Cost Effective Bead Resin Unloding System

A. Rowe, I. Lopez, M. Rizzo
Department of Mechanical Engineering
Northern Illinois University
Dekalb, IL 6011

Abstract— **The focus of the resin unloading device was to create a mobile, low maintenance, cost effective and functional system that decreased the risk of accidents. The device decreased the waste experienced during unloading. Considering this, various aspects of the system were designed with the intention to reduce waste and increase the safety of unloading. These features not only helped create a safe work environment, but they added to the ability for the device to be used on various smaller particle flows. These features made the system more versatile for multiple industry applications.**

INTRODUCTION

The purpose of the bead resin unloading, and transportation device is to cut costs while also improving the safety and efficiency of work. The proposed device would allow for an opportunity to eliminate the need for manual transportation while also increasing the safety of unloading and transportation. The goal of the project is to find a safe, cost effective way to unload resin beads while also meeting industry standards for flow rate.

The project idea stems from an experience a group member encountered while visiting a factory. Here the manager explained the current system. The current system takes full shipping containers, lifts them via forklift where they are then dumped into a reactor. The containers dumping hole size is not much larger than that of the reactor entrance, however without the use of a contained funneling system contamination and waste are encountered. Contamination is defined by any contact with a foreign surface. Here a foreign surface is any surface that is not enclosed or sanitized. Contaminated particles are then considered waste and have to be scrapped.

Current products on the market only address the transportation of particles without addressing the need for a safer more efficient unloading. Typical belt conveying systems are used in many particle transportation systems. However, many of the current systems are built for large scale operations where the cost of these products run high. This is due to the higher cost in tension rollers and conveyer belt costs. Creating a system for a smaller scale operation allows for a more cost-effective solution to be utilized in smaller manufacturing settings. A smaller more efficient unloader would make smaller businesses able to afford a new, more effective unloading system.

This new resin unloading system also reduces the amount of floor space used. The unloader is mounted onto 5 casters. Each caster provides reinforcement to the system while also providing mobility. The system takes up roughly four square feet of floor space. This allows smaller companies to roll the system out onto the floor, use the device, then roll it back and away in storage.

MECHANCICAL DESIGN

Material

The primary goals of the newer resin unloading system was to provide a more efficient, mobile device capable of moving resin up a 5-foot incline. To fulfill the goal of a more efficient device the resin needed to be constricted down to a smaller transportation method. To accomplish this 3-inch schedule 40 PVC was used. The PVC reduces the area for the resin particles to escape when they enter the reactor.

To create a mobile and structurally sound device, casters were mounted to the steel base frame. The steel allows the device to support upwards of 550 pounds while also providing a strong anchor point for the casters to be attached. The casters provide points of contact at each corner, while also providing a point of contact in the center of the design.

Blower

The system runs and relies on the AC Infinity inline blower to transport the resin from the hopper to the reactor.

Figure 1: AC Infinity Inline Blower [1]

The blower is attached to the edge of the base frame and is then reduced to meet the PVC where resin is dropped into the flow stream. The blower is capable of producing up to 800 cubic feet per minute of air through the system. However, the blower can reduce the amount of air pushed through the system by adjusting the speed on the handheld controller. Reducing the amount of air through the system creates a better, less turbulent flow stream. However the amount of resin reaching the reactor per unit time is reduced dramatically.

Frame/Hopper

The frame is comprised of 1 inch by 1 inch 1/8th inch thick steel tubing. The steel provides a sturdy foundation that is capable of supporting a fully loaded system. Steel also provides a robust and durable design. A lighter option such as aluminum would be more susceptible to impact damage that could be encountered in a manufacturing environment.

The frame design was created with strength at the forefront. The frame was constructed by welding the steel tubing into a square section then welding in a center cross member that spans the length to the square frame. Then, angled supports were welded as seen in Fig. 2.

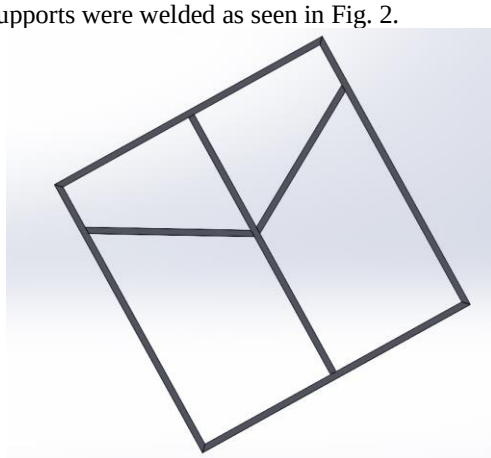

Figure 2: Steel Base Frame with Angled Supports

The angled supports not only provide a relief for the stress developed, but they also allow for the barrel stand to be attached. The barrel stand has 3 supporting legs that are spread equidistant around the hopper. These legs are then centered and welded on each support member as seen in Fig. 3.

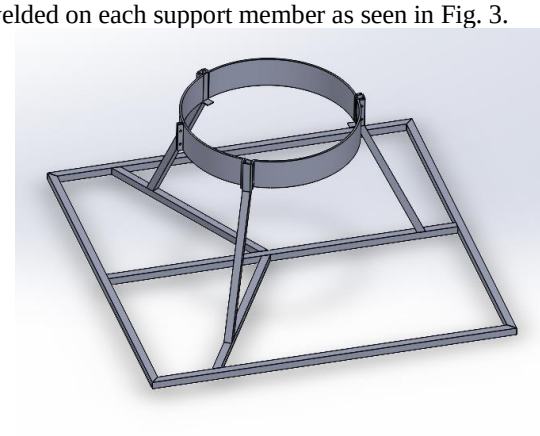

Figure 3: Barrel Stand Mounted on Frame

The hopper then rests on the barrel stand where it is secured by tightening the band around the barrel.

FLOW ANALYSIS

Blowback

The design constructed initially had a few drawbacks, specifically blowback into the hopper. When the resin levels in the hopper were low, approximately the last 5%, the resin was being pushed back up into the hopper. This prevented the resin from flowing down into the flow stream and up to the reactor.

Preventing blowback was tested in many different ways. One way was to reduce the volume flow rate as the resin got to lower levels. This reduced the blowback but prevented all the resin from climbing up to the exit. Another method was to add a longer radius WYE fitting. This would provide a near parallel entrance of the resin into the flow stream. However, under certain applications the resin would create a clog since it is meeting the flow with nearly no velocity.

Pressure

After flow analysis was conducted, it was concluded that not only turbulent flow was causing blowback but also pressure. It was concluded that the higher-pressure inlet at the blower created an issue with the flow. The resin is added midway through the horizontal run. Here the higher-pressure flow seeks out a lower pressure exit. Since the resin entrance is encountered first and the pressure at the entrance is at atmospheric pressure, the flow attempts to push back into the hopper thus creating blowback.

Addressing this issue was quite simple. The hopper being used is a 55-gallon drum. A lid was attached to the top of the drum. When the system is starting up, blowback is still being created. However, after running for a short period a small pressure is built up in the hopper. This dramatically, reduces the blowback and the system runs more efficiently.

CONCLUSION

The resin unloading system decreases the amount of waste produced, provides a more mobile option, and increases the safety provided the device is used correctly. This compact design will allow resin to be transported from shipping containers into the reactor more efficiently and at a lower cost than comparable designs currently used in the industry. The mobile design will allow smaller facilities to utilize the device. The design also provided the option for the system to be moved out of the way by simply unlocking the casters and pushing the system by the supports. Overall, the device has decreased the waste produced thus increasing profit margins for the user.

ACKNOWLEDGMENT

The authors would like to give a special acknowledgement to Dr. Bobby Sinko and Sonali Rawat for their support and guidance throughout this project. The authors would also like to acknowledge the Northern Illinois University College of Engineering program for providing funding for the project.

REFERENCES

[1] HVAC Ventilation, CLOUDLINE T8, Quiet Inline Duct Fan System with Control, Accessed April 8th , 2021.
https://www.acinfinity.com/hvac-home-ventilation/inline-duct-fan-systems/cloudline-t8-quiet-inline-duct-fan-system-with-temperature-and-humidity-controller-8-inch/?gclid=CjwKCAjw07qDBhBxEiwA6pPbHoNSgHp_BVytWLoZf1aDl8kPO4Ox1oSzSZDrwZZOFyD4ImQaKwmqUxoCJWsQAvD_BwE