Evaluation of Effective Microorganisms Wastewater Treatment Method for Use in a Solar Aquatic Facility in Bozeman, Montana, USA.

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Abstract

The EPICenter (Education Performance and Innovation Center) building will be the largest building in the state of Montana, USA. This "green building" project strives to employ the most cutting edge sustainable technologies known today. Before putting it all together, a prototype is being constructed to demonstrate how all these unique concepts can work together effectively and efficiently. The wastewater treatment at the EPICenter will use biological systems to clean the water. A solar aquatic facility located in an adjoining greenhouse, will produce non-drinking water from the building's wastewater. It will also provide an excellent educational tool for the EPICenter visitors demonstrating the building's wise water management.

Effective Microorganisms (EM) technology has been proposed to enhance the efficiency of the solar aquatic facility. The EM Wastewater Treatment Method is currently being researched at the Universities of Missouri and Montana State to assess the best methods of incorporating EM into the EPICenter's solar aquatic wastewater treatment facility. The EM Method can control foul odor, greatly reduce sludge solids and their treatment, reduce/eliminate H2S gas emissions, strengthen the system immunity

INTRODUCTION

Montana State University is building a new chemistry/biology laboratory called the EPICenter (Education, Performance & Innovation) building, otherwise known as the "green building" project. The defining characteristic of the EPICenter building is the cutting edge sustainable technologies that it will employ. Many of the proposed technologies have not been prototyped yet, so a prototype building of the EPICenter is being developed to demonstrate and integrate all these new systems together using funds from the National Institute of Standards and Technology. Some of these technologies are currently in research and development. This project gives industry and research partners a place to test prototypes of concepts, systems, and products in a reasonably short time period.

Much of the past 3 years has been spent identifying the frontier of these technologies and assessing the efficacy of the newest, most promising research. MSU specialists have evaluated different technologies for every aspect of the construction and operation of the laboratory. MSU has contracted out much of the actual construction of the building to Berkebile Nelson Immenschuh McDowell Architects (BNIM). BNIM has in turn contracted out consulting on incorporating EM into the wastewater treatment system to Sustainable Community Development (SCD), LLC.

The proposed wastewater treatment system at the laboratory illustrates the philosophy behind the technology evaluation process MSU advocates. In the EPICenter, a whole life cycle approach to water and waste is taken in order to reverse the wasteful trend that currently describes conventional water use. The EPICenter building will treat its own domestic and chemical wastewater using an in-house wastewater treatment system. The treatment system consists of a constructed wetland in an adjoining greenhouse, which uses biological systems to clean the water to swimming water quality in accordance with EPA standards. The solar aquatic facility already demonstrates MSU's devotion to sustainability. However, the goals of the EPICenter project include using established technologies in innovative ways in order to develop new combinations of technologies in an effort to demonstrate the integration of all these ideas into a comprehensive picture of the peak of sustainable building technology at the turn of the millennium. Based on this concept, also known as "plus ultra" technology development, MSU has assessed and intends to incorporate the Effective Microorganisms Wastewater Treatment Method into the solar aquatic facility of the EPICenter Building.

For over eight years Effective Microorganisms (EM) have shown great promise in wastewater treatment. Application of EM in septic systems, lagoons, activated sludge systems, and other remediation projects has reduced water quality indicators such as biological oxygen demand (BOD), suspended solids (SS), sewage odor, coliform bacteria, and other water quality defining criteria. EM suppresses pathogenic species while promoting beneficial microorganisms as it has done in several other different systems.

The EPICenter building strives to reduce unnecessary energy consumption and will employ state of the art energy saving amenities (e.g. motion sensing faucets and toilets). Therefore, the least energy intensive technologies are sought and preferred. EM has been shown to conserve energy in other wastewater treatment systems with significant reductions or the elimination of sludge treatment, and with reductions in electricity costs of agitation/aeration.

The goals outlined in the wastewater treatment proposal for the EPICenter Building are paraphrased here. The EPICenter Building should use established technologies in innovative ways to:

1. Operate the wastewater treatment facility in a healthy manner for everyone
2. Provide clean water effluent for non-drinking water purposes and for irrigation
3. Educate visitors and users

EM can achieve these goals while enhancing the solar aquatic facility by managing the microbial ecology in the wetland and throughout the water's life cycle.

Probiotics, or "Superbugs," are not new to the waste treatment industry. Most experts in the field view microbial inoculants with a certain amount of skepticism. Inoculants have a recognized niche in the start-up phase of an activated sludge system that most experts concede. However, EM can bring more strength to the continuous waste treatment system through its unique synergistic microbial diversity that it supports and promotes, whether i an activated sludge system (e.g. Gushikawa City Library1) or another system. The Universities of Missouri and Montana State are currently researching EM's incorporation into the solar aquatic wastewater treatment facility.

Materials and Methods

Based on previous EM wastewater treatment systems created in Japan, Sustainable Community Development has created a preliminary system design schematic with the help of EM Research Organization (EMRO) experts. Due to the novelty of this research the design is subject to many modifications in the future and is not included here due to space limitations. The EM wastewater treatment design is similar to some conventional treatment systems. For the time being, a conventional system was chosen as a control for the research rather than a solar aquatic system, due to ease of comparison. There is an overwhelming amount of data on activated sludge processes that would facilitate proving the efficacy of the EM wastewater treatment method. Once some basic questions have been answered and enough data warrants that EM plays a significant role in the activated sludge treatment, then EM will be studied in a solar aquatic treatment system. The City of Columbia uses both an activated sludge system and one of the largest state-of-the-art constructed wetlands in the United States to treat its wastewater. Therefore Columbia will provide an excellent resource for research in how biological systems treat wastewater with EM.

The treatment system outlined in the preliminary design schematic consists of an 1) anaerobic, 2) aerobic, 3) settling, and 4) filtration tank, with a 10% recycle stream. The system introduces EM in 2-3 independent ways:

1. Extended-EM is injected into the influent at an approximate ratio of 1:5,000, EM to wastewater influent.
2. The recycle stream (10% of the influent) will be well cultured with EM and will help initiate the inoculation process at the influent.
3. The last step of treatment at the filtration tank could use EM-x Ceramics to offer a final, tertiary treatment.

Also, another possible opportunity to enhance EM presence in the system is in the aeration tank. Ceramics, pebbles or other porous biofilter material could better house the effective microorganisms in the aeration tank.

The prototype system can be set up to receive two different types of waste. Either a synthetic waste feed in a laboratory setting at the University of Missouri, or the influent wastewater at the Columbia, Missouri, USA wastewater treatment plant could be used. Setting up the system at the city plant has several advantages:1) developing a more intimate relationship with the City of Columbia who could be a potential advocate of an EM Wastewater Treatment Method system, 2) free limited analysis of influent, and 3) a variable influent. The influent waste from the city will vary greatly unlike the synthetic waste, thereby subjecting the microorganisms to random toxins released occasionally from industries in Columbia. These toxic plumes, if concentrated enough, can result in minor or major 'bug kills' where some or all microorganisms are eliminated. Major bug kills arise once in a while at the Columbia plant. This temporarily damages the treatment system, and would significantly set back microbial activity research. The advantage of these toxic plumes would be to assess the resilience of EM to these 'real world' wastes.

The synthetic waste would better represent simple domestic sewage waste treatment and would better match the concurrent waste treatment research at Montana State University at this stage. But choosing what system to model in detail is a significant issue and a critical first step toward long-term focused research. Risks and advantages of both systems will be further scrutinized before choosing one to research.

A major focus of the research is the chemistry involved in the EM Wastewater Treatment Method. Dr. Teruo Higa illustrates a more complete view of the chemical pathways and mechanisms used in the EM wastewater treatment method in the Appendix2. This is merely included as a reference and is not explained here.

Many of the predicted problems in the waste treatment systems can be remedied with effective microbial management. EM is a tool to manage this incredibly influential ecology. Effective Microorganisms increase the beneficial microbial cultures while they feed on the pathogenic species. The EM wastewater treatment method is an established technology that meets all the proposed objectives of the EPICenter Building wastewater treatment system.

Results

EM can increase reliability of the "notoriously fragile" microbial ecosystems by bolstering the beneficial microorganisms and thereby reducing the pathogenic microorganisms through competitive exclusion. This will tip the balance of the microbial populations in favor of the beneficial microbes and hence it will increase the system's resilience. This tipping of the balance facilitates the reduction of biochemical oxygen demand (BOD), and suspended solids (SS), thereby reducing the potential for environmental pollution.

EM has also effectively reduced sludge solids in other wastewater treatment systems and in some cases removed the need for sludge treatment. This has fully offset the cost of the EM in at least one facility1. Little or no solids handling will be necessary because EM works to stabilize organic material and to reduce or eliminate the harmful pathogenic organisms that are in typical wastewater sludge.

The EPICenter building treats both chemical and domestic wastewater. The chemical waste will be mixed with domestic wastewater before entering the solar aquatic treatment system. The EM wastewater treatment method shows promise for remediating both types of waste, chemical and domestic. For example, EM's ability to remove harmful metals from the effluent has reduced copper, manganese and zinc concentrations in other experiments3.

Discussion and Conclusions

The EPICenter Building strives to use water meaningfully and The scientists at Montana State University and University of Missouri are working toward incorporating EM into the wastewater treatment system in order to improve its efficiency. A sound project infrastructure complete with contacts and support from the two universities, BNIM Architects, and the City of Columbia provide an excellent arena for proving the efficacy of the EM wastewater treatment method. Some expected results include, increasing the reliability of the microbial ecology, and the reduction of BOD, SS, and ammonia odors.

The EPICenter building project focuses on Education, Performance and Innovation. EM will be a great addition to the project because it increasing each of these areas, by educating the users in microbial ecology management, and by greatly enhancing the performance of the waste treatment system in an innovative way.

References

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