

**POLYPROPYLENE-BASED COMPOSITE MATERIALS FILLED WITH HAZELNUT SHELLS AND MODIFIED BY LIBAID T-2***Arzumanova N. B., Kakhrmanov N. T.*

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Polymer composite materials containing natural fillers are of significant interest from the point of view of sustainability and rational utilization of agricultural waste. Hazelnut shells, which are lignocellulosic in nature, can be used as dispersed fillers. However, a major drawback of such systems is the aggregation of filler particles due to the presence of polar functional groups on their surface and weak interfacial interaction with the non-polar polymer matrix. Figure 1 illustrates the composition and processing scheme of the PP/hazelnut shell/Libaid T-2 composites investigated in this study.

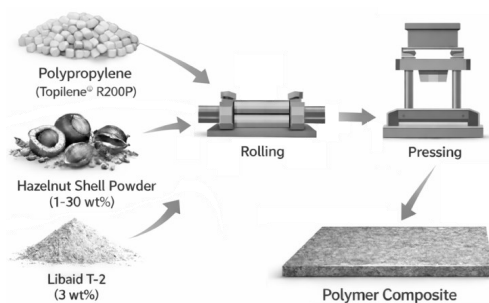


Fig. 1. Composition and processing scheme of the PP/hazelnut shell/Libaid T-2 composite

Hazelnut shells contain cellulose, hemicellulose, and lignin, all of which have hydroxyl groups on their surfaces. These groups promote the formation of hydrogen bonds between filler particles, leading to their aggregation into agglomerates and resulting in a heterogeneous composite structure with pores and local regions of high filler concentration, which adversely affects the physical, mechanical, and rheological properties of the material. Polypropylene, a non-polar polymer, does not sufficiently wet the surface of the filler particles, hindering their uniform distribution within the matrix.

To reduce filler aggregation and improve the composite structure, the modifying additive Libaid T-2 was introduced into the system, where it acts as a physical binder and dispersing agent. Libaid T-2 contains functional groups capable of interacting with the hydroxyl groups of the lignocellulosic structure of hazelnut shells to form hydrogen bonds. This interaction enhances interfacial adhesion between the filler and the polymer matrix, reduces the surface energy of filler particles, and decreases their tendency to aggregate. As a result, the use of Libaid T-2 leads to a reduction in the size of filler agglomerates, a more uniform distribution of hazelnut shell particles within the polypropylene matrix, the formation of a more homogeneous composite microstructure, and a decrease in the number of pores and structural defects. The reduced degree of filler aggregation contributes to stabilization of the physical and mechanical properties of the composites.

It has been established that in polypropylene composites filled with hazelnut shells, filler particle aggregation is a key factor governing the structural state and properties of the material. The loading of Libaid T-2 effectively decreases the degree of aggregation by promoting interfacial interactions between the components of the system.