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Opinion

Bio-Degradable Polymer Composites as Abrasive Wear Materials

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Opinion

In agricultural machinery, the trend of using more and more engineering polymers subjected to abrasive wear started years ago. This short review focuses on the possibility of a fully biodegradable composite (PLA/Hemp fibre) as wear material for abrasive applications. It is proved that there are operating conditions where PLA/HF composite can play role. Engineering polymers in agricultural machinery are applied mainly due to agro-technical and tribo-mechanical reasons. Polymers can achieve a significant weight reduction of the machines that can reduce the risk of soil compaction. They are corrosion resistant and perform acceptable strength and wear even in highly abrasive media. The use of engineering plastics has also reduced the amount of lubricants used to lubricate machine parts, thus reducing the environmental impact. The big question is how to minimize the wear debris and other difficult or slow decomposing micro-plastic particles getting to the environment. Logically, there is a need to examine any suitability of fully biodegradable polymers or their composites. Due to the uncertainty of mechanical properties and poor wear resistance of natural biopolymers, they are currently not recommended for machine element production. Composite versions are worth researching. Research in this direction for biopolymer composites is still in its beginning, and literature results mainly deal with the technological issues of fiber reinforcements and the determination of different material properties.

Sawpan et al. [1] show that the (PLA) represent the most common example of a polymer matrix from renewable resources. It has acceptable mechanical properties, and it will degrade to carbon dioxide, water and methane in the environment after several months to 2 years, not like the petroleum-based polymers, which need hundreds of years to degrade. It is considered as one of the most essential bio-polymers. Thakur et al. [2] presented the advantages of it compared to the petroleum-based polymers. The properties of PLA were demonstrated by La Mantia et al. [3] and were shown to be comparably easy to produce. With increasing demand, it will become cheaper to produce. It was demonstrated [4] that composites which use natural plant-based fibers have several advantages over synthetic fibers, including high toughness and good thermal resistance. Alagirusamy et al. [5] mentioned other advantages, like lower cost, lower weight and density, high stiffness and favorable, specific mechanical properties. Originating from renewable sources is another advantage, but all of these are aside from the most important properties, which are being biodegradable and recyclable. There are several different fiber materials, that can be used as the reinforcement component in bio-composites. Summerscales et al. [6] used flax, hemp, jute and kenaf in preparing the composites. The use of natural fibers as a reinforcement material for composites was initially in a car manufacturing, for instance, door panels, seat backs, headrests, package trays, dashboards, and other interior parts [7]. Ku et al. [8] reported that having properties like low cost, low density, comparable specific tensile properties, being nonabrasive to equipment, nonirritating to the skin, reduced energy consumption, less health risk, renew-ability, recyclable, and biodegradability, made natural fibers better than synthetic fibers like (glass and carbon) and that makes them more useful. Regenerated cellulose fibers can be used [9] for the reinforcement in bio-composites. These results are somewhat less environmentally friendly than bio-composites compared to the usage of hemp fibers since the regenerated cellulose fibers are produced industrially. While the raw material, usually wood pulp, is biodegradable and stems from renewable resources, the process of manufacturing regenerated cellulose fibers has a larger environmental impact than that of several natural fibers, like flax or hemp [9]. The most unfavorable disadvantages, which can come from using natural fibers, are hydrophilic in nature, which leads to high moisture absorption. The reason being, during the process of making composite materials, the presence of moisture can lead to voids being created, these voids affect the mechanical properties of the composite [3]. Concerning a potential applicability of fully degradable bio-composite in abrasive condition as wear material, a detailed study was introduced. The bio-composite PLA-HF (polylactic acid/Hemp Fiber), a fully bio-degradable product was compared to five engineering polymers (polyamide grades and UHMW-PE HD1000) in laboratory test models, which were abrasive pin-on-plate and slurry tests. Figure 1 shows the on-line measured wear (expressed in mm as a decrease of the height of the tested polymer pin samples) in abrasive pin-on-plate test configurations.

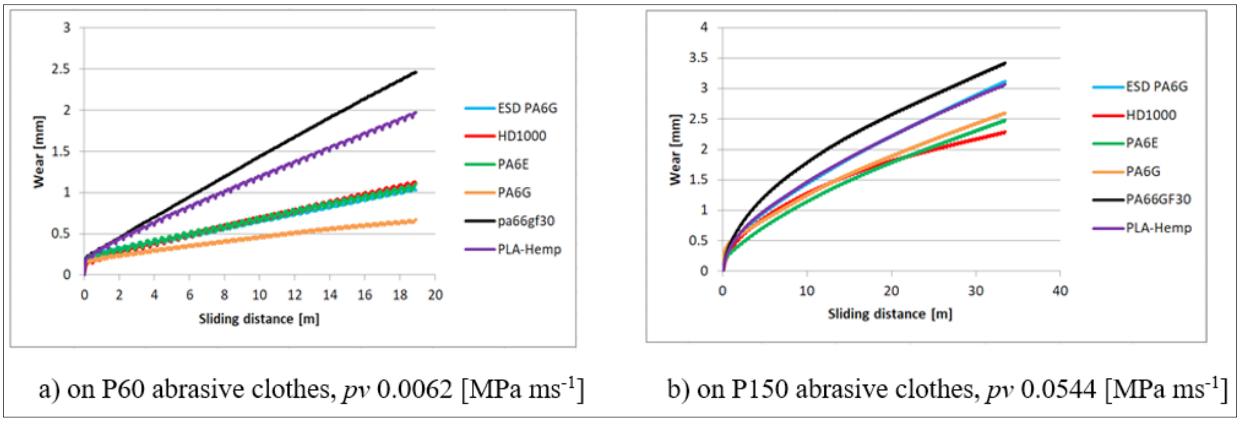

Figure 1: Abrasive wear against sliding distance of engineering polymers and PLA/HF bio-composite [10].

It can be seen that the PLA/HF bio-composite was not the worst, but a poor average among the tested materials. However, the fact of relatively low applied pv values (normal load x sliding speed) refer to a slideway surface application instead of a heavily loaded machine element. The presented results confirm that the fully biodegradable composite solution may have a role at some practical cases. More details of the abrasive tribological properties can be read in [10].

References

1. Sawpan MA, Pickering KL, Fernyhough A (2011) Improvement of mechanical performance of industrial hemp fibre reinforced polylactide biocomposites. Compos Part A Appl Sci Manuf 42(3): 310-319.
2. Thakur VK, Thakur MK, Gupta RK (2014) Review-raw natural fiber–based polymer composites. Int J Polym Anal Charact 19: 256-271.
3. La Mantia FP, Morreale M (2011) Green composites. A brief review. Compos Part A 42(6): 579-588.
4. Masirek R, Kulinski Z, Chionna D, Piorkowska E, Pracella M (2007) Composites of poly(l-lactide) with hemp fibers: Morphology and thermal and mechanical properties. Journal of Applied Polymer Science 105(1): 255-268.
5. Alagirusamy R, Fangueiro R, Ogale V, Padaki N (2006) Hybrid yarns and textile preforming for thermoplastic composites. Textile Preforming for Thermoplastic Composites, Textile Progress 38(4): 1-71.
6. Summerscales J, Dissanayake NP, Virk AS, Hall W (2010) A review of bast fibres and their composites. Part 1-fibres as reinforcements. Composites: Part A 41(10): 1329-1335.
7. Holbery J, Houston D (2006) Natural-fiber-reinforced polymer composites in automotive applications. Journal of the Minerals Metals & Materials Society 58(11): 80-86.
8. Ku H, Wang H, Pattarachaiyakoop N, Trada M (2011) A review on the tensile properties of natural fibre reinforced polymer composites. Composites Part B: Engineering 42(4): 856-873.
9. Shen L, Worrell E, Patel KM (2010) Environmental impact assessment of man-made cellulose fibres. Resources, Conservation and Recycling 55(2): 260-274.
10. Muhandes H, Kalácska A, Székely L, Keresztes R, Kalácska G (2020) Abrasive sensitivity of engineering polymers and a bio-composite under different abrasive conditions. Materials 13(22): 5239.

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