Chemical Disinfection in Rural Ecuador

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Introduction

The Clean Water Institute, in conjunction with Calvin University seeks to address issues with water availability in developing countries, particularly as it relates to quality of the water.

The research done this summer was to investigate the potential implementations of improvements for clean water in rural Ecuador.

These improvements manifested themselves in two distinct initiatives:

The first initiative was to investigate the implementation of a passive chlorinator in a small Ecuadorean community. This involved literature review to decide a chlorinator to pursue, followed by extensive testing to validate the efficacy of the chlorinator under a variety of conditions.

The second initiative involved the investigation of the viability of the generation of sodium hypochlorite solution and the successive disinfection of containers which has been previously established as a means of bacteria entry to drinking water (Jagals).

Objectives

Goals

- Establish potential options for a chlorination system in Ecuador
- Determine the viability of a specific chlorinator for implementation in rural Ecuador and make adjustments as necessary
- Establish the feasibility and procedure for a carboy disinfection system
- Determine the situational and financial viability for an on-site sodium hypochlorite electrolysis system

Methods

Sodium Chloride Electrolysis

One of the stages of research involved the investigation and implementation of a system in which a brine solution (1 *m* NaCl solution) was applied with an electrical current to produce a sodium hypochlorite solution. Several successive trials were taken and found that Hypochlorite concentrations in excess of 17000 ppm could be synthesized in under 48 hours. Acidity and time dependent concentration data were recorded as a means of determining bleach concentrations in the event of improper operation or instrument malfunction.

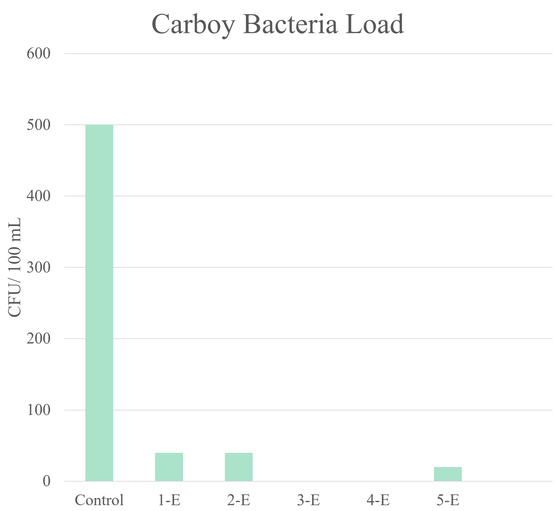

Figure 2: Bacteria load in the water after carboy disinfection. The far left indicates the control group and the others indicate disinfected containers

Carboy Disinfection

In conjunction with the research into NaCl electrolysis was an attempt to establish a procedure for carboy disinfection. Such a procedure would seek to maximize chlorine economy and minimize bacteria presence. Following literature review, a surface contact time of 1 minute and hypochlorite concentrations of ~1000 ppm were utilized. Preliminary research indicated a significant reduction in bacteria presence.

T Chlorinator Objectives

The primary objective of the summer research at Calvin was the determination of a chlorinator for use in rural Ecuador.

The first stage of this research involved a widespread literature review into the potential passive chlorinators on the market. The challenge with the Ecuadorean project was particularly challenging for a several factors:

Little access to electricity or complex instrumentation

Lots of chlorinators rely on electrical power and expensive technical components which do not fit the Ecuadorian environment well not fit the Ecuadorian environment well.

Lack of Resources

Geographic constraints couples with lack of available technical resources requires a robust chlorination system.

T Chlorinator – Selection and Trial

Upon extensive literary research, the CTI-8 chlorinator was selected as the best choice for the given design constraints. Its simple and robust design showed promise in delivery of consistent chlorine concentrations that could meet the needs of rural Ecuador.

Following the selection of the CTI-8, extensive testing of the chlorinator was undertaken to determine its response to tablet surface area, volumetric flow rate. Testing also was undertaken to see if control of an unchlorinated bypass line could enable the user to exert external control over the chlorination system.

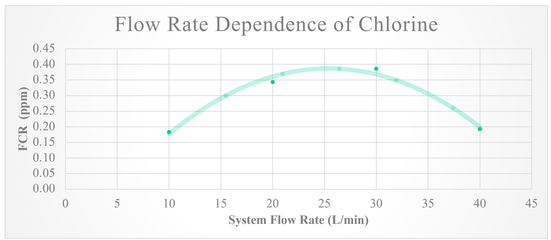

Figure 2: *Flow rate vs Chlorine Concentration for the CTI-8*

Conclusions

Conclusions of Study

This summer research came away with several conclusions:

- Sodium chloride electrolysis was not financially viable due to high start up costs compared to using commercial bleach
- Carboy disinfection showed a 96% reduction in bacteria, (n=5)
- For flow rates of 10-40 liters/min concentration varied slightly with flow rate
- Adjustment of a bypass valve meant that chlorination could be adjusted simply and precisely

Implications

Conclusions of Study

This summer research demonstrated the efficacy of the CTI-8 T chlorinator and a carboy disinfection system. Implementation of the T Chlorinator in San Isidro will take place in March of 2024.

References

Jagals, P.; Jagals, C.; Bokako, T. C.; (1988). The Effects of Container Biofilm on the Quality of Water Used from Plastic Household Containers, Journal of Water and Health.

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