SYNERGETIC EFFECT OF HAZELNUT SHELLS AND BENTONITE ON THE PROPERTIES OF HYBRID POLYETHYLENE BIOCOMPOSITES

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The remnants of agricultural crops are produced in billions of tons and are available at low prices; only a small part of the residue is used as domestic fuel or fertilizer, as the main part burns in the field, causing air pollution and environmental hazards. Using these remnants as filler in polymer materials can solve the problem. Natural fillers from agricultural waste are replacing synthetic fibers as reinforcement in polymer composites due to their non-toxicity, low density, low cost, renewability, biodegradability and, therefore, a positive impact on the environment [1]. Despite all these positive properties, natural fiber composites suffer from a lower modulus of elasticity, lower strength, limited durability and relatively poor moisture resistance. To solve these problems and improve the basic properties of polymer composites reinforced with agricultural waste, a potential way is to combine two types of fillers. Therefore, the idea is to obtain a synergistic effect of filler properties on the overall properties of hybrid biocomposites. Thus, the main goal of this study was to assess the effect of the combination of natural bio-filler and bentonite on the physicomechanical properties of hazelnut shell/bentonite/polyethylene hybrid biocomposites.

Low density polyethylene (LDPE) grade 15 803-020 was used as a polymer matrix, which was provided by SOCAR POLYMER LLC, Sumgait, Azerbaijan. Bentonite clay from the Dash-Salakhly deposit (Gazakh, Azerbaijan) was used as filler. The chemical composition of the bentonite clay of the Dash-Salakhly deposit: SiO_2 – 58.60, Al_2O_3 – 13.40, Fe_2O_3 – 4.70, FeO – 0.18, TiO_2 – 0.39, CaO – 2.05, MgO – 2.30, P_2O_5 – 0.11, SO_3 – 0.25, K_2O – 0.39, Na_2O_3 – 2.30, LOI (loss on ignition) – 1.33. The extracted bentonite clays of the Dash-Salakhly deposit contain more than 85 % montmorillonite, in the exchange complex of which sodium and magnesium cations prevail. Hazelnut shells of the popular variety Atababa, provided by a hazelnut producer from the city of Khachmaz in northern Azerbaijan, were used as reinforcing filler.

Hazelnut shells are known to be hydrophilic, while polyethylene is hydrophobic in nature. Thus, hydrophilic hazelnut shells react poorly with hydrophobic polyethylene, which leads to a decrease in tensile strength and elongation at break. When combining peanut shells with bentonite, the hybrid composites showed better tensile strength than hazelnut shell/LDPE composites. Nanoclay enhances interfacial interaction and adhesion between fiber and polymer matrix, thereby improving the mechanical properties of composites. Of course, it should be noted that the improvement of the mechanical properties of composites by adding nanoclay can only be achieved up to a certain concentration of nanoclay. The decrease in tensile mechanical properties at higher bentonite concentrations is likely due to agglomeration of nanoclay plates, which sharply reduces the dispersion of particles in the matrix and, therefore, the effectiveness of reinforcing nanoparticles in improving mechanical properties.

Thus, bentonite clay, consisting mainly of montmorillonite, can be used as filler in hybrid polymer composites due to its well-known exfoliation / intercalation chemistry, large surface area, cost effectiveness and availability.

References

1. Shejkar S.K., Agrawal A., Agrawal B. Walnut shell particulates as filler material in polymeric matrix: a review // International Journal of Engineering Research in Current Trends. – 2020. – V.2. – №3. – P. 41–43.