Floc Probe

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May 16th, 2014

Abstract

The visualization of the floc blanket in Aguaclara plants has been difficult and limited, so our team has tried to simulate it and create a new apparatus to solve or at least to reduce the problem. We found reports and materials from the turbidimeter team that could help in our task. Research was done on commercial sensors that could help monitor the floc blanket level, but none of the results were feasible. An experimental set up was also created in order to simulate the floc blanket and clear water interface with no success. Finally, a sludge judge apparatus was created to hopefully help with the observation of the floc blanket in San Nicolas.

1 Introduction

The other main objective of the team is to develop a method to monitor the floc blanket depth and sludge depth in the floc hopper. It should also be possible to visualize the floc blanket during its development, as it is crucial to ensure its formation. The options to be analyzed may include transparent tubing, LED lights or even sensors. With more information, the operator will be able to know how well the floc blanket is performing and when to drain the sludge from the floc hopper.

The floc blanket is a fluidized bed that forms in the sedimentation tank below the plate settlers. The blanket acts as a filter for larger flocs and improves the efficiency of the sedimentation tank by decreasing the turbidity of the water that goes through the plate settlers and therefore ensures that only settled water comes out of the effluent launder. The floc weir and hopper system maintains the height of the floc blanket and keeps it from rising into the plate settlers. Once the floc hopper fills, it can no longer prohibit the height of the floc blanket from rising and therefore needs to be cleaned out by the plant operators.

Currently, plant operators monitor the floc blanket height and formation by shining an LED light through the plate settlers. This is inconvenient for the plant operators and requires a trained eye to discern what is actually happening below the plate settlers. In the San Nicholas plant, there is an observation hole from the channels in front of the sedimentation tank down through the floor into the top of the floc hopper which is part of the design of the plant. Our

Figure 1: Turbidimeter Team Final Design

objective is to create a device that can go through the hole and monitor the height of the floc blanket for the plant operators.

2 Literature Review

2.1 Turbidimeter Team Final Reports

In 2011, there was an AguaClara sub-team dedicated to the development of a low cost, portable turbidimeter that would be able to test possible water sources for AguaClara plants. They developed and calibrated a turbidimeter that was able to measure turbidities above 15 NTU, was 60 cm long, and cost less than $5. The final design for turbidimeters consisted of a blue LED light with a large HDPE block which was used to diffuse the light (see 1).

3 Methods

3.1 Commercial Floc Probe Possibilities

We investigated many commercial level sensors and most of them (including ultrasonic sensors) were only useful to measure the liquid-air interface. The sensors appropriate to be used in bulk solids were capacitance, vibrating and peddle wheel sensors. They can be quite useful and could be installed tocontinuously monitor the level of the floc blanket. Some less expensive sensors are listed in 1.

However, if the operators would need only periodic detection of the floc-water interface, a permanent sensor is not necessary. A periodic detection can be done much more easily by submersing a light device and watch its light fade as it enters the floc blanket. It is our intent to use the methods developed by the Turbidimeter Team and adapt them to detecting the height of the floc blanket.

Level Switch Types	US$
Mini Tuning Fork Level Switch	230.00
Peddle Wheel Dry Bulk Level Monitor	161.00
Tilt Switch Probe	166.00
Wall Capacitive Sensor	150.00

Table 1: Commercial Sensors

3.2 Floc Blanket Simulation Set Up

After a discussion with Casey Garland, who told us that a typical floc blanket has a suspended solids concentration anywhere between 600 - 4000 mg/L, we attempted to create a experimental set up that would mimic the interface in the floc hopper between the clean water on top and the thick layer of sludge at the bottom. If we could design a device that would distinguish the level of the flocs, this would help the plant operators determine when the floc hopper would need to be purged.

We tried to create an experiment that would simulate the interface between the floc blanket region and the clear water above it. A magnetic stirrer and a beaker were the equipment used for our experiments. For our first trial we created an ethanol layer above a layer of suspended clay solution. We created an extremely turbid solution of clay and water (3 grams in 50 ml) and then gently layered approximately 20 ml of ethanol on top2. Although the ethanol had a lower density than the clay water and should have remained on top, the clay particles did not remain solely in the water, but were also suspended into the ethanol. For our second attempt we used vegetable oil and Pine Sol cleaner. We used the cleaner instead of the clay solution because the clay was settling very fast and since the cleaner has a dark brown color, the difference in color and turbidity would still be similar to the real system. As we poured the vegetable oil above the dark brown solution, bubbles of oil that were difficult to remove were generated at the interface, resulting in a non smooth interface that was not desired. Althought the layers remained distinguishable, conversations with Drew and Monroe indicated that we should focus on building a sludge judge rather than simulating the floc hopper because there are several currently unknown factors as to why the operators in San Nicholas cannot take advantage of the floc hopper viewing hole.

3.3 Sludge Judge

The sludge judge was constructed by attaching a circle of clear acrylic to the end of a 1" PVC pipe with epoxy. A submersible LED light is then suspended with a thin bar of metal approximate 2" from the bottom of the PVC pipe to illuminate the space between the LED and the acryclic (4). The purpose of the sludge judge is to enable the viewer to examine only a small section of water at a time without having to look through an entire column of turbid water(3). With the cap at the bottom, the majority of the viewing column is instead air

Figure 2: Clay and Ethanol Floc Blanket Simulation

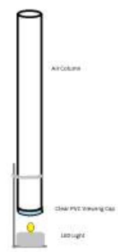

Figure 3: Sludge Judge Diagram

and makes it easier to examine the true turbidity of the water.

While fabricating the first model of the sludge judge, the acrylic was accidentally moved during its application to the PVC and the epoxy smeared across the inside of the sludge judge(5). Unfortunately this clouded the acrylic, prohibiting it from giving a clear view of the LED. If this were to happen in Honduras, the sludge judge would then be rendered useless. We then constructed a second model and were careful not to smudge the epoxy. The other concern with the fabrication is the practicality of the length required for the sludge judge. Ideally, the sludge judge will be lowered into the viewing hole all the way to the bottom of the floc hopper. This will end up being approximately 5 to 6 feet from the top of the viewing hole to the bottom of the floc hopper. If the PVC pipe needs to be that length, it will be cumbersome to manipulate. Additionally, we were not able to make a sludge judge that length, since it is our intention to send it to San Nicholas with Jon Christensen or Walker Grimshaw this summer. Finally, while we were able to make a temporary sludge judge, we were not able to test it because we were unable to simulate the change in floc density and because we don't know the exact current conditions San Nicholas. Without more informa-

Figure 4: Sludge Judge

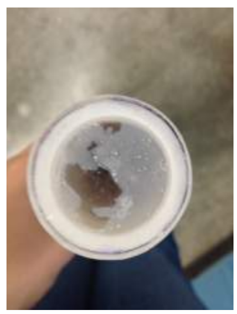

Figure 5: Clouded Acrylic

tion, there was not more we could do than fabricatethis sludge judge and wait for feedback if it is put in use in San Nicholas.

4 Conclusions

We could conclude that monitoring the floc blanket through sensors were not a feasible possibility and therefore being able to see the floc blanket with a light isthe best option. We could not simulate a floc blanket experimentally, so we hope that the sludge judge apparatus can be useful to future teams or possibly used in San Nicolas to get more information about the floc problems there. There were not many more actions we could have taken with the little information we had.

5 Future Work

Future floc probe teams should consider investigating a way to make the clear cap removeable so that in the case that it might get dirty again or encounter epoxy problems, it would be easy to clean it without having to create an entirely new device. They must also look into a way to extend the sludge judge to the proper length without introducing a leak or interface where water might enter the sludge judge and obscure the view. A future team could also work on replicating a floc weir/floc hopper so that tests could be made in the lab. They could also work on improving the design of the sludge judge so that the length would not make it cumbersome but would make it easier to use and store. With more information from San Nicholas, it will be easier to tackle these problems.