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A Literature Review on Properties of Recycled High Density Polyethylene Composites

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Abstract: Plastic waste becomes a major concern for the most of environmental condition. Plastic is the one of the most dangerous material, which can develop the human health hazards. To reduce the plastic waste and replace it into some useful product is the challenging process. When we dump plastic into water, land etc. it is hazardous. So, we need to reuse into useful material with use of composite. In this paper the discussion of recycled high density polyethylene and mechanical behavior of RHDPE with natural fiber and also combination of various material fibers are being studied in this paper.
Keywords: RHDPE, Recycle;

I. INTRODUCTION

rHDPE (Recycled High Density Polyethylene) is the type II plastic, one of the fastest growing waste is the environment even though it is recyclable. Recycling is the one of the best field in doing innovation in the industry. India recycles 60% of plastic as compared to world average of 22% also plastic contain calorific value equal to fuel. Around 15,342 tn of plastic waste generated every day in India. 6000 tn remain uncollected and littered. They are around 3500 units organized and 4000 units unorganized plastic processors are mostly the smaller players. rHDPE is one of the major plastic to recycle. To overcome this disposal problem, we need to reuse or recycle the rHDPE for environmental, human and animal safety purpose [1].

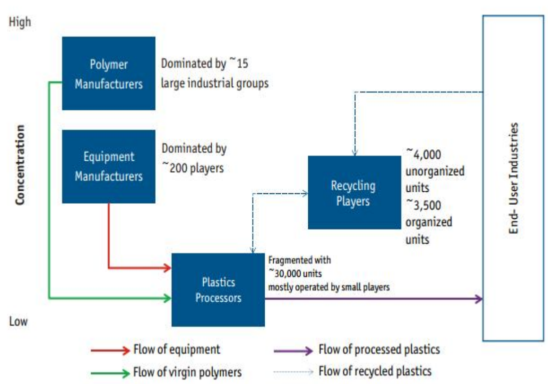

Fig.1.1Structure of Indian Plastic Industry[1]

Fibers: over past 20, polymer matrix composite reinforced with vegetablefibers have attracted and have great mechanical properties such as tesile strength for low density, low environmental impact, renewability, recyclability and low cost. Good quality of the vegetables fibers such as flax fiber reinforced plastic is used for non-structural applications.

Vegetable Fibers: They are six types of vegetable fibers are as follows: bast fibers contain jute, hemp, flax, ramie and kenaf; seed fibers contain coir, cotton, kapok. Core fibers contain jute, hemp, kenaf. Grass and reed fibers containwheat, corn rice. And all other type is in the wood and root.

These fibers are composed of clusters made up of long elementary fibers. The elementary fibers have varying lengths depending on the kind of plant, ranging from 20 mm to 70 mm for flax against 2 mm to 3 mm for softwood. They have extremely thin cell walls (5 µm up to 15 µm) and a diameter between 15 µm and 35 µm. These clusters of elementary fibers, whose cross section consists of 12 to 48 cells, are called technical fibers. Technical fibers are the basic element for both the textile industry and the preparation of composites. For example, flax technical fibers have lengths in the range 0.3 m to 0.6 m and diameters falling between 50 µm and 500 µm. As shown in Fig. 1, inside each technical fiber, the elementary fibers are joined together by a matrix (middle lamella) primarily consisting of pectin and hemicellulose (structures composed of low molecular weight polysaccharides). Typically, elementary fibers display a 5- to 7-edge polyhedral section, which improves the packaging capability with respect to a circular section. They consist mainly of cellulose, lignin and non-structural compounds such as waxes, salts and organic nitrogen compounds. The structural characteristics of elementary fibers are mainly due to cellulose, which has a high molecular weight and a Young's modulus of E = 135 GPa[2].

Following are a few of the reasons why composites are preferred for certain applications:

A. High strength to weight ratio
(Low density high tensile strength)
B. High creep resistance
C. High tensile strength at elevated temperatures
D. High toughness [3]

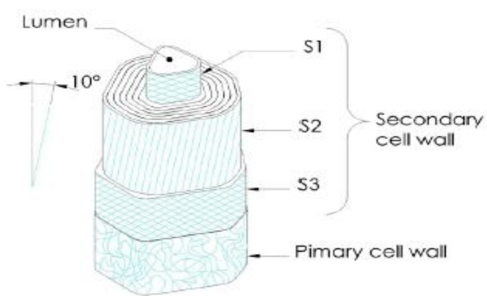

Fig. 1.2 Structure of Bast Element Fiber [3]

II. LITERATURE REVIEW

K. Wanga, F. Addiego a, A. Laachachi a, B. Kaouache a, N. Bahlouli b, V. Toniazzo, D. Ruch has discussed about the properties of HDPE such as density of HDPE 0.936 g/cm^3 the molecular weight of the HDPE is 55,000 g/cm^3 its polydispersity index is about 6. A maleic anhydride-grafted polyethylene (Sigma-Aldrich, Belgium) denoted as MAPE was selected as coupling agent between HDPE and Flax fiber.[5]

The use of vegetal fiber to reinforce thermoplastics could reduce the carbon dioxide footprint of the resulting composites compared to conventional thermoplastics composite filled with glass fiber due to their low-density, biodegradability, and renewability. Physical properties discussed that hemp fiber dispersion state within HDPE matrix and the composites morphology were investigated by using a pressure controlled scanning electron microscope FEI Quanta FEG 200 (SEM) at different magnifications. The non-deformed materials were cryo-fractured in the liquid nitrogen. To characterize the evolution of the microstructure and to analyze the failure of the materials under dynamic loading, the materials were analyzed by coupling observations conducted with an optical microscope Leica MZ12.5 and observations conducted with the SEM. The failure mechanisms for the deformed samples were correlated with the strain rate and the filler loading. [5].

Runzhou Huang, Xinwu Xu, Sunyoung Lee, Yang Zhang, Birm-June Kim and Qinglin Wu was discussed the morphology of HDPE, Scanning electron microscopy (SEM) was used to characterize the morphology of GF filled HDPE composites. Typical SEM micrographs for GF filled composites are shown in Figure 2.1 at 10 wt % and30 wt % loading levels. Certain fiber pullout appened during the fracture process as indicated by the circular voids on the fracture plane. Fiber pullouts were observed on the surface of GF-filled HDPE composites (Figure 2.1) due to poor bonding of fiber to matrix leads to easy fiber pullout during theimpact. Composites showed lower impact strength than neat HPDE due to insufficient fiber to matrixcontact. This is consistent with low impact strength at 10 wt % and 30 wt % GF loaded compared withthe pure HDPE

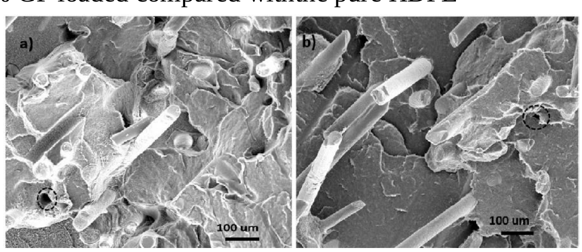

Fig. 2.1 Scanning electron microscopy (SEM) micrographs of fractured surfaces of glass fiber (GF) filled high density polyethylene (HDPE) AD60 composites. (a) 10 wt % GF;(b) 30 wt % GF. Most.

Most glass fibers were aligned perpendicular to the fracture plane (i.e., along the injection molding flow direction). Fiber breakage can contribute much less to energy than that the fiber pullouts in the net fractured energy.[6] A greater number of fiber pullouts can be observed on the fractured surface of a specimen with 30 wt % GF content than that of 10 wt % GF loaded. This was thought to be due fiber aggregation at the higher loading level in the composite matrix, which reduced their effective bonding.

Also discussed the Flexural modulus for GF filled composites exhibited an increasing trend with increased filler content. The neat HDPE AD60 had a flexural modulus of 0.85 ± 0.06 GPa while it was 5.8 ± 0.2 GPa for GF filled HDPE composites having 40 wt % of GF .The increase of flexural modulus was attributed to the enhanced interfacial interaction existed between the filler and matrix, which allowed

the transmission of stress from HDPE to GF thereby improving the stiffness of the GF filled HDPE composite.

Based on the statistical data analysis, GF-filled composites showed a significant strength increase with increased GF loading level. At the 40% GF level, the strength was 2.29 times higher than that of the neat resin. Fiber alignment as shown in the SEM micrographs (Figure 1) played an important role in determining the flexural strength. The increased strength benefited from the uniaxial aligned GFs.[6]

M. Arun Kumar[2]discussed about the new kind of wood plastic composite was produced by combination of wood flour, recycled high polyethylene (HDPE), Waste Printed Circuit Boards (WPCB) and their additives. This study shows the combination of 40% of nonmetallic PCB with wood plastic composite by conical counter rotating twin screw extruder. This study results shows the flexural strength was 23.4 MPa, tensile strength was 9.6MPa ,impact strength was 3.303J/sq.m and screw withdrawal strength was 1755 N. This composite was prepared by the following steps, First of all the mixture of nonmetals and wood was decomposed at 260oc to 380oc, then decomposition of HDPE was obtained at 440oc to 500oc.

Dynamic properties are observed [6] Storage Modulus (E′)—The effect of temperature on the storage modulus of GF-filled composites having 0%, 10%, and 30% loading levels is shown in Figure 3, respectively. A general trend of increase of the storage modulus with increased filler content in the composites was observed. E′ is more associated with the molecular elastic response of the composites, indicating the stiffness of the material. The increase of E′ with increased filler content was due to mechanical limitation posed by increasing filler concentration embedded in the viscoelastic matrix. The E′ decreased with temperature increase and converged to a narrow range at higher temperatures. The reduction of E′ with increasing temperature was due to the softening of the matrix and initiation of the relaxation process

The neat AD60 resin had an impact strength of 28.57 ± 2.0 kJ/m2. The strength decreased significantly when the filler was added to the system. At the 10% filler loading level, the impact strength for GF filled composites are 9.62 ± 0.37 kJ/m2 and 6.03 ± 0.13 kJ/m2, respectively. For GF-filled composites, the impact strength increased with further increase of GF content beyond the 10 wt % level. As GFs are well bonded to the plastic matrix, the partially aligned GFs in the direction perpendicular to the impact force could help absorb the impact force imparted to the test samples. The enhanced impact strength at higher GF filling beyond 10 wt % due to GF fiber clustering in composite can be ruled out.[6]

III. CONCLUSION

From the research discussed, it is clear that HDPE and fibers are suitable for various engineering applications. Carbon fiber, wood fiber is used for the replacement of common plastics. Based on the study of various research papers, the HDPE and fibers have various physical and mechanical properties in various combinations. Depending upon the properties of composite, we can reuse that material for various applications. As disposal of waste is a major problem in the today's world due to limited landfill space as well as hazardous to human health by utilization of Waste in various engineering applications.

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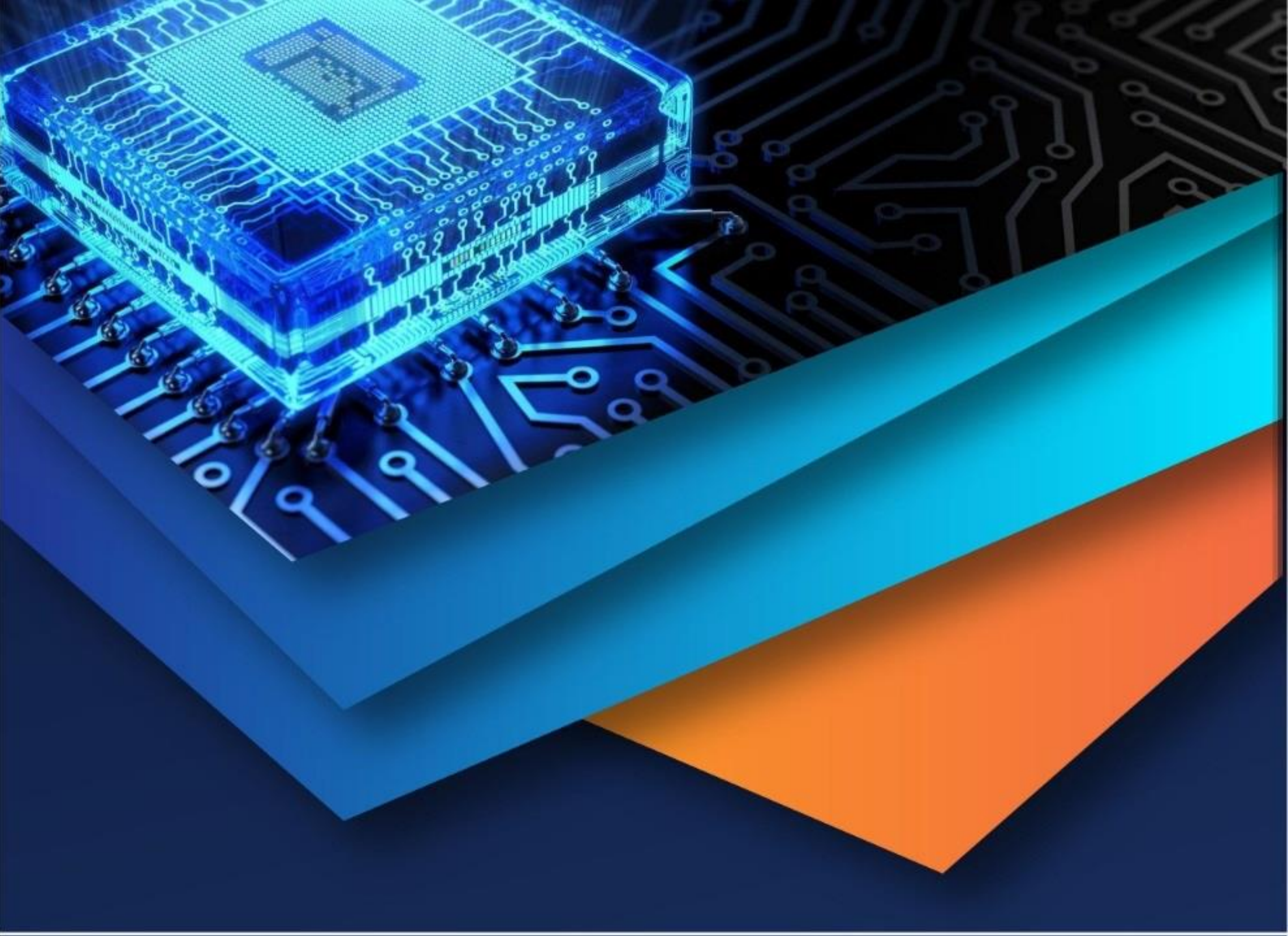

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