Foam Capture

Problem Statement
Foam infused doors are being produced within a heated press. When foam is injected into the doors, the foam expands and exits vent holes on the back (bottom) end of the doors. This escaped foam coats the sides of the heat press and hardens. Hardened foam on the sides of the heat press can damage future doors. To avoid damage to future doors, the workers must stop production and clean the heat press. Stopping production for cleaning results in a loss of an average $100,000 per year in labor alone.

Requirements

<table>
<thead>
<tr>
<th>Req #</th>
<th>Requirement</th>
<th>Description</th>
<th>Verification Method</th>
<th>Requirement Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No liquid noise emitted</td>
<td>The problem solution should allow production to continue during day time</td>
<td>Analysis</td>
<td>Performance</td>
</tr>
<tr>
<td>2</td>
<td>Safe for workers</td>
<td>The design should not endanger the health of employees and follow company’s safety protocols</td>
<td>Demonstration</td>
<td>Performance</td>
</tr>
<tr>
<td>3</td>
<td>Causes no damage to doors</td>
<td>The device should not cause any damage to the nylon or reduce the life of the doors.</td>
<td>Inspection</td>
<td>Functional</td>
</tr>
<tr>
<td>4</td>
<td>Removable</td>
<td>The device can be removed from the bottom of any frame</td>
<td>Inspection</td>
<td>Interface</td>
</tr>
</tbody>
</table>

Concepts
- The team’s initial concepts included:
  - Capture tubes
  - Capture cups
  - Mesh guards
- The team decided to pursue the capture cup concept and design multiple iterations of a foam-capturing cup.
- Pictured below are three preliminary designs of the team’s foam-capturing cup.

Final Design
- After weighing the benefits and drawbacks of each primary design the team landed on a final design, which is pictured below.

This final design is referred to as the Foam Capture Device (FCD).

- When in use, the FCD is placed on the back end of the door, over ventilation holes, then easily removed and cleaned by workers.
- The FCD is produced with a flexible filament known as TPU material and features a removable solid aluminum stabilizer.
- These features allow the workers to easily clean any excess foam that escapes the doors and is captured by the cup.
- Additionally, the Stabilizer given a rubberized coating to reduce slip between the stabilizer and the vertical stiles of the doors.
- A script was created to display an array of possible stabilizer thicknesses, at any given length, as well as the minimum allowable thickness.
- Using this relationship, the red line represents a 1.25 factor of safety.

Results
- To ensure optimization, the team sent the sponsor seven variants of the FCD for testing; each with varying wall thickness and infill. In the table below, the results from testing are shown.

<table>
<thead>
<tr>
<th>Req #</th>
<th>Wall Thickness</th>
<th>Perimeter</th>
<th>Quantity of Foam</th>
<th>Cleaning Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1/4in Wall</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
</tr>
<tr>
<td>B</td>
<td>1/4in Wall</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
</tr>
<tr>
<td>C</td>
<td>1/4in Wall</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
</tr>
<tr>
<td>D</td>
<td>1/4in Wall</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
</tr>
<tr>
<td>E</td>
<td>1/4in Wall</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
</tr>
<tr>
<td>F</td>
<td>1/4in Wall</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
</tr>
<tr>
<td>G</td>
<td>1/4in Wall</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
<td>TOO WIDE</td>
</tr>
</tbody>
</table>

- The goal was to optimize area of foam capture, FCD rigidity, and ease of cleaning.

Summary
- In conclusion, the team and the sponsor decided to go with variant C.
- This version of the FCD has a 1/4-inch wall thickness with a 50% infill.
- It is 20 inches in length to ensure it covers all vents.
- The decided stabilizer length is 18 inches, with a thickness of 1.5 inches.
- The team has sent their sponsor a stl. file of this variant and the sponsor plans to produce all further FCD’s in-house.

Team & Acknowledgements
Team Members:
- Dylan Langham BSET
- Abby Crozier BSET
- Christopher Hall BSE-ME
- Mentor: Dr. Wesley Stone
- Sponsor: Ryan Kalanish