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A New Concept in Treating Wastewaters ... "Constructed Wetlands"

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During the last few years a new technology for treating municipal and industrial waste water has emerged, which also shows some potential for treatment of farm and home wastewaters. This technology involves the construction of "artificial wetlands" and establishing a dominant vegetation of Typha (cattails), Sphagnum (moss), certain algae, and other plant species which have the potential to beneficially affect small flows of waste water moving through them by biochemical processes. Interest in these systems has steadily increased because of their low cost (1/10 to 1/2 that of conventional treatment), efficiency, and near nonexistent maintenance. These "constructed wetland" biochemical-treatment systems appear to have such a great potential that over 200 experimental systems have already been established in the Appalachian region for acid mine drainage (AMD) and municipal water treatment. These systems are designed to mimic natural wetland ecosystems and their function in water purification.

How "Constructed Wetland" Systems Work

Wetlands accomplish water improvement through a variety of physical, chemical and biological processes operating independently in some circumstances and interacting in others. The specially established vegetation obstructs flow of the water to be treated, thereby reducing the velocity and increasing the residence time. This enhances sedimentation and immobilization of many substances of concern which are suspended or dissolved in the water. Increased water surface area for gas exchange improves dissolved oxygen content for decomposition of organic compounds and oxidation of dissolved metals in the water. The process is similar to the decomposition occurring in most conventional water treatment plants, except for the scale of the treatment area and the composition of microbial populations which are likely to be different. In both cases, an optimal environment is created and maintained for micro-organisms to conduct desirable biochemical transformations of water pollutants.

Use of "Constructed Wetlands" For Wastewater Treatment

"Constructed wetlands" currently treat wastewaters from towns and small cities, mine drainage, urban stormwater runoff, livestock production, failed septic tank fields, land fill leachate, paper mills, tanneries, food processing plants, petroleum refineries and many other small industrial sources. The few operating systems for agricultural waste treatment have been designed with mass loading information from municipal systems, but monitoring information from these is limited.

<u>Advantages</u>

Advantages of "constructed wetlands" include relatively low construction costs (essentially grading, dike construction and vegetation planting) and low operating costs (monitoring water level and plant vitality and collecting samples). Properly designed and constructed systems do not require chemical additions, or other procedures used in conventional treatment systems.

Typically, construction costs range from 1/10 to 1/2 of those encountered in conventional treatment systems. For example, a TVA designed system for treatment of municipal wastewaster at Benton, Kentucky, cost $260,000 in 1986, compared to a 1972 estimate of $2.5 million for a comparable conventional treatment system involving chemical additives. Two other systems designed for secondary and tertiary treatment of municipal wastewaters for communities of 500 (Hardin) and 1000 users (Pembroke) varied from $212,000 to $366,000. Operating costs for these systems are less than $10,000 per year. A TVA wetland controlling acid mine drainage cost $28,000 for construction and plant establishment, about the same as the annual cost of chemicals alone to provide comparable conventional treatment. Operating costs for these municipal systems, other than monitoring, sample collection and analysis, have been less than $500 per year.

The efficiency of these "constructed wetlands" systems for wastewater treatment has been very good, especially in terms of biological oxygen demand, total suspended solids and fecal coliform bacteria. With proper design and adequate treatment area, removal of nitrogen compounds and phosphorus are readily accomplished. Metallic ion removal, even from strongly acidic waters, is excellent and slight increases in pH are common when influent seep water is moderately acidic. But little improvement has been demonstrated for strongly acidic waters.

Disadvantages

Constructed wetlands require relatively level landscapes and much more land area than do package treatment plants. Where land costs are high (large cities, rugged terrain) artificial wetlands are more expensive to construct than conventional systems although lower operating costs over a 20 or 30 year plant lifetime must be factored into the decision process. Current design recommendations specify 15-50 acres of treatment area per million gallons per day depending upon the level of pretreatment and the desired discharge limits. However, present design, construction and operating criteria are imprecise because wetland systems, either natural or constructed, are complex, dynamic systems about which we have only limited understanding.

Another disadvantage of artificial wetlands is their delayed operational status. Because peak removal efficiencies of constructed wetlands are dependent upon vegetation growth and establishment, design efficiencies are not likely to be attained until after two or perhaps three growing seasons. Long-term effectiveness is poorly documented since no successful operating scale system has been in operation for more than ten years. Nevertheless, because these systems simulate natural wetland ecosystems that have functioned to purify water for thousands of years, system efficiency is not likely to be detrimentally impacted by age. Artificial constraints, however, may require modifications of these systems or restarting them after some period of time. Acid mine drainage accumulation deposits may need to be recycled or mined, for example, while litter accumulations in municipal systems or agricultural systems may need to be cleared or purified.

Summary

Public concern during the last 20 years has strengthened state and federal legislation regulating wastewater discharges, and resulted in substantial progress in treating point sources of water pollution, especially for large cities and major industries. Widespread implementation of the "constructed wetland" treatment technology may accomplish similar objectives for small communities, small industries and livestock operations. This technology seems amenable to a substantial range of hydraulic and pollutant loading, and the pressing need for low cost technology systems acceptable to industry, farmers, developers, and communities.

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