Douglas G. Kelley & Associates, Inc.

Chemistry Consulting

Use of *Hydro*FLOW to Optimize Antimicrobial Performance in Apple Packing Dump Tanks

Case History March 2016

The Site

The case study site is an apple packing facility in the US Pacific Northwest.

The Background

This facility packs conventional and organic apples using a single packing line, and is interested in reducing the use of chemicals while, at the same time, minimizing the risks associated with food safety bacteria (E. coli, Listeria, etc.) and decay-causing mold, present within their flume water systems.

The packing line has a dual-flume system, with the flumes in series called the T-Dump and the Treatment Tank. The apples are transferred from storage bins into the T-Dump flume water tank, which is the most heavily fouled water in the facility due to the dirt and debris present on the bins and fruit. A large volume recirculation pump creates sufficient flow to float the apples along the T-dump flume to an elevator, where they are lifted out and dropped back down into a second flume, called the Treatment Tank. The Treatment Tank water stays considerably cleaner than that in the T-Dump, but can still contain a significant loading of bacteria and decay microorganisms.

Due to a 2014 listeriosis outbreak that was linked to consumption of carameled apples, there has been an increased effort to develop best practices to minimize the presence of food safety pathogens in apple packing water systems. The chemical treatment programs employed at this packing facility are consistent with most other apple packing facilities in the Northwest. The T-Dump flume was treated with citric acid and peroxyacetic acid (PAA), for the purpose of providing a strongly acidic medium for de-scaling hardness from apples while relying on the antimicrobial activity of PAA for microorganism control. The Treatment Tank was treated with chlorine (Sodium Hypochlorite, NaOCl) and a buffering acid to maintain the pH around 7.0, and was typically heated to about 90^{o}F in order to warm the skin of the apples to properly accept a wax coating.

The Problem

Despite treatment of the T-Dump flume with 80 ppm of PAA, the measured levels of total aerobic bacteria and total fungi (molds/yeasts) were in the range of 10^{3}-10^{7} cfu/mL, each. These results indicated very poor microbial control of bacteria and fungi within the treated T-Dump flume water system. See the Table below for actual readings using the SaniCheck Test Kit from Biosan Laboratories, which detects both total aerobic bacteria (48 hour test) and total fungi (96 hour test).

The Solution

A *Hydro*FLOW water conditioning device, which is powered by the patented Hydropath technology, was installed onto the 6 inch recirculation pipe that carries the T-Dump flume water from the back of the flume to the front where the new bins of apples are introduced. This proprietary technology produces an oscillating AC signal at 150,000 Hz that changes the nature of water, possibly disrupting "hydrogen-bonding" between water molecules in a fashion similar to that of a surfactant. Therefore, in the presence of a sufficient *Hydro*FLOW signal, the molecules of water act more independently, allowing for unique benefits of scale inhibition and microbial reduction.

Our goal in this study was: 1) to determine the benefit of the Hydropath signal in the presence of the normal treatment dose of chemical, and 2) to determine the minimum chemical dosage required, in the presence of the Hydropath signal, to maintain equal or better microbiological control as compared to the use of chemicals alone.

The Table below shows the effect of the *Hydro*FLOW device on the performance of PAA to sanitize the bacteria and mold in the T-Dump flume water system. The water in the T-Dump flume was held for one week before being discharged. The flume was cleaned and refilled with fresh water for the following week's operations. Results from the weeks of October 12th and October 19th were obtained with chemicals only, showing the levels of microbiological contamination in the T-Dump flume in the range of 10^3 to 10^7 cfu/mL, for both bacteria and fungi, and with PAA dosages in the range of 39 to 52 ppm.

Once the Hydropath signal was initiated during the week of October 26th there was a dramatic decrease in both bacteria and fungi in the tank, with microbiological levels ranging from 10^1 to 10^3 cfu/mL, despite low PAA dosages ranging from 18 to 35 ppm. Testing through the following week of November 2nd showed similar results of 10^1 to 10^2 cfu/mL with PAA doses that were increased to a range of 63 to 77 ppm and then dropped to 14 ppm (dosage fluctuations were accidental - due to operator error).

Table. Effect of *Hydro*FLOW on Total Aerobic Bacteria and Total Fungi in the T-Dump Flume Water System.

Date	PAA (ppm)	TAB (cfu/mL) (48 hours)	Fungi (cfu/mL) (96 hours) .	
10-12-15	42	10^4	10^3	
10-14-15	46	10^5	10^3	
10-16-15	52	10^5	10^3	
10-19-15	41	10^4	10^3	
10-21-15	39	10^3	10^3	
10-23-15	49	10^7	10^5	← The Hydropath signal was initiated during the week of October 26th
10-26-15	35	10^2	10^2	
10-30-15	18	10^1	10^1	
11-2-15	63	10^1	10^2	
11-4-15	77	10^2	10^2	
11-6-15	14	10^2	10^2	

Treatment Tank (Chlorine Reduction)

The *Hydro*FLOW water conditioner was moved to the Treatment Tank to determine the effect on chlorine usage and performance.

In the week prior to initiating the Hydropath signal the microbiological testing under conditions of 40-50 ppm of Total Chlorine at a pH of 6.7 showed no measureable bacteria or fungi in the water system (non-detect).

Once the *Hydro*FLOW signal was initiated, the chlorine dose was reduced. Interestingly, even with dosages as low as 10 ppm Total Chlorine, the microbial results remained at non-detect. Also, the Free Chlorine and Total Chlorine levels were exactly the same.

However once the *Hydro*FLOW was turned off, and the Total Chlorine was left at 10 ppm the Free Chlorine level dropped to less than half that of the Total Chlorine, and microbial counts became detectable (ranging from 10^1 to 10^3 cfu/mL).

As a side-benefit, the cleaning and sanitation personnel reported that the debris accumulated on the side walls of the flumes was significantly lighter and easier to clean when the *Hydro*FLOW unit was in operation than under the normal operation of chemical treatment.

Conclusion

The results of this study have demonstrated the dramatic benefit of Hydropath's eco-friendly technology for enhancing the ability of sanitizers to control bacteria and fungi in apple flume water systems reducing the Minimum Inhibitory Concentration (MIC). Similar benefits have been observed in cooling water systems, pools, and other industrial water applications.

For further information about the unique benefits of Hydropath's proprietary, eco-friendly, water conditioning technology, please contact:

Doug Kelley, Ph. D.
509-679-4637
dgkainc@gmail.com