Eco-Pure Peat Moss Biofilter Scientific Principles

The 300 Series Peat Moss Biofilter was developed by Joan Brooks, PhD and Ed Festa in Fort Myers, Florida during 1998-1999. The wastewater treatment process of the 300 Series Peat Moss Biofilter is based upon the engineering and research conducted by Dr. Brooks at the University of Maine, 1979-1988. Dr. Brooks' research culminated with her Doctoral Thesis at the University of Maine Graduate School in December 1988, The Role of Fungi in the Sphagnum Peat Wastewater Treatment System.

In the abstract to her paper, Dr. Brook writes, "Treatment of the septic tank effluent (with sphagnum peat moss) is attributed to physical filtration, adsorption and microbiological activity".

Sphagnum peat moss provides an excellent, balanced environment for organisms that provide outstanding treatment of septic tank effluent. The treated effluent from the 300 Series Peat Moss Biofilter is recognized as meeting the Advanced Secondary Effluent Standard. As noted above, treatment occurs by a combination of physical, biological and chemical processes.

Filtration of Septic Tank Effluent

The physical structure of the moderately decomposed peat moss (von Post 2-4) could account for physical filtration of septic tank effluent (Brooks, 1998). This will account for the low total suspended solids (TSS) in the effluent from the 300 Series Peat Moss Biofilter.

Sphagnum Peat Moss pH

The initial pH of the peat moss used in the 300 Series Peat Moss Biofilter can be below 4.0, which is acidic. Bacteria contained in septic tank effluent cannot exist in this acidic environment.

In the book Wastewater Engineering, Treatment and Reuse, Fourth Edition, 2003, Metcalf & Eddy, it is written, "The concentration range suitable for the existence of most biological life is quite narrow and critical (typically 6 to 9)".

In addition, in his book, Evapotranspiration, Nutrient Uptake, Soil Infiltration of Effluent Water, 1985, Dr. Alfred Bernhart, P.E., writes, "Acidity in domestic effluent water, such as pH 6.5 (or lower) is detrimental for microbial activity".

In a septic tank wastewater tends to be alkaline, and becomes increasingly so as the bacterial enzymes dominate amino acids forming ammonia. (Brooks, 1998)

The pH of the 300 Series Peat Moss Biofilter effluent ranges from 6.25 to 6.75. In the book Wastewater Engineering, Treatment and Reuse, Fourth Edition, 2003, Metcalf & Eddy, it is written, "For treated effluents discharged to the environment the allowable pH range usually varies from 6.5 to 8.5".

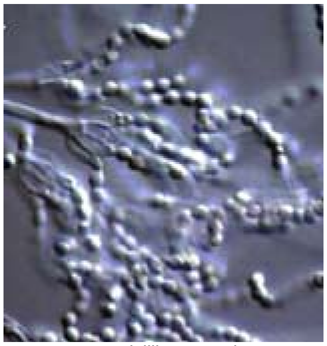
Biological Fungi Inhabitants of Eco-Pure Sphagnum Peat Moss

Fungi play a crucial role in the 300 Series Peat Moss Biofilter. Throughout her research Dr. Brooks' identified the pennicillium as one of the most prominently occurring fungi in sphagnum peat moss. **Pennicillium fungi** is the source for penicillin, the first antibiotic.

Discovered by Alexander Fleming a Scottish born microbiologist in 1928, the name Penicillium comes from the resemblance of the fungus to a paintbrush (penicillus is the Latin word for paintbrush). Penicillin works against bacteria, by disrupting bacterial cell wall synthesis. Penicillium fungi produce substances that are toxic to bacteria, causes them to burst (cell lysis).

The cool, aerobic, acidic environment of the peat system may favor the growth of fungi over that of bacteria. Dr. Brooks found the ratio of fungi to bacterial activity in sphagnum peat to be, 8 to 1 in winter months and 6 to 2.5 in summer months.

In the 1984 paper for the Journal of Environmental Health entitled, Use of Peat for On-site Wastewater Treatment: II Field Studies, Dr. Brooks, et al. found a 99.999% reduction of indicator organisms was achieved without additional disinfection in field studies.


Pennicillium Fungi

The fungi present in the sphagnum peat moss are ubiquitous in nature and neither their population levels nor their presence are unique to the peat wastewater treatment system (Brooks, 1988).

Nitrosomonas bacteria and Nitrobacter bacteria responsible for nitrification-denitrification reactions may not be present in peat environments. If they are present they may be inert.

Research shows reduction of nitrogen in peat moss due to extensive synthesis of fungal mycelia, the vegetative part (body) of the fungus (S.E. Waksman and E.R. Purvis, The Microbiological Population of Peat, Soil Science 34, no. 2 (1932).

In literature cited by Dr. Brooks, Chemical Activities of Fungi, (New York Academic Press, 1949), J.W. Foster, states that all naturally occurring forms of nitrogen can be utilized by various fungi. In addition, V.W. Cochrane, writes, Organic and inorganic forms of nitrogen were taken up rapidly during the growth phase of fungi; Physiology of Fungi, (New York John Wiley & Sons, 1958).

Dr. Brooks concludes that all fungi present in sphagnum utilize all forms of nitrogen contained in septic tank effluent: organic nitrogen, 90-95% reduction, ammonia nitrogen, 95-99% reduction, and nitrate nitrogen.

Dr. Brooks's research states that Aureobasidium pullulans fungi, frequently recovered from peat bogs, can utilize both ammonium-N and nitrate-N and adapts readily to low temperatures. Botrytis can grow on a wide range of nitrogen sources and produces an antibacterial metabolite. Trichoderma polysporium, a widely distributed soil fungus, utilizes amino-N followed by ammonium, urea and nitrate. Cladosporium fungi, can utilize nitrites and nitrates as nitrogen sources and vegetative growth can occur at temperatures as low as -10o c.

Rotifera

Dr. Brooks states that there are the existence of rotifera within the sphagnum peat moss treatment system.

Rotifera are the lowest forms of multi-cell animals. They range in size from 0.5 - 1 millimeter long. They attach to soil particles with their two-toed foot and catch their food by the fast sucking, rotating movements of the small hairs around their mouths. Rotifera feed on bacteria and each can eat 5 million bacteria per day. They can survive if only a few bacteria are present, feeding on solid particles, such as fats (Bernhart, 1985).

Dr. Bernhart writes that rotifera need free dissolved oxygen, for vigorous activity 3 mg/l or more, they can sluggishly get by with 1.5 mg/l. Aerobic conditions are needed for reproduction. This aerobic environment is provided by passive air movement through the 300 Series Peat Moss Biofilter.

Nematoda

Excessive growth of fungi within sphagnum peat moss is controlled by the existence of Nematoda; the most numerous multi-cellular animals on earth. Dr. Berhart provides a detailed discussion of Nematoda in the aforementioned book.

Nematoda are small non-segmented round worms, 2-3 millimeter long and 0.1 to 0.2 millimeter in diameter. They exist only in the presence of free oxygen, high dissolved oxygen (DO) and fully aerobic conditions (D.O. > 3.0 mg/L) are needed for reproduction.

Nematoa multiply sexually, and only if they can attach themselves to some large particle, such as sand (or peat) grains. They do not reproduce if suspended in water, thus the hydraulic loading of the 300 Series Peat Moss Biofilter is critical for performance.

Each nematode eats 15 million bacteria per day and also eats inert solid material.

Enchytraeids, pot worms

Also existing in the sphagnum peat moss system are Enchytraeids or pot worms. Pot worms are very small, little white worms, 1/4” to 1” long.

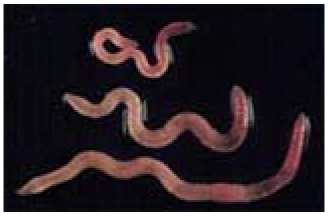
Research conducted by soil scientists have shown pot worm densities of 250,000 individuals per square meter. The highest populations are found in acid soils, such as sphagnum peat moss.

Pot worms feed on bacteria and fungi. They eat dead organic matter and small feces. In addition, pot worms are predators of some nematodes.

The population of enchytraeids helps keep the environment of the 300 Peat Moss Biofilter in balance. Enchytraeids do not exist in anaerobic environments.

Oligochaetes, earth worms

During her research and often cited in the literature review of her doctoral thesis, Dr. Brooks’ noted the existence of oligochaetes or earth worms within sphagnum peat moss.



Earth worms can range from a few millimeters to several feet long. There are 2,700 different kinds of earth worms in existence. They are ecologically important in their roles of turning over and aerating the soil. They break down organic matter, dead plants, feces, and decaying animals.

Earth worms do not exist in anaerobic conditions.

Because the 300 Series Peat Moss Biofilter is an enclosed environment we do not see a large population of earth worms. When we do see oligochaetes, they are the smaller of the species.

Aerobic Environment of Sphagnum Peat Moss

As mentioned repeatedly above, organisms that live in sphagnum peat moss cannot survive in anaerobic conditions. The environment within the 300 Series Peat Moss Biofilter is aerobic.

The effluent from a septic tank that enters the 300 Series Peat Moss Biofilter is anaerobic. Eco-Pure test data conducted at the Massachusetts Alternative Septic System Test Center show's the dissolved oxygen level of the septic tank effluent to have an average of .11 mg/L. Due to the aerobic condition of the 300 Series Peat Moss Biofilter, the effluent's average dissolved oxygen is 5.12 ml/L. This prohibits the growth of anaerobes.

Research has documented that anaerobic bacteria from septic tank effluent replace the aerobic bacteria in soil pores clogging the soil with a slime layer. This limits the soil to properly treat and absorb the septic tank effluent often resulting in surface ponding and failure.