Microbac® LABORATORY SERVICES

Geosmin and MIB and Resulting Taste and Odor Problems in Finished Drinking Water

Committed to providing their customers quality drinking water, utilities across the country perform thorough chemical and biological testing to ensure that their product meets primary drinking water standards established by applicable regulatory agencies. Secondary standards relating to the aesthetic quality of drinking water are not mandated, but are often a source of consumer complaints when they are exceeded. In several instances, complaints regarding the taste and odor of a water, a secondary standard, have been related to two compounds, **Geosmin** and **MIB**. Consumer complaints regarding a musty and earthy odor have been attributed to these two compounds and continue to be an area of study in regard to their formation, measurement, and removal to improve aesthetic drinking water quality.

Geosmin, chemically known as 1,2,7,7-tetramethyl-2-norborneol, is an organic compound that is responsible for the earthy smell often associated with fresh-turned dirt. The name, Geosmin, directly translates to "earthy smell" from its origin over 100 years ago. **MIB**, or 2-methylisoborneol, has also been associated with musty taste and odor concerns in drinking waters. Both Geosmin and MIB are low molecular weight volatile tertiary alcohols. In water sources, these compounds are produced by some species of cyanobacteria (blue green algae) and actinobacteria (a group of gram positive bacteria). The presence of these bacteria are required for the formation of the compounds, however, production of the compounds are not always evident when these bacteria are present. MIB is produced during the life cycle of these bacteria and Geosmin is commonly trapped in the cell bodies and released in high concentrations when these bacteria die. As a result, taste and odor can be directly related to summer algae blooms in some water systems. There are other known sources of these taste and odor compounds that can be attributed to the decay of timber, leaves, and other naturally-occurring organic matter commonly found in surface waters.

Both Geosmin and MIB have extremely low odor thresholds to humans. It is not uncommon for the average person to detect the presence of theses compounds in the 10 to 30 part per trillion (ng/L) concentration range. Often during the summer months, water systems that depend upon surface water sources will experience complaints from consumers regarding taste and odor which can directly be attributed to Geosmin and MIB.

The presence of these two compounds in drinking water is an increasing concern. Quite simply put, consumers do not want their water smelling and tasting like dirt. This gives the impression that the water is not clean and, therefore, unsafe to drink. The matter is further complicated because these compounds are difficult to remove and continue to pose a problem at extremely low concentrations. To better understand this issue, two areas of study are actively underway as to the exact mechanisms of the chemical formation and how they can be cost-effectively removed from finished drinking water sources.

Recent studies conducted by Brown University chemists have discovered the protein responsible for the formation of Geosmin **(1).** The researcher found the gene responsible for Geosmin formation in streptomyces coelicolor, a strain of plant-munching bacteria found in soil. Understanding the mechanism as to how these odor chemicals are formed may lead to corrective measures to reduce or remediate occurrences. Since these mechanisms are poorly understood, studies continue to identify other water quality parameters such as dissolved oxygen, total organic carbon, temperature, and various nutrients to identify correlations between these parameters and increased concentrations of taste and odor-related chemicals. It is already well documented that increased nutrient concentrations (phosphorus and nitrogen) contribute to the formation of algae blooms in the warmer months.

When present in water at objectionable levels, engineering controls must be used to reduce or eliminate the concentration of Geosmin and MIB present in finished water. Adsorption onto activated carbon is one effective way of reducing Geosmin and MIB concentrations. This treatment technology is also effective at eliminating other undesirable chemicals from finished waters such as trihalomethanes, various other unwanted organic compounds, and a general reduction in Total Organic Carbon (TOC). Different treatment efficiencies will be observed from various water systems and effective removal is highly dependent upon contact time and other water quality parameters.

Other treatment approaches include the use of sand filters. Removal of taste and odor compounds has been demonstrated with sand filters that contain biofims. Higher removal efficiencies have been demonstrated with older beds that contain well-established biofims. As with activated carbon treatment, sand filter efficiency is contact time-dependant and varies with changing water qualities. A third treatment technology that is gaining in popularity is ozone. Ozone technologies are effective at treating and removing chemical and biological parameters of concern in finished water. Ozone treatment can prove to be a cost-effective treatment and removal mechanism over the long run, but often involves costly capital investments. Other approaches include ozone-enhanced biofiltration, which is effective for disinfection and trace organic removal and removal of odorants such as Geosmin and MIB.

Part of the effective control and treatment of Geosmin and MIB is having the ability to accurately measure the concentrations of these compounds in source and treated waters. Engineering decisions required for effective removal must be made on sound analytical data. Over treating or unnecessary treatment can result in unneeded expenditures, while under treatment can result in water quality that does not meet consumer standards and results in complaints. As increased study in the formation and control of taste and odor contaminants evolves, reliable analytical data is imperative.

Previous analytical methodologies for the analysis of Geosmin and MIB included closed loop stripping and conventional purge and trap techniques. Closed loop stripping involved large sample volumes and an adsorbent bed which must be eluted properly for accurate compound quantitation. With purge and trap technologies, large enough sample volumes cannot be easily analyzed to obtain the sensitivity required without encountering technological challenges. One of the current and effective ways to measure the concentration of taste and odor compounds in raw and finished water sources is Solid Phase Microextraction (SPME) followed by GC/MS detection. The SPME method utilizes a SPME fiber that is exposed to the headspace of the sample being evaluated. Target compounds from the sample are adsorbed in the fiber coating and then thermally desorbed from the fiber in a heated injection port. The method has recently been accepted and published as Standard Method 6040 D, Analysis of Taste and Odor Compounds. The method is sensitive for the odor compounds to the low single digit part per trillion reporting limits using quadrapole or ion trap mass spectrometers. The method allows for the easy and reliable extraction of the analytes of interest from drinking waters with good precision across a range of concentrations.

Summary

Taste and odor-related problems are a rising concern for water suppliers. Studies have indicated that 3% of utilities had a continuous problem with 10 percent of utilities having greater than 150 days per year of taste and odor-related problems. Two compounds, **Geosmin** and **MIB**, have been identified as the source of several of these complaints. The compounds originate primarily from various forms of algae and bacteria and can increase in concentration based upon various food sources of organic material. Current treatment technologies include the use of activated carbon, sand filters with biological active colonies, and ozone treatment. The efficiencies of these technologies can vary considerably depending upon overall water quality. To maintain high quality drinking water with acceptable taste and odor qualities, utilities must be able to accurately measure pre and post-treatment concentrations of these taste and odor-producing chemicals to cost effectively utilize existing resources. The use of SPME for the detection and measurement of Geosmin and MIB will be an important tool in providing consistent and reliable data to assist with the engineering controls to control taste and odor problems in finished drinking waters.

Microbac Laboratories, Inc.'s Camp Hill Division has incorporated methodology to detect the presence and concentration of Geosmin and MIB in drinking and source waters. The methodology, based on Standard Method 6040 D, provides for the determination of Geosmin and MIB in finished drinking water, source water, or drinking water in any treatment stage.

(1) *Brown University (2007, September 19). Good Earth: Chemists Show Origin Of Soil-scented Geosmin. ScienceDaily. Retrieved March 19, 2010, from http://www.sciencedaily.com/releases/2007/09/070916143521.htm*

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