Effect Of Compatibilizer and Kolanut Filler Contents on the Sorption Characteristics of Low Density Polyethylene Composite

Onuegbu G. C., Anyiam C. K., Akanbi M. N., Obidiegwu M. U. and Onuoha F.N.

ABSTRACT-The effect of kola nut filler and compatibilizer contents on the transport of benzene through low density polyethylene (LDPE) composite was studied at the following temperature 40^0C,60^0C and 80^0C .The kola nut powdered used was ground at 25µm particle size 0-5Wt% of kola nut powder and 0-2.5Wt.% of compatibilizer were mixed with 200g of low density polyethylene in an injection moulding machines. The injected polyethylene/kola nut composites were taken for sorption test. The sorption data obtained for kola nut powder filled low density polyethylene at the different temperature investigated were expressed as the molar percentage uptake (%Q_t) of solvent per gram of the kola nut composites. Results show that the solvent uptake for any particular solvent at the five filler content (0-5 Wt %) generally increased with increase in sorption temperature but decreased with increase in compatibilizer and filler contents.

Index Terms- Benzene, Compatibilizer, Composites, Filler Content, Sorption, Solvent, Polyethylene

1. INTRODUCTION

In order to overcome the draw backs of the addition of fillers, compatibilizer has to be added to reduce the repellence of the polymers and fillers respectively. As a result, the polymers will like the filler more, the filler will adhere better to the polymer matrix and the properties of the final mixture (flexibility, solubility of the filler in the polymer will be enhanced [1]. Such compatibilizers have to be on one hand compatible with the polymer (ideally they have to be the same chemistry of the polymer and on the other hand they have to react/interact or better glue to the filler. The most commonly used compatibilizers aretitanates, silananes, zirconates and organic acid, chromium chloride coordination complex.

Numerous studies have used graft copolymers of synthetic polymers (examples are polypropylene and polyethylene) and maleic anhydride (M.A.) as coupling agents for thermoplastic composites [2],[3]. In order to improve the similarity and adhesion between filler and thermoplastic matrices, several chemicals have been employed and maleated coupling agents were found most suitable for organic filler [4]. The coupling agent (M.A-PP or M.A.-PE) can modify the interface by interacting with both the filler and the matrix, thus forming a link between the components [5]. Kokta et al, studied the use of silanes as coupling agents with different combination of solvent and additives in thermoplastic composites [6].

- *Onuegbu G. C. currently lectures in Federal University of Technology Owerri , Nigeria, E-mail: gc_onuegbu@yahoo.com*
- *Anyiam C.K. is currently pursuing doctoral degree program in Polymer engineering in Federal University of Technology Owerri , Nigeria, E-mail chokuim@yahoo.com:*
- *Akanbi M. N., Obidiegwu M. U. and Onuoha F.N.currently lectures in Federal University of Technology Owerri , Nigeria*

The effect of compatibilizer on the transport characteristics of polymers has been studied by Boggoera et al [7].They studied jute fibre filled polypropylene and reported that the water absorption values of the composites increased with increase in the jute loadings and in the presence of the compatibilizer MAPP. The amount of water absorbed was found to decrease with increases in compatibilizer contents. Similarly, Alireza et al, studied the use of filled wood sample at 175, 190 and $205^{0C}$with different amounts of high density polyethylene and coupling agents. Water sorption thickness swelling and diffusion coefficients of composites were measured for a 4-week period. Immersion in water showed that composites with wood treatment at 190 ^{0}C and 205 ^{0}C had considerable high ware resistance. Addition of coupling agent reduced water sorption, thickness swelling and diffusion co-efficient. Diffusion co-efficient is more pronounced in composites with untreated wood .Treating wood at 190^0C resulted in good flexural properties and excellent water resistance [8]. Andizeg et al, reinforced polypropylene with wood fibre at different filler loadings in the presence of coupling agents (MAPP) and discovered that addition of coupling agent decreased the water sorption properties of the composites [9]. In a similar study, Smith investigated the effect of chemical modification on the mechanical properties, morphology and water absorption of low density polyethylene/egg shell powder composites. They concluded that the tensile strength and water sorption resistance of the modified LDPE/Egg shell powder composites are higher than that of unmodified low density polyethylene/ Egg shell powder composites [10].

2. MATERIALS AND METHODS

2.1 Materials

The low density polyethylene (LDPE) used in this study was bought from CEE PLAST Industry Limited, OsisiomaNgwa, Aba, Abia State, Nigeria. It is a product of INDORAMA group, a subsidiary of Eleme Petrochemical Company Limited, River State, Nigeria. It has a melt flow index of 0.4g/10min at 190^0C and density of 0.922g/cm ^{3}. The filler used in filling the low

density polyethylene is kola nut. It was bought locally from Ezinihitte Mbaise, Imo State, Nigeria. This was sun dried, crushed to fine powder and sieved to 25µm mesh size.
Compatibilizer: Maleic anhydride-grafted –polyethylene (MAPE) was used as compatibilizer
Reagent: Benzene was obtained from Sigma Aldrich Company, U.S.A.

2.2 Preparation of Polyethylene Composites

The low density polyethylene (LDPE) composites of kola nut powder(KN) were prepared by thoroughly mixing 200g of low density polyethylene with approximate filler quantities(0,1,2,3,4,and 5 wt%.). The composite were melted and homogenized with filler in an injection moulding machine at 173^0C and the resultant composites were produced as sheets.

2.3 Testings

0.2g of low density polyethylene and low density polyethylene composite samples were cut weighed and put into sample bottles with covers. Twenty millilitres of benzene was poured into the sample bottles. The thermostatic water bath 40^0C, $60\,^0$C and 80^0C for the sorption experiment. After equilibration at the required temperature, the sample bottles containing the weighed composite sample were put into the equilibrated water bath and allowed to equilibrate for times ranging from 30-510minutes at 30minutes intervals. At the expiration of required time, each sample was removed from the bottle using a forceps. The solvent adhering to the surface of the composites samples was removed carefully by pressing the samples between filter paper wraps. Care was taken to ensure that the solvents absorbed by the samples were not removed during the process of whipping the filter paper. The wet sample was weighed and the difference in mass between the dry and the wet sample were recorded. The experiment proceeded but equilibrium sorption was not reached. The molar percentage uptake of solvent per gram of the LDPE and LDPE/KN composites (Q_t) was expressed as .

$$Q_t = \frac{\Delta M}{M_0} / \text{Molar mass of solvent} \times 100 \quad \ldots\ldots\ldots\ldots\ldots (1)$$

M_0 =mass of dry sample (g)

WhereΔM = Change in mass (difference between the dry and wet samples)

3.0 Results and Discussion

3.1 Sorption Characteristics

Sorption Characteristics of LDPE and LDPE/KN at 0-5.% and 2µm particle size were studied at the following temperatures 40, 60 and 80^o. The sorption data obtained for the kola nut powder filled low density at the different temperature investigated were expressed as the molar percentage uptake (%Q_t)of Solvents per gram of the kola nut composites. The molar percentage uptake (%Qt) at any particular temperature and filler contents of the compatibilized LDPE/KN composites used were plotted against the square root of time and are shown in figures 1-5. Each of these figures shows initial increased in the mass of the solvent sobbed with time. This is in agreement with the work of Obasi et al, who investigated the transport of toluene through linear low density polyethylene/natural blends .They also found that the mass of toluene sobbed generally increased with time at the three temperatures investigated [11].

Figures 1-7 show that the benzene uptake for the solvent at the five filler content (0-5 wt.%) generally increased with an increase in temperature. This is due to the increase in heat energy of the solvent and the increase in mobility of the polymer. And this was observed by Johnson and Thompson (2000) who studied the effect of epoxidation on the transport behaviour and mechanical properties of natural rubber reported that the mole percentage of uptake of hexane in epoxidized rubber showed increased with increases in temperature. Similar observation on the above was also reported by Ismail and Suzaimah, who studied the swelling properties styrene butadiene Rubber/Epoxidized Natural blends [12].

Figure1-7 showed that the sorption of the benzene into LDPE was higher than those of compatibilized LDPE/KN because LDPE is an amorphous polymer. It was found that molar percentage uptake of the composites for the benzene at filler contents (0-5 wt. %) was generally decreased with increase in compatibility contents at any temperature. This is due to the strong interface between the filler and matrix which reduced the free volume of the composites. It is in agreement to the work of Alireza et al, who filled wood sample at 175, 190 and 205^0C with different amounts of HDPE and coupling agents [7].

The figures also show that the sorption of LDPE/KN composites decreased with increase in kola nut filler contents due to increase in cross link density. This observation is in agreement with the work of Ahmed et al, who investigated sorption properties of natural rubber/ linear low density polyethylene blend in toluene [13].

CONCLUSIONS

The effect of compatibilizer on the sorption characteristics of kola nut powder filler low density polyethylene has been studied. The molar percentage benzene uptake (%Q) in the filled LDPE was found to show increase in the mass of the absorbed benzene with time at a given temperature and filler contents. Benzene uptake of LDPE/KN composites increased with increase in sorption temperature but decreased with an increase in compatibilizer and filler contents.

ISSN 2229-5518

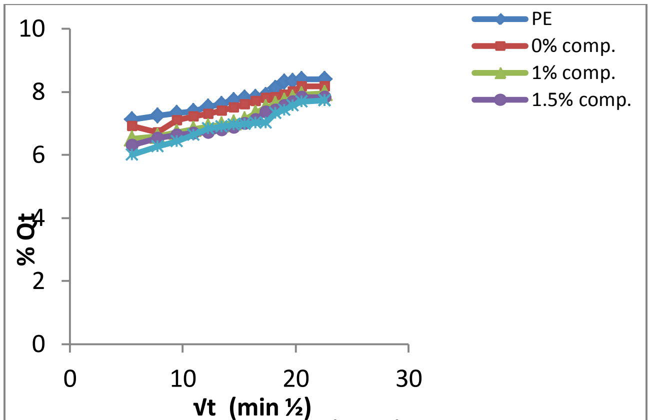

Figure 1 Plot of % Qt versus √t (min ½) for Kola nut powder (wt.% of Filler=1%) filled Low density Polyethylene in Benzene at different compatibilizer content at 40°C.

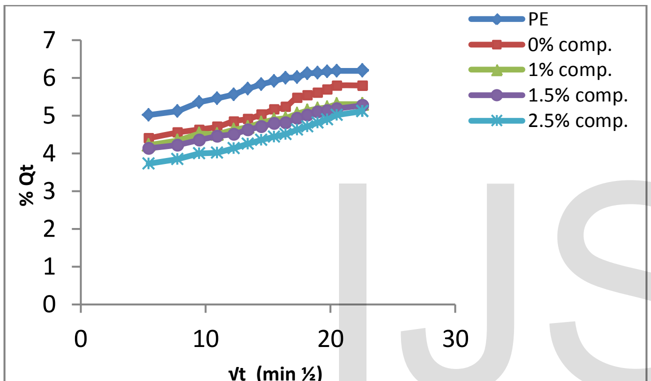

Figure 2: Plot of % Qt versus √t (min ½) for Kola nut powder (wt.% of Filler=3%) filled Low density Polyethylene in Water at different compatibilizer content at 40°C.

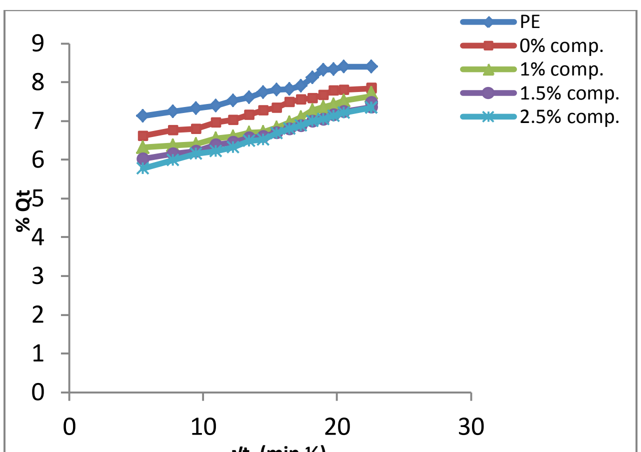

Figure 3: Plot of % Qt versus √t (min ½) for Kola nut powder (wt.% of Filler=4%)filled Low density Polyethylene in Benzene at different compatibilizer content at 40°C.

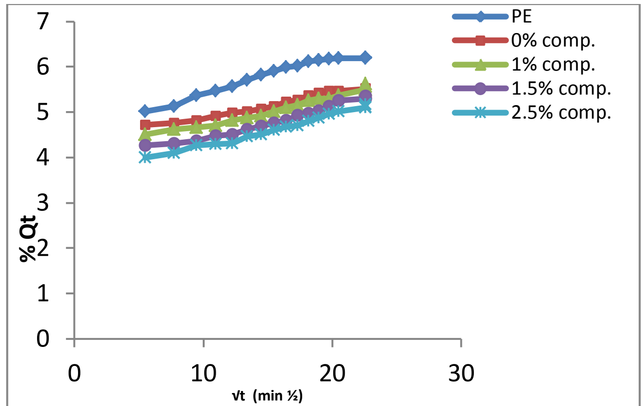

Figure 4: Plot of % Qt versus √t (min ½) for Kola nut powder (wt.% of Filler=1%) filled Low density Polyethylene in Water at different compatibilizer content at 40°C.

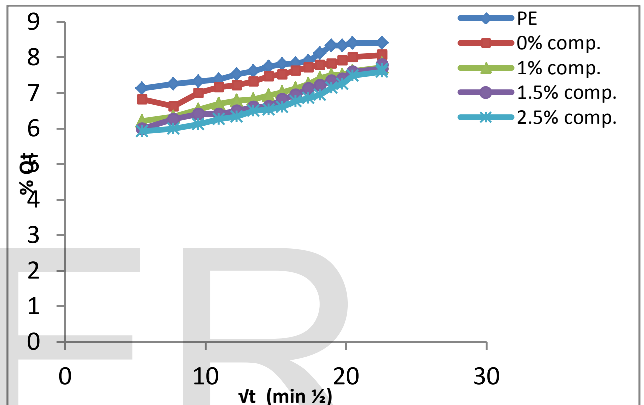

Figure 5: Plot of % Qt versus √t (min ½) for Kola nut powder (wt.% of Filler=2%) filled Low density Polyethylene in Benzene at different compatibilizer content at 40°C

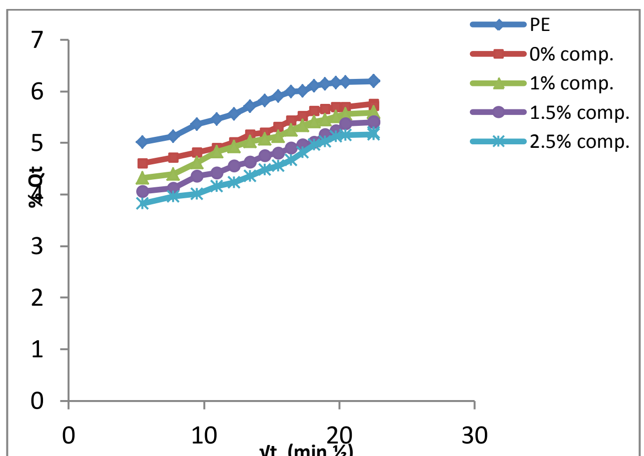

Figure 6: Plot of % Qt versus √t (min ½) for Kola nut powder (wt.% of Filler=2%) filled Low density Polyethylene in Water at different compatibilizer content at 40°C.

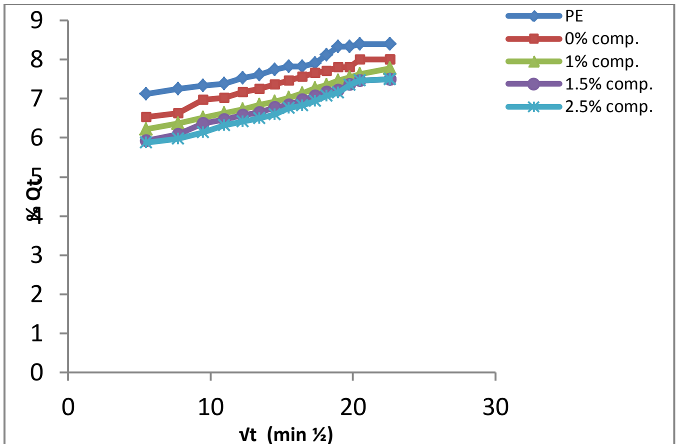

Figure 7: Plot of % Qt versus √t (min ½) for Kola nut powder (wt.% of Filler=3%) filled Low density Polyethylene in Benzene at different compatibilizer content at 40°C.

References

[1] Ismail, H. Study on the effect of coupling Agent on the Mechanical Properties of Composite from Kenaf and recycled Polypropylene, Journal of Mechanical Enginneering , 6, 2010. 201-206.

[2] Kazayawoko, M., Balatinecz, J.J., Wood hans, R.T. and Law, S Effect of wood Fibre Surface Chemistry on the Mechanical properties of wood fibre-polypropylene Composites, International journal of Polymeric Materials, 37, 2006.237-261.

[3] Maldas, D. and Kokta, B. V. An Investigation of the Interfacing Adhesion between Reclaimed newspaper and recycled Polypropylene Composites Mechanical properties. Journal of Adhesion. Science and Technology, 8, 12, 1994. 1439-1451.

[4] Mengeloglu, F. Kurt, R. Gardnes, D.J.O, and Neille, S. Mechanical properties of extruded High Densitypolyethylene(HDPE) and polypropylene (PP) wood flour decking bard, Iran Polymer, Journal, 1007, 2007. 477-487, .

[5] Felix, J. M. and Gatenholm, P. The Nature of Adhesion in Composites of Modified Cellulose Fibres and polypropylene. Journal of Applied Polymer Science, 42, 1991. 609-620 .

[6] Kokta, B. V. and Raj, R.G. The Effect of Processing Conditions and Binding Material on The Mechanical Properties of Bagasse Fibre Composites, Journal of Polymer Science,35, 1991.204-216.

[7] Boggoera G., Dekanski, A. Park, V. Poleti, D.,Grozdanor, A., Buzarovskam, A., Avelle, M. and Gentile, G. Natural Fibres in Polymer Composite Materials, XLVI SavitoviseSmekoyHemijskoDrustra 6, 2006 17.

[8] Alireza, K. and Karl, R. E. Composite Materials and Engineering Center, Washington State University Pullman, USA, 9, 2010. 9164-1806.

[9] Andizeg, K., Bledzki, R.O. and Omar, F. Effect of Fibre and Coupling Agent on Physical and Mechanical Properties of Wood Fibre Reinforced Polypropylene Composite, Journal of Applied Polymer Science, 11, 2009 57-70.

[10] Smith, M.T. Advances in Understanding Benzene Health, Effects and Susceptibility. Ann. Rev, Pub. Health, 31, 2010. 133-148.

[11] Obasi,H.C., Ogbobe, O., and Igwe, I.O., Diffusion Characteristics of Toluene into Natural Ruber/Linear Low Density Polyethylene Blends, International Journal of Polymer Science,23, 2009, 132-142.

[12] Ismail,H. and Suzaimah, S. Styrene Butadiene Rubber/ Epoxidized Natural Blends, Dynamic Properties, Curing Characteristics and Swelling Studies, Polymer Testing, 19, 2000. 879.

[13] Ahmed, A.M., Mohd, D.H. and Abdullah, H. Mechanical Properties of Filled Natural Rubber /Linear low density Polymer, Journal of Applied Polymer Science, 13, 2004. 31-73.