Enhancing the Mechanical Recycling of Plastics

by

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ABSTRACT

The plastic waste problem has become a serious environmental issue as over 400 million tons of plastic waste are generated annually. Unfortunately, plastic production is only continuing to rise. Most plastic waste is landfilled, mismanaged, or accidentally released into the environment, while only a small portion is recycled (about 9% in the US). This underscores the need to develop more sophisticated technology to maximize plastics recovery and minimize unnecessary use of virgin petroleum feedstocks. Unrecovered plastics represent a missed opportunity for economic and environmental benefit. This thesis explores potential technological schemes that could be deployed in material recovery facilities (MRFs) to enhance post-consumer plastic recovery.

The first two parts of this work probe a cyclone separation process to improve retention of small format plastics within MRFs. By leveraging the density difference between glass and plastic, the plastics can be sorted out with higher than 90% efficiency. Additionally, environmental and technoeconomic feasibility studies demonstrated that the introduction of the cyclone separation process would be a beneficial addition to MRF operations. Further experiments explored the limits of this technology by investigating the impact of feed shape, size, infill, and aspect ratio on separation performance. The experiments were further explained by computational fluid dynamics (CFD) simulations and modeling.

The last two parts of this thesis study how machine learning could be employed within plastics sorting. An expansion of optical sorting technology to support polyester bioplastics was investigated using reflectance spectroscopy and machine learning techniques. Random forest and k-nearest neighbor models were trained on a spectral dataset and demonstrated classification accuracies of 92% and higher. Additional probing into sample attributes, feature importance, and tolerance to external noise was performed. Finally, an alternate sorting scheme in recycling based on sorting by brand rather than plastic type was demonstrated by leveraging AI. It was shown that this new sorting technology could be used to implement an economically-viable extended producer responsibility (EPR) scheme that would better align the incentives of all participants in the plastics system in order to improve recycling rates.

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