Agua Clara Inlet Manifold Fabrication Team

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Abstract

This report will cover the research that is currently being done in Cornell's AgauClara lab to create a fabrication method for the diffuser tubes on the inlet manifold. This team needs to develop a method by which the diffusers can be easily manufactured in Honduras. Very little work had been done on this fabrication process as this is a new part of the AguaClara plant. This report will first discuss the need for the diffusers and how they help the plant be more efficient. The diffusers must be fabricated in fast and efficient way and each diffuser should be identical to one another. This report summarizes the research that is currently being done as well as plans for future research.

Literature Review

The Inlet Manifold is a part of the sedimentation tank. The diffuser tubes which this team will be fabricating extend from this inlet manifold, see Figure_1-. The tubes are necessary because they help to create a uniform flow between the manifold ports by eliminating any horizontal velocity components and they also create a line source which will divide the two sides of the sedimentation tank and suspend all flocs heading toward the center of the tank. The specifications for the design were determined in August 2011, and this is the design that will be fabricated for new plants beginning this fall. Suggestions for how the diffusers could be created include various ways of heating the PVC they will be made out of and then using a mold or a jack system to create the specified shape.

In August of 2011, a design to improve the ability of AguaClara plants to form floc blankets was discovered and this design will be built in Atima, Honduras. The conceptual design for the new system has been created. However, a new method is needed to fabricate the inlet manifold system.[1] The preliminary design for the Atima plant calls for a 15.24 cm diameter manifold, 4.4 cm diameter ports every 12.1 cm, diffusers that are 7.62 cm in diameter and approximately 60 cm long. The diffusers pipes will be heated, reshaped, and stretched by 20% into a rectangle that is 3.2 cm wide and 12.1 cm long, see the Diffuser tube in Figure_1-. The rectangular section should extend as long as possible so that there is a long distance for the fluid to approach uniform flow.[2]

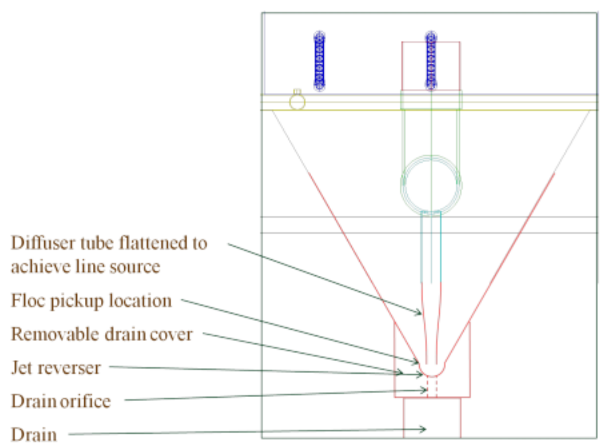

Figure 1: Sketch of the inlet manifold with diffuser tubes

Methods

An easy and cheap method is needed to fabricate the new inlet manifold. In order to do this, PVC pipe should be heated and then molded into a rectangle that is 3.2

cm wide and 12.1 cm long. After some research was done, it was determined that PVC pipe could be heated using boiling water, a heating blanket, or a heat gun.

Boiling Water Method

Boiling water is by far the cheapest method and easiest resource to come across. An initial test was done to see whether boiling water could heat the PVC pipe up to a high enough temperature that it could be molded.

1. Place water in a microwaveable container that the PVC pipe fits in
2. Put the container full of water into the microwave
3. Heat the water using the microwave until it starts to boil
4. Submerge the PVC pipe in the boiling water
5. While the PVC pipe is heating, repeat steps 1-4 with another container
6. Put the PVC pipe in the new boiling water container and reheat the old one
7. Keep switching containers with boiling water until the PVC pipe is very hot
8. Using protective gloves, stretch the PVC pipe over the mold

Design of the Mold

A plaster of paris mold has been created to press the hot PVC pipe onto so that it stretches to the dimensions at the end of the mold (See Figure 2). To make the mold the triangular sides of the mold were cut out from foam board (See Figure 4). They were then laid down side by side and taped together. The plaster of paris was then poured into the poster board form and left to dry. The final product can be seen in Figure 3. The mold is made of plaster of paris so that it can withstand the high temperatures and water that it will come into contact with when the PVC pipe is placed onto it. The plaster of paris mold has also been covered in a waterproof epoxy so that it will not be a problem for the mold to be constantly coming into contact with water.

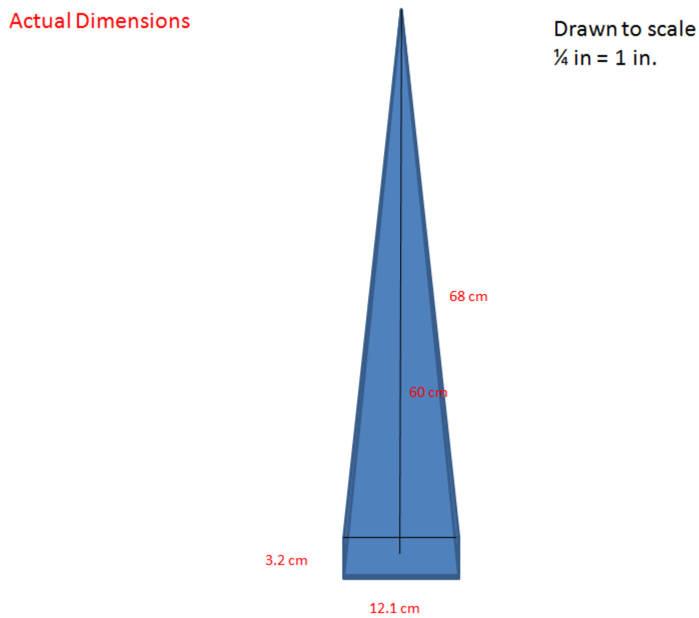

Figure 2: Mold design

Figure 3: Mold for 3" pipe made out of plaster of paris and coated with polyurethane

Figure 4: Cut outs of mold sides for plaster form

Mid-Semester Redesign

After meeting with the Design and Sedimentation Tank teams at the beginning of October we learned that a few changes to the diffuser tubes need to be made. The largest change is that, 2 inch pipe will now be used instead of 3 inch pipe. The sedimentation tank bottom geometry will also change (similar to 1). Instead of the rounded tip extending into the two angled sides there will now be a omega shaped bottom of the tank extending again into the two sides, now specifically angled at 50 degrees. The new bottom design will also include a piece of stainless steel extending from the tip in the middle of the omega shape up into a slit in the diffuser tube. This piece of metal has been added to help to keep the diffuser tube centered over the bottom of the sedimentation tank. See Figure 5 for a preliminary design of the new bottom geometry.

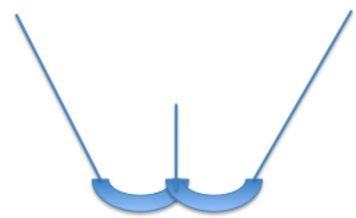

Figure 5: New design for bottom of sedimentation tank

Analysis

The method of using boiling water proved to be very successful in heating the PVC pipe up to an appropriate temperature. There was a bit of a problem in keeping the water hot because of the limited size of the microwave. It seemed that a hot plate would be a lot more efficient because it would keep the water at a constant boiling temperature so the PVC pipe can be heated a lot quicker and kept at the hotter temperature.

After testing with a hot plate we found that there were a lot of issuses we ran into. First, it is hard to find a suitable container large enough to hold the amount of water we need to emerse the PVC in. After deciding to use a large plastic container, we ran into problems when trying to heat up the water quickly as the plastic on the bottom on the container began to melt before the water was able to come to temperature.

Conclusion

Though the boiling water method seemed promising, after actually testing this method it has been established that this will not be a good choice for the final fabrication process. Boiling water is too fickle and not enough direct heat. When testing with the hot plate the container we kept the water in got extremely hot, but the water and the pipe itself did not.

Future Research

If using the mold to shape the PVC does not work other options will need to be considered. A jack system could be used. In this system there would be two piecesof metal that would be the desired width of the rectangular shape at the bottom of the pipe and which would then be put into the pipe and then pulled apart until the desired length of the rectangle has been reached.

After deciding that heating with boiling water is not our best choice for heating the PVC we need to find other heating methods. One method that will most certainly be tested is using a heating gun, as we have access to one in the shop. Monroe has suggested this, as he used this method with some success when first testing how the fabrrication of the diffuser pipes may occur.

References

1. Floc Blanket Research
2. Inlet Manifold Fabrication