Plant Layout Optimization

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Abstract

The AguaClara plant layout is dominated by the sedimentation tank configuration because the sedimentation tank length is used for the flocculator and entrance tanks. The sedimentation tank length is indirectly set by the user by selecting the number of sed tanks and sed bays. This determines a flow rate per sed tank and hence a length of the sed tank. The changes in plant layout are dramatic and have many consequences including total length of tank walls, diameters and lengths of piping, shape of the building that houses the reactors, and distance the operator has to walk between control and observation points.

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skills systems and CEE 4540

1 Introduction

The AguaClara plant layout has evolved rapidly based on feedback from implementation partners, review of the AutoCAD drawings, and addition of new unit processes. The need for a system perspective that integrates multiple objectives and the many constraints makes obtaining optimal solutions complex. The dominant issues related to plant layout including the following:

- Many sites are sloped and thus excavation costs can be reduced if the lower elements of the plant are on one side. The drain channel running along the one side of the plant was the lowest element prior to the addition of the filters. The filter could logically go at the top of the plant across the walkway from the sedimentation tanks (figure **??**).
- Construction costs can be reduced if tank walls are shared.
- Placing the filter next to the sedimentation tanks could share a wall, but it also requires a retaining wall beneath the filter to stabilize the soil under the sedimentation tank.
- The flocculator needs to have an even number of channel so that the coagulant stock tanks are on the "uphill" side of the plant.

- The flocculator channel width could be optimized so that an even number of channels provides the target collision potential or the rapid mix pipe could connect to the other end of the first channel for the case of odd number of channels.

- The flocculator depth could be optimized so that an even number of channels provides the target collision potential. This would require a transition in the slab beneath the sedimentation and flocculation tanks.

- There are design transitions for tubing sizes that may be significant. For example the inlet manifold for the sedimentation tanks is designed to have a maximum energy dissipation rate (downstream for the transition from the inlet channel) that is less than or equal to the maximum energy dissipation rate in the flocculator. The inlet manifold pipes are the biggest pipes in the sedimentation tanks and there cost may be somewhat significant in the design. Thus it might make sense to design sedimentation tanks to have flow rates equal to the maximum flow rate that can be handled by the inlet manifold. Should the number of sedimentation tanks normally be set to optimize the use of the inlet manifold tubing?

- Short sedimentation tanks require extra long plate settlers because a larger fraction of the sedimentation tank is taken up by channels and thus the upflow velocity through the plate settlers is higher. This in turn requires deeper sedimentation tanks and usually this means deeper flocculator tanks as well.

- Plate settler sheets come in specific lengths (often 12 feet) and thus it may be beneficial to set the length of the plate settlers so that there is no waste. This results in an improved capture velocity for the sedimentation tanks, but requires making the tanks deeper. Should the use of plate settler sheets be optimized to reduce waste of plate settler material or should the plates be cut to the exact length that gives the target capture velocity.

- The number of plates per sedimentation tank bay are constrained to be easily divided into modules. Should the number of plates per module be fixed for all AguaClara plants or should the number of plates per module be varied to more closely achieve the target capture velocity?

- Should plate settlers be standardized to always have the same length and the same number of plates per module?

- It may be highly desirable to design facilities that can easily be expanded by the addition of flocculator channels sedimentation tanks and filters. How could the plant layout accommodate higher flow rates? Will increased capacity be provided by adding to the existing facility or by building a parallel plant (as was done at Marcala)?

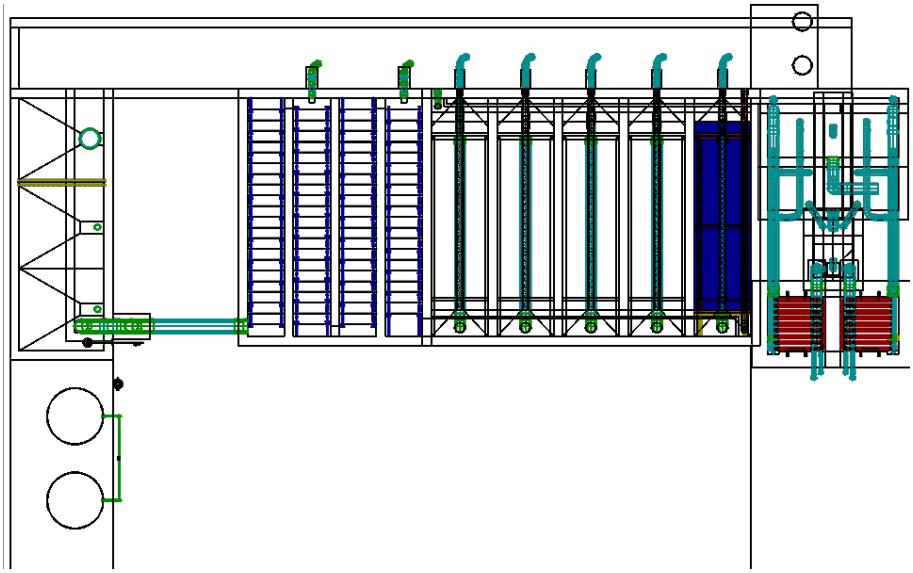

Figure 1: Top view of a 15 $\frac{L}{s}$ plant.

2 Tasks

It will be most efficient to automate the cost estimation process by adding material costs to the design tool. You can likely obtain budgets from APP for the Alauca or Atima plants. Use the cost estimation capabilities that you create to methodically determine the best options for cost reduction in the plant design and to give expert advice on improved design algorithms.

Although the cost estimation is important, it is not the only factor. As you propose new design layouts review those layouts with the team in Honduras to ensure that the AguaClara design philosphies are met.