Aerobic Biodegradation of Geosmin

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BACKGROUND

Geosmin

- Geosmin is a naturally occurring compound found in lakes around the world.
- Geosmin is created by algae and gives water an earthy smell and taste.
- The compound is not harmful to ingest but humans can detect the compound in concentrations as low as 10 nanograms per liter.

Aerobic Biodegradation

- The process is were microbes decompose compounds in the presence of oxygen.
- The process has been shown to occur with geosmin with certain microbes present .
- The process is accelerated in the presence of outside materials added such as ethanol (A Saito, T Tokuyama, A Tanaka, T Oritani, K Fuchigami, 1999).

PURPOSE AND HYPOTHESIS

Geosmin (Figure 1) is found in lakes, including those used to supply water to areas in the Tulsa, Oklahoma area. The typical solution to remove geosmin from the water supply is to kill the algae before they produce the compound. On several occasions it has been observed that if algaecide was added to the water supply after the algae blooms, after 24 hours the geosmin levels are reduced. The purpose of this experiment is to provide an answer to how geosmin degrades over a twenty four hour period by just the presence of algaecide in the water supply.

One explanation that has been proposed is that there is a naturally occurring biofilm, located in the pipe, that biodegrades the geosmin before it reaches the treatment plant. A report from Chemosphere states that, "…[B]iological sand filtration (was) shown to be an effective process in the complete removal of geosmin, the removal was shown to be mostly through biodegradation." (Ho, Hoefel, Bock, Saint, and Newcombe, 2006) It is the purpose of this study to determine how important the aerobic biodegradation of geosmin is in the pipeline.

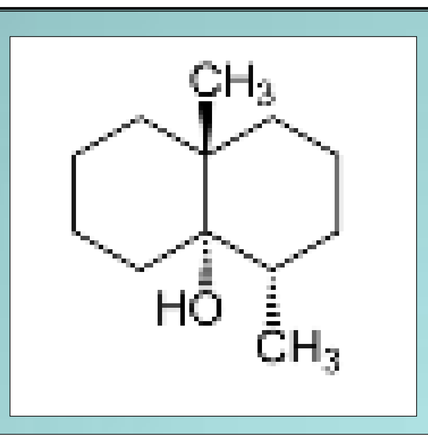

Figure 1. Structural Formula of Geosmin

MATERIALS AND METHODS

The experiment comprised of two different sets. These test were conducted to determine the effects of natural occurring bacteria found in the Tulsa lake on geosmin. One hypothesis was that the bacteria were biodegrading the geosmin within a twenty four hour period as the water traveled through a pipeline on its way to the water treatment plant. All tests comprised of four 25 mL samples. The samples were left overnight at room temperature and were tested all within a twenty four hour window of when the water was placed in the reactors. The samples contained100 ng/L of geosmin. Each test will have a major specific difference outlined in the following:

- Test One, Control: The test will contain distilled water and geosmin.
- Test Two, Lake Water: The test will comprise of the lake water and geosmin.

The geosmin was analyzed by a solid-phase microextraction (SPME) followed by gas chromatography/mass spectrometly (GS/MS). The SPME fiber is injected into the reactor 35 minutes after the extraction process. The fiber is then placed into a mass spectrometer and ran for a 20 minute period. The area under the curve is given and placed into an equation to give the amount of geosmin present in the sample.

The equation used to find the amount of geosmin remaining after the 24 hour period in the reactor was created by graduate student Han Bai Park is:

Y=(x-320000)/14000,

where X is the area under curve and Y is the percentage of geosmin remaining in the sample. Representation output from the GC/MS is shown in Figure 2.

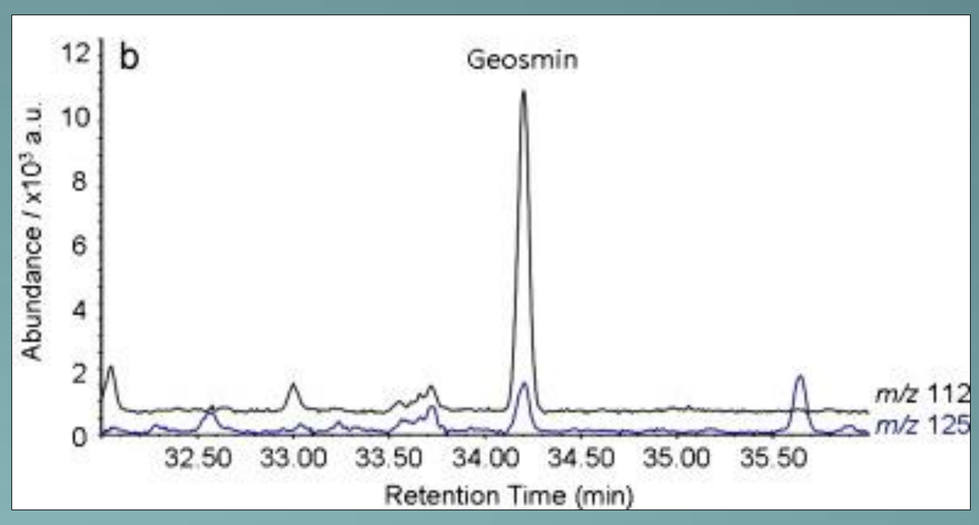

Figure 2.Chromatography of Geosmin, Ochiai, Sasomoto

RESULTS

Experimental resolts are compared to clibration standards of known geosmin concentration, using the calibration equation.

The first test was a control with only 100 ng/L of geosmin and distilled water. This test was to show that the geomin was not degrading by itself. There were four replicated tests run with the proper procedure to insure that data was valid. The data also showed that no amount of geosmin had degraded. This proved that our method for collecting and analyzing geosmin provided stable and consistent results.

The second test was ran with 100 ng/L of geosmin and lake water. Two tests ran in the set were used to discover whether or not naturally occurring bacteria found in the lake were degrading the geosmin while it traveled down the pipeline to the Mohawk Treatment Plant. The tests found that no geosmin had been degraded within the 24 hour window.

CONCLUSIONS

The tests found that geosmin was not degrading by just naturally occurring bacteria found in the pipeline. Mass spectrometer readings have shown that very little geosmin would degrade over the twenty four hour period. The treatment plant in Tulsa produces significant geosmin removal in the pipeline with the addition of an algaecide. The experimental results presented here indicate that biodegradation is not a key mechanism in geosmin removal. Multiple runs of the same test were conducted to provide accurate results. The time in which the geosmin was given to degrade was the same as the time it takes for the water to degrade in the pipeline.

Research is still being conducted to find what causes the geosmin to degrade in the pipeline. Addition of the algaecide and trying to match pipe line condition are a few of the next tests that will be conducted for the experament.

Mohawk Water Treatment Facility, Baucum

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