Physicochemical Study of Eco-Friendly Sugar Palm Fiber Thermoplastic Polyurethane Composites

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The physicochemical properties of an innovative and environmentally friendly composite material based on sugar palm fiber (SPF) and thermoplastic polyurethane (TPU) were examined. The base material with short fibers was extruded and hot pressed to produce the TPU-SPF composites with different synthetic parameters. Operating parameters including temperature for extrusion (170 to 190 °C), rotational velocity (30 to 50 rpm), and fiber particle sizes (160, 250, and 425 µm) were investigated. The aims were to optimize rotational velocity, temperature, and fiber size of the TPU-SPF composites. Firstly, the influence of rotation of velocity and temperature on the tensile properties was investigated. Secondly, effects of different fiber sizes on tensile, flexural properties, and impact strength as per ASTM standards were tested. The morphological, thermal, and physicochemical properties of the synthesized TPU-SPF composites were ascertained with Fourier transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), X-ray diffraction (XRD), and thermogravimetric analysis (TGA). The optimal results were observed with a temperature of 190°C and a rotational velocity of 40 rpm. Meanwhile, the strength and modulus for tensile and flexural were best for fiber size 250 µm. Moreover, the impact strength reached a peaking trend at 250 µm fiber size.

Keywords: Environmentally friendly composites; Thermoplastic polyurethane; Sugar palm fiber

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INTRODUCTION

Natural fiber-reinforced polymers are gaining more attention over synthetic fibers in composites (Dittenber and GangaRao 2012), due to better results in the abrasiveness of the equipment, cost reduction, renewability, biodegradability, and good mechanical strength (Biagiotti *et al.* 2004; Pilla 2011). Natural fibers such as flax (Bos *et al.* 2006), wood (Ratnam *et al.* 2010), hemp (Wötzel *et al.* 1999), waste cellulosic products (Jawaid and Khalil 2011), and jute (Roy *et al.* 2012) have been studied intensively as alternatives to synthetic fibers. The petroleum thermoplastic polyurethanes (TPU) are greatly needed in many industries, as they are used in the automotive instrument panels (Engels *et al.* 2013), sporting goods, caster wheels, medical devices, power tools, drive belts, inflatable rafts, outer cases of mobile electronic devices, and footwear (Herrera *et al.* 2002). The TPU has unique properties due to the inter-molecular interactions and a distinctive combination