International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org Volume 2 Issue 6‖ June. 2013 ‖ PP.79-83

The Effect of Pulverised Ground Nut Husk on Some Mechanical Properties of Polypropylene Composites

[1*]G.C. Onuegbu, [2]S.C. Nwanonenyi, [3]M.U.Obidiegwu.
[(1,2&3] Department of Polymer and Textile Engineering, Federal University of Technology, P.M.B.1526, Owerri , Nigeria.)

ABSTRACT: *Polypropylene composites of ground nut husk powder were prepared at filler contents of 0 to 40 wt. %. The particle sizes of the groundnut husk powder investigated were 0.2, 0.4, 0.6, 0.8, and 1.0µm. The polypropylene composites were prepared in an extrusion moulding machine and the resulting composites were extruded as sheets. Some mechanical properties of the prepared composites were determined using Instron testing machine and Izod impart tester respectively. Presence of pulverised ground nut husk improved the tensile strength, modulus, flexural strength and impact strength of the composites and these properties increased with increase in filler contents and decrease in the filler particle size. The strain-at-break of the composites was however observed to decrease with increase in the filler contents, and particle sizes.*

KEYWORDS: *Filler, Particle Size, Polypropylene, Ground nut shell, Composite.*

I. INTRODUCTION

The past decades have witnessed increasing interest in the use of fillers in the polymer industry. Fillers greatly enhance the dimensional stability, impact resistance, tensile and compressive strength, abrasion resistance and thermal stability when incorporated into polymers. Fillers which merely increase the bulk volume, and hence, reduce price, are known as extender fillers while those which improve the mechanical properties particularly tensile strength are termed as reinforcing fillers (Oksman , et al. 2004) .

Polypropylene is one of the most important polyolefin's that have wide range of applications. Presently, there has been an increase in the use of filled polypropylene electrical and automotive engineering which is mainly due to its excellent stiffness property that enables it to substitute conventional materials in demanding engineering application (Sun et al,1986). Typical fillers for polypropylene are glass fibres, glass sphere, talc, asbestos, calcium carbonate, silica and mica. The use of mineral fillers and fibre in making polymer composites has certain drawbacks, for example, glass fibres require great deal of energy to produce since processing temperatures can exceed 1,200^{o}C.They tend to abrade processing equipment, and also increase the density of the plastic system (Sanadi, et al 1995) .There has been a confined search for filler materials in compounding polypropylene and which is likely to grow with the introduction of improved compounding technology, and row coupling and compatibilizing agents that permit the use of high filler/reinforcement content(Katz et, al 1987).As suggested by (Kartz and Milewski. 1989) ,fillings up to 75 parts per hundred(pph) could be common in future.

Different filler materials have been studied for making polypropylene composites. These materials included wood, kenaf and sage fibres, (Gahleitner, et al. 2006), saw dust, (Najafi , et al 2006), flax, (Moran, et al 2007), hemp strand, Mutje , et al. 2006), green coconut fibre, (Leblanc 2006), organo-montmorillonite (Wenyi , et al. 2006). Thus, (Fan et al. 2007) who studied polypropylene-montmorillonite nanocomposite reported a decrease in modulus and tensile strength of the composite with increasing clay content. Similarly, (Chen, et al. 2006) who investigated the properties of polypropylene filled with magnesium hydroxide reported that the addition of magnesium hydroxide improved the flame retardant property of polypropylene/magnesium hydroxide composites, but seriously deteriorated the mechanical properties. Filler content of 0 to 5 wt. % were investigated at a particle size of 0.30 µm. The properties of the polypropylene composite determined were the tensile Strength, Tensile modulus, Flexural strength, strain-at-break, water sorption, (24-hr) and impact strength.

In the present report on further utilization of ground nut husk powder in filling polypropylene ,the central objectives are to (i) investigate fully the properties of polypropylene made from ground nut husk (ii) determine the effects of ground nut husk powder particle size on the properties of polypropylene composites. Filler contents of 2, 4 and 6 wt. % were used in this report.

The use of ground nut husk powder in filling polypropylene or any other thermoplastic had not been reported in the scientific literature to our knowledge. Ground nut husk is a domestic waste. The waste presently does not have any known domestic application in our locality, and could be found littering dust bins in our big cities and farm yards in villages.

II. MATERIALS AND METHODS.

Materials

The polypropylene used in this study was obtained from Eleme Petrochemical Company Limited, Eleme Rivers State; Nigeria. It has a melt flow index of 2.5-3.5 g/min, and density of 0.926 g/cm^3. The ground nut from which groundnut husk powder was produced was bought from the market within Owerri metropolis, Imo state, Nigeria .The husk was properly treated to remove impurities before it was crushed and sieved to three particle sizes namely, 0.2, 0.4, 0.6, 0.8 and 1.0µm.

Preparation of polypropylene composites

The polypropylene composites of ground nut husk powder were prepared by thoroughly mixing 30 g of polypropylene with appropriate filler quantities (2, 4, and 6 wt. %). The polypropylene was melted and homogenized with the filler in an extrusion moulding machine. The composites were extruded as sheets.

Testing

The tensile specimen were prepared according to Tensile strength ASTM D 638, modulus ASTM 1822, flexural strength ASTM D 790-97, impact strength ASTM D256, and water sorption (24-hr) (ISO 180) properties of the prepared polypropylene composites were determined using standard methods. Since polypropylene filled or unfilled is a thermoplastic,

III. RESULTS AND DISCUSSION

Mechanical Properties

The mechanical properties of polypropylene composites are illustrated graphically as shown in figures 1-6 at filler particle sizes, 0.2, 0.4, 0.6, 0.8, and 1.0 µm.

Tensile Strength

Figure 1 shows the effect of filler contents, and particle sizes on the tensile strengths of unfilled, and filled polypropylene. The tensile strength of polypropylene composites was observed to increase with increases in ground nut husk powder content and particle size. From Figure 1, it is clear that the smaller the particle size of ground nut husk powder, the higher the tensile strength of the polypropylene composite at any ground nut husk powder content considered. The better dispersion and filler-matrix interaction may be the two main reasons or factors responsible for the observed trend. Similar observations have been reported by (Bigg ,et al. 1987) and(Fuad , et al.1995) for other filled systems. However, (Fand, et al. 2007) reported decrease in tensile strength of polypropylene-montmorillonite composites with increases in clay content.

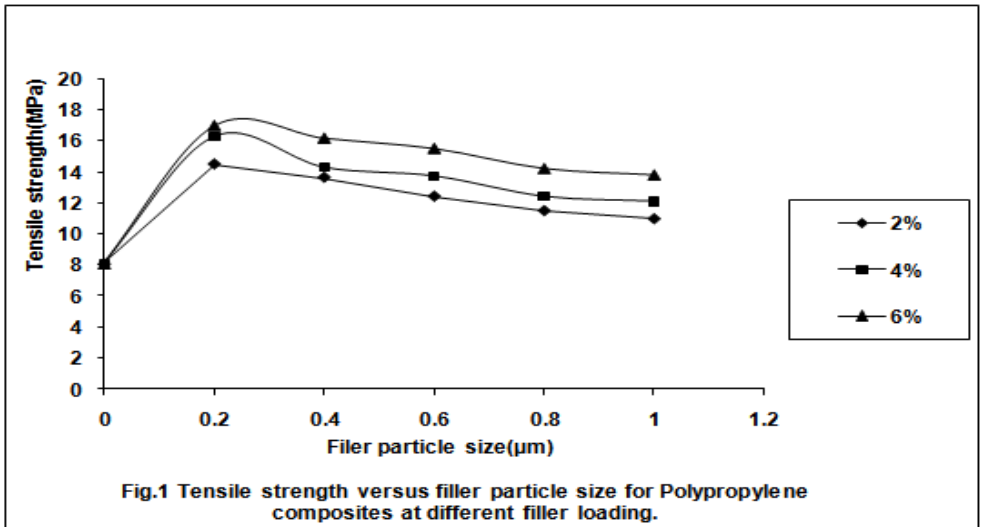

Fig.1 Tensile strength versus filler particle size for Polypropylene composites at different filler loading.

Tensile Modulus:

Figure 2 illustrates the effects of ground nut husk powder content, and particle size on the modulus of prepared polypropylene composites. Like was observed on the effect of filler contents and particle sizes on the tensile strength of filled polypropylene, the modulus of the composites increased with increases in filler contents and filler particle sizes. This observation highlights the fact that the incorporation of fillers into polymer matrix improves the stiffness of the composites (Das ,et al. 2002).The ground husk powder filled polypropylene also exhibited higher modulus on the composites.

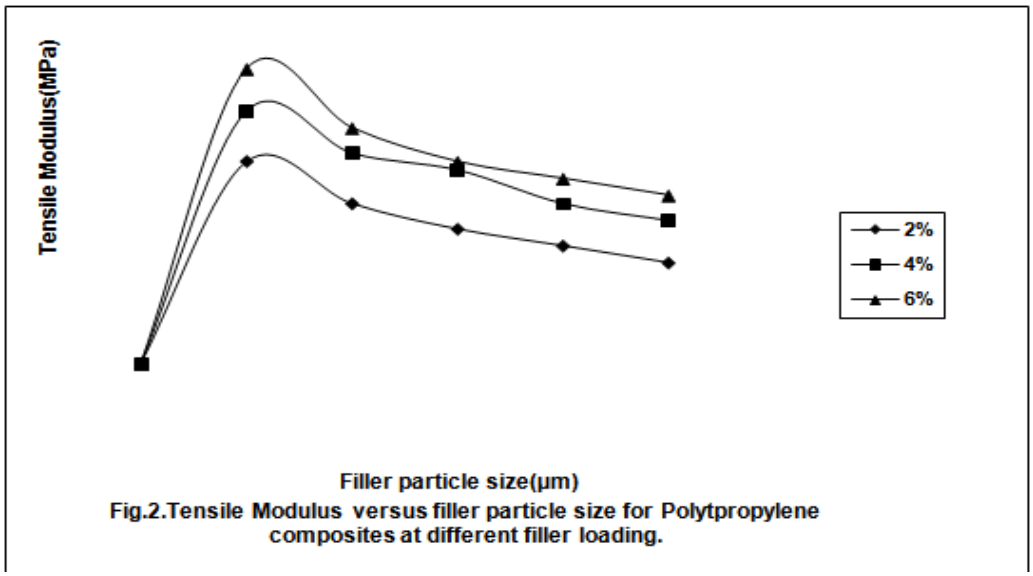

Fig.2.Tensile Modulus versus filler particle size for Polytpropylene composites at different filler loading.

Flexural Strength:

From Figure 3, the flexural strength of polypropylene composites is seen to increase with increases in filler contents, and decreases in filler particle sizes. (Embu , et al 2002) who studied the effect of mica content on the mechanical properties of polypropylene composites reported increases in the flexural strength of the composites with increasing mica content.

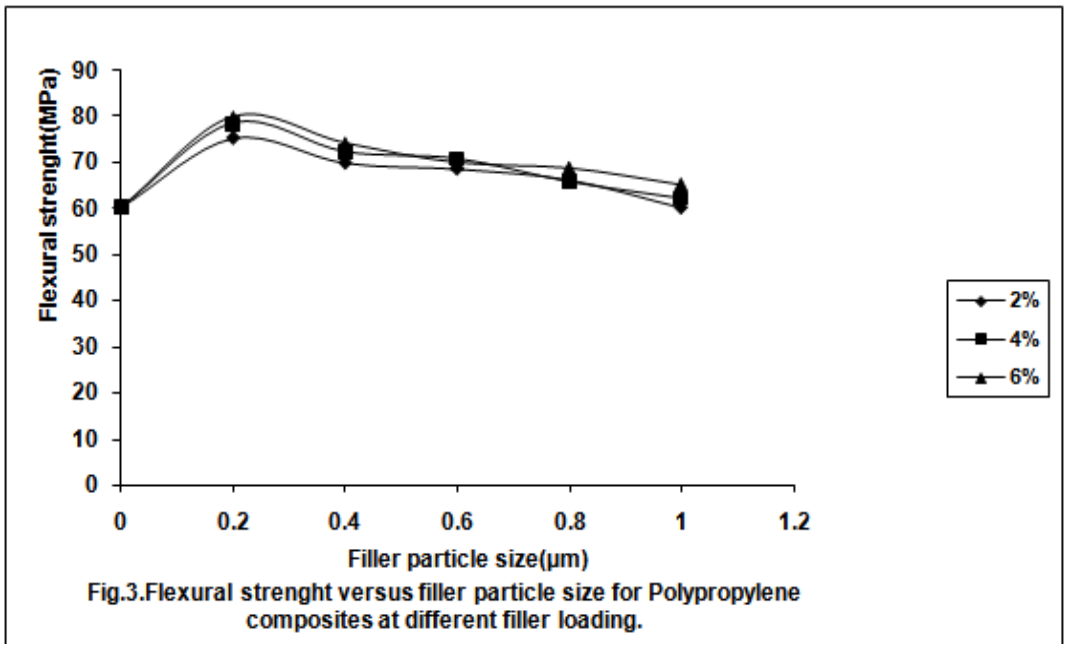

Fig.3.Flexural strenght versus filler particle size for Polypropylene composites at different filler loading.

Strain- at- Break:

Figure 4, shows that strain-at-Break for ground husk powder-polypropylene composites decrease with increase in filler contents at any given filler particle sizes considered. Fillers can be considered as structural elements embedded in the polymer matrix, and at the concentrations of the fillers used (2, 4 and 6 wt. %), the contents might not be high enough to significantly restrain the polypropylene molecules. Consequently, highly localized strains might have occurred at the concentrations investigated, causing dewetting between polypropylene and the fillers, thus, leaving essentially a matrix that is not ductile. Such a reduction in strain at break of a composite with increasing filler content, irrespective of filler particle size has been reported by Ismail, et al. (2004). The figure 4 shows that the Strain at breakage of the polypropylene composites decrease with increases in the filler particle sizes.

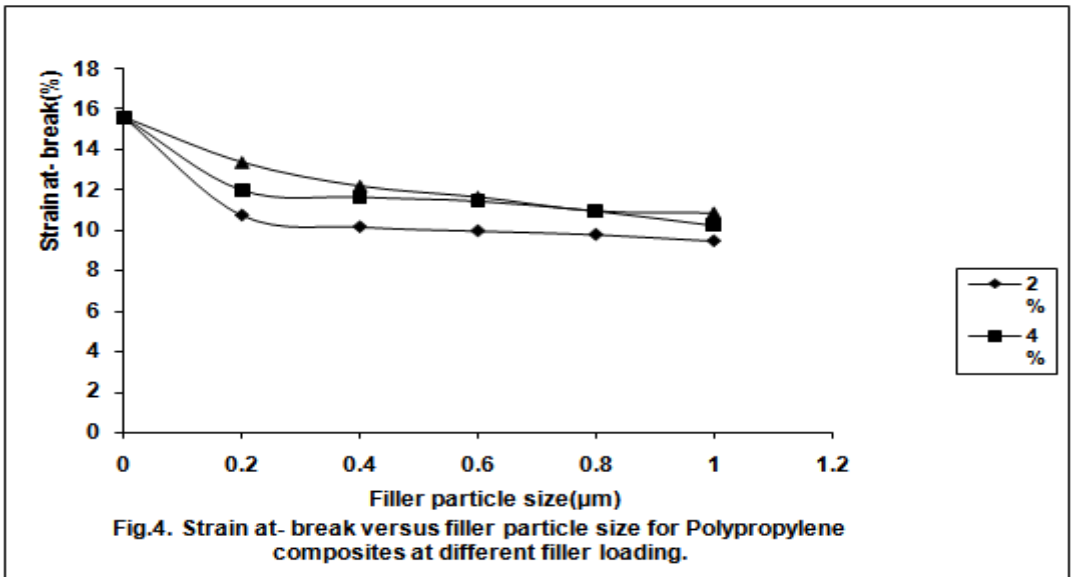

Fig.4. Strain at- break versus filler particle size for Polypropylene composites at different filler loading.

Impact Strength

The impact strength of polypropylene composites of ground husk powder at a particular filler particle size was observed to increase with increase in ground nut husk powder content (Figure 5). The increase in impact strength of the prepared composite was very remarkable for ground nut husk powder composites of polypropylene. This remarkable performance indicates that ground husk powder was effective in distributing the applied stress over a large volume at the base of the notch, and which helped to prevent propagation of cracks by carrying large part of the load in the area under the crack. The increase in impact strength of a polymer composite with increase in filler content has been reported in the literature by (Bigg, et al. 1987). The impact strength of the prepared composites for particular filler and at given filler content was observed to decrease with increase in filler particle size. Thus, increasing the particle size of ground husk powder at given filler content probably increased the level of stress concentration in the composites with the resultant decrease in impact strength.

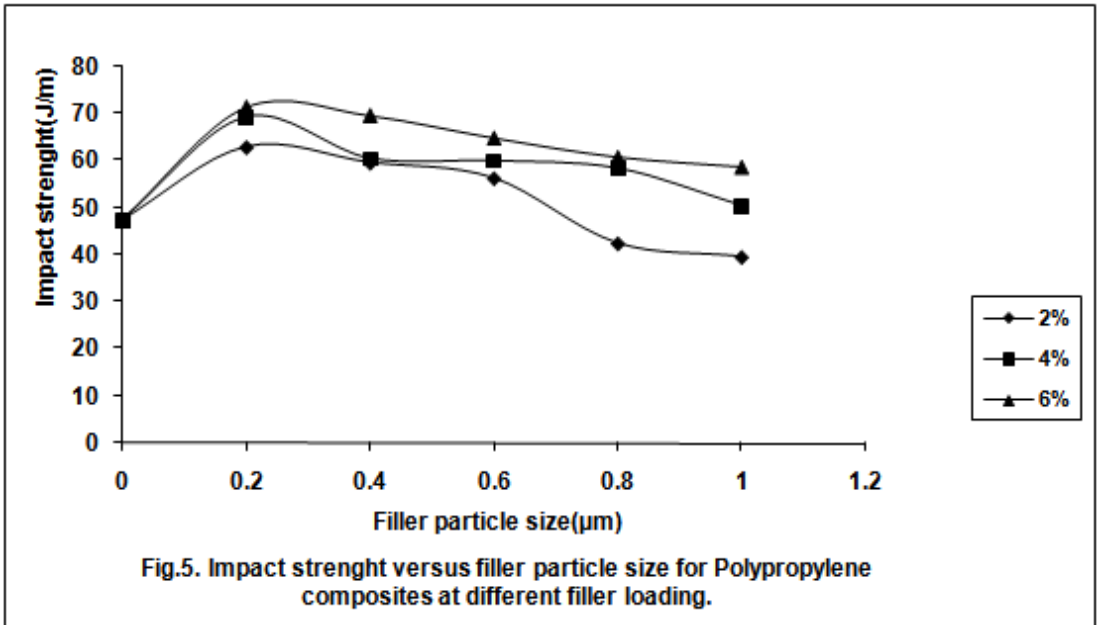

Fig.5. Impact strenght versus filler particle size for Polypropylene composites at different filler loading.

Water Sorption

At a given filler particle size, the water sorption of polypropylene composites was observed to increase with increase in the amount of filler incorporated into polypropylene This result indicated enhancement of sorption properties and impact strength of the composites as reported by (Kokta, et al. 1989).

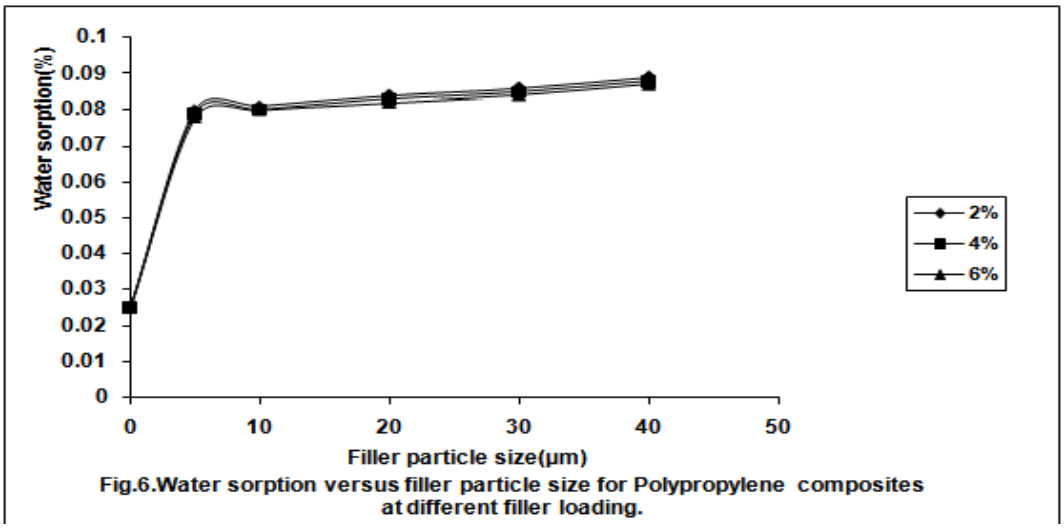

Fig.6.Water sorption versus filler particle size for Polypropylene composites at different filler loading.

IV. CONCLUSIONS

The mechanical properties of ground husk powder filled polypropylene have been determined in this study. Ground nut husk powder has shown greater property improvement in the prepared composites. These mechanical properties of husk powder filled polypropylene were observed to increase with increases in filler contents, and decreases in filler particle size. The present study has highlighted the benefits of using ground nut husk powder as filler for polypropylene. The results obtained shows that, the scope of application of polypropylene can be greatly broadened with ground nut husk powder, as a filler

REFERENCES

[1]. Bigg ,D.M. Polym. Comp. (1987). 6 (2) 8:115-122.
[2]. Bledzki, A.K., Gassan J.(1999) Composite Reinforced with Cellulose Based Fibres, Progressive in Polymer Science, 24(3): 221-228.
[3]. Chen, X. Yu. J. Guo S. (2006). J .Appl. Polym. Sci. 102:4943.
[4]. Clemons, C. (2002).Wood-Plastic Composites in the Limited States. The interfacing of two industries, Forest Prod. J.,52(6),10-18
[5]. Das,S.N, Khastgir, T.K, Chakraborty, D.(2002) .Effect of Filler Blend Composition on the Electrical and Mechanical Properties of Conductive AVE composite ,8:400.
[6]. Embu, Y.E, Biggs, C.C. Heath R. (2000).Nig. J. Polymer Sci Technol, 1:40.
[7]. English, B. Chow, P. Bajwaz, D.S.(2007). Processing composites. New York : CRC Press,
[8]. Fan, Y, Lou, J, Shinozakaki M. (2007). J Appl Polym Sci, 103:204.
[9]. Fuad, M.Y.A., Ismail Z.I, Ishak Z.A, Omar, A.K.(1995) . Application of Rice Husk Ash as Fillers in Polypropylene". Eur Polym J , 31(9): 885-893..
[10]. Gahleitner, M, Kretzschmar, B. Pospiech, D, Ingolic, E, Reichelt, N,
[11]. Bernreitner, K.J, (2006). Morphology and Mechanical of Polypropylene/polyamide 6 Nanocomposites J.Appl Polymer Sci, 100(1):283.
[12]. Ismail, H, Rozman, H.D ,Jaffri, RM, Mohd, Ishak, Z.A(2004).Oil Palm Wood Flour Reinforced Epoxidized,J Polym ;33(3) 65:528 .
[13]. Katz, H, Milewski, J.V.(1987). Handbook of Fillers for Plastic; New York,Reinhold.
[14]. Kokta, B.V, Raj, R.V, Daneault.(1989). J. Polym Plastic Technol Eng Use of wood Flour as Filler in Polypropylene;Studies on Mechanical Properties (3); 243.
[15]. Leblanc, J, Furtado C.RG., Leite M.C.A,Visconte, L.L.Y.(2006) . investigating Polypropylene-Coconut Fibre composites", J Appl Polym Sci.102 (2) 1922.
[16]. Moran J.A.V., Petrucci, R, Kenny J., Vazquez, A .(2007) .Mechanical Properties of Polypropylene composites based on Natural Fibre" J Apply Polym Sci ; 103(1):227-237.
[17]. Mutje, P, Vallejos, M.E., Girones, J., Vilascca F., Lopez A., Lopez J.P., Mendez
[18]. J.A.(2006).Effect of Maleated Polypropylene as Coupling Agent for Polypropylene composites Reinforce with Hemp Strand" J.Appl Polym. Sci. 102(1): 833
[19]. Najafi, S.K. Hamidinia E., Tajvidi M.J.(2006). J. Appl. Polym. Sci. Mechanical Properties of Polypropylene Composites from Saw dust and Recycle Plastic .100:3641.
[20]. Oksman, K. Selin J.F.(2004). Plastics and composites from polylactic acid. Kluwer; Academic press.
[21]. Plackett, D. Logstrup L.A. Batsberg W.P. Nielsen I. Comp. Sci. Technol. (2000)
[22]. Biodegradable Composite based on 1-Polylactic and Jute Fibres,Composites Science and echnology.63(9): 1287.
[23]. Rowell R.M, Sanadi A., Jacob R . Caulfield D . (1999) . Kenaf properties Processing and product Missippi ,State university,Ag . Bio. Engineering32:381.
[24]. Sanadi A.R., Caulfield D.F., Jacobson, R.E, Rowell R.M (1995). Ind. Eng. Chem. Res.34:1891.
[25]. Sun L., Xiao M., Xiao P., Song J., Wang W., Zhang Y., Gong K.(1986) SPEANTETech.Paper .
[26]. Weny. W.I., Xinofeiz P., Guoguan W.I., Jianfeng C.(2006). J. Appl. Polym. Sci. 100:2875