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The use of different types of chain extenders during reprocessing of PET bottle wastes

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The aim of this study was to evaluate the effectiveness of the reactive extrusion process in order to improve the properties of PET film. The research was conducted mainly with the use of PET post-consumer waste in the form of flakes, therefore, the subject of the presented works is indirectly related to the improvement of methods of processing recycled bottle wastes.

Poly(ethylene terephthalate), similarly to other thermoplastic polyesters such as PBT or PET, is a polymer that is very sensitive to melt processing conditions. Even in the processing of virgin polymer, it is necessary to use material at very low moisture content. In the case of PET waste reprocessing, the additional problem appears in the form of contamination and inclusions of foreign polymers and the low molecular weight polymer caused by primary processing. Currently, there are several technological solutions that enable PET recycling. Their main task is to separate this polymer from other material fractions. However, most of the offered technologies do not solve the problem of changing the processing properties of PET, caused by a decrease in molecular weight[1]. Changes caused by polymer degradation lead mainly to a reduction in polymer viscosity and accelerate the crystallization process, which may lead to a reduction in the transparency of the manufactured packaging. At present, intensive development works are aimed at eliminating the problem of low molecular weight of PET regranulates by using the reactive extrusion technique. This method consists in introducing a chemical compound with a high degree of reactivity directly into the cylinder of the plasticizing system during the technological process. By assumption, the used modifier should lead to the initiation of the polymer chain extension reaction, which is why these additives are popularly called chain extenders (CE)[2]. Unfortunately, in many cases the efficiency of the process is insufficient to improve the prop-

erties of the polymer, which requires the use of larger amounts of additives. It is also possible to cross-link the polymer structure in the case of high reaction efficiency, which is also a disadvantageous phenomenon[3].

The problems associated with the reactive extrusion process are doubly difficult in nature in applications requiring the appropriate purity of the used polymers, including packaging intended for contact with food. The process of using chain extender additives requires their complete reaction of the modifier with the polymer, which prevents possible contamination of the food. This process requires optimization, which was the main core of the conducted work.

As part of the research work, three types of active additives were used for processing with PET. The widely used styrene-based chain extender (styrene-acrylonitrile-glycidyl methacrylate ternary random copolymer, SAG), was used as the reference material[4]. This CE is commonly used as a viscosity modifier and compatibilizer of polymer blends. Unfortunately, in the case of packaging applications, its use in materials intended for contact with food is not recommended. Two other commercially available viscosity modifiers, intended for the production of food film, were tested during this research. As part of the preliminary work, the reactive extrusion tests were performed. These tests were aimed at demonstrating rheological changes in the processed polymer. For the purpose of the experiment different types of virgin and recycled PET blends were prepared with addition of CE, from 0.2 to 1.0%. The initial assessment of rheological properties was carried out on the basis of rotational rheometer measurements (oscillation mode) and Intrinsic viscosity (IV) results.

The trial results showed significant differences in effectiveness for individual modifiers. Especially its reduction for additives intended for contact with food. This clearly suggests the use of a different type of reactive agent or a lower level of its content.

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