Effect of Tensile Strength, Elongation Break and Water Absorption

M.H.S. Ginting*, R. Hasibuan, M. Lubis, B. Tanujaya, F. Suwito, F.A. Winoto and R.C. Siregar

Department of Chemical Engineering, Universitas Sumatera Utara, Jalan Almamater, Medan 20155, Indonesia

*Corresponding author: E-mail: hendra.ginting@usu.ac.id

Received: 23 October 2018; *Accepted*: 12 February 2019; *Published online*: 21 May 2019; AJC-19399

The object of this study was to determine the effect of variations in the composition of clam shells (0, 1, 2, 3, 4, and 5 % wt.) on the properties of tensile strength, elongation at break and water absorption polyester composite filled clam shells (*Anadara granosa*). The method of making composites using two parallel plate molding, polyester mixture and clamshell (*Anadara granosa*) was put into a molding pressure at 125 psi through two parallel plates for 40 min. The results showed the effect of variations of clam shell fillers (*Anadara granosa*) affected the properties of tensile strength and elongation at break and water absorption. The highest tensile strength was 97:3 (% wt.) 17,785 MPa, elongation at break condition (100:0) 9.766 % and water absorption 0.811 %.

Keywords: Clam shell, *Anadara granosa*, Polyester composite, Plate molding.

INTRODUCTION

The composite materials is growing rapidly in the automotive and constructive industries, especially those composites which consist of unsaturated polyester resin matrices. It has low viscosity and hardness at room temperature when a catalyst is added. Polyester resins have rigid and slightly brittle properties, more thermal resistance to heat, flexible insulation properties, and adhesion chemical resistance, which are easy to process, molding and affordability [1].

To improve the mechanical properties of polyester resin, fillers are added. Fillers of polyester resin composites are usually fibers glass, because of compatibility between the matrix properties and fillers [2]. Natural fillers and compounds of fiber glass with natural fillers [3] are tends for polyester composites produced to have good mechanical properties.

Research on unsaturated polyester resin filled with natural ingredients has been carried out, using clam shells [4], lontar fruit fibers [5], eggshell powder [6], snail skin powder [7] and $CaCO_3$ [8]. In this study the fillers used are clam shells. Utilization of clam shells research in Indonesia is not optimal because it is used as a craft or decorative art. Clam shells contains calcium carbonate compounds of 94-99 % (total overall weight of shell) [9-13] carbonate groups (CO_3^{2-}), 0.51 % magnesium and 0.078 % silicates (Si-O). Clam shells as mineral fillers are hydrophilic and provide good interaction with the polyester matrix.

The use of clam shells as mineral fillers are expected to produce composite products to be a strongest mechanical properties, so that in the future this composite product can be used as an alternative to automotive and construction basic materials. The purpose of this study is to determine the effect of clam shell filler composition on tensile strength, elongation at break and water absorption of polyester composite

EXPERIMENTAL

Clam shells as fillers were obtained from restaurants in seafood restaurants around Jl Yos Sudarso, Medan, Indonesia randomly chosen, while other chemicals *viz*. unsaturated polyester resins as matrices and methyl ethyl ketone peroxide (MEKPO) as catalysts were purchased from PT Justus Kimia Raya, Medan, Indonesia.

Fillers: Clam shells (*Anadora granosa*) are washed with mineral water to remove mucus and dirt. It is dried under the sun for 12 h. Dry clam shells are grounded using a ball mill become particles for 8 h. Clam shells particles are sieved up to 170 mesh particle size.

Polyester matrix: Unsaturated polyester resin with variations are mixed with MEKPO catalyst 1 % wt. of resin weight [14-16]. The mixture is stirred by using a mixing device made of iron for 10-15 min until homogeneous.

Preparation of composite: This polyester composite is made by mixing matrix dough and fillers: 100:0; 99:1; 98:2; 97:3; 94:4; 95:5 (% wt.) into 200 mm × 200 mm × 3 mm iron plate mold which is especially smeared with lubricant such as glycerin so that the resin is not attached to the mold. The mold was pressed at a pressure of 125 psi for 40 min [3]. The dried composite is removed from the mold and smoothing at the surface with a sandpaper.

Tensile strength and elongation at break: A composite size of 200 mm × 200 mm × 3 mm made of dumble form specimens, tested for tensile strength and elongation at break according to ASTM D 638 using servo control computer system universal testing machine AI-7000 M model Capacity 2000 kg, Power 1Φ 220 V 50 Hz. This tool load is 100 kgf with a speed of 50 mm/min.

Water absorption: Water absorption characteristics were tested by soaking in water at room temperature every 12 h until the composite material not longer absorbed water (saturated). Specimens were made with a size of 25 mm × 25 mm × 3 mm according to ASTM D570, at each time period of immersion, the sample is taken and cleaned with tissue paper to absorb water. The sample is weighed and calculated by the following equation:

$$w_g = \frac{w_e - w_o}{w_o} \times 100\ \% \qquad (1)$$

where: w_g = percentage of composite weight gain; w_e = composite weight after immersion; w_o = weight of composite before immersion.

FTIR analysis: FTIR spectra was analyzed from Prestige-21 Fourier Transform Infrared Spectrophotometer with A21-004602022 LP Series Number, Power 220-240 V 50/60 Hz produced by Shimadzu Corporation.

RESULTS AND DISCUSSION

Tensile strength: The greater the value of tensile strength of a material means that a larger force is needed to break the material. The effect of variations in clam shell filler composition on the tensile strength properties of unsaturated polyester composites is presented in Fig. 1.

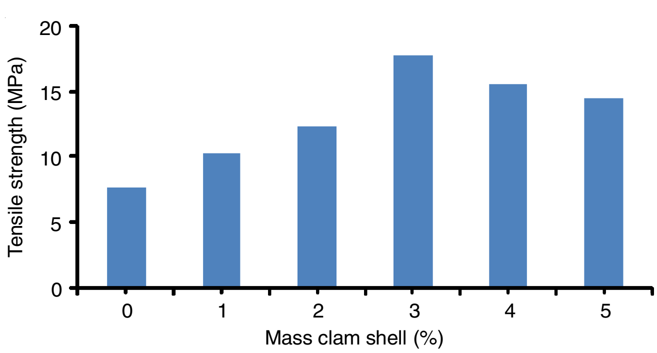

Fig. 1. Effect of variations in the composition of clam shells on the tensile strength properties of polyester composites

Tensile strength increased along with the addition of clam shells, The highest tensile strength at the composition of 3 % clam shells filler is 17.785 MPa. The increase in tensile strength is caused by the clam shell being good distributed into the polyester matrix. The addition of mineral fillers to polymeric materials increase the composite tensile strength and calcium carbonate is a hydrophilic filler which can provide good interaction with polyester matrix. Hydrophilic groups from the surface of calcium carbonate interacted with OH group of polyester polymer chains. This increased tensile strength is also supported by Yilmaz *et al.* [13].

Fig. 1 showed the tensile strength decreased when filler composition is increased to 4-5 %. As the filler particles formed a larger agglomerated and uneven particle distribution, so the tensile strength decreased. The same observations are also reported by Yusof and Amalina [14] that increased filler content (wt. %) decreased the tensile strength.

Elongation at break: The effect of variations using clam shells filler composition on elongation at break properties is presented in Fig. 2. The elongation at break properties decreases along with the addition of clam shell mass. The greatest at the composition of 0% filler which is 9.766 %. This decrease is caused by more clam shell being distributed into the polyester matrix, so the composite material becomes more rigid, but in other side the elasticity decreases [13]. The higher of filler content, the lowering elongation properties. High tensile strength has an impact on decreasing the elongation at break. The properties of tensile strength are inversely proportional to elongation at break.

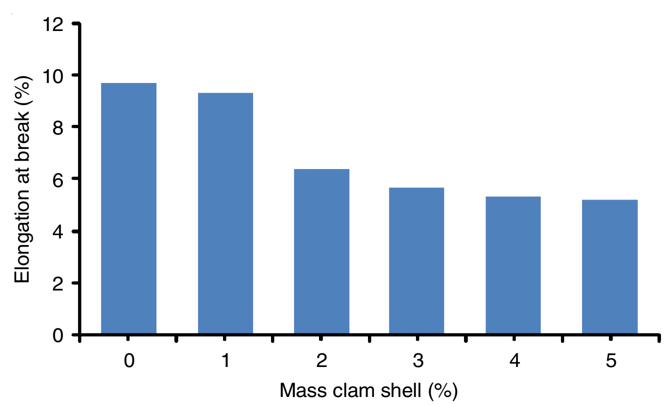

Fig. 2. Effect of clam shell filler composition variations on elongation at break properties polyester composites

Water absorption: The purpose of analyzing water absorption properties to find out whether a composite can be damaged if submerged in water. When the composite is soaked in water, the water will be diffused into the composite, and can damage the composite structure from the inside so as to reduce the composite mechanical of properties The effect of absorption time variation on water absorption of clam shell composites is shown in Fig. 3.

Fig. 3 showed that the highest water absorption in first 24 h (0.811 %) reached the saturation point, where the polyester composite:clam shell (97:3) does not absorb water any more and the water content in the composite remains constant. This water absorption is influenced by clam shells (*Anadara granosa*). This mineral component is finely distributed into the matrix

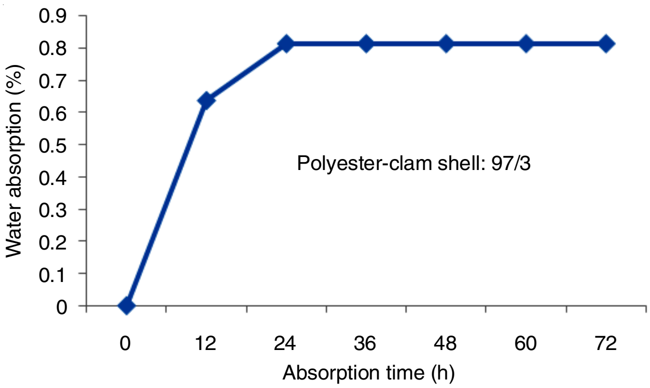

Fig. 3. Effect of absorption time variation on blood shell composite water absorption

and the resulting composite has a tight porosity, so the water absorption is small.

FTIR analysis: The results of FTIR of polyester composite filled with clam shells, unsaturated polyester and particle clam shell are shown in Fig. 4. Fig. 4 showed the absorption bands at 1701.22 cm^{-1} which is attributed to carbonyl stretch group (C=O), band at 1600.91 cm^{-1} is stretched due to aromatic ring group, unsaturated bonding (C=C) at 1070 cm^{-1} as deformation peak. Meanwhile the FTIR of composites shows additional peak at 1268-1132 cm^{-1} assigned as vibration of asymmetric stretching of Si-O-Si bonds and the band at 996 cm^{-1} is Si-OH because clam shell particles contained silicate groups, which is supported by Sudirman *et al.* [16].

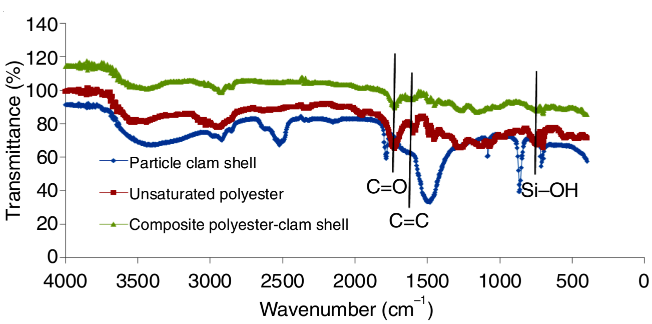

Fig. 4. Analysis of Fourier transform infrared polyester composites filled with clam shells, Unsaturated polyester and particle clam shell

Conclusion

Addition of clam shells (*Anadara granosa*) as filler in unsaturated polyester composite increased the tensile strength, elongation break and also its water absorption capacity. The highest tensile strength is achieved at the composition of 97.3 wt. %, 17,785 MPa, while the elongation break is greatest at composition (100: 0), 9,766% and water absorption is found to be 0.811 %.

ACKNOWLEDGEMENTS

This research is supported by Ministry of Research and Technology and the Higher Education Republic of Indonesia (PDUPT Implementation of year 2018 Contract Number: 58/ UN5.2.3.1.R/ PPM/2018; dated 5 February 2018).

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

REFERENCES

1. M. Malik, V. Choudhary and I.K. Varma, *J. Macromol. Sci. Part C: Polym. Rev*., **40**, 139 (2007); https://doi.org/10.1081/MC-100100582.
2. A. Kausar, *J. Plastic Film Sheet*., **35**, 22 (2019); https://doi.org/10.1177/8756087918783827.
3. T. Sathishkumar, J. Naveen and S. Satheeshkumar, *J. Reinf. Plast. Compos*., **33**, 454 (2014); https://doi.org/10.1177/0731684413516393.
4. Y. Mahshuri and M.A. Amalina, *Mater. Res. Innov*., **18**, S6-291 (2014); https://doi.org/10.1179/1432891714Z.000000000970.
5. M. Matasina, K. Boimau and J.U.T. Jasron, *J. Teknik Mesin Undana*, **1**, 91 (2014).
6. S.B. Hassan, V.S. Aigbodion and S.N. Patrick, *Tribol. Ind.*, **34**, 217 (2014).
7. C.I. Madueke, B. Bolasodun and R. Umunakwe, *IOSR J. Polym. Textile Eng.*, **1**, 39 (2014).
8. J. Kiehl, J. Huser, S. Bistac and C. Delaite, *J. Compos. Mater.*, **46**, 1937 (2012); https://doi.org/10.1177/0021998311427780.
9. V. Fombuena, L. Bernardi, O. Fenollar, T. Boronat and R. Balart, *Mater. Des.*, **57**, 168 (2014); https://doi.org/10.1016/j.matdes.2013.12.032.
10. A.J.A. Hazmi, A.B.Z. Zuki, M.M. Noordin, A. Jalila and Y. Norimah, *J. Anim. Vet. Adv.*, **6**, 591 (2007).
11. M. Mohamed, S. Yusup and S. Maitra, *J. Eng. Sci. Technol.*, **7**, 1 (2012).
12. A.S. Kamba, M. Ismail, T.A.T. Ibrahim and Z.A.B. Zakaria, *J. Nanomater.*, **2013**, Article ID 587451 (2013); https://doi.org/10.1155/2013/587451.
13. M.G. Yilmaz, H. Unal and A. Mimaroglu, *Express Polym. Lett.*, **2**, 890 (2008); https://doi.org/10.3144/expresspolymlett.2008.104.
14. M. Yusof and M.A. Amalina, *Key Eng. Mater.*, **594-595**, 57 (2013); https://doi.org/10.4028/www.scientific.net/KEM.594-595.57.
15. L.A. Pothan, Z. Oommen and S. Thomas, *Compos. Sci. Technol.*, **63**, 283 (2003); https://doi.org/10.1016/S0266-3538(02)00254-3.
16. M. Sudirman, M. Anggaravidya, E. Budianto and I. Gunawan, *Procedia Chem.*, **4**, 107 (2012); https://doi.org/10.1016/j.proche.2012.06.016.