Department of
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Biomass Extraction Optimization

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Background

A local producer of oils refined from bio-materials requested our assistance with redesigning the collection equipment on a new type of biomass extraction system. Their current oil trap design is inefficient at capturing the oils which leads to lost revenue from missed product and increased maintenance time.

Figure 1: The production equipment used to extract the biomass oils.The material is placed inside the large black cylinder seen in the center and the control panel for operation is seen on the right.

The company has multiple systems used to produce the oil. Plant matter is inserted into the machine where the and the trap system is responsible for collecting the oil. The old process took roughly 48 hours to complete, and needed for further refinement to separate the product from waste material.

Project Objectives

- Reduce equipment failures on oil extraction machine
- Make the trap easier to clean by having fewer complex surfaces
- Add internal sensing to optimize system control and detect early faults
- Reduce cycle time for the machine by extracting oil more efficiently
- Manufacture in accordance with NSF 51 to satisfy food safe industry standards
- Integrate new design with existing Fusion 360 model
- Produce 1st generation prototype and begin live testing

Key Components

1. Removable trap lid
2. Fittings that allow for internal coils
3. Sensing array to measure pressure
4. Sensing array to measure temperature
5. Inlet for oil flow
6. Stainless steel trap body – this is where the oil is captured
7. Outlet for oil flow
8. Valve that allows reservoir to be “hot swapped” (swapped mid-cycle)
9. Glass flask to catch oil

Computer Modeling

Fluid flow simulations were used to examine how the current design was performing. The inlet and outlet were located adjacent to each other in the lid of the trap and the trap body also had a large volume-to-surface-area ratio. These were observed in the models to be inefficient and can be seen in Figure 2 (left). Additionally, we conducted the same simulation on our improved design. The offset inlet and outlet, as well as the increased surface area provided by the had a positive effect on the trap performance (Figure 2, right).

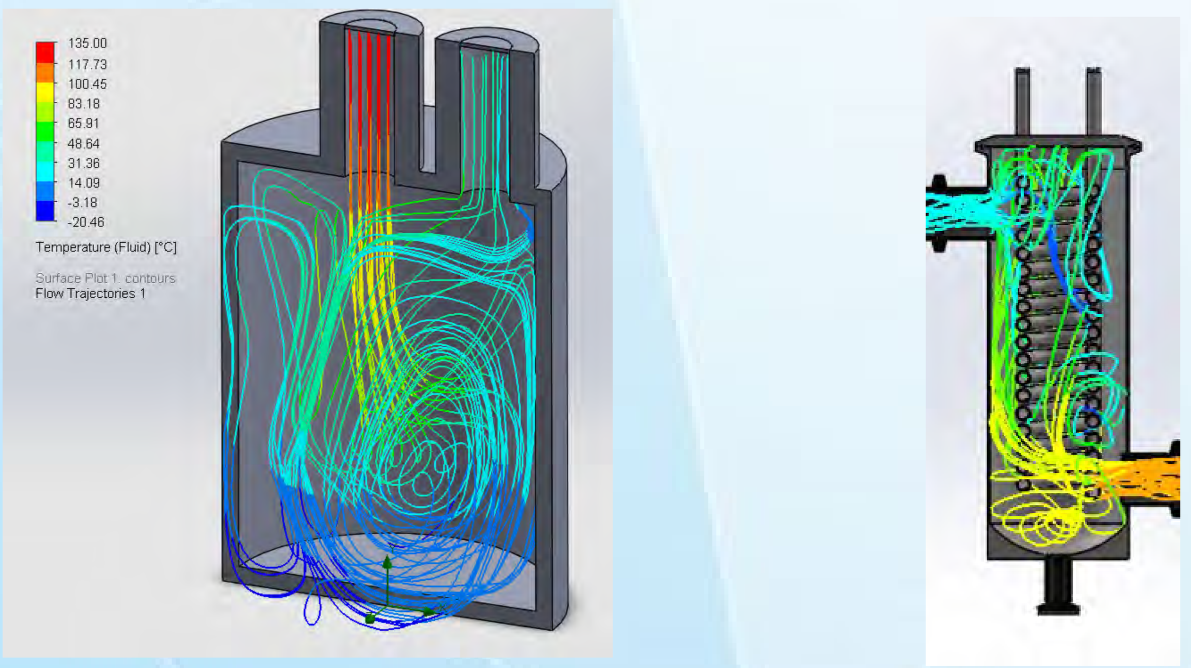

Figure 2: Fluid flow and heat transfer analysis on the original trap design (left). Flow enters in left spout and exits on the right. Analysis on the new system (right). Flow moves from the bottom right to the top left. Hotter temperatures are shown in red and colder temperatures in blue.

Results & Conclusion

In testing our prototype we discovered a few key results that lead to conclusions about the system as a whole. The trap performed well in a vacuum test for integrity and integrates well with the existing system. The flask can be used to monitor cycle progress and can be removed mid cycle should it get full. The trap system is cost competitive with other non-optimized off the shelf options.

The new design has resulted in large improvements in efficiency. The improved setup has already resulted in cycle times under 21 hours compared to the previous 48. The measurement equipment will allow for precise control over the process to prevent faults and help separate waste product and oil more easily. In addition, the valve and capture flask allow for emptying the machine mid cycle and a convenient way to store the oil. In conclusion, the trap system we have designed will be a viable future solution for the company as they expand their production.

Figure 3: CAD rendering of the final trap design. A steel coil can be seen inserted into the trap to regulate temperature.