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Use of peat in wastewater treatment with special reference to onsite systems

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INTRODUCTION

Peat can be described as partially fossilized plant matter which occurs in wet areas where there is a lack of oxygen; the accumulation of the plant matter is therefore more rapid than its decomposition. Peat moss is a rather complex material containing lignin and cellulose as major constituents. These constituents, especially lignin bear polar functional groups, such as alcohols, aldehydes, ketones, acids, phenolic hydroxides and ethers that can be involved in chemical bonding. Because of the very polar character of this material, the specific adsorption for dissolved solids such as transition metals and polar organic molecules is reported to be quite high (ref.1).

Peat deposits are found throughout the world and these vary in thickness usually from a few metres to tens of metres. World peat resources reported by Kivinen and Pakarinen are shown in Table 1 (ref.2).

Table 1. World Peat Resources

Country	Biological Peatland ha x 10^6	Peat Production – Tonnes x 10^3 Fuel Peat	Moss Peat	Total
Canada	170.0	—	488	488
U.S.S.R.	150.0	80,000	120,000	200,000
U.S.A.	40.0	—	800	800
Indonesia	26.0	—	—	—
Finland	10.0	3,100	500	3,600
Sweden	7.0	—	270	270
China	3.5	800	1,300	2,100
Norway	3.0	1	83	84
Malaysia	2.4	—	—	—
United Kingdom	1.6	50	500	550
Poland	1.4	—	280	280
Ireland	1.2	5,570	380	5,950
West Germany	1.1	250	2,000	2,250
Total	417.2	89,771	126,601	216,372
Total (Approx.)	420.0	90,000	130,000	220,000

In addition to the developing countries China, Indonesia and Malaysia shown in Table 1, Sri Lanka is also known to have a large peat deposit at Muthurajawela (ref.3). Besides being plentiful and relatively cheap, peat has several other factors that make it an attractive medium for wastewater treatment. Peat has a greater cation exchange capacity and a greater buffering capacity than mineral soil. Peat is more extensively used in horticulture because it can result in increased microbial activity, enhance the rate of infiltration especially in fine-textured soils and provide better soil aeration. Peat moss has an adsorption capacity about three times lower than that of activated charcoal and seven times greater than that of coal.

PEAT USE IN INDUSTRIAL WASTEWATER TREATMENT

Mueller found peat effective in the removal of phenol (ref.4). Brown et al found that peat absorbed dieldrin (ref.5). Studies by Soniassy showed that peat could adsorb odourous gases such as dimethylamine, ammonia and hydrogen sulphide (ref.6). Poots et al investigated the adsorption of acid dye from textile mill effluents using peat and found it to be successful (ref.7). Alkyl benzene sulphonate (ABS) was removed using peat as an adsorbing agent (ref.8). Research by several investigators has shown that peat is effective in removing a number of elements such as antimony, copper, cadmium, lead, mercury, nickel, uranium, zinc and zirconium (ref.1,3, 9,10). Peat has been found effective in the removal of oil (ref.11,12).

USE OF PEAT IN MUNICIPAL WASTEWATER TREATMENT

Several investigations have shown peat to be an attractive medium for use in municipal wastewater treatment. Nineteen cities in Finland use a series of ditches in natural peat bogs to treat primary effluent (ref.13). In Wisconsin, effluent from a three-lagoon wastewater treatment system undergoes tertiary treatment through a peat bog (ref.14). Successful treatment of secondary effluent through spray irrigation on a peat filter bed has been reported by Farnham and Brown (ref. 15). Nichols and Boelter reported on the successful operation of a peat-sand filter bed treating secondary effluent in a campground located within the Chippewa National Forest in Minnesota (ref.16). Their studies indicated that the peat-sand filter bed accomplished almost complete removal of fecal coliform bacteria and phosphorus. About 90% of the wastewater nitrogen was removed during the second and third years of operation, but this declined to about 50% by the fifth year due to oxidation of peat and release of nitrogen. Complex landfill leachate has been successfully treated in peat filters on a laboratory scale in Canada (ref.17).

UTILIZATION OF PEAT IN ONSITE SYSTEMS

Pit Latrines

Nichols et al studied the movement of fecal bacteria, N and P from pit latrines as well as the effectiveness of peat latrine liners in reducing this movement in the Boundary Waters Canoe Area Wilderness in the Superior National Forest in northeastern Minnesota (ref.18). The study involved eight pit latrines; three latrines were reported to be constructed on deep moderately well-drained clayey soils; five were reported to be built on shallow well-drained loams/sands. One pit on each soil type was reported to be unlined; the remaining pits were reported to be lined with peat contained between two layers of o.6 cm hardware cloth, 15 cm thick on the sides of pits and 30 cm thick on the bottoms. Peat liners appeared to reduce the movement of bacteria from the latrine pits. In a three year period of sampling, fecal coliforms were reported to be found in the soil adjacent to only one of the five peat-lined pits, but some soil samples taken near each of the three unlined pits were reported to contain fecal coliforms. The one peat-lined pit from which fecal bacteria were found was reported to be located on a site where the soil was shallow and was frequently at or near saturation due to water movement along the soil-bedrock interface. No movement of P from latrine pits was reported except at one site with very sandy soil. In such soil, a peat liner would appear to be of some value if a peat with a high P adsorption capacity were to be used. A peat liner would have to be viewed as an additional protection against P and bacteria movement rather than as a substitute for proper soil conditions. Nitrogen movement was not affected because of peat liners; the study showed that nitrogen impact on water quality was minimal because of dilution.

Septic Tank Effluent Treatment

Researchers at the University of Maine have recently conducted both laboratory and field studies to evaluate the capability of peat for treating septic tank effluent (ref.19,20,21).

Laboratory studies. Laboratory columns were used to determine the treatment capacity of sphagnum peat at varying hydraulic and organic loadings. 30 cm of peat compacted to a density of 0.12 g/cm^3 was found sufficient to treat septic tank effluent at a hydraulic loading of 8.1 cm/d. BOD and suspended solids (SS) reductions exceeded 95% and 90% respectively. COD reduction was reported to be only 80% due to the organic matter leached from the peat itself. Excellent (>99%) fecal coliform reduction was obtained. A hydraulic loading of 4.1 cm/d for the typical strength septic tank effluent was suggested, as the loading rate of 8.1 cm/d proved to be excessive at low temperatures (5^{o}C).

Field studies. Three full-size sphagnum peat filter beds were installed and monitored by the University of Maine researchers to determine the treatment levels after application of septic tank effluent. Two systems were lined, with an overboard discharge and one was provided with a subsurface discharge. Gravity feed, dosed feed and pressure feed arrangements were used respectively for the three systems. All the systems were reported to have performed equally well, with 99% fecal coliform removal, with 90% BOD reduction and greater than 80% COD reduction. Phosphorus reduction was respectively 58%, 62% and 96% in the three systems. Nitrate in the effluent from the three systems was reported to be less than 4.5 mg/L as N. Based on these studies, the authors concluded that the use of sphagnum peat for septic tank effluent appeared to be an acceptable alternative in areas where conventional subsurface systems could not be installed.

RESEARCH AT THE UNIVERSITY OF REGINA

A 3-year research study to investigate the efficiency of peat filters in respect of removal of pollution parameters (BOD, COD, TSS, phosphorus, nitrogen, heavy metals and indicator microorganisms) while treating septic tank effluent and municipal secondary effluent has recently been undertaken at the University of Regina. The investigation would involve laboratory studies - both batch and column studies, to determine the adsorption characteristics of peat. Studies are proposed to be conducted to examine whether adsorptive capacity of peat can be economically increased by pH adjustment or other chemical means. The possibility of peat adsorptive capacity by resting the peat between applications will also be studied.

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