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Enhancement of natural fiber-reinforced plastics by polyester and seaweed waste fibers

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Abstract

A bio-based composite material made from wastes from Posidonia oceanica (PO) and sugar cane polyester (SCPES) has been developed in the current work. DSC and TGA have been used to investigate the thermal deterioration of composites, and the results demonstrate an improvement. Using dynamic mechanical analysis (DMA) data, it has been found that the storage modulus (G) increases significantly as the Posidonia oceanica concentration rises. There has been a 60 % increase in stiffness in 40 % composites compared to unfilled materials in tensile test results. Flexural modulus of polyester, when unloaded is more than twice that of polyester, when fully loaded. In addition, Shore D hardness as well as Charpy impact test findings reveals that HDPE's intrinsic high impact energy absorption is intact in HDPE-PO composites, confirming this improvement in mechanical properties. As a result of the low water absorption rate (less than 8 %) and the long immersion time, these composites are assured to preserve their dimensional stability.

Introduction

Mediterranean endemic seaweed Posidonia oceanica covers around ~60% of the seabed up to 40m deep [1]. Furthermore, it covers an area of 2,800km^2 [2] on Spain's coast in the Mediterranean Sea. In order to keep the erosive process from progressing, Posidonia oceanica performs an important function as a natural bottom barrier. More than 400 plant and 1,000 animal species can be found here [3]. Considering its role in protecting the maritime environment, coast and seabed conservation, and

biodiversity, it should be protected by legal means. When it comes to European flora, for example, it is a protected species. The Posidonia oceanica meadows have been designated as a conservation area at the national level by countries like France and Spain [4], [5]. Posidonia oceanica releases rhizomes seasonally, ranging from 500 to 2,000 g dry wt m^{-2} every year, dependent on weather circumstances like winds, storms, or maritime currents [6], [7], [8]. Posidonia oceanica wastes can be seen on beach in the shape of leaves and stalks, as well as typical fibrous balls throughout the fall and winter [9]. Since Posidonia oceanica wastes decompose and attract insects, beaches must be cleaned each year to remove them, which has a detrimental influence on tourism and the odours they produce [10], [11]. The beach tourist industry is well-developed in Mediterranean countries. This comes at a significant financial cost [12]. Although Posidonia oceanica waste has traditionally been used as fodder for livestock and as a source of traditional medicine and glass packaging, these traditional uses result in an insignificant usage of this waste, which is plentiful and expensive to remove from beaches; this surplus, that can be originate in huge density, has anti-inflammatory properties, and it is difficult to remove from beaches [13], [14], [15]. Several writers have looked into the possibility of Posidonia oceanica being used as an environmentally friendly dye adsorbent or for the manufacturing of pulp and paper using lignocellulosic fibres in the recent years [16], [17]. It's also possible to use these waste materials to make natural-fiber reinforced plastic (NFRP), which has recently gained popularity due to growing environmental awareness [18]. There has been a significant increase in the manufacture and use of NFRPs and WPCs in the recent few decades [19], [20], [21]. There are numerous advantages to WPCs in terms of both economics and the environment, as well as their ability to be moulded using typical manufacturing methods like as hot-press moulding, extrusion and injection moulding [22], [23]. High dimensional stability, light weight, longer life, and minimal care requirements make WPCs an excellent alternative to wood [24], [25]. In the construction of items with modest structural requirements, WPCs are commonly employed. North America and Europe are seeing an annual growth of 18 and 14 % in the use of these materials in items such as industrial flooring, railing and mouldings as well as indoor furniture and automotive interior parts [26]. Recycled and recyclable plastics can also be employed as matrix to improve WPCs' environmental friendliness, resulting in mechanical qualities comparable to virgin or petrochemical-derived polymers [27], [28], [29], [30]. From sugar cane, Braskem has made a significant advancement in the field of ecologically friendly polymers. In terms of performance, Braskem's various commercial grades of “Green PE” are identical to the comparable petroleum-based PE gradations, but they have a significant ecological advantage [31], [32], [33], [34], [35]. Biobased HDPE was used as the matrix and waste fibres from PO were used as strengthening to create natural fibre reinforced plastics (NFRPs) as a result to industrial difficulties connected with seaweed wastes. It is explored by evaluating the MFI and dispersal of Posidonia oceanica particles and interactions between fibres and matrix by SEM examination. Posidonia oceanica fiber-reinforced composites can be tested for their thermal behaviour using DSC and TGA, as well as their mechanical characteristics using tensile/flexural tests, Charpy's impact tests as well as Shore D hardness measurements. Mechanical-dynamical in shear is also discussed in terms of temperature.

Section snippets

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