PRODUCTION OF POLYMER GRANULES FROM SECONDARY POLYMER WASTE

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Abstract: The production of polymer granules from secondary polymer waste represents a critical step in promoting sustainable recycling practices and reducing the environmental impact of plastic waste. This process involves the collection and reprocessing of post-consumer or post-industrial polymer waste materials, which are then transformed into reusable granules suitable for manufacturing new polymer products. The procedure typically includes sorting, cleaning, shredding, and melting the waste polymer, followed by pelletizing to form uniform granules. Key challenges in this process include the need for effective contamination removal, maintaining the polymer's mechanical properties, and ensuring consistency in the granule size and quality. The use of secondary polymer waste not only helps conserve raw materials but also mitigates the environmental burden associated with polymer production and disposal. Additionally, advances in recycling technology, such as the development of more efficient sorting systems and chemical recycling techniques, are enhancing the viability and scalability of secondary polymer granule production. This approach offers a promising pathway for the circular economy, contributing to sustainable material use and waste reduction in the polymer industry.

Keywords: Secondary polymer waste, Polyethylene (PE), Polypropylene (PP) Polyethylene Terephthalate (PET), Plastic granules.

Introduction: Polypropylene is a highly resistant synthetic polymer from which most plastic products are made today. During the production process, enterprises generate a large amount of polypropylene waste, which must be recycled and reused. The decomposition period of PP waste can be up to 500 years, and the thermal properties make this type of waste the most frequent cause of large-scale

fires at landfills, therefore its processing is the only reasonable approach to production, consumption and preservation of the environment**.** HDPE waste includes many varieties, bottles and other containers, pipes and bags are made from this material, so the volume of such products in landfills is growing by 15-17% every year. However, low pressure polyethylene is essentially an ethylene compound. It does not decompose for more than 300 years and smolders when burning, releasing toxic substances. A time goes by, HDPE waste breaks down into small fractions and, according to environmentalists, causes the death of thousands of animals when ingested. Recycling is the only possible way to dispose the HDPE waste, since burial and incineration are not efficient and dangerous. The ever-growing consumption of polymers has led to an alarming increase in plastic waste, posing significant challenges to environmental sustainability. As a result, effective recycling and reprocessing of polymer waste have become critical objectives in the efforts to reduce environmental pollution and promote a circular economy. Among various recycling methods, the production of polymer granules from secondary polymer waste has emerged as a promising solution. Secondary polymer waste refers to used or discarded polymers derived from post-consumer goods, industrial scraps, or rejected manufacturing products. These materials, when properly recycled, can be converted back into useful polymer granules that can be reused in manufacturing processes, reducing the demand for virgin plastic production. The transformation of polymer waste into granules involves a series of stages, including sorting, cleaning, shredding, melting, and pelletizing. The granules produced in this manner can serve as raw materials for the creation of new plastic products, thus minimizing the overall environmental footprint associated with plastic production and disposal. Despite its potential, the recycling of polymer waste faces several challenges, such as contamination with foreign materials, degradation of polymer properties due to prior usage, and difficulty in maintaining uniformity in granule size and quality. Nevertheless, advancements in recycling technologies, including innovations in sorting mechanisms, cleaning processes,

and palletization techniques, have significantly enhanced the efficiency and scalability of polymer granule production from secondary waste. The importance of this process is underlined by its dual benefit of reducing landfill waste and conserving valuable raw materials. As demand for sustainable solutions continues to rise, the production of polymer granules from secondary polymer waste stands as a key player in the development of a more sustainable and resource-efficient future.

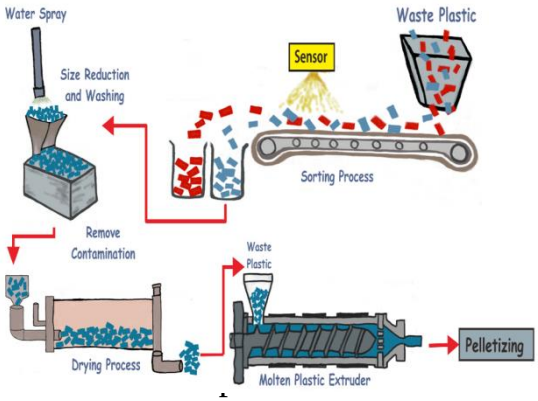
Pic.1. Various polymer waste.

Secondary polymer materials can be recycled into various products, such as films, cups, toys, granules etc. Plastic granules, in its most general definition, are raw materials produced in different sizes and shapes. When plastic granules are melted and poured into the mold, they take shape practically. For this reason, plastic granule raw materials are preferred in different sectors. Plastic granule, which is the raw material form of plastic, is frequently used today due to its low cost and easy manufacture [1]. Secondary Plastic granules are produced from different polymers. Secondary Plastic granules have different properties and usage areas in terms of color, structure and shape. The recycling process of plastic can be divided into various types: primary, secondary, tertiary, and quaternary recycling [2]. Primary recycling is the processing of a specified and uncontaminated material, commonly scrap, from an industrial process. Furthermore, to provide a good product quality, recycled scrap or waste plastics can be mixed with new materials [3]. Nevertheless, the primary recycling process needs homogeneous, clean, and non-degraded materials, such as packaging, bottles, and pre-consumer

products, with the product of primary recycling being quite similar to a virgin one [4]. The mechanical recycling of plastic waste is secondary recycling; the most common method for recycling plastic waste. Mechanical recycling processes post-consumer plastics, to produce the raw materials for various plastic products [5]. In comparison, the recycling process depends on the chemical and physical properties of the waste plastic feed, in terms of its origin, composition, and form [6,7]. **Picture 1** is related to the technology of recycling waste plastics by the mechanical method. Mechanical recycling includes several techniques, for instance, collection, separation, sorting, and washing [8]. The main objective of the waste plastic sorting process is to obtain high-quality recycled plastic goods, especially from a single polymer stream. Waste sorting technologies are based on various chemical-physical properties of the plastic, for instance, chemical compounds, size, color, and shape. Furthermore, the materials from post-consumer waste contain various polymeric materials and organic substances [9,10]. The subsequent process is size reduction. The typical process for size reduction involves cutting or shredding; nevertheless, this process depends on the type of plastic waste stream and plant layout. These processes may occur before or after the sorting stage [11].

Pic.2. The technology of recycling waste plastic by a mechanical method: sorting process, size reduction, drying process, and molten plastic.

The other processes include size reduction, extrusion, and granulation. These may occur in different sequences and at different times [12]. The extrusion and granulation processes are required to create a granulation that is possible to convert into flakes. Furthermore, the polymer flakes are typically loaded into an extruder, heated, and pressed through a die, to form a continuous solid polymer product



(strand). This car the pelletized process. The granulation method nds into pellets, which can then be used to ler the full life cycle of polyurethane foams (PUFs), PUFs were upcycled and reshaped to bulk polyurethanes (PUs) using a transcarbamoylation reaction of up to five cycles. Moreover, four PUFs were prepared and reshaped by compression molding at 160 °C for 30 min, demonstrating the potential of this recycling pathway for PUFs from different origins. Tertiary or chemical recycling refers to the degradation of polymer bonds. As a result, the recovery of the oligomers monomers produces a smaller molecular weight. Hence, thermoplastic can be obtained with this method.

Conclusion: The production of polymer granules from secondary polymer waste presents a viable and sustainable solution for addressing the growing concerns associated with plastic waste management. By recycling and processing secondary polymer waste, significant environmental benefits can be achieved, including the reduction of landfill waste, decreased pollution, and the conservation of raw materials. The process of converting secondary polymer waste into high-quality granules enhances the circular economy, promoting resource efficiency. The recycling techniques employed, such as extrusion and granulation, ensure that polymer granules meet industry standards, making them suitable for various

applications across multiple sectors, including automotive, packaging, and construction. However, challenges such as contamination in secondary waste, the need for advanced sorting technologies, and quality control remain. Future research and development efforts should focus on improving the efficiency of recycling processes, reducing energy consumption, and addressing the economic viability of large-scale operations. By optimizing these factors, the production of polymer granules from secondary polymer waste can contribute significantly to the reduction of plastic waste, aligning with global efforts toward sustainability and environmental conservation.

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