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Position Statement 2

THE USE OF ALUM FOR LAKE MANAGEMENT

Aluminum sulfate, called alum, when added to lake water removes phosphates through precipitation, forming a heavier than water particulate known as a floc. This floc then settles to the lake bottom to create a barrier that retards sediment phosphorus release. There are two policy-related issues with the use of alum:

1. Whether alum is safe for humans and aquatic life, and

2. Balancing the use of alum as it is used to mitigate eutrophication symptoms versus the more tedious, but more direct approach of mitigating the causes of eutrophication.

There has also been recent discussion about whether alum is considered an algicide in the context of NPDES rules. The concern is, if a product makes a claim that it controls algae, then it is presumed to be an algicide and therefore can be regulated under NPDES. For purposes here, alum is not considered an algicide for the simple reason that any algae control effects following an alum application are the result of phosphorus reduction rather than any direct toxic effects on algae control.

How Safe is Alum?

Alum is applied to lake water as aluminum sulfate, or $Al_2(SO_4)_3 \cdot 14\ H_2O$. As aluminum sulfate is added to water, it forms aluminum ions, which are hydrated (combined with water):

$$Al^{+3} + 6\ H_2O \rightleftarrows Al\ (H_2O)_6^{3+}$$

In a series of chemical hydrolysis steps, hydrogen ions are liberated, which may lower the water pH, and ultimately forms aluminum hydroxide ($Al(OH)_3$), which is a solid precipitate:

$$Al^{3+} + H_2O \rightleftarrows \text{intermediate reactions} \rightleftarrows Al(OH)_3(s) + H^+$$

The solid precipitate forms a flocculent material, referred to as a floc, that has a high capacity to adsorb phosphates. The aluminum hydroxide blanket, when applied appropriately, separates the sediment from the water column, which reduces internally supplied phosphorus.

Free aluminum may persist at pH less than 6 or other hydroxides may form at pH greater than 9; although toxicity may occur at pH > 8 in some conditions. Both forms may be toxic to aquatic life. As a practical matter, the use of buffered alum has mitigated this concern by controlling the pH to acceptable ranges. Indeed, there has been only one reported case in the United States in recent years where toxicity has been a problem.

Human health concerns are largely avoided simply because people do not drink untreated lake water. However, even if they did, aluminum concentrations in lake water are normally within EPA drinking water standards very shortly after bulk applications.

There is an obvious concern with lakes or reservoirs used as drinking water supplies. However, the water treatment process at many, if not most, water utilities uses alum as a clarifier before filtration anyway. Again, the raw water supply does not exceed drinking water standards shortly after an alum application.

There have been reports that aluminum is a cause of Alzheimer's disease. However, recent epidemiological studies have found no association. In fact, the form of aluminum in lake water after an alum application, aluminum hydroxide, is the active ingredient in over-the-counter antacids. The issue here is the form of aluminum. While it is true that "free" aluminum has toxic properties, it is also very reactive and does not persist in this form. Where applied, the trade-off of short-term toxicity risk against phosphorus control is implicitly accepted.

<u>When is Alum Appropriate?</u>

This question may be as much a question of lake management philosophy as one of lake management policy. We know alum can control internal phosphorus release, and we know alum can also control phosphorus inputs when applied directly to inflowing water. Most often, the question to ask is, "when is the use of alum appropriate in terms balancing the management of the cause of excess phosphorus versus simply neutralizing excess phosphorus in the lake?"

There are a number of ways to consider this question. Managing the cause of excess phosphorus is the preferred approach. This view is widely held by lake management practitioners. Why keep treating symptoms without addressing the underlying causes? This watershed approach is advocated by the US EPA, NALMS and many others.

In light of the watershed approach espoused above, there are many cases where using the watershed approach exclusively may neither mitigate excess phosphorus in lakes nor even be feasible (see Welch and Jacoby 2001; Osgood 2000). Thus, the use of alum may be the only practical way to accomplish meaningful and timely water quality improvements. Using alum as an element of a comprehensive watershed and lake management program will often be needed to achieve meaningful results in a timely and cost-effective manner.

Considering that alum applications may be effective for 5 to 15 years (Welch and Cooke 1999), as well as the fact that watershed phosphorus control seldom goes far enough, repeated applications on some periodic basis will likely be necessary. In extreme cases, annual alum applications have been proposed (Osgood & Nürnberg 2002).

Increased water clarity following alum applications can have the unintended effect of increasing light availability and therefore increasing the area of rooted plant growth in lakes.

Issues & Concerns

Alum is a safe and effective method to mitigate excess phosphorus in lakes and reservoirs. Note, there are many other methods and approaches to consider in managing lakes (see Wagner. 2001). The concerns with using alum cited here can be managed or balanced.

NALMS Positions

1. Alum is a safe and effective lake management tool.

2. Alum applications should be designed and controlled to avoid concerns with toxicity to aquatic life.

3. Watershed management is an essential element of protecting and managing lakes. In cases where watershed phosphorus reductions are neither adequate nor timely, alum is an appropriate tool to accomplish meaningful water quality objectives.

References

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Adopted by the NALMS Board of Directors on February 26, 2004