ANC Control

Acid Neutralizing Capacity (ANC) Control Team

Overview

Abstract

The ANC Control team has conducted laboratory research to investigate the feasibility of using a lime feeder to add alkalinity to the influent water of AguaClara plants. This was necessary in order to maintain the pH within the ideal range for flocculation after the addition the chemical coagulant, alum, which has an acidic effect. Low-alkalinity source waters in Honduras do not provide sufficient buffering capacity naturally to resist the drop in pH. The team has found that proposed lime feeder designs consistently fail to produce saturated effluent for a length of time which would make them economically and practically viable. The failure is believed to be caused by precipitation of calcium carbonate on the calcium hydroxide solid surfaces. The recent availability of poly-aluminum chloride, an alternative coagulant to alum with a much smaller acidic effect, in Honduras has reduced the need for lime feeders with AguaClara plants.

Introduction and Objectives

Flocculation in AguaClara plants relies on sweep coagulation of particles, which works optimally within a pH range of 6.5 to 7.5 because aluminum hydroxide, the precipitate responsible for making particles "sticky", is more soluble in acidic water. The addition of alum, the chemical coagulant generally used with AguaClara plants, is followed by aluminum hydroxide precipitation, which lowers the pH of the plant flow. Low alkalinity source waters often found in Honduras provide little buffering capacity to counter alum's acidic effect, so the pH often falls below the ideal range for flocculation performance. Low-pH water is also a potential problem for corrosion of the distribution system and human health. The team would like to add a base to the plant flow along with alum to provide acid neutralizing capacity and maintain a more desirable pH.

Calcium hydroxide, often called slaked lime or dead lime (cal muerta), is an inexpensive and readily available chemical used in making tortillas in Honduras. Because it is relatively insoluble, chemical dosing using a pre-mixed stock solution saturated with calcium hydroxide would require impractically large volumes of water. Instead, the team has investigated the possibility of using a lime feeder to continuously deliver calcium hydroxide-saturated effluent to the plant influent. A lime feeder is a reactor in which a fluidized bed of solid lime is continuously dissolving, producing saturated effluent while keeping solid particles from being carried out with the effluent.

During laboratory experiments with lime feeders the concentration of the effluent consistently drops prematurely. The team now believes that the failure to maintain saturated effluent for the anticipated duration of a run, calculated based on the amount of lime initially added, is due to calcium carbonate precipitation within the reactor which inhibits dissolution of calcium hydroxide.

An alternative coagulant, poly-aluminum chloride (PAC), which is now economically competitive with alum in Honduras due to the recent availability of a transportation-friendly crystalline form, does not consume alkalinity to the same degree as alum. AguaClara Engineers in Honduras have tested the chemical with AguaClara plants very successfully with respect to both maintaining raw water pH and removing turbidity. We anticipate that all AguaClara plants will soon adopt PAC as their coagulant, reducing the demand for lime feeders because it will no longer be necessary to buffer against high acidity. The Fall 2010 ANC Control team has discontinued research with lime feeders because of the declining need. The team is now writing a final report which organizes all of the knowledge produced by ANC Control teams to facilitate any future lime feeder investigations.

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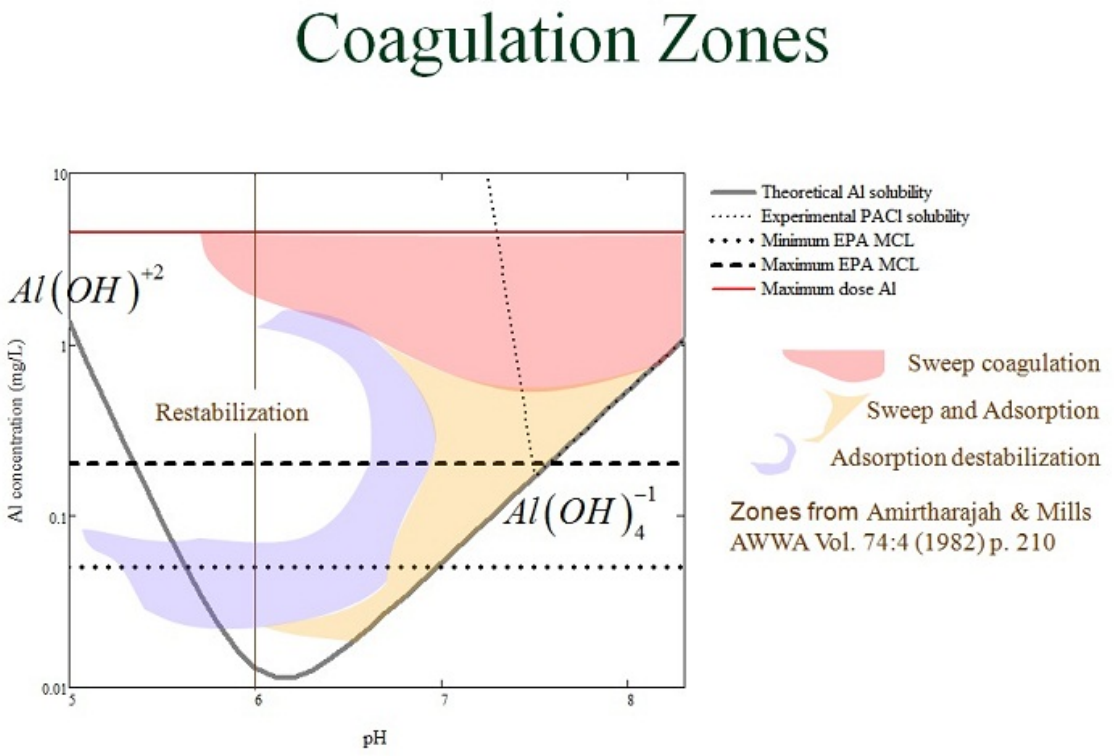

Figure 1. Solubility curve for aluminum hydroxide. Target pH range is shown in orange.

The objective of the ANC Control team has been to design a lime feeder system to deliver saturated calcium hydroxide effluent to the influent surface water to increase its alkalinity. The lime feeder design must be inexpensive and simple to construct, install, and operate. As with all AguaClara technology, it cannot use electricity. In order to be economically viable, the lime feeder must be efficient enough with respect to the fraction of added lime which dissolved in the effluent that the system is less expensive to operate than dosing with a soluble base such as sodium carbonate. In order to be practical, it must be able to operate independently for at least a 24-hour period without the need for cleaning or fresh lime.

Research by Semester

Fall 2005 - Spring 2006 Research was conducted until it was discovered that the plant at Ojojona was successful without a lime feeder. Research was discontinued until it was recognized that low alkalinity in Honduran source waters may still be affecting flocculation. The early research teams conducted experiments with a variety of proposed lime feeder designs and first proposed calcium carbonate precipitation as a failure hypothesis.

During Fall 2009 research the team created a new lime feeder design consisting of a vertical column and a tube settler which is the basis for the current design.

The Spring 2010 team modified the lime feeder design to include a way to feed lime during an experiment and decreased the capture velocity by doubling the diameter of the tube settler from 2.5cm to 5cm. They also conducted a number of experiments with the lime feeder apparatuses and developed the lime hypotheses for why the lime feeder failed to maintain saturated effluent.

The Summer 2010 team continued to develop the calcium carbonate precipitation hypothesis, improved on evaluation methods, and used Honduran lime for experimental runs.

The current team (Fall 2010) is discontinuing lime feeder research because of the availability of poly-aluminum chloride, an alternative coagulant which does not consume alkalinity to the same degree as alum. The team is working on organizing ANC team research and results.