Linear Chemical Dose Controller Summer 2011 Detailed Task List

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1. Allow new team members to fill out necessary paperwork, perform lab training, learn Mathcad and LCDC experimental protocol. (Zia, 6/13/11 - 6/17/11)
   (a) **Progress Update: Completed.**
2. Review last semester's data, results, analysis, research reports and lab techniques with new team members. (Matt & Zia, 6/13/11 - 6/17/11)
   (a) **Progress Update: Completed.**
3. Immediately continue last semester's (Spring 2011) lab experiments to identify and minimize minor head loss through the system.
   (a) Investigate the effect on minor head loss of the radius of curvature of the small diameter tube. Are these losses significant? (Matt & Zia, 6/18/11 - 6/24/11)
      i. **Progress Update: Completed.** Analysis: The loss are significant, so we've taken the step of moving the CHT farther away from the drop tube to straighten out the SDT. This has decreased minor losses through the system and the maximum percent error at any point in the system.
   (b) Determine the effect of coiling the small diameter tube(s) on minor head loss through the system. If there is additional minor head loss, are they significant? (Matt & Zia, 6/18/11 - 6/24/11)
      i. **Progress Update: Completed.** Analysis: Coiling the SDT, in small, tight coils as well as loose, circular rings, significantly increases the minor head losses through the LCDC system and is not going to be a viable option for the LCDC system.
   (c) Finalize the method for modeling minor head losses. If we use Mathcad's genfit function, determine which parameters should be allowed to change (minor loss coefficient, kinematic viscosity, tube inner diameter). (Matt, 6/25/11 - 7/1/11)

    i. **Progress Update: Completed.** Analysis: We will use the genfit function and allow kinematic viscosity and the minor head loss coefficient (k-value) to change to allow genfit to fit the curve.

(d) Determine the tradeoff between small diameter tube length and LCDC system maximum percent error. Longer tubes reduce the maximum percent error, but how long is too long for a small diameter tube? Ask Sarah and Dan what they think about this. (Matt, 6/25/11 - 7/1/11)

    i. **Progress Update: Completed.** Analysis: Sarah says that SDTs with lengths of 2 meters can be used and suggested running the tube along a wall through a piece of PVC tubing to keep the SDT(s) straight and semi-protected. This setup would allow the CHT to be positioned farther away from the drop tube. We have found that SDTs of 2 meters assembled in the manner stated in the previous sentence reduce the maximum percent error below 10%.

(e) Decide upon the optimal constant head tank (CHT) and drop tube barbed fittings. The choices include barbed fittings for tubes with inner diameters of 5/32" or 3/16", or newly-fabricated stainless steel fittings. For simplicity and consistency, the system should use barbed fittings or steel fittings for both the CHT and drop tube, rather than a combination of the two. While making this decision, identify the tradeoffs between the options regarding ease of use, simplicity of construction in the field and hydraulic performance. (Matt & Zia, 6/25/11 - 7/8/11)

    i. **Progress Update: Completed.** Analysis: We will use the 3/16" barbed fittings. We have performed over 15 experiments with them using a wide range of tubes and have yet to have a problem with the connection between the SDT and the barb. Furthermore, they minimize minor head losses better than the homemade steel fittings.

4. Design a new way to calibrate the LCDC system. Does calibration at a total head loss of 10 cm reduce the maximum percent error to acceptable levels? Will the LCDC still be able to deliver the maximum desired dose if calibration is performed at a total head loss of 10 cm? If not, perhaps evalute the possibility of producing LCDCs with set maximum flow rates. Rather than calibrating the LCDC, the stock tank fill volume would be set so that it allows the LCDC to deliver the correct dose. (Matt & Zia, 6/25/11 - 7/8/11)

    (a) **Progress Update: Completed.** Analysis: We have decided to design the system so that it will be calibrated at the maximum flow point to ensure that it delivers 2.5 mL/s per SDT. We will use 1.85m SDT(s) to deliver this flow rate. Then, the amount of water added to the coagulant stock tanks will be varied so that the LCDC delivers the desired maximum dose. Experimental results have yielded less than 8% maximum percent error with this tube length.

5. Test the reducer and multiple parallel SDTs to see if there are any problems connecting 2-9 parallel SDTs. Find the best way to minimize the sharp turn just out of the CHT and just before the drop tube barb fittings to minimize the minor losses. (Matt & Zia, 7/2/11 - 7/8/11)

   (a) **Progress Update: Completed.** Analysis: We have to figure out a better way to attach the small diameter tubes because the tubes which make a sharp turn to attach to the barbed fittings are experiencing more minor head loss.

6. Determine which new flow controller design to implement. This decision will be based upon testing of the screw that fastens the slider to the lever. Is the screw's connection secure enough to use the vertical design or will the screw/slider wear out over time? Will the connection be impacted by chemicals (PACl, chlorine, alum) or raw water being spilled on it? Determine how it can be placed within an AguaClara plant if we use a long SDT. (Zia, 7/5/11 - 7/11/11)

   (a) **Progress Update: In progress.** Analysis: Sarah Long is deciding upon which flow controller design to implement and I'll be in touch with her while she does that.

7. Investigate the maximum chlorine concentration in the chlorine stock tank to avoid losing chlorine as a gas. Finding this upper limit will allow us to use a higher chlorine concentration in the stock tank and therefore have lower chemical flow rates necessary for adequate disinfection. (Matt & Zia, 7/9/11 - 7/15/11)

8. Design an easy way for the plant operator to measure the real-time plant flow rate. Is the LFOM the best location for a scale or would a scale somewhere on the LCDC or elsewhere in the entrance tank be better? Is there a way to put a plant flow rate scale on the LCDC's lever? (Matt & Zia, 7/9/11 - 7/15/11)

9. Assemble an up-to-date, comprehensive list of every piece (including McMaster parts numbers or other part ID numbers) needed to assemble the chemical dose controller and flow controller. Check the chemical compatibility of all parts. (Matt & Zia, 6/20/11 - 7/15/11)

   (a) **Progress Update: In progress.** Analysis: We have a list of all the parts needed downstream of the CHT besides the fittings used at the bottom of the drop tube and the counterweight parts. Parts necessary upstream of the CHT will not be included on this last, as they are likely to change depending upon the size and design of the plant.

10. Order all parts necessary to fabricate a new LCDC and flow controller in the lab. Do this to practice how it would be done in an AguaClara plant in Honduras. (Matt & Zia, try to place the order by 7/15/11, assemble and test 7/18/11 - 7/29/11)

11. Work with the design team to devise an automated method to generate the LCDC chemical flow rate labels and plant flow rate labels to be included in the design files. (Matt & Zia with help from design team, 7/30/11 - 8/5/11)

    (a) **Progress Update: In progess.** Analysis: We have created a simple design file that takes as inputs the plant flow rate, the maximum desired chemical dose, the maximum stock tank coagulant concentration, and the maximum number of dosing tubes and outputs the desired stock concentration and the number of dosing tubes necessary. However, this file has not yet been input into the ADT.

12. Additional topics:

    (a) order the parts necessary for the float connection and the counterweight. Test these parts and assemble them to make sure they work. Place this order ASAP (as of 7/6/11)

        i. **Progress Update: Completed.** Analysis: Everything is good, just have to figure out a good way to attach the counterwight.