Chemical Dose Controller Modifications

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Problem Definition

Introduction

Over the past several semesters, the AguaClara Chemical Dose Controller (CDC) team has progressed towards a more robust linear dose controller for AguaClara plants. However, these changes have yet to be completely integrated into the Automated Design Tool (ADT). My task for the semester was to complete updates to the CDC code.

The main task was to properly incorporate the new CDC manifold system into the CDC drawing code. The Spring 2013 CDC team created a SketchUp displaying the new manifold system along with the entire proposed dosing system, which can be seen in Figure 1.

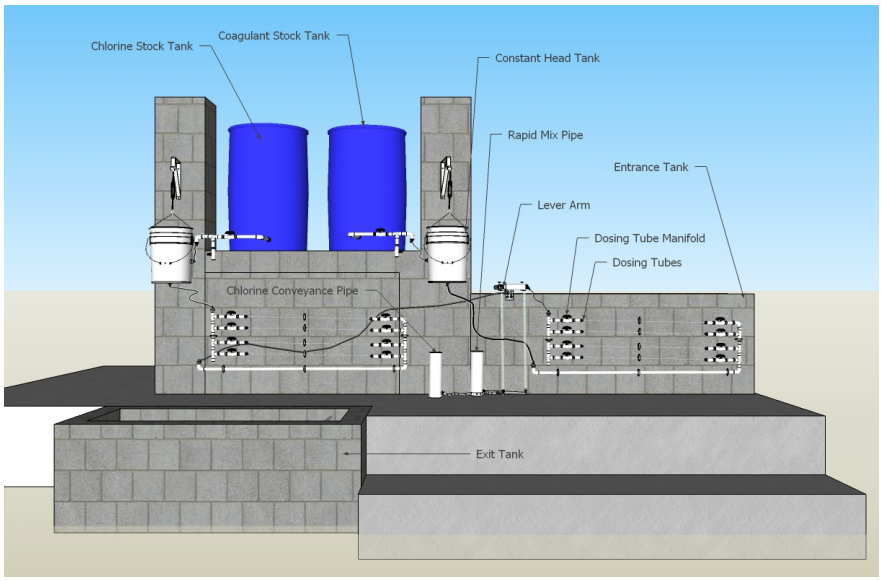

Figure 1: CDC SketchUp

Additionally, several changes to the code which supports the CDC drawing code have been made in the past years and had yet to be completely incorporated into the CDC drawing file. Specifically, the design team has moved away from using inserted drawings for pieces of the system such as the constant head tanks and has created functions to draw these elements from scratch, and a previous design team member created a flexible tubing function to more accurately represent the tubing used in the chemical dose controller. These functions needed to be properly called in the CDC drawing file.

Lastly, it is necessary to revise the sizing and concentration of the chemical stock tanks in order to design for a concentration that will both avoid corrosivity and allow for simpler proportions of chemicals to be used.

Accurate representation of the CDC in AutoCAD drawings produced by the ADT is essential to ensure adequate understanding of its operation by those using AguaClara designs; completion of this task would allow for this increased understanding of the CDC by those using AguaClara designs.

Design Details

Incorporating the Manifold System and Completing the Dosing Drawing

The new manifold system, shown above in Figure 1, had to be accurately represented in the drawing. Significant work on this task had already been completed by design team member Heidi Rausch. A drawing of the entrance tank for a

20 L/s plant with the manifold system running along the side can be seen in Figure 2.

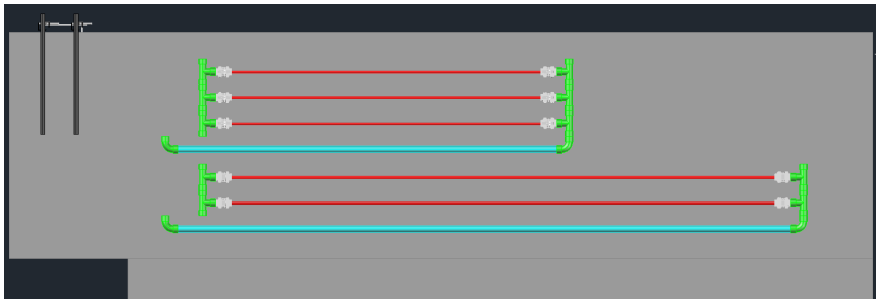

Figure 2: 20 L/s Entrance Tank with Preliminary CDC Manifold Drawing

As can be seen in Figure 2, the connections between the different components of the system still needed to be added. Specifically, the flexible tubing function needed to be utilized to draw tubing from the stock tanks to the constant head tanks, from the constant head tanks to the manifold system, from the manifold system to the top of the drop tubes on the lever arm, and from the bottom of the drop tubes to the rapid mix pipe (for coagulant) and to the chloring dosing site at the effluent to the filter. In order to do so, proper inputs to the flexible tubing function which was created in past semesters, FlexTubeF, needed to be determined. FlexTubeF was modified slightly to allow for more intuitive inputs. FlexTubeF previously required inputs of the number of divisions over which to trace the path, a 2-point point array specifying the direction which the inlet and outlet face, the length of the tube minus the length which fits over fittings on either side, inlet and outlet coordinates, nominal diameter of the tubing, and the desired layer name and color. By modifying the function, it was possible to simplify the selection and calculation of these inputs.

Completion of modifications to the FlexTubeF function would allow for flexible tubing to be drawn connecting the points stated previously. Once completed, this would be the first time the path of the coagulant and chlorine stock will have been fully included in the drawing.

Also, updates to the constant head tank and calibration column code require completion. The current drawing output of this code is shown in Figure 3. The constant head tanks need to be properly sized and placed in a location that will allow for simple connections between the constant head tanks and stock tanks, as well as the constant head tanks and the manifold systems running along the entrance tank wall.

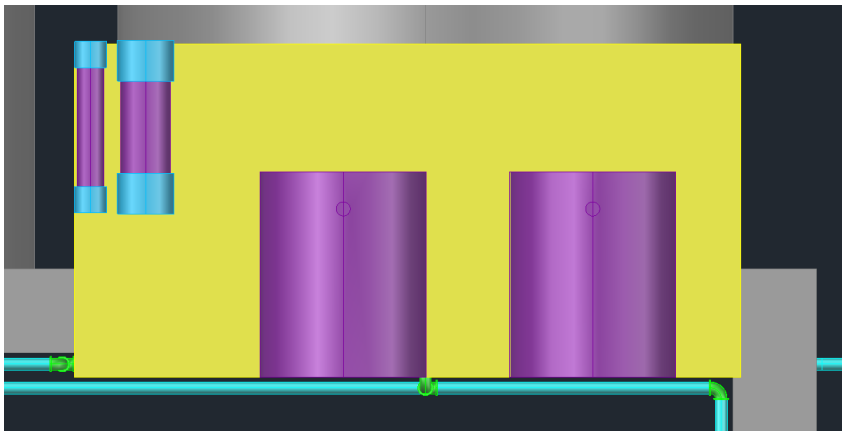

Figure 3: Constant Head Tanks and Calibration Columns

Revising Stock Tanks Sizing and Stock Concentration

The current algorithm for stock tank sizing and stock concentration needs to be revised to design for ease of operability and reduce the effects of corrosion on the dosing system. Specifically, the stock concentration and stock tank size should be such that the operator can mix an integer number of 25 kg sacks of PACl into the stock tank to produce the correct concentration. This, according to AguaClara Engineer Drew Hart, will allow for more accurate stock tank concentrations because the mixing process is simplified and will reduce the burden of calculation on the operator. Also, the stock concentration should be capped at approximately 120 mg/L to reduce the corrosive effects coagulant and chlorine stock solutions have on fittings, especially ball valves, which currently require frequent replacement. Drew Hart also specified that coagulant stock could be refilled once every 24 hours while chlorine stock should not last longer than 48 hours.

Code for this change will require iteration since the stock tank concentration and stock tank size are interdependent. It is my goal to create a function that is as efficient as possible for this calculation by avoiding long-lasting loops.

Documented Progress

Flexible Tubing

It was quickly realized that the FlexTubeF function would not, as written, output proper script to draw flexible tubing. Various options were explored for fixing the function, but all ended up being fruitless. Although having flexible tubing drawn in the design tool would enhance understanding of the flow of

chemical stock through the entire dosing system, many other important improvements to the drawing were possible to achieve without needing to fix the flexible tubing function. Fixing and finalizing the flexible tubing function will be a task for future semesters.

Before moving on from the flexible tubing, several contributions were made to make the function inputs more intuitive for users. Instead of taking an input of inner and outer diameter, only a nominal diameter is required and inner and outer diameter is calculated and utilized within the function. Dimensions for the inner and outer diameter of flexible tubing were incorporated into the file PipeDatabase. Previously, only the available inner diameters (for both English and metric units) were listed in the ExpertInputs file. The layer name and color were eliminated as inputs, as coding convention calls for this to be determined outside of a function that draws an object. Thus, once the function is fixed, it will require proper inputs that align with AguaClara coding conventions.

Dosing Manifolds

The dosing manifold code previous to this semester did not completely represent the most recent design proposed by the CDC team, as represented in Figure 1. Several simple changes were required to update the code to the most recent design.

Over the course of the semester, change in the entrance tank code were made that impacted the dosing manifold and made it evident that the manifold code, as written, was not robust. The drawing seen in Figure 2 shows an ideal case in which both manifold systems fit easily on the entrance tank wall. However, this is not the case for many flow rates, or even a 20 L/s plant with the corrections to the entrance tank code made this semester. Placement of the coagulant and chlorine dosing manifold was corrected to allow for proper placement along the entrance tank wall. This is shown in Figure 4. The CDC research team has suggested having an extra dosing tube for each manifold for all designs; however, this is not vital when the design already calls for more than one dosing tube, which occurs on many occasions. I modified the code to only draw an extra dosing tube when only one is required for dosing; that is, there will never be less than two tubes drawn.

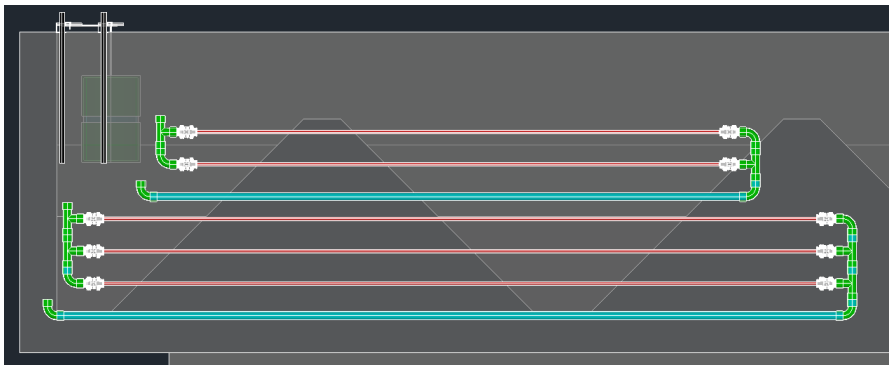

Figure 4: Updated Manifold Drawing - 40 Lps

Future Work

Many portions of this task remain for future semesters. The first portion would be to complete placement of the both manifold systems to ensure that they will have space to be attached to a wall at any flow rate. The second portion would be to fix and finalize the flexible tubing function and utilize it to draw the tubing which connects various pieces of the chemical dose controller, as detailed in the Design Details section above. Another portion is to finalize the updates to the calibration column and constant head tank drawing code. The final portion would be to revise the sizing and concentration of the chemical stock tanks in order to design for a concentration that will both avoid corrosivity and allow for simpler proportions of chemicals to be used.