FACTSHEET

December 2015 # 013

BIOFILTRATION

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Introduction

Biofiltration is a general term that describes any water treatment that occurs via biological activity where the water passes through a growth media. When used in the context of wastewater treatment, it often is referring to the purification abilities of microorganisms, but it can also refer to plant activity. Biofiltration is a tertiary stage of treatment targeting dissolved nutrients such as phosphorus and nitrogen. In the following description of biofiltration the focus will be on the treatment that microorganisms provide.

Description

Biofilters, or bioreactors, are structures that harbour communities of microorganisms that consume or breakdown organic matter and nutrients present in water. Depending on the types of material in the wastewater different types of organisms will be present. They form communities of organisms that can be made up of a combination of different species of bacteria, fungi, and/or yeasts. Biofilters are designed to encourage the growth and prolifertation of these beneficial microorganisms by providing them with the ideal conditions. These organisms require the appropriate media to attach and grow, food and nutrient sources, proper temperature, pH, and oxygen ranges. These conditions can be provided with a properly designed biofilter.

The media to which organisms attach can be made up of many different types of materials (Figure 1). The most important factor in selecting a media is the amount and type of surface area available for colonization. Examples of media include inert materials such as sand, gravel, or rocks, and man-made materials such as plastic and glass structures. Organic material can also be used, including woodchips, coconut material, crustacean shells, and compost. Some organisms require additional materials for survival such as organic matter or nutrients that may not be found in

Figure 1: Examples of media in a biofilter; lava rock, an inert material (left), woodchips, an organic material (center), and synthetic cording, a man-made material (right)

the wastewater. These materials can be provided through the selection of the appropriate medium.

The amount of oxygen available in the system will also determine the type of organisms that will be present. This will in turn determine the type of treatment that is provided in the biofilter. Different organisms require varying oxygen levels to thrive: aerobic organisms need oxygen-rich environments while anaerobic organisms need very little to no oxygen. The oxygen levels of a system can be controlled to produce the ideal environment for different types of beneficial organisms depending on the contaminant targeted.

Examples of Biofilters

Many treatment technologies can act as biofilters as it is a broad category. The goal when designing biofilters is to create the ideal environmental conditions to encourage the growth and proliferation of the types of microorganisms that are best suited for removing the targeted contaminants. Woodchip biofilters, constructed wetlands, and BioCords are examples of common biofilters that can be used to treat vegetable washwater.

Woodchip biofilters are simple systems that only require a tank or pit to hold woodchips and water. These filters are designed to remove nitrate from wastewater by hosting denitrifying bacteria under low oxygen conditions. They are heterotrophic organisms which require an organic carbon source for energy and attachment sites. Denitrifying bacteria are anaerobic, so high water levels are maintained in the biofilter to ensure saturated woodchips which keeps the oxygen concentrations low to allow the bacteria to use the nitrate as an oxygen source. These simple design considerations are an effective way to create the ideal environment for denitrifying bacteria to enhance nitrate removal.

Constructed wetlands (CW) are engineered systems designed to replicate the beneficial physical, chemical, and biological processes that occur in natural wetlands. CWs require an excavated area to hold the wetland media that can be a mixture of sand, gravel, and/or organic material, depending on the requirements of the system. The wetland media provides attachment sites for microorganisms and is also planted with hardy wetland plants. The ecosystem created in CWs breaks down organic material, filters out solids, and removes nutrients. By mimicking natural wetlands, CWs are able to successfully treat a number of different wastewaters.

BioCords are man-made bioreactors that contain synthetic cords with large surface areas to which microorganisms can easily attach. A BioCord system is submerged in an existing pond or tank that contains nutrient rich wastewater. The BioCord is aerated with very fine bubbles to increase oxygen levels, to enhance biological activity and boost contaminant removal. The bacteria that grow on BioCords are able to break down organic material, decrease solid loads, and remove nutrients. They do not require any supplemental inputs from the substrate they live on.

Considerations

Biofiltration can be used as a final polishing step prior to discharge. It can also be deployed in a recirculating system for water reuse if placed before the disinfection stage to avoid impacting the organisms in the bioreactor. It is important to remove as much suspended solids as possible prior to the biofilter to avoid plugging the media, which reduces the space available for oxygen and water movement. Depending on the type of media used it will need to be periodically replaced. For example, woodchips will eventually decompose and some sediment will accumulate in the bottom.

The microorganisms in biofilters are living creatures and are affected by their environment. Air and water temperature, water chemistry, and loading rates will all impact the health of a biological system. Low temperatures can decrease the biological

activity of a system but if it is properly designed to account for this, biofilters can be used year-round. If used outdoors, additional steps will need to be taken to prevent freezing in the winter. Some systems designed to remove nutrients, may require an additional easily accessible food source which can be supplied by the media to be added to encourage biological growth.

Cost

The cost of biofilter systems is highly variable and dependent on size, structure, media, and targeted nutrients. There are many different types that range in cost. Under low volume and nutrient load, woodchip biofilters can be inexpensive whereas high volume situations can be complex and incur more costs to stage the filtration activity. The capital costs will include the structure to hold the media and pumping systems to move washwater through treatment. The ongoing cost of the media itself can range depending on the material and how often it will need to be replaced. Pumping infrastructure will also be ongoing. Some systems may require additional equipment to operate such as aeration systems to provide oxygen to microorganisms or dosing systems to control the pH.

Conclusion

There are many different types of biofilters and different ways to utilize biofiltration for water treatment. Biofilters can be simple, inexpensive treatment options or they can be more advanced systems that combine multiple treatment techniques. By manipulating an environment to make it favourable for specific microorganisms to live, effective water treatment can be achieved.

This factsheet was prepared by Eric Rozema on behalf of the Holland Marsh Growers' Association Water Project. This project was undertaken with the financial support of the Government of Canada through the federal Department of the Environment. Ce projet a été réalisé avec l'appui financier du gouvernement du Canada agissant par l'entremise du ministère fédéral de l'Environnement.