Optimization of a Battery-Powered Glass Crusher

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Introduction

This project focuses on enhancing a glass shredder system that plays a crucial role in local glass recycling efforts. The goal is to research and find a suitable solution that would make the shredder compatible with battery power. This would pave the way for a broader program that reduces glass waste in the Charlotte area and provides alternative uses.

Several potential solutions were researched and tested to identify the most effective approach for operating the shredder utilizing a battery. Options such as implementing a soft starter which would allow the distribution of recycling and decrease the bottleneck that the Innovation Barn currently has.

This research aims to contribute to practical, local solutions that support sustainability, resource efficiency, and the development of a growing circular economy in Charlotte.

Objectives

- Enable the glass crusher to operate reliably on battery power.
  - Currently, the crusher only functions reliably when connected to a wall outlet,
- Develop and test prototypes to expand the capabilities of the program.
  - These prototypes will help explore design improvements and support future scaling of the project.
- Promote sustainability by integrating crushed glass into a circular economy.
  - By repurposing waste glass into usable materials and developing Closed loop recycling systems.

Solutions

Soft Starter

An electrical device that slowly ramps up the input voltage to a motor to reduce wear and input current, which allows fine control of the motor's torque.

Capacitor Swap

Capacitors create phase shifts that allow single-phase motors to run. By switching the current capacitor for a smaller capacitor, less inrush current is required.

New Battery

A new battery, one capable of delivering sufficient current during startup to ensure reliable operation would be a long-term solution to this problem

Flow Chart of Setup

Results

Plot Description

- From the plots below, **Figure 1** shows that Level A-E resulted in the lowest inrush current when using the soft starter
- While the wall supply met this demand, **Figure 2** shows the battery—when used with the soft starter—could not provide enough current, leading to a startup failure.
- **Figure 3** illustrates the effect of motor cool-down time, showing that while a maximum cool-down interval was not established.

Plots

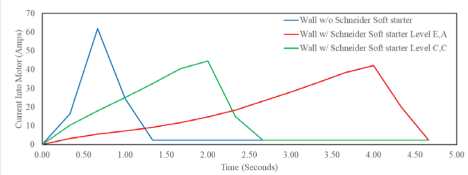

Figure 1: Impact of Soft Starter

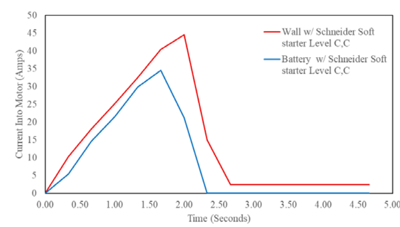

Figure 2: Impact of Wall Power Vs. Battery Power

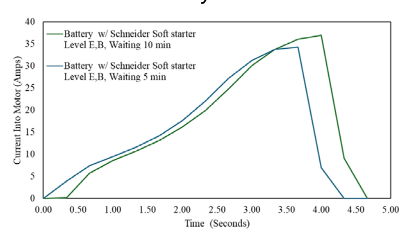

Figure 3: System Cool Down Impact

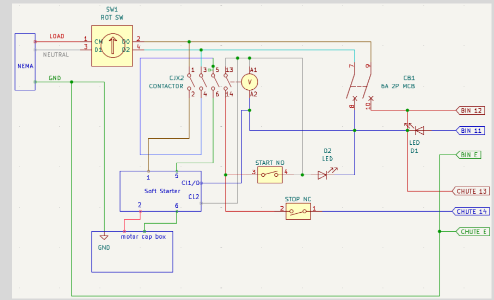

Figure 4: Electrical Diagram with Soft Starter, made with KiCad

Conclusions

This project provided a valuable opportunity to explore and apply complex electrical systems in a practical setting. The implementation of the soft starter significantly reduced inrush current, it ultimately fell short of successfully starting the motor under battery power. Future improvements could include integrating a higher-capacity battery capable of meeting the motor's startup demands.

In addition to the technical work, this project supported the development of key engineering skills. This project also made a step towards leading Charlotte to circular economy and local production, making Charlotte achieve its 2054 goal of a Fab City. Overall, the experience contributed meaningfully to both technical knowledge and practical problem-solving capabilities.

References