Journal of Energy & Environment

Journal homepage: www.uniten.edu.my/jee

Study of Physical and Mechanical Properties of Oil Palm Empty Fruit Bunch Fiber Reinforced Polypropylene Composites

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KEYWORDS

Oil palm empty fruit bunch
Polypropylene
Physical and mechanical properties
Scanning electron microscopy

ABSTRACT

The physical and mechanical properties of oil palm empty fruit bunch (OPEFB) reinforced polypropylene (PP) matrix composites with different fiber loading (10, 15, 20, 25, and 30 wt%) have been studied. Two different type of chemical treatments namely oxidized sodium periodate ($NaIO_4$) oxidation and urea ($CO(NH_2)_2$) coupling reaction has been used to improve the properties of the composites. In the current research, OPEFB fiber reinforced PP composites were manufactured using high voltage hot compression technique. Scanning electron micrographs of the fractured surfaces were taken to study the fiber/matrix interface adhesion. Reduced fiber agglomeration and improved interfacial adhesion was observed under scanning electron microscope in the case of oxidized OPEFB fiber and improved the compatibility in the case of urea treated oxidized OPEFB fiber reinforced PP composites. Tensile and flexural modulus significantly increased with fiber loading. However, tensile and flexural strength are found decreased beyond 25% by weight fiber loading. Effect of water absorption on the composites was also observed and it was found that oxidized OPEFB fiber reinforced PP composites absorbed less water compared to raw and urea treated oxidized OPEFB fibers reinforced PP composites. Overall, chemically treated OPEFB fiber reinforced PP composites showed better fiber/matrix interactions as observed from the good dispersion of fibers in the matrix system. Unlike the untreated OPEFB fiber reinforced PP composites, all treated OPEFB fiber reinforced composites had the same tendency of increasing the mechanical properties of composites.

1. INTRODUCTION

Malaysia has about 3.5 million hectares of oil palm producing annually over 10 million tons of crude palm oil (CPO), making it the world's leading producer of the oil. However, CPO and its economic co-products, palm kernel oil and palm kernel cake, constitute only 10% of the crop, leaving the rest of the biomass to waste. The biomass includes oil palm empty fruit bunch (OPEFB). OPEFB is the residual bunch after removal of the fruits constituting 20% to 22% of the weight of the fresh fruit bunches [1]. Ellis et al. (1994) stated at present, OPEFB is mainly used as mulch. However high transportation cost caused the economics are marginal. It is seldom disposed as burning item (fuel) as the shell and fruit fiber is sufficient for the oil palm [2-4].

Recently, OPEFB has been investigated as a raw material for building materials, solid fuel pellets, chemical products, particleboard, fiberboard, blockboard, and pulp and paper [5]. Traditional plastic materials are reinforced by glass fibers, which are both expensive and harmful to the environment. Natural fiber-reinforced thermoplastic composites form a new class of materials which seem to have good potential in the future as a substitute. However, lack of good interfacial adhesion and poor resistance to moisture absorption makes the use of natural fiber-reinforced composites less attractive. Various fiber surface treatments like mercerization, isocyanate treatment, acrylation, latex coating, permanagante treatment, acetylation, silane treatment and peroxide treatment have been carried out which may result in improving composite properties. It is also known that the use of coupling agents such as silanes, titanates, zirconates, triazine compounds, etc. also improves fiber–matrix adhesion [6-10]. The mechanical properties of a fiber-reinforced polymer composite depend not only on the properties of constituents, but also on the properties of the region surrounding the fiber known as the interphase.

One of the main disadvantages of natural fibres/plastic composites is the poor compatibility exhibited between the hydrophobic polymeric matrix and the hydrophilic fibres. Poor

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