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EVALUATION OF MECHANICAL & THERMAL PROPERTIES OF POLYPROPYLENE – PALM KERNEL NUT SHELL POWDER COMPOSITES FOR GREEN ROOF TECHNOLOGY

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***ABSTRACT**: Polypropylene (PP) composites with different loadings (10, 20 and 30 wt %) of filler. Palm Kernel Nut Shell Powder (PKSP) was prepared by using twin screw extruder. The mechanical (tensile, flexural, compressive, hardness and impact) properties were investigated for these composites and the same were found to increases for filler loading up to 20% and then decreases. Melt flow behaviour and thermal properties (DSC and TGA) were also analysed for these composites in green roof application. Microscopic result showed the uniform filler distribution in the PP matrix.*

Keywords—PKSP (Palm kernel nut shell powder), polypropylene (PP), Mechanical properties, Thermal properties, Morphological properties.

I: INTRODUCTION

Thermoplastic materials are being used increasingly for various applications. Thermoplastic biocomposites are more economical to produce than the original thermoplastics and, as a result, it may be possible to meet any future shortages of thermoplastics. Also, the use of celluloses materials in thermoplastic composites is highly beneficial, because the strength and toughness of the plastics can be improved. Moreover, celluloses raw materials are very cheap, highly available and renewable. The majority of celluloses raw materials are lingo celluloses materials of different polarity to thermoplastics. Lignocellulose-based fibers are the most widely used as biodegradable filler.Lignocellulosic fibers have many advantages, including that they are biodegradable and renewable, with acceptable specific properties compared to glass fibers. Intrinsically, these fibers have a number of interesting mechanical and physical properties. Palm Kernel Nut Shell Powder (PKSP) is one of the lingo celluloses biofibers are by product of palm kernel oil processing industries. The PKSP has high lignin (53.4%) contain than lignin contain (29.4%) of coconut shell powder [1], so composites made from PKSP-Thermoplastics has very good mechanical and physical properties than coconut shell powder-thermoplastics composites and can be extensively used as a raw materials for “Green Roof Technology”.

The bond between reinforcing material and thermoplastic plays an important role in the mechanical properties of a composite material. The degree of adhesion/interfacial bonding depends on a number of factors, such as the nature of the celluloses and thermoplastic as well as their compositions, the aspect ratio of the fibers, the method of incorporating the celluloses into the resin and the processing conditions.

II: EXPERIMENTAL

A. MATERIALS

The polymer used in this study was PP (H110MA) manufactured by Reliance Industries Limited and supplied by Prutha Packaging Pvt.Ltd, Ahmedabad. The MFI of material is 11 gm/10 min. The fillers were supplied by Vijayaa Hi-Tech Industries, Andhra Pradesh, India, having particle size 80 µm. The composition of PKSP is shown in Table 1. [4]

composition	wt%
Cellulose	28.6%
Hemicelluloses	18.0%
Lignin	53.4%

Table 1

B Composite and Specimen Preparation

PKSP-PP composites were prepared using different composition which is mentioned in Table 2.

The PKSP-PP mixture was melt blended in Co-rotating Twin Screw Extruder having L/D ratio 40:1

using temperature range of 170 - 190 °C. Granules obtained were used for injection moulding after pre-drying at 70 °C for the duration of 3-4 hrs. The process was carried in injection moulding machine (Battenfeld 500) at 190-220 °C to produce standard test specimen for mechanical properties.

Batch	PKSP	PP	Code
1(3Kg.)	10 % 0.3 Kg.)	90 %(2.7 Kg.)	10PKSP-PP
2 (3Kg.)	20 %(0.6 Kg.)	80 %(2.4 Kg.)	20PKSP-PP
3 (3Kg.)	30 %(0.9 Kg.)	70 %(2.1 Kg.)	30PKSP-PP

Table 2

C Characterization of Composites

Tensile strength and modulus were evaluated at laboratory conditions using Universal Testing Machine (INSTRON) as per ASTM D 638 method with a crosshead speed of 50 mm/min. Flexural strength and modulus were tested by AUTOGRAPH (AG-IS) according to ASTM procedure D 790. Impact strength was measured by impact tester (CEAST, Resil Impactor) at ambient condition according to ASTM D 256. Hardness values were measure by ASTM D 785 (R scale) with 1/2" ball indenter and 60 Kg load using hardness tester (SWARAJ ENGINEERING).DSC characterization (PERKIN ELMER, Diamond DSC) was carried out using heating rate 2 °C/min and nitrogen purging rate at 50 ml/min. Virgin PP as well as PKSP-PP composite samples were subjected to thermo gravimetric analysis using TGA (PERKIN ELMER, Pyris 1 TGA) equipment and samples of 10 mg were heated from 50 to 800 °C at a heating rate of 10 °C/min in nitrogen atmosphere. Scanning Electron Microscope (SEM) analysis was performed using JEOL (JSM-5610LV) for evaluating the fractured topography of the composites [1-2].

III: RESULT AND DISCUSSION

Mechanical Properties

Figure 1 shows the effect of filler (PKSP) on tensile strength and tensile modulus of composites. The reduction in tensile strength with increasing filler loading was due to imperfect interfacial bonding between filler and matrix. It was observed from figure 1 that the incorporation of PKSP in PP matrix increases the tensile modulus because filler increase the stiffness of the composites which cause to effective stress transfer from matrix to the interface.

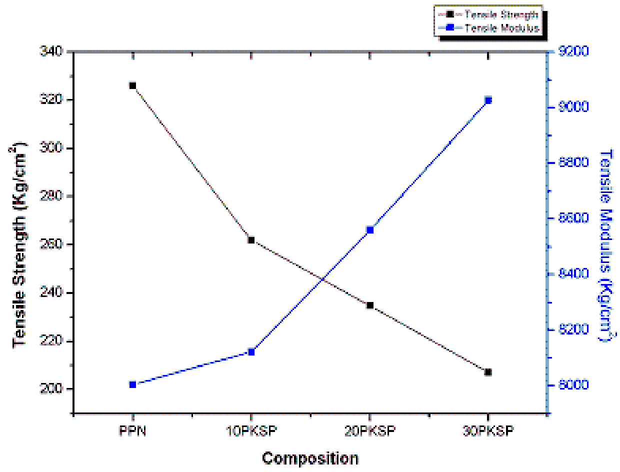

Fig 1. Effect of filler content on Tensile strength and Tensile Modulus

Figure 2 shows the effect of filler on the flexural strength and flexural modulus. As the PKSP concentration increases the flexural strength increases due to effective load transfer by filler due to high lignin content. The flexural modulus increases with higher filler concentration due to increase in stiffness of the composites.

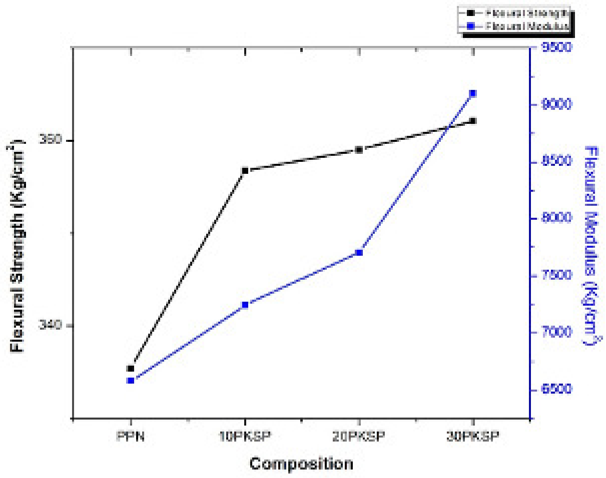

Fig 2 Effect of filler content on Flexural strength and Flexural Modulus

Figure 3 shows effect of filler content on the Impact strength of PP. Up to 20% filler content ability of PP to absorb energy slightly increase then decreases sharply with increase in PKSP concentration.

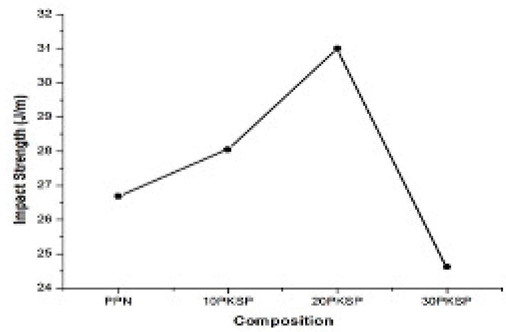

Fig 3. Effect of filler content on Impact strength

In Figure 4 as PKSP concentration increases, the hardness of composite slightly increases then decrease.

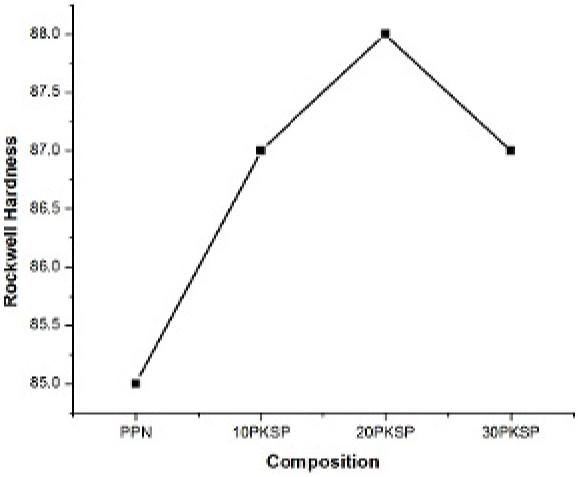

Fig 4. Effect of filler content on Hardness

Fig 5 shows the effect of filler on Compressive strength of the composites. High lignin content of filler provide stiffness at lower concentration of PKSP the compressive strength increase due to high lignin content of filler then agglomeration of fillers around PP matrix reduce the compressive strength.

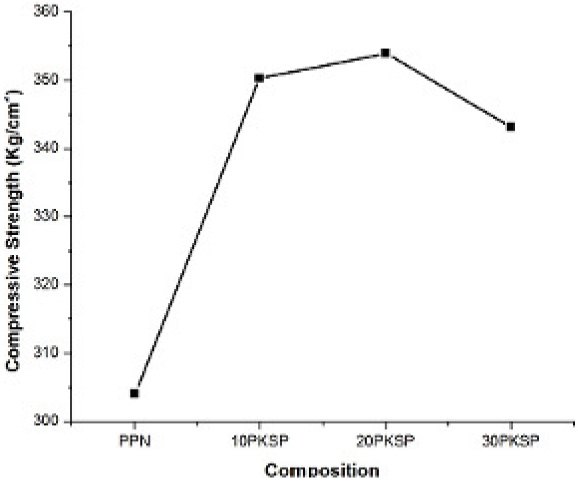

Fig 5. Effect of filler content on Compressive Strength

Thermal Properties

Figure 6 show the overlay of all individual thermo grams of PP (unfilled) sample and PP filled with PKSP at various concentration. As the concentrations of PKSP increase melting point of composites slightly increase. The increase in Tm values might be due to hindered chain movement with rise in filler concentration.Figure 7 shows Thermo Gravimetric Analysis technically used to check % filler content left over after mass loss due to pyrolysis of PP by heating to the temperature range of 50-800 ^{0}C and analysis of decomposition temperature of PP and PP filled with different filler concentration. It shows that no significant change in decomposition temperature of PP with rise in filler content. And thermal stability is not affected.

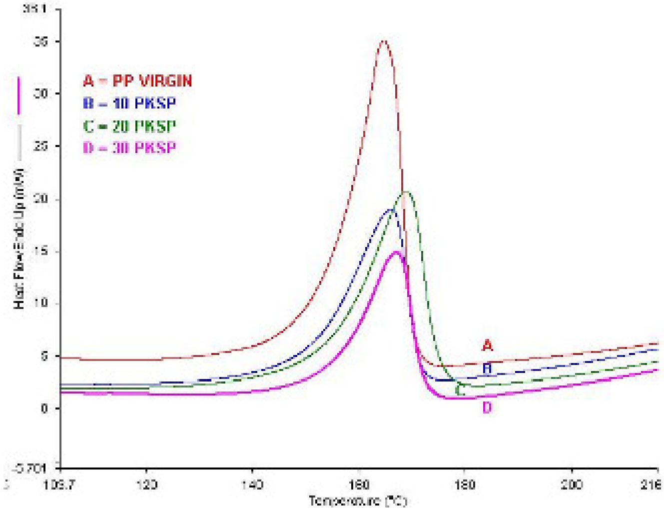

Fig 6 DSC Analysis

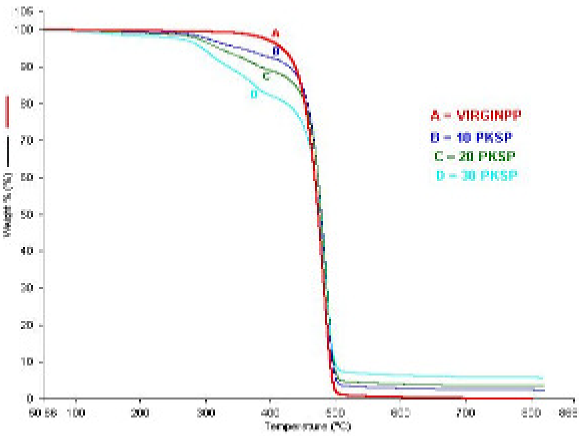

Fig 7 .TGA Analysis

Phase Morphology

The SEM photomicrographs of impact fractured surfaces of PP/PKSP composites of samples 10PKSP-PP, 20PKSP-PP and 30PKSP-PP are shown in figure 8, 9 and 10.Photomicrographs clearly indicate that the particles of PKSP are uniformly and distinctively located in PP matrix which resembles with the result of left over filler % obtained by TGA. Some agglomeration of fillers is observed on the fractured surfaces of composites supports the poor interfacial bonding of filler and matrix.

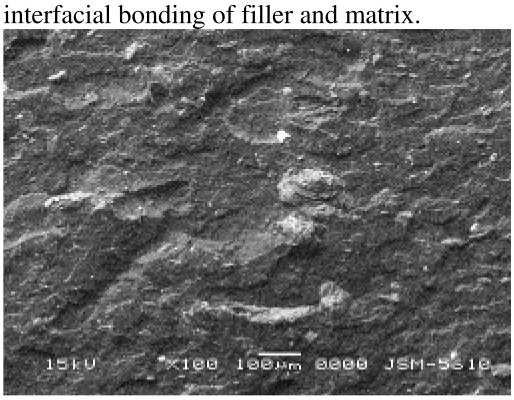

Fig 8. SEM micrographs of 10PKSP-PP

Fig 9. SEM micrographs of 20PKSP-PP

Figure 10 indicates at higher filler agglomeration of the filler particles may lead to the deterioration of the mechanical properties.

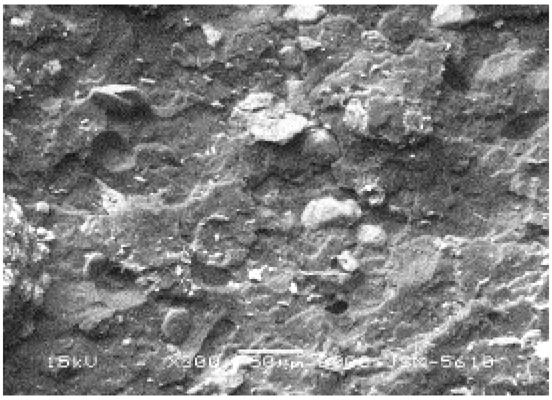

Fig 10. SEM micrographs of 30PKSP-PP

IV: CONCLUSION

With increase in the PKSP loading the Flexural strength, tensile and flexural modulus increase. This due to high Lignin contents of PKSP which increase the stiffness of composites. Impact strength, hardness and compressive strength of composites increase up to 20% filler loading then decrease due to agglomeration of fillers.

Weak interfacial bonding of PKSP and PP matrix decreases the tensile strength. The thermal stability of composites decreases as the PKSP content increases in the PP matrix due to decomposition of hemicelluloses, cellulose and lignin present in the PKSP at 300 – 320 ^{O}C. So increase in flexural strength, flexural modulus and impact strength (up to 20%) is highly beneficial with high cost reduction in manufacturing water retention and drainage tray for "Green Roof Technology"

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REFRENCES

[1] E .Y. Ishidi, E.G. Kolawale, K.O Sunmonu // "Study of Physio-Mechanical Properties of high Density Polyethylene (HDPE) – Palm Kernel Nut Shell Composites", Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS)

[2] E .Y. Ishidi, E.G. Kolawale, K.O Sunmonu // "Morphology and Thermal Properties of Alkaline Treated Palm Kernel Nut Shell – HDPE Composites" Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 2 (2): 346-350

[3] A Romisuhani, H Salmah1 and H Akmal // "Tensile properties of low density polypropylene (LDPE)/palm kernel shell (PKS) biocomposites: The effect of acrylic acid (AA)", 9th National Symposium on Polymeric Materials (NSPM 2009)

[4] Dagwa I.M, Builders P.F. and J.Achebo// "Characterization of Palm Kernel Shell Powder for use in Polymer Matrix Composites" International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS Vol:12 No:04

[5] Agunsoye J. Olumuyiwa, Talabi S. Isaac and Sanni O. Samuel // "Study of Mechanical Behaviour of Coconut Shell Reinforced Polymer Matrix" Composite Journal of Minerals and Materials Characterization and Engineering, 2012, 11, Published Online August 2012 (http://www.SciRP.org/journal/jmmce)