TetraClean Sanitation Solution™ for Retort Cooling Systems

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Abstract

Ozone has been approved under 21 CFR part 173.368 for the use as a secondary food additive for the treatment, storage, and processing of food. Along with the ability to control bacteria within a food product, ozone also has additional chemical properties that make it a key additive to canning retort processing water. The use of ozone in retort processing water, specifically in the cooling canals, has the added benefit of controlling scaling, biofilm formation, foaming, water clarity, and additional detergent/chemical needs. The specific use of the TetraClean Sanitation Solution™ system ozone in pet food canning retorts will be summarized in a case study in which the following is seen: rapid improvement of the overall water quality used in the canning retort process, reduction of active bacteria to such a level that it was not detected for the majority of the case study and finally acceptance of the canned and use product by feline test subjects with no difference between the use of the ozone process compared to the traditional chlorine process.

Introduction

Ozone has been recognized as an efficient sanitizer for the production of food products. Certain food products such as salad mixes[1] benefit from the application of ozone for the reduction in spoilage and extension of shelf life. Other food producers such as sushi manufacturers utilize ozone for sanitation of the fish, vegetable, and rice mixture that is used in the production of sushi, along with extension of the shelf life [2].

Additionally, ozone has been identified as an efficient bactericidal treatment for the cooling water used in canning retorts. As bacteria are not only detrimental to the food product contained inside the can, such as sources of food poisoning, *C. botulinum*, but also as corrosion sources[3-7].

Bacterial concentrations bacterial concentrations in retort cooling water have been identified as not to exceed certain critical levels, i.e. 100 colony forming units per 1 mL. This critical limit has been developed based on the concept that during the retort cooling process a volume of 0.01 mL of the cooling water will make it past the mechanical seal of the can lid thus depositing one bacterium inside the sealed can [8, 9]. This one bacterium could then propagate and lead to canned product spoilage and contamination.

Studies by the California Energy Commission [10] have shown results in which:

1. Processing chiller bath water with a concentration of 2-4 PPM ozone using ¼ gallon of makeup water remained visibly clear and the microbial counts, aerobic plate count and E. coli, were equivalent to a three stage chlorinated chiller bath.

Research performed at the Department of Food Science at Louisiana State University [9] determined:

1. Ozone treatment of shrimp showed a four log reduction of *L. Monocytogenes* in spiked shrimp samples.
2. Increase in consumer acceptability of the final treated shrimp product when compared to simple refrigeration.

This report will outline the process control utilized in a cat food canning retort cooling water study. The results from the study will demonstrate the following advantages of using ozone to control:

1. The bacterial concentrations in the cooling water.
2. The acceptability of the finished product with the feline consumer.
3. The corrosion control and process quality of the retort can cooling water.

Background

Retort cooling water systems have historically required a variety of chemical treatments to prevent multiple adverse conditions from developing. The water, unless it is softened, will require treatment with phosphate-based chemicals to prevent Calcium and Magnesium scaling. The water also must contain an oxidative biocide to deactivate microbes that may be present in the cooling water. 21 CFR part 113 requires that a residual oxidizing agent be measureable at the point of discharge within a

retort cooling system. Unfortunately, most biocide treatments are corrosive to metal surfaces within the retort cooling system. Consequently, a chemical rust inhibitor is added to slow corrosion rates of metal surfaces. This also applies to steel cans/containers that may sometimes have spots where the protective coating was scratched off during container closure operations. Some level of organics will unavoidably accumulate from the containers placed in the retort system.

Typically, a detergent blend of chemicals is used to disperse the grease in order to prevent fat films from being deposited on the retorted containers. Consequently, the combined chemical program can be costly and it requires managing chemical inventories, storage, and disposal of chemical packaging. One must consider the safety risk factor of handling hazardous chemicals that require personal protective gear, and the need to train employees on how to safely handle the chemicals required to maintain compliance with OSHA regulation.

If organic loading is substantial, the biocides added to control microbes can be blocked or tied up, rendering the chemical treatment ineffective, which the only alternative is to add more biocide. Biofilm growth can occur within the cooling system, reducing the effectiveness of the cooling tower efficiency. Some biocides require a lower pH in order to be activated. In some cases acid is added to the cooling water which lowers the pH but increases the corrosion of the cooling tower. Regardless of whether acid is used or not, the biocides contribute to the corrosion rates of metal equipment.

If organic loading is high, there will be a layer of fat and grease that coats the reservoir system, in spite of the detergent in use. If that is the case, retort cooling systems must be frequently drained and manually cleaned. These areas frequently fall under OSHA confined space requirements. Entry and work in a confined space requires personnel training and specialized equipment. The manual labor necessary to clean retort cooling systems is not an enjoyable task.

Increasingly, there is pressure for businesses to become more sustainable and to reduce waste and reliance on the use of chemicals. There is also pressure to reduce chemicals and their by-products that goes to municipal waste treatment.

Consequently retort cooling water is increasingly recycled to reduce the consumption of chemicals and water used. As the retort water is reused, organic load increases with each retort cycle. The organics originate from the exterior of the containers being retorted or from damaged containers. The organics accumulate and adhere on the entire cooling system surface including cooling towers, reservoirs and piping. Typically these are not accessible and the organics support the growth and accumulation of biofilm. This in turn reduces the cooling capacity of cooling towers and result in extended cooling cycles. So, the technology employed must be able to oxidize, flocculate and remove the organic and biofilm deposits.

Cooling Water Process Control

One of the optimum alternatives to managing retort cooling water systems is the TetraClean Sanitation Solution™ system. This system utilizes a patented technology that creates small bubbles of ozone gas diffused into a stable aqueous solution. The ozone does not off gas easily in this solution and has the following properties not found in traditional ozone systems:

- The Oxidative Reduction Potential (ORP) of this system is higher than other FDA approved oxidizing chemicals.
- The residual ozone in the retort system can be measured via an ozone test kit at the point of discharge.
- An ORP monitor can be used to continually measure and transmit information to a PLC for record retention.
- This system has eliminated chemical biocides and although an oxidizer, it is less damaging than other chemical oxidants.
- Traditional rust inhibitor chemicals used in the retort system can be significantly reduced and potentially eliminated.
- The detergent/dispersant chemicals are like-wise eliminated as this system rapidly flocculates the organics, which are then skimmed off the retort cooling reservoir water. Only minimal over flow is required to skim off the flocculated organics. Then as the overage goes into the drain, where the system's ORP maintains the drain in a sanitary condition.
- The need to drain and clean cooling reservoirs is greatly reduced or even eliminated.
- Filtering systems use can be modulated as the flocculation of the cooling water is completed during each cycle.
- Biofilms consisting of Exopolysacharide Substances (EPS), mineral scale, and bacteria such as *Klebsiella pneumonia* and *Pseudomonas aeruginosa* exist within the retort cooling water system, these will be effectively controlled and not return.[3, 5-7]

Case Study1

TetraClean™ undertook a project at a large pet food canning plant to improve the companies retort cooling process. Our past experience in retort operations was first developed at a small regional supplier. At that facility we tested our solutions in a Malo style (crate less) canning system. (System similar to the retorts in Figure 1)

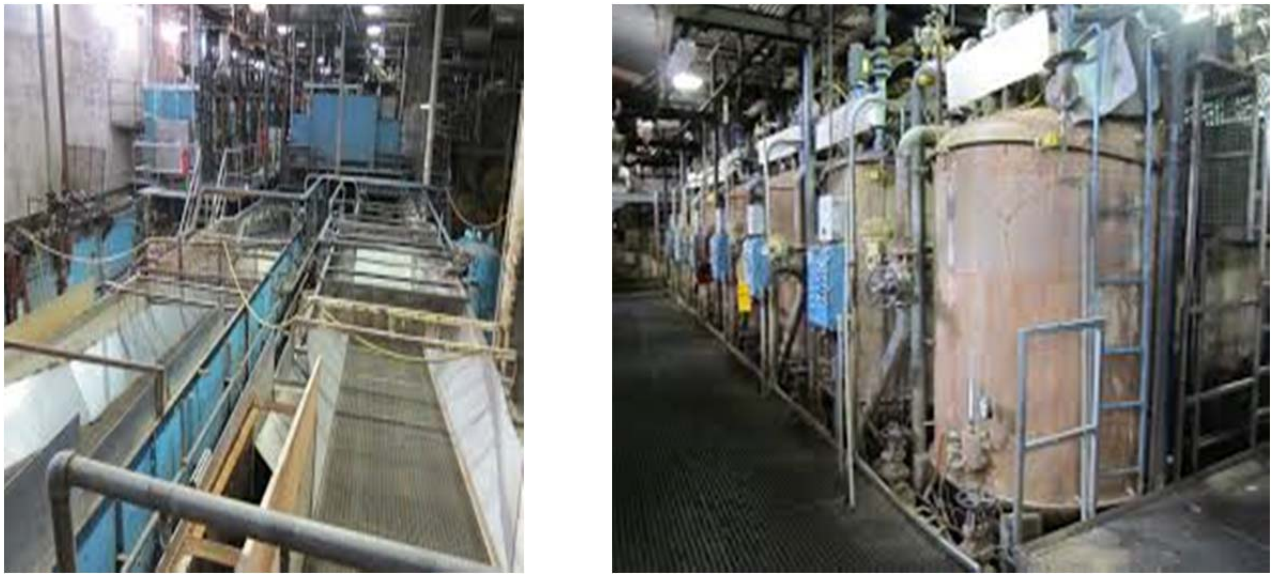

Figure 1: Malo Style (crate less) canning system

The TetraClean™ system was incorporated into the cooling canal to reduce the amount of sodium hypochlorite that was currently added to the water for microbial control. The process of a feasibility study was started in the fall of 2009. A product (Cat Food) palatability study was performed to determine if there were any negative effects in adding ozone in their product manufacturing process.

The process was further modified at the end of May 2010 with replacement of chlorine in the retort canals with ozone. A patented system was installed on May 17th and testing started on all 3 production lines. An ozone solution of 5 gallons per minute was fed to each line. The Plant did several scratch tests of final canned product and found no issues with the ozone system.

Case Study2

TetraClean™ System use in a crate style retort system.

TetraClean™ designed another system for use in a crate style retort. This system reduced the amount of chemicals used in controlling microorganisms in the water, along with providing a safer system for employees with better documentation control.

The results for:

- Process Water Control
- Bacteria Control
- Product Acceptance by Feline End User is described in the following sections.

Process Water Control

Visual records of the effects of ozone treatment in retort water are illustrated in Figures 2-7 below. Ozone has helped clarify retort process water by:

- Reducing the amount of organic and inorganic material (i.e. Iron and Manganese) suspended in the retort water (Figures 2-5)
- Reduced the foaming behavior of the retort water (6-7)

The retort water process required reduced chemical loading as reported in the previous section and cans did not show any corrosion in scratch tests. With the reduction of foaming, the organic load was controlled such that detergent cleaning was reduced or eliminated.

Overall process control showed such an improvement that the cost savings in chemicals and retort down time showed a rapid return on investment with the system.

Figure 2: Retort Cooling Can Water Clarity with No Ozone

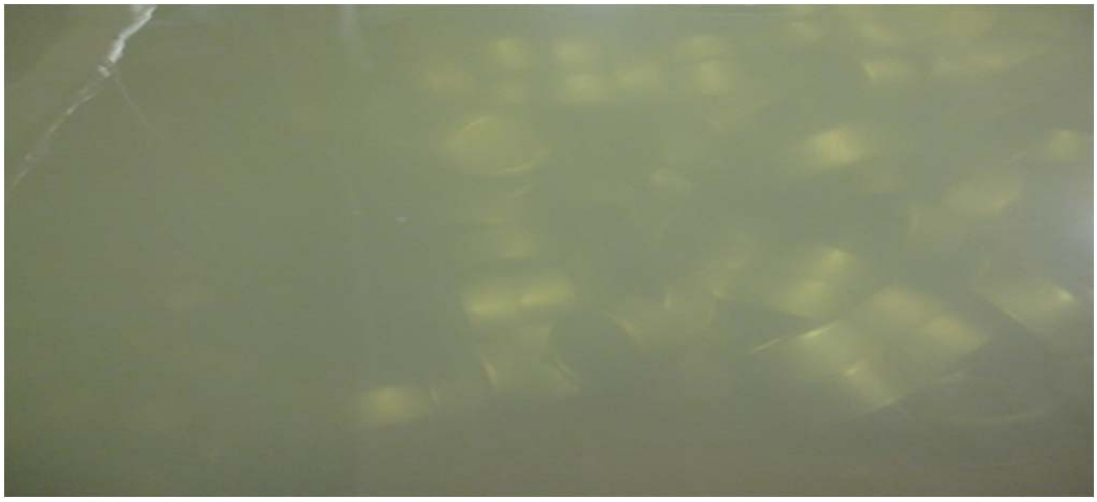

Figure 3: Malo Retort Cooling Water Clarity with Ozone

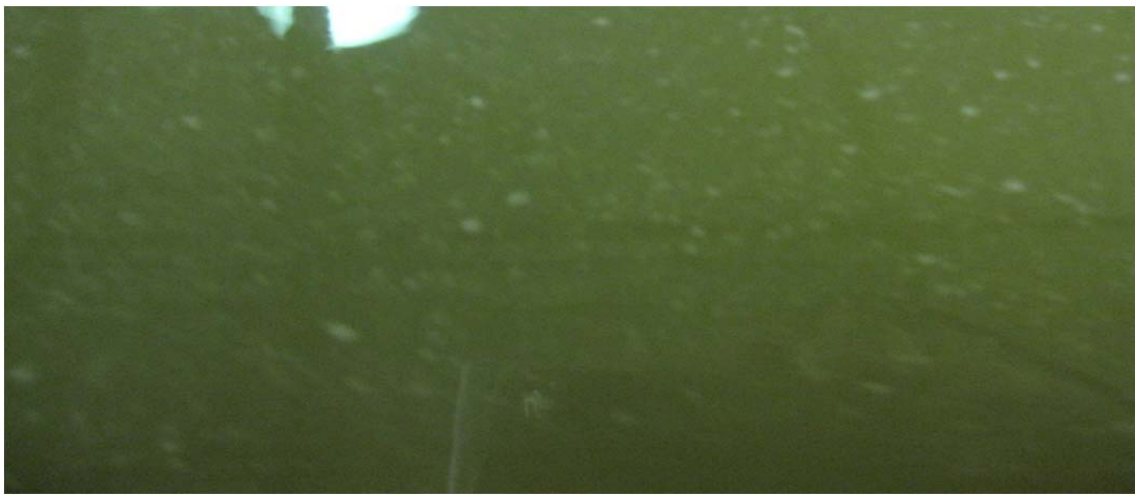

Figure 4: Malo Retort Water Clarity before Ozone Treatment

Figure 5: Water Clarity after Ozone Treatment

Figure 6: Water Foaming before Ozone treatment (note the organic accumulation on the wall)

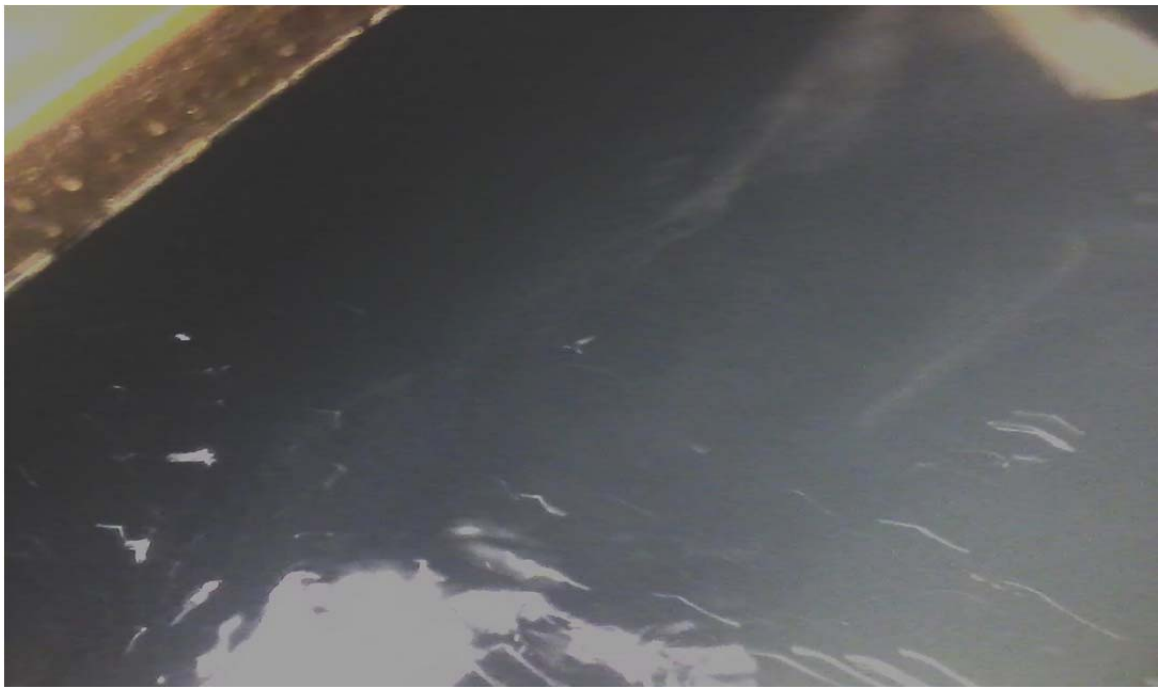

Figure 7: Water Foaming after Ozone treatment

Control of Microorganisms

Microorganism control is key to the prevention of product spoilage, product contamination, and bacteria promoted corrosion in retort systems. Bacteria data provided for the retort utilized in this case study is illustrated in Figures 8-9 below.

As can be seen from Figure 8, total colony counts for bacteria in the three sampling points outlined exceeded on a regular basis the 100 CFU per 1 mL recommendations for retort water. Levels above 1000 CFU per 1 mL clearly impose a risk of not only aerobic bacteria (APC) being introduced into the final product but pathogenic bacteria such *as E. coli, Listeria, Salmonella, Klebsiella, Pseudomonas* or *Botulism* also being introduced [8, 9, 11-13]

Figure 9 provides the bacteria concentration detected over a one-month period in Canal 4 of the retort water system. Only one sample during that time period had any detectable level of bacteria and the concentration was below the 100 CFU per 1 mL recommendation. As such, the addition of ozone through the TetraClean™ system into the retort production process showed immediate efficacy and control of all bacteria previously seen.

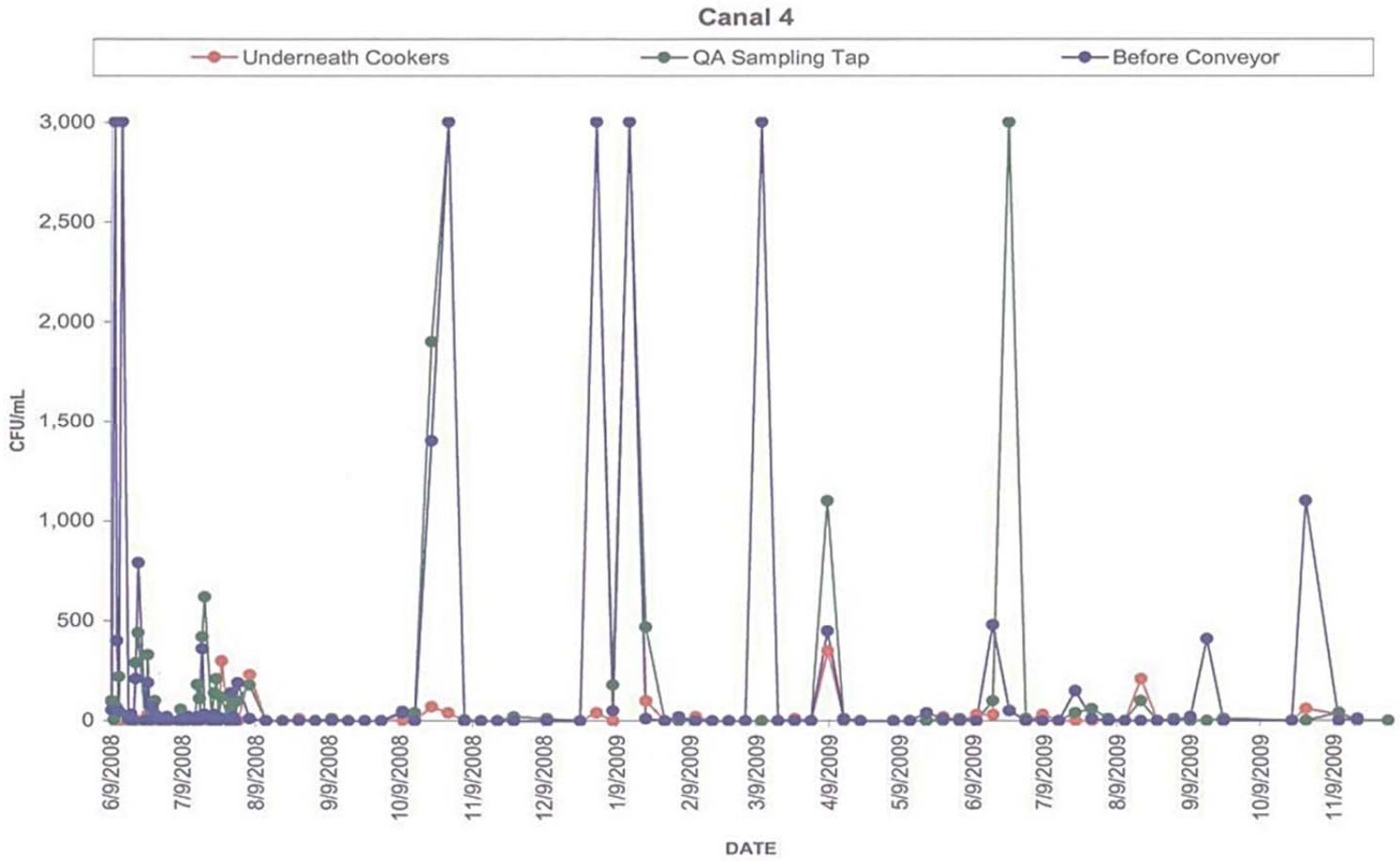

Figure 8: Bacteria Concentrations Prior to Implementation of the Ozone Treatment System

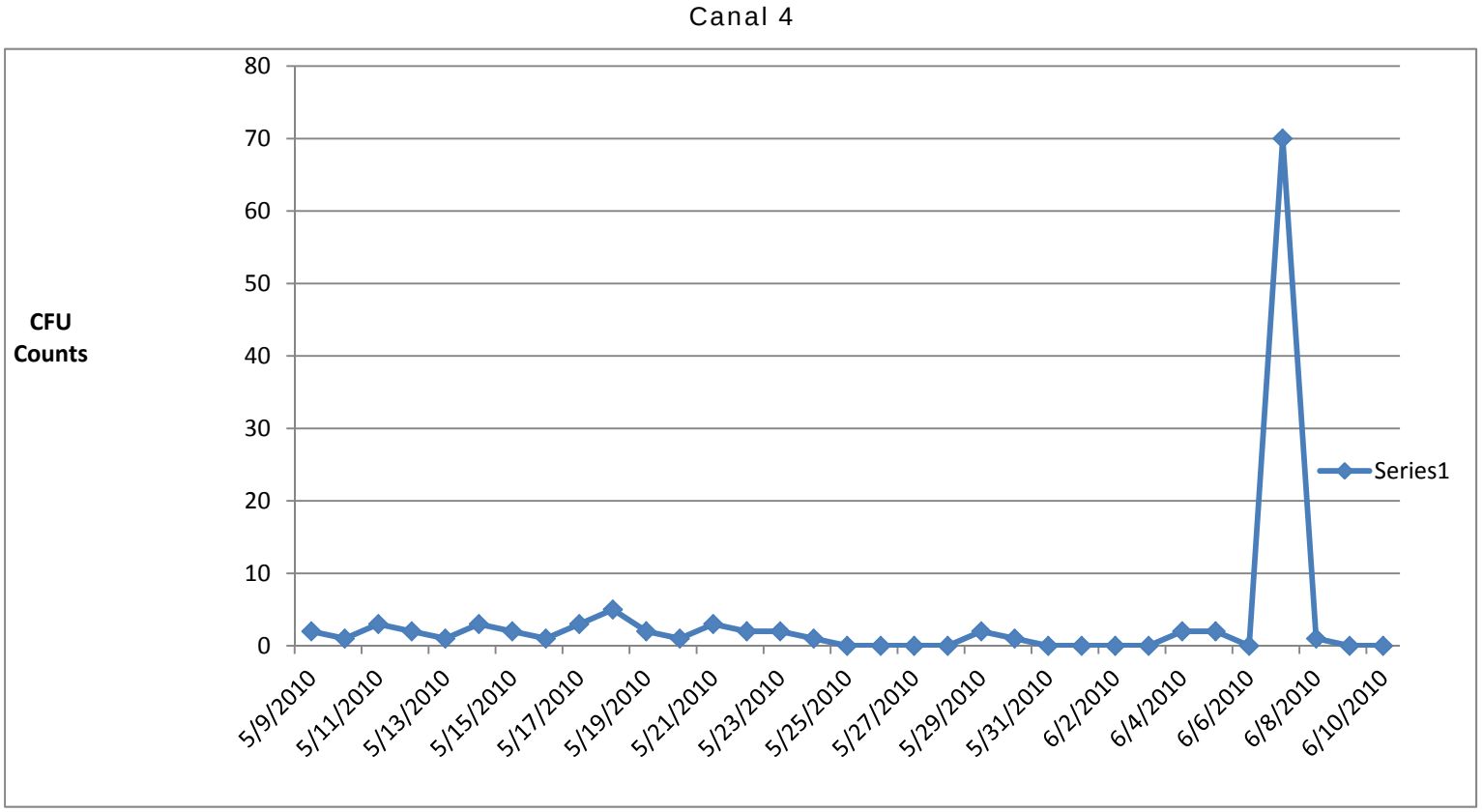

Figure 9: Bacteria Concentrations after Implementation of Ozone Treatment System

Product Acceptance by Feline End User

With the control of both process water quality and active bacteria, the final test of the TetraClean™ system ozone system would be whether the small amount of cooling water that permeates the can seal before complete closure affects the odor or taste of the final product. No disinfection system will ever be accepted by the canning community if it affects the final economic profits of the community.

Tables 1-3 and Figure 10 below summarize the product TetraClean™ system acceptance by the feline consumer. There is no statistical difference between cat food processed with or without the ozone from the TetraClean™ system.

Table 1: Cat Food. Daily Average Diet Intakes (grams)

	With Ozone (G)	Without Ozone (G)	Total(G)
Day 1	46.53	47.93	94.47
Day2	47.73	41.27	89.0
Day 3	40.87	42.87	83.73
Day4	43.93	40.73	84.67
Average	44.77	43.2	87.97

Table 2: Cat Food. Diet Intakes Statistics 1

	With Ozone Treatment of Cooling Water	Without Ozone Treatment of Cooling Water
Mean Weight Percent Consumed	49.2 %	50.8 %
As Ratio of Weight Consumed	1.00	1.03
Population of Cats	15	
Standard Deviation	8.57 %	
Pooled Standard Deviation	8.57 %	
t	0.508	
t (two tailed)	2.048	
Results Significantly Different	No	

Table 3: Cat Food. Diet Intakes Statistics 2		
	With Ozone Treatment of Cooling Water	**Without Ozone Treatment of Cooling Water**
Average Daily Intakes (grams)	44.77.(g)	43.3 (g)
As Percentage of Weight Consumed	50.89 %	49.11 %
As Ratio of Weight Consumed	1.04	1.00
Per Body Weight of Cat (grams/kilograms)	47.12 (g/kg)	45.47 (g/kg)

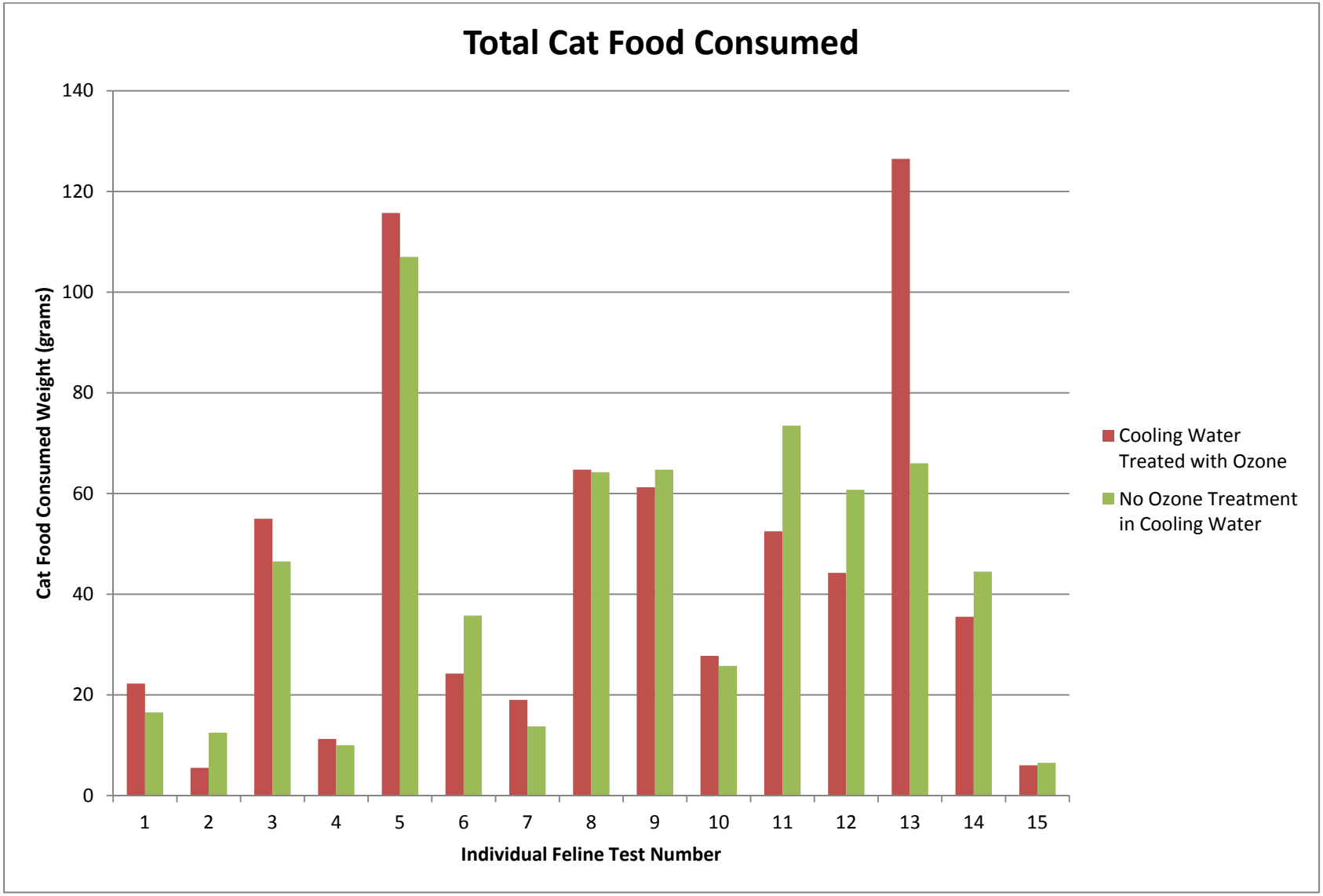

Figure 10: Total Cat Food Consumed by Test Felines in Ozone Study

Summary and Conclusions

The results from the case study employing ozone treatment in retort canning process water shows that the TetraClean™ ozone system can provide the following benefits:

- Reduction of chemicals used for:
    - Disinfection
    - Control of grease and organic chemicals
    - Control of inorganic chemicals and scale formation
    - Control of all bacteria types and sources
    - Reduced retort process operations and maintenance
        - Emptying and cleaning cooling reservoirs
        - Reduced risk of personnel injury due to confined space entry and other OSHA requirements
        - Not having to order and maintain chemical inventories
        - Increased employee training, documentation, and record-keeping for use of retort chemicals and oxidizers.
        - Reduced maintenance of Right to Know MSDS information.

Besides simplifying and reducing the effort required to maintain an effective retort cooling system, the technology is green and sustainable. With an oxidizing rate greater than 3,000 times that of chlorine, TetraClean Sanitation Solution™ is a much more efficient and stronger solution than any other alternative available. TetraClean Sanitation Solution™ simplifies and solves the problems for retort cooling systems. This has saved a processor over 90% of their chemical costs in retort operations and reduced the labor to maintain their compliance with the regulations.

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