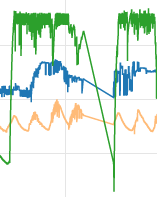
Designed and Implemented by Graham Miller, Aaron Stokes, and Daniel Hull

Guided by Dr. Palmeri

Pinch Valve Integration

This document has been written to produce a written documentation of the integration of the pinch valve into the anaerobic digestion pasteurization latrine. With hope, this document will help streamline the groups thoughts and ensure robust development of a motor that will produce the desired outputs.

The problem statement can be most aptly understood from a plot. Please observe the green HTR line. The temperature probe is monitoring the inside of the pasteurization system. As the current system is designed, the microcontroller works to hold temperatures between 68 and 72 degrees to effectively eliminate bacterium from the processed effluent. The sudden drop in temperature is a resultant of an influx of fluids into the pasteurization system. This occurs from a large onset of individuals using the bathroom at consistent patterns daily, notably for instance the hours of 6-10 A.M. Without controlled flow, an influx of waste fluids at room temperature can cause the pasteurization system to destabilize. Several problems occur from this, the waste has not been adequately digested, and the pasteurization does not work efficiently. A controlled valve system could solve this problem.



The controlled valve system has been designed to use a linear stepper motor. (Seen here <http://www.omc-stepperonline.com/nema-23-noncaptive-linear-stepper-motor-56mm-body-150mm-lead-screw-t11-x-2-p-150.html)> This bipolar stepper has the following specs (2.0 A rated, a recommended voltage of 24-36 V) An adjustment of the stepper motor step wise can move up and down a screw that pushes down or opens flow through a master flexing tube. This tube through lab testing has the following flow properties.

There appears to be a clear exponential rate in flow rate as a function of the stepper motor from the closed position. The vision is to control of the stepper motor from an Easy Driver(ED) board. (<https://learn.sparkfun.com/tutorials/easy-driver-hook-up-guide)> Notable specifications of the Easy Driver include a maximum of 750mA per phase or 1.5 A for the bipolar arrangement. The ED board contains options for microstepping, which we will not use. It will have a power input of 6V to 30V. A 12V power supply should suffice. The power supply should be able to supply a spec of 2A. It can supply a maximum load voltage of 30V. The ED board responds to input digital logic of 0-5V on two pins (DIR and STEP) which set the direction and step amount respectively. The maximum step frequency is 500KHz. A microcontroller board will control the digital outputs to the ED with three pins utilized, one for each of the DIR, STEP, and SLEEP pins.

The system should be responsive to these sudden changes in the amount of liquid waste as to adequately allow for flow to enter throughout the day. The system will feedback from a number of bucket tips per a unit time. The length of time will determine the sensitivity by which the step motor will adjust flow rate. As this new flow is over the course of tens of minutes to hours, the time will need to be over the course of minutes. Responsive code will be implemented in a C++ class and implemented in the .ino file.

Key system failures introduced by this valve would be a full closure as to prevent backup in the digester. Monitoring where the current position is in software or a lack of bucket tips are potential software approaches to ensure failure of this nature doesn’t happen. It’s important to note control boards and stepper motors of the ED nature must be isolated from dust. One important consideration is that the ED generates a lot of heat if used constantly. This will need some circulation as to prevent the operating conditions to exceed its designed standard. Sleep functionality implemented in the prototype also seemed to reduce the heating of the ED board. The board did not get even close to warm when this functionality was implemented. The pins of the linear step motor from the ED board must be in precise orientation. Any variation results in improper control of the linear step motor. If the linear step controller were to get off, and move all to the top I have gotten the pin stuck in that position before. Resetting the position and monitoring the position will be important.

A link to a pdf that I found issue for common stepper motor failures is the following. (<http://www.anaheimautomation.com/manuals/forms/Common%20Causes%20for%20Step%20Motor-Driver%20Problems.pdf)>