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Powder Coating Oven

Heat Ventilation and Circulation Analysis

Section 1

Introduction

The goal of this project is to create a powder coating oven. The powder coating oven will be used to coat things for the rocket club and the Baja club. This analysis will discuss the heat ventilation and circulation system for the powder coating oven. Ventilation and circulation are essential to every oven because it is responsible for uniform heat distribution and temperature control. Without uniform heat distribution and circulation, it could cause the items being powder coated to cure unevenly causing damage to occur to the coat. It will also cause issues such as the oven overheating or excessive fuel consumption. This analysis will work towards building a system that regulates both the air flow and temperature of the oven.

Method

For this system it can be assumed that the heat will be entering through the bottom of the oven. It can also be assumed that hot air naturally rises, meaning that once the air enters at the bottom it will naturally rise to the top of the oven. Figure 1 below shows a simulation of air flow in the oven.

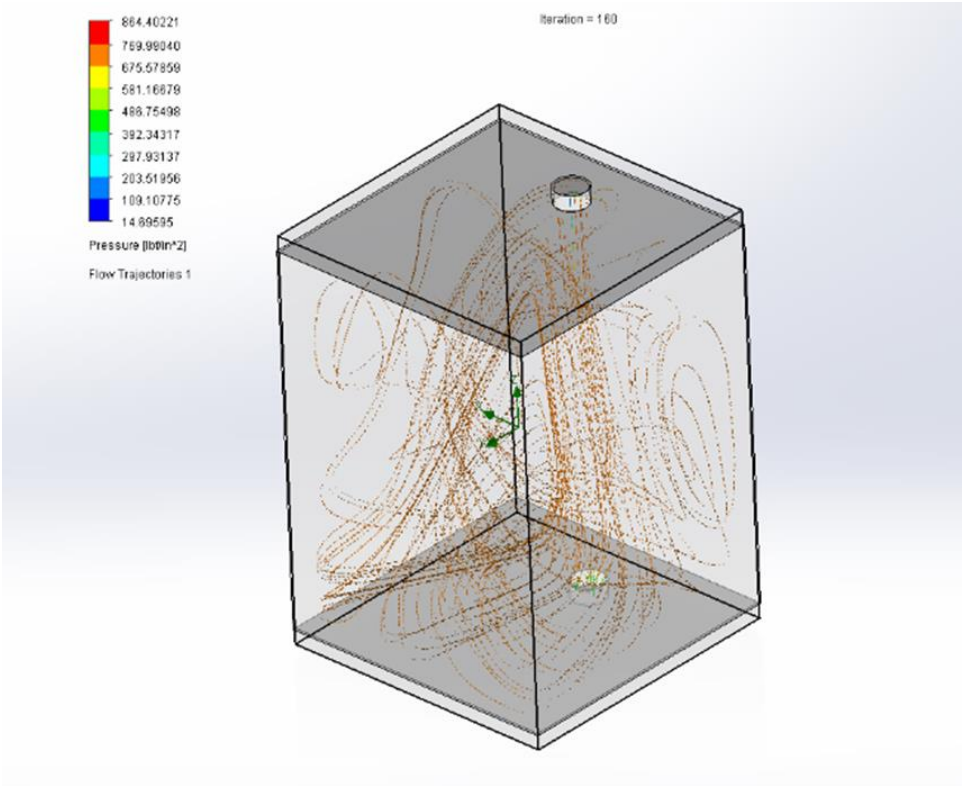

Figure 1: Natural Air Flow Simulation

This simulation shows the projected trajectory of the air particles once they enter the oven from the bottom. It also shows an additional hole at the top of the oven where a blower is located in order to help circulate the air more evenly. However, this will not be enough to allow proper air circulation to occur. As shown in Figure 1, the air flow mainly targets the center of the oven and not the sides.

Assuming that four thermocouples will be in the oven; one on the top, one on the right side, one on the left side, and one on the bottom; this will cause error in the temperature measurement provided by the thermocouples. A solution to this issue would be to create a circulation system that would target the sides of the oven.

Results

In order to combat the lack of air circulation a system of air ducts was developed to circulate the rising air allowing it to reach the sides of the oven. Figure 2 below shows the developed circulation system.

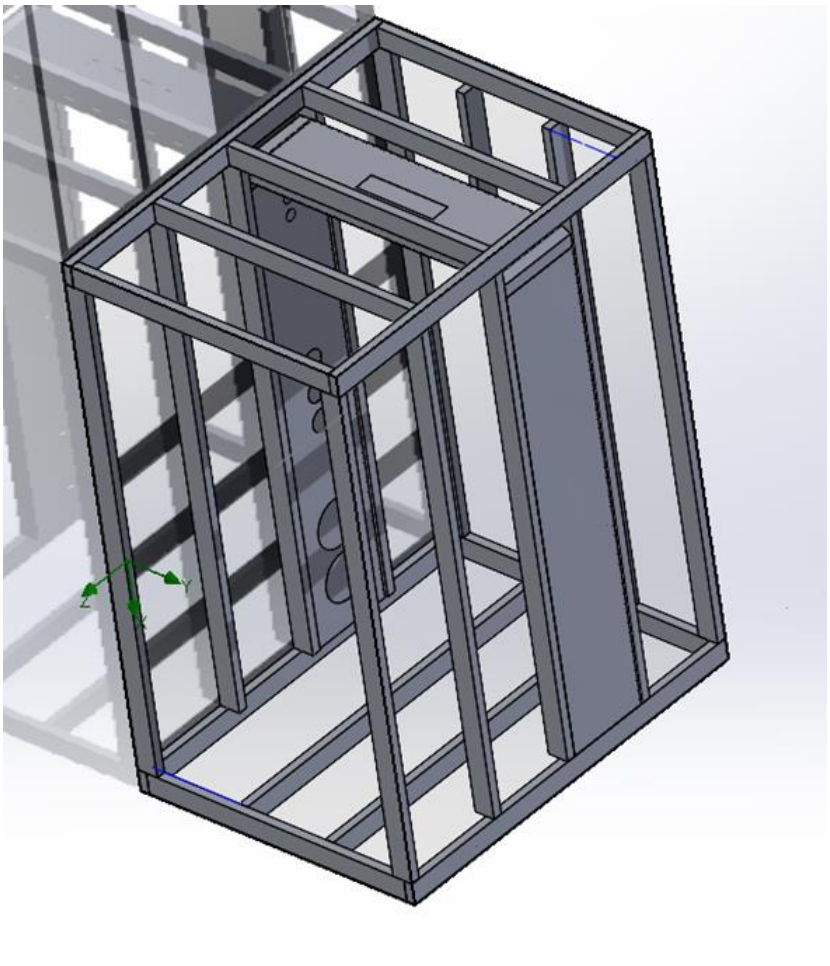

Figure 2: Heat Circulation System

As shown in Figure 2 the circulation system will be composed of a series of stackable wall ducts that will be attached to the 2x4 frames of the oven. When looking at the wall ducts it shows that all wall ducts are approximately the same size. This is to avoid causing cavitation which is the shaking of pipes or ducts due to the air moving from a large pipe to a small pipe. The pressure of the air exceeds the area causing the pipe to shake. However, if air passed from a small pipe to a large pipe, it would not cause cavitation, but it may cause the air to lose velocity due to the increase in pipe mass. Given this information the

ducts were selected to have the same area in order to not cause cavitation or loss of velocity. The ducts will have holes running along them to help air flow reach the sides of the oven. An automated vent will be placed at the both of the oven to help regulate both the temperature and the pressure of the oven.

Discussion

To begin the circulation system heat would enter from the bottom back wall of the oven through a torpedo heater. Heat would then naturally rise and enter the inlet of the squirrel cage blower. It would then be released through the exit connected to a series of elbow and wall ducts. These ducts will run alongside the left and right side of the oven. The ducts will include holes in the oven for air to be released. These holes will vary in size from the smallest at the top and gradually increase in size to allow uniform air flow out of the ducts. The vent at the bottom will be programmed into the control system to allow the vent to open and close when the temperature becomes too great as opposed to just having the heater turn on and off to allow for fuel loss to be minimized. The vent will also open when the pressure of air inside the oven exceeds the pressure outside the oven. If the pressure inside the oven exceeds the pressure outside the oven it will not allow for proper air circulation to occur.

Conclusion

Given the above simulations and schematics the stackable wall duct circulation system is a plausible solution that will allow for air to circulate throughout the entire oven. Further simulations can be done to solidify the locations of the wall ducts for optimal air circulation. However, the current schematic accomplishes the necessary tasks of air circulation, pressure regulation, and fuel efficiency for the oven.