

Design, Validation, and Effectiveness of a Prototype Triboelectric Separation Machine for Heterogenous HPDE and Paper Flake Mixture



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ABSTRACT

Cost effective solutions for separating plastic and other materials are necessary to improve plastic recycling rates. A pilot scale prototype separator machine was developed around an overhead triboelectrically charged conveyor belt and vibratory table concept to separate paper flake from a shredded heterogenous mixture of paper labels and high-density polyethylene (HPDE) plastic flakes. The material mixture was run through a polycarbonate processing box attached to a vibratory table that excited the material vertically towards a polytetrafluoroethylene (PTFE) conveyor belt that was tribocharged with a polyurethane (PU) roller which attracted the loose paper flake from the HDPE. A set of experiments were conducted to find the most effective combination of control inputs on the machine. The prototype separator machine demonstrated a peak effectiveness value of 57%, but the machine requires design changes before the concept can be fully evaluated for its use at an industrial scale.

INTRODUCTION

Material recycling is becoming an increasingly important aspect of communities and markets throughout the world. High density polyethylene (HPDE) is a type of recyclable plastic material used for consumer product containers like water bottles, supplements, and prescriptions. This thesis investigation seeks to build upon the research provided in Sumner [1] by developing a prototype pilot-scale triboelectric separator machine for a heterogenous HPDE plastic and paper flake material mixture.

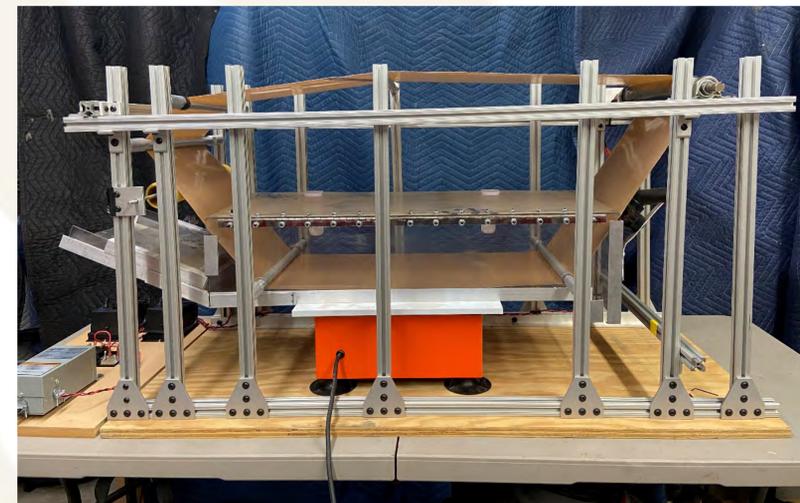
OBJECTIVES

1. Develop a concept for the HPDE /paper flake mixture separation process and design a proof-of-concept experiment to validate that concept.
2. Design and build a prototype triboelectric separator machine for a heterogenous HPDE/paper flake mixture based on the results of the proof of concept and utilizing the recommendations of the Sumner [19] study.
3. Conduct a set of experiments to prove or disprove the efficacy of the prototype separator machine and determine the most effective combination of control input settings.

RESULTS & DISCUSSION

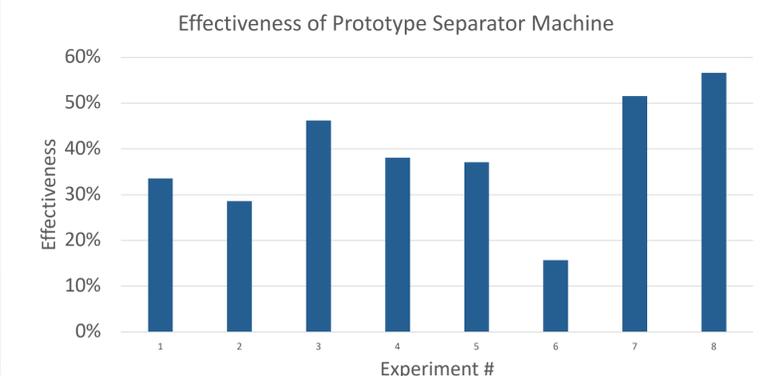


Proof of concept experiment demonstrated efficacy of overhead PTFE material that had been tribocharged with a PU roller and vibration mechanism to provide amplitude to material – paper separated from HPDE/paper flake mixture



- As built prototype separator machine shown above
- PTFE belt would migrate laterally (walk) along the rollers after a small amount of running time – can be seen in left lower image -held belt static for experiments
- Separated paper from mixture – up to 0.171% by mass.
- Process worked, but several design changes need to be made including a new belt and insulated rollers

ANALYSIS & CONCLUSIONS



- All three objectives were successfully met, and the machine demonstrated a peak effectiveness 57%.
- Prototype separator machine separated paper from the HPDE/paper flake mixture but was not as effective as expected.
- Design improvements must be made to the prototype separator machine for it to fully function as intended.

ACKNOWLEDGEMENTS & REFERENCES

[1] S. Sumner, "Triboelectric Separation of Paper and HPDE Flake Mixture," M.S. thesis, College of Engineering and Computer Science, California State University, Sacramento, 2016.