THE ENDANGERED SPECIES ACT AND CHLORINATED WATER DISCHARGES

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Introduction

The National Marine Fisheries Service (NMFS) enforces the Endangered Species Act (ESA) in order to protect 14 groups of salmon and steelhead that are listed as threatened. ESA prohibits the harming or "taking" of a listed fish, except in specific instances previously approved by NMFS. The Act's "4-d Rule" creates a mechanism for NMFS to sanction specific activities that could otherwise harm fish, *providing* certain principles within the Act are met. NMFS officials prefer the safest and best practices whenever special provisions are made in accordance with the Act.

All forms of chlorine are hazardous to aquatic life even at extremely low levels. (The acute level for chlorine is 0.019 milligrams per liter.) Theoretically, a hazardous waste discharge (for fish) occurs every time a waterline is flushed or when a water tank is drained for routine maintenance. Since water utilities must use chlorine for disinfecting water provided for human consumption, every chlorinated water supply is technically transformed into a hazardous liquid (from a fisheries standpoint) whenever it must be released into the environment. Moreover, the Clean Water Act prohibits uninterrupted discharges of water containing a chlorine residual in excess of 0.011 milligrams per liter (*essentially zero*). Therefore, chlorinated water must now be neutralized, or discharged into a sewer system if available.

Methods

Neutralization of chlorine by way of chemical addition is one method that is accepted for addressing dangerous chlorinated water discharges near sensitive streams. Proper chlorine disposal techniques require vigilant planning and precise field operations.

Traditionally, chlorinated water has been chemically neutralized using "good old boy" sulfur-based compounds such as sodium thiosulfate, sodium metabisulfite, sodium bisulfite, sodium sulfite, or sulfur dioxide. How these reagents were initially approved for common use is not known. Whether any of these compounds could be successfully submitted for approval today is doubtful. Sulfites can be liberated during handling, which can trigger asthma attacks. Sulfur-bases chemicals can be hazardous in other situations. Scientists are not sure how the human body reacts to sulfites. Therefore, sulfite-containing compounds are suspect. Sulfur-based chemicals are often byproducts from another chemical process.

The use of vitamin C as a new and innovative option for performing routine chlorine neutralization within the water and wastewater industry was published three years ago. Since then, numerous water utilities have converted from sulfur-based compounds to vitamin C, based on environmental advantages.

Vitamin C ($C_6H_8O_6$) is an essential nutrient for all living things. It is commercially manufactured from common, renewable crops such as corn or sugar beets. And vitamin C is the only dechlorinating reagent with a National Fire Protection Association (NFPA) rating of 0,0,0.

Vitamin C was recently certified by the National Sanitation Foundation (NSF) for the Integra Chemical Company as a recognized chlorine neutralizer. NSF certification is mandatory for every chemical that is used to treat water consumed by humans. The City of Lacey, Washington was the first water purveyor to benefit from this certification by incorporating vitamin C into their routine water treatment process. Lacey uses vitamin C to reduce chlorine levels following iron/manganese treatment that requires chlorine to facilitate the removal of those inorganic compounds. Vitamin C offers expanded appeal when public perception is weighed.

Results

Sulfur-based reagents typically generate hydrochloric acid (HCl) as a byproduct. Vitamin C, as ascorbic acid, generates a milder and safer acid, dehydroascorbic acid. While other sulfur-based byproducts produced during dechlorination are not commonly known, vitamin C is essentially converted into inorganic chloride and dehydroascorbate, which is also a healthy component.

Fish can tolerate extremely high, acute doses of ascorbic acid without injury. According to an article in the Journal of Food Science, live channel catfish were able to withstand concentrations of ascorbate with levels ranging from 10 to 3,000 milligrams per liter over a 24-hour period. Additional research results are consistent with these findings.

During initial investigations it was learned that not only is vitamin C a safe chlorine eliminator, *it is an essential nutrient for fish*. Without it, fish suffer distortions of the vertebral column and eventually die. A Japanese study found that eels with diets void of vitamin C soon lost their overall health and eventually died from brain hemorrhages. Eels with normal levels of vitamin C remained healthy throughout the study.

Environmentally, it makes good sense to use a reagent that is *beneficial*, to eliminate a lethal pollutant that can harm fish at low concentrations.

Certain sulfur-based compounds are notorious oxygen scavengers. This becomes a critical issue if chemical overdosing occurs. A recent study by the American Water Works Association Research Foundation documented the potentially destructive effect of sulfur-based compounds on oxygen levels in treated water. Their findings, which were based on field measurements, indicated that vitamin C has less of an effect on oxygen levels. Additional research is needed.

Changes in pH are also an important concern for fish in receiving waters. Ascorbic acid will lower pH under extreme conditions (low alkalinity water) during flushing operations. Changing from ascorbic acid to sodium ascorbate, another form of vitamin C, eliminates this concern. Sodium ascorbate features a pH of approximately 7.5 and has a limited effect on the final pH.

With the promulgation of vitamin C technology came the necessity for new methods to inject a vitamin C solution into a stream of water in excess of 2000 liters per minute (500 gpm). The water industry had no practical device available to them five years ago. Today there are at least 10 devices available from private vendors. Some suppliers now even include a sample of vitamin C as part of the product package.

The rate of chemical reaction is significantly faster for vitamin C. Because of the slower reaction time required with sulfur-based reagents, especially sodium thiosulfate, assurance testing must take place “further downstream”. The reaction time for vitamin C is nearly instantaneous, allowing verification of neutralization near the point of discharge. Water utilities have found that 2.5 kilograms of ascorbic acid will neutralize one kilogram of chlorine in water. For sodium ascorbate, 12% more is required.

It is important to stress that regardless of the dechlorination technique or reagent used, continuous care must be taken to guarantee the complete effectiveness of chlorine neutralization. Other parameters such as pH, dissolved oxygen, turbidity, and other conditions must be validated throughout any treatment process.

The efficacy of vitamin C technology has been verified through sound scientific research. The Environmental Protection Agency (EPA) published a report that evaluated ascorbic acid as a reagent suitable for eliminating chlorine from field samples. It is the dechlorinating reagent of choice for volatile organic chemical (VOC) testing which can be influenced by chlorine residuals. The medical field also instituted vitamin C technology for treating tap water used during dialysis treatment for patients with kidney disorders. It has been documented to be an effective dechlorinating reagent in numerous studies.

It is requested that future research and/or in-field findings be shared with the author.

Conclusion

Some water professionals and environmental authorities feel that within ten years, vitamin C will be the exclusive reagent authorized for controlling discharges which contain chlorine or other halogens.

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