

Gresham WI Bio-Dome Pilot Study



Introduction

Wastewater Compliance Systems (WCS) and its independent representative Jason Metz, of Marshall Bond Pumps, made contact with the Village of Gresham WI around the beginning of July 2010. Over the course of a number of conversations and visits to the community, Gresham learned more about the Bio-Domes sold by WCS as an alternate form of ammonia removal. Eventually Gresham agreed to host a pilot study over the course of the winter to test the Bio-Domes locally and to evaluate the removal capabilities in cold weather conditions. The purpose of the pilot study was to determine if the Bio-Domes could be used instead of a CO₂ addition system in order to help Gresham meet their new permit requirements.

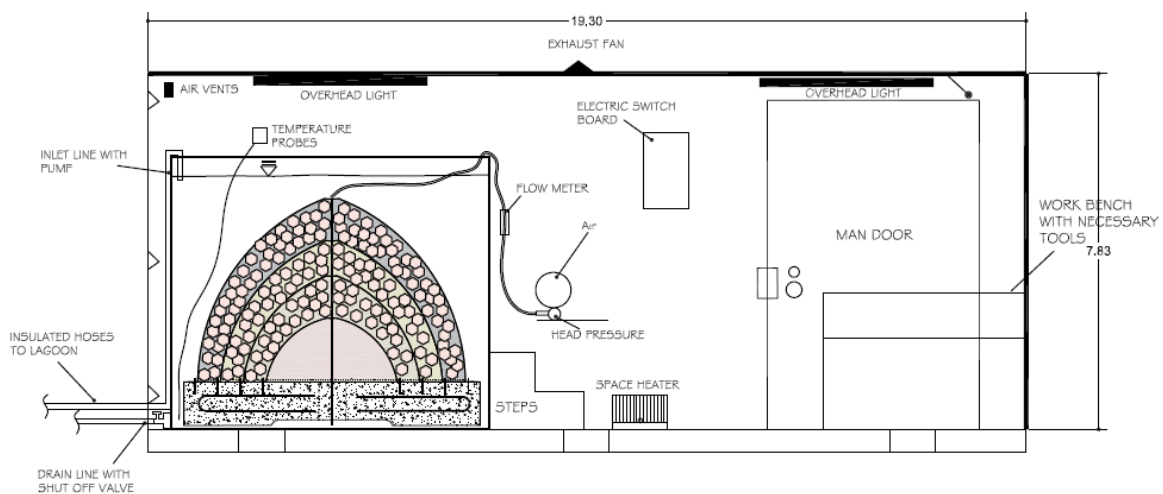
After coordinating with the WDNR, Gresham and Gresham's consulting engineer, Ken Ligman of Becher Hoppe Engineering, WCS delivered the Mobile Pilot Unit shown above on October 7th 2010. The pilot study ran through the winter months during which Gresham took samples of both the influent and effluent each week in order to measure the performance of the unit.

The following document provides a description of the equipment used, the operational procedures, and the results of the pilot study. Additionally, readers of this summary should be aware that there is a companion spreadsheet with the results of all samples taken that is available upon request if it wasn't provided with the copy of this report.

Setup and Operation

Equipment

Wastewater Compliance Systems' (WCS) Mobile Pilot Units are designed to be a turn-key pilot demonstration of the Bio-Domes for small communities. The pilot unit, consisting of a 20' cargo container, comes equipped with 1 Bio-Dome in a 1500 gallon tank, an air compressor with air-flow meter to provide air to the bio-dome, a pump to provide fresh influent, a 4 channel temperature data logger and all of the paraphernalia required to connect the system and operate the Bio-Dome. The drawing below provides a general layout of the equipment in the pilot unit. The only requirement for Gresham was a 120 VAC source of power on a 20 amp breaker. In this instance because of Gresham's desired location, a new power line was installed to deliver power to the Pilot Unit.



Installation

The WCS Mobile Pilot unit was delivered to Gresham WI on the 7th of October, 2010. A WCS representative was on-site to aid in placement, installation, startup and training. Over the following 36 hours the pilot unit was placed on the northern edge of Gresham's western lagoon and brought online. A pump was suspended in the lagoon roughly 40 feet from the shore of the lagoon using an old surface aerator pontoon to anchor it in position. The influent and effluent lines were wrapped in heat tape, insulated and covered with a protective shell in order to prevent freezing of the 1" lines during the winter months. The air compressor was set to provide 20 liters / minute which is roughly 2/3 CFM. With the pump providing fresh influent and the air supply in operation the pilot unit was fully operational. The pictures below, from left to right, show the pilot unit after installation, the influent line anchored to the pontoon, and the pilot unit in operation in February 2011.



Operation

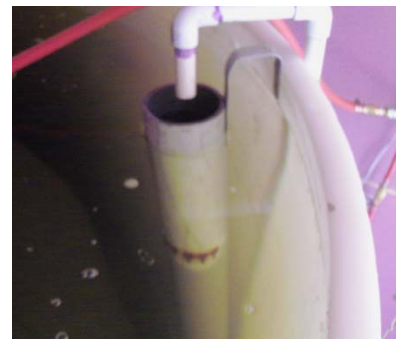
After delivery and installation, the operation of the pilot unit was managed 100% by the Village of Gresham. The operators made three trips to the pilot unit per week to ensure everything was operating as it should and samples were collected from the influent and bulk solution (effluent) every Wednesday for analysis by a certified lab (Davy Laboratories). The pilot unit was allowed to run for 2 weeks before sampling began on the 20th of October 2011. Thereafter sampling occurred every week (with a few exceptions listed below in the Significant Events section) until April 13, 2011. The samples were analyzed for BOD, TSS, Ammonia, Nitrates + Nitrites, TKN, TN, pH and once a month alkalinity. Additionally, tank water temperature, pH and later DO (after WCS sent Gresham a DO probe) were measured during each visit.

The pilot unit was set up to operate on a “punctuated flow” basis. WCS uses punctuated flow to allow for greater process control in providing product demonstrations. Punctuated flow is achieved by setting the influent pump on a timer so that it turns on every 3 hours for a pre-determined amount of time. By initially measuring the flow rate of the influent (which varies from location to location) WCS can then adjust the pump-on time to create different HRT’s. Gresham initially began operation with a 10 day HRT and over the course of the study cut the HRT down four different times until the final samples were taken with a 1 day HRT.

Significant Events

The following list is intended to identify changes in operating conditions, improvements to the pilot unit, and explanations for the three instances where no sample was taken.

- October 7th, 2010 – Pilot Unit Installed
- October 18th, 2010 – Operation confirmation visit by WCS and installation of overflow sensor
- November 9th, 2010 – Inlet Drop pipe installed to prevent short circuiting. (Picture top right)
- December 8th, 2010 – Sample lost due to shipping error.
- December 22nd, 2010 – HRT changed to 4 days.
- February 3rd, 2011 – Air Solenoid valve installed to introduce air cycling for denitrification. Air is cycled off for 2 hours a day reducing the effective HRT to 88 hours from 96. (Picture bottom right)
- February 23rd, 2011 – HRT reduced to 48 hrs with 2 hr air cycling creating an effective HRT of 44 hrs.
- March 2nd, 2011 – Overflow sensor tripped, stopping influent pump. No sample taken this week.
- March 23rd, 2011 – After sample was taken HRT reduced to 24 hours with 2hr air cycling creating an effective HRT of 22 hrs.
- March 23rd, 2011 – Later in day, overflow sensor tripped again. It was determined that ice slush was accumulating at the discharge end of the effluent line, preventing the tank from draining fast enough to keep up with the influent.
- March 29th, 2011 – Effluent line still not draining correctly. No sample taken.



Results

The primary focus of the pilot study was the removal of ammonia from the wastewater in cold weather conditions. While focus was placed on following the influent and effluent ammonia levels, analysis was also performed to measure BOD, TSS, Total Nitrogen, TKN and once a month Alkalinity. The following pages contain summations of the results obtained along with charts providing a graphical illustration of results of each lab analysis.

It should be noted that because the influent pump was placed close to the effluent side of the lagoon, after the wastewater had already passed by the coarse bubble aerators, a significant amount of treatment had already occurred with regards to BOD, and TSS removal.

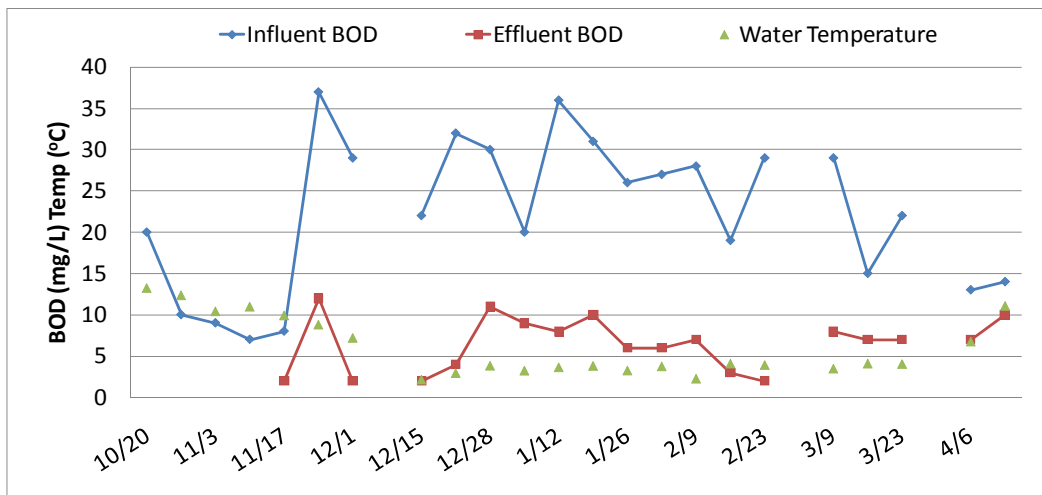
Alkalinity

While not a variable that is included in the permits, Alkalinity is a key component of the nitrification process as well as a buffer in water bodies to help minimize pH swings. Over the course of the pilot study, Gresham had five samples analyzed for alkalinity levels. The table below shows the influent and effluent alkalinity levels and the date the samples were taken.

Date	11/22/10	12/1/10	1/4/11	2/9/11	3/9/11
Influent	235	233	239	247	245
Effluent	124	126	128	119	124

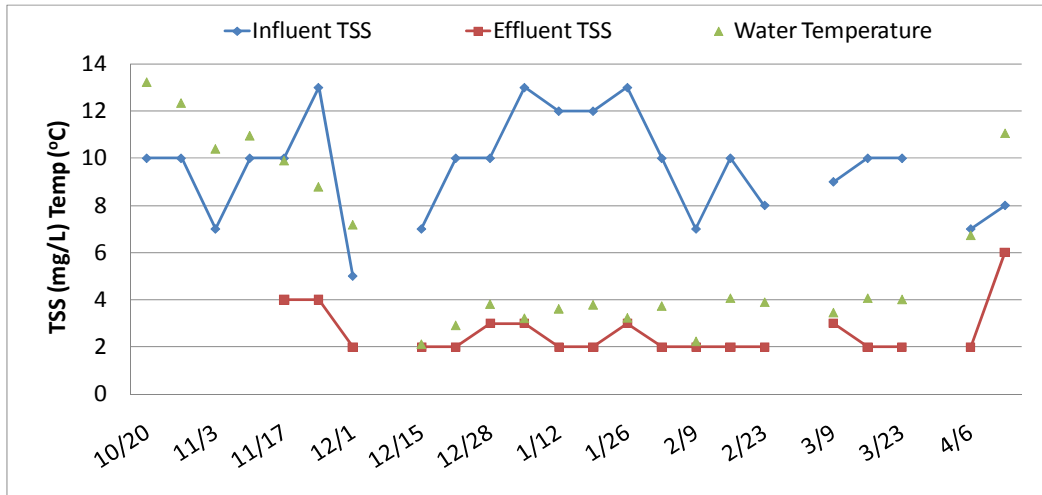
BOD

The chart below shows the BOD influent and effluent levels for the BOD in the pilot unit. Please note that in the case of the effluent, the test used by the lab does not offer a resolution below 2 mg/L and many of the samples were reported as below 2 mg/L. On the chart they are shown as 2mg/L. Of the 17 samples shown, only three exceed 10 mg/L with the remainder returning BOD effluent results below 10 mg/L and in four instances, below 2 mg/L.



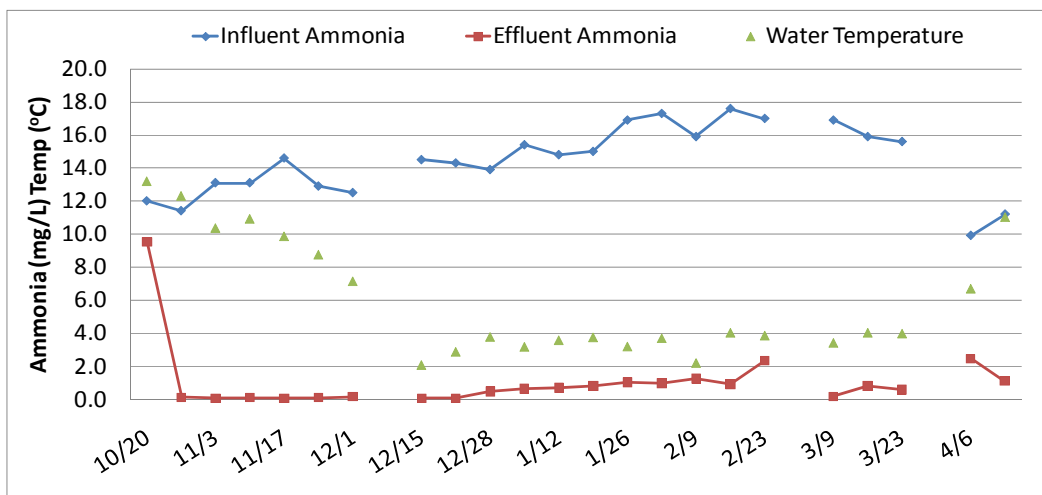
TSS

Again the TSS analysis has suffered as a result of tests that are unable to accurately return a result below 2 mg/L. The chart below provides a comparison of the influent and effluent TSS levels. With the exception of the last data point, the TSS levels are consistently below 4 mg/L for the duration of the pilot study, well below the expected limit for the Village of Gresham.



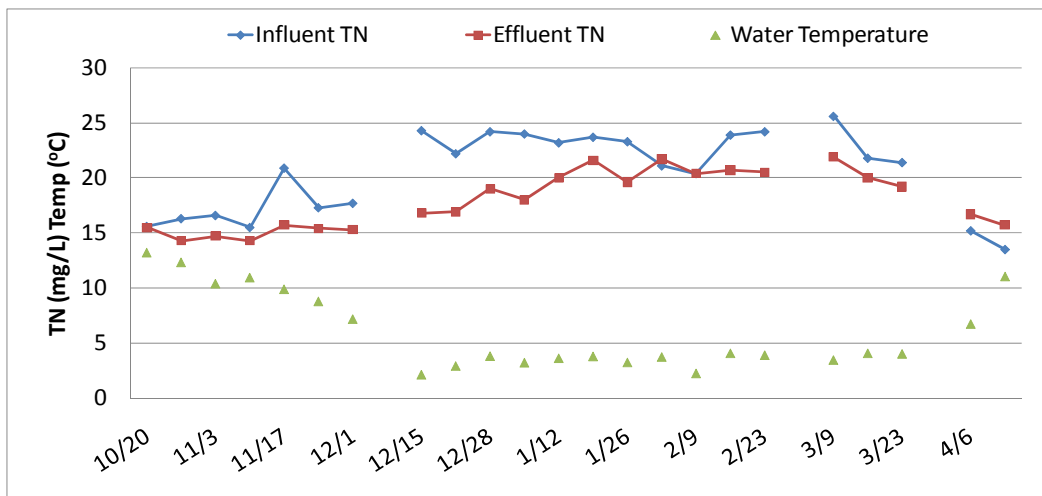
Ammonia

The average effluent concentration during the 10day HRT period is .098 mg/L. As the retention time was cut the effluent concentration began to rise (alongside a rise in the influent concentrations) to an ultimate high of 2.34 mg/L. The ammonia effluent levels drop again to below 1mg/L after March 1st. WCS believes this is because Gresham experienced a spike in their influent BOD on February 16th, and over the subsequent weeks the bio-film was able to establish itself more robustly. These results show that the Bio-Domes are capable of nitrifying in water temperatures below 4°C. WCS also showed nitrification as low as .4°C in a USDA sponsored research project operated in Utah the results of which are available on the WCS website.



Total Nitrogen

As can be seen on the chart below, the Bio-Domes are capable of providing simultaneous denitrification. Over the course of the pilot study the average reduction in TN was 2.23 mg/L with a high of 7.5mg/L. This is indicative of the micro climates within the Bio-Domes that operate anoxically. In an effort to improve the denitrification rate, WCS installed a solenoid valve on the air feed line in order to cycle the air off for two hours each day. This occurred on Feb 3, 2011. Unfortunately there was no statistical improvement of the denitrification rate after the solenoid valve was installed which is probably a result of the combination of very low BOD levels (no carbon source for the denitrification) and DO levels consistently about 10 mg/L. In order to improve denitrification trials in the future, reducing the DO levels through either shorter HRT's or longer air off periods should induce more denitrification along with fresh influent to provide a carbon source during denitrification periods.



Conclusion

The pilot study has shown that the Bio-Domes are more than capable of nitrifying ammonia even in water temperatures as low as 34.6°F (1.4 °C) to levels below 1 mg/L. In addition to ammonia removal, the Bio-Domes will act as a final polishing step for BOD and TSS before the wastewater is discharged from the lagoon.

After considering the cost of the proposed Bio-Dome system when compared to the CO₂ bubbling system being considered, the Village of Gresham has elected to change their plans in order to utilize the Bio-Domes to help them address their ammonia limits. In the end the Bio-Domes proved to be roughly equal in cost with regards to upfront capital cost and installation but less expensive from an O&M perspective. When compared to other technologies for cold weather nitrification, the Bio-Domes are far less expensive and offer a simple solution to an issue that has long been a problem for everyone living in colder climates.

Customer Impressions

Gresham Municipal Utilities is satisfied that the Bio-Dome system will help us meet and exceed the regulatory limitations placed on our lagoon system. The test data backs up what WCS had set out to achieve. In an energy dependent world we are very glad to find a “greener” answer for our systems performance. Throughout the pilot study WCS was more than helpful. We set out to prove that this system would work in a cold weather environment and it exceeds all the standards we need to meet in the years to com. This could be the answer to the problems that small utilities face in the future!

-Art Bahr, GMU Manager.

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