FHS, A NEW PHYTODEPURATION SYSTEM FOR ITS IMPLEMENTATION IN SMALL RURAL TOWNS

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Abstract

FHS (helophytes semi-submerged filter) is a new phytodepuration system, consisting in man made wetlands with dense populations of emerging type helophytes (mainly *Typha* genus), with its rhizosphere suspended at some distance from the surface of ponds or channels with flowing wastewater. It has significant advantages over other phytodepuration systems, mainly because of ease of implementation and increased oxygenation capacity by combining the effect of helophytes themselves with direct diffusion of atmospheric oxygen through the water surface. The plant's submerged area has a large specific surface, which acts as a support for the establishment of microorganisms that degrade organic matter and whose growth is favored by the pumped oxygen from the leaves to the roots of plants. FHS system can be used to perform secondary treatment by microorganisms attached to the root system, and can also be used to perform a tertiary treatment in secondary effluents from other systems. It can also decontaminate water with certain toxic compounds and, in certain circumstances, absorb heavy metals in mining waters. The system has been developed and patented by the Politechnic University of Madrid (UPM) and marketed through the company ALVARTIS Consulting and Technical Assistance, belonging to Essentium. Holding.

Introduction

FHS is a wastewater phytodepuration system based on constructed wetlands with a culture of helophytes (also called swamp plants, emerging or amphibian macrophytes) transformed into floating and held in semi-submerged position (mid-water) to increase the plant's surface in direct contact with water. The functions of helophytes allow: i) Mainly removal of dissolved organic matter by diffusion of oxygen through the aerenchyma by partial pressure difference between the atmosphere and the root system (passive driving), increased as a result of photosynthesis, but even active with dormant or dead plants, and ii) provide high specific surface support for bacteria in the rhizosphere, where aerobic microorganisms that consume organic matter and nitrogen-fixing bacteria live attached. Consequently, in the wetland two areas are differentiated: 1) aerobic zone, at top, where the rhizosphere of helophytes is, 2) anaerobic zone, at bottom, where solids, bodies of dead microorganisms, etc. are deposited by sedimentation and digestion phenomena take place, so that there is not a net production of sludge, as its destruction offset its production due to by the high ratio surface/volume of the system.Other processes that occur in the wetland, according to climate, type of waste water and plants used are: sedimentation and retention of suspended solids as a result of the network of roots; destroying pathogens by bacteriophage, low temperature, UV radiation, biochemical inhibition, etc.; absorption of nutrients (eutrophying elements) by plants (N, P, K, Mg, ...) nitrogen removal by physical-chemical and biological processes (nitrification and denitrification), phosphorus removal by retention and slow release mechanisms; heavy metals absorption and detoxification of harmful chemicals (phenols, glycols, quaternary ammonium salts, ...) by microorganisms, fungi, etc. The plants used are mostly of the genus *Typha* and preferably *Typha* wide climatic tolerance, resistance to salinity, ease of harvest and control, high performance and possible use of biomass generated.

Methods

FHS system is implemented preferably in shallow channels, but may also be used in lakes, ponds or tanks for specific applications (sludge treatment, complementary treatment on the surface of the digestion tanks or aerobic biological systems in conventional treatment plants, etc.) Can be used as a secondary (removal of organic matter) and / or tertiary treatment, both to treat urban wastewater or contaminated natural waters. Given that its only limitation is the land availability, the system is particularly suitable for small or medium towns, as well as peripheral urban developments or isolated facilities (hotels, resorts, houses, airports, ports, military installations, prisons, factories, etc..), or as a complementary system in larger sewage treatment plants. Water is previously subjected to a pretreatment to remove coarse solids and grease and a primary treatment of decantation and anaerobic digestion (Imhoff tank or Emscher tank) to remove 20-30% of organic matter. Then water flows through the wetland, established over a number of channels leveled with zero slope, grouped in horizontal terraces. The dimensions of the channels have been studied to optimize performance and facilitate maintenance of the system (Fig 1).

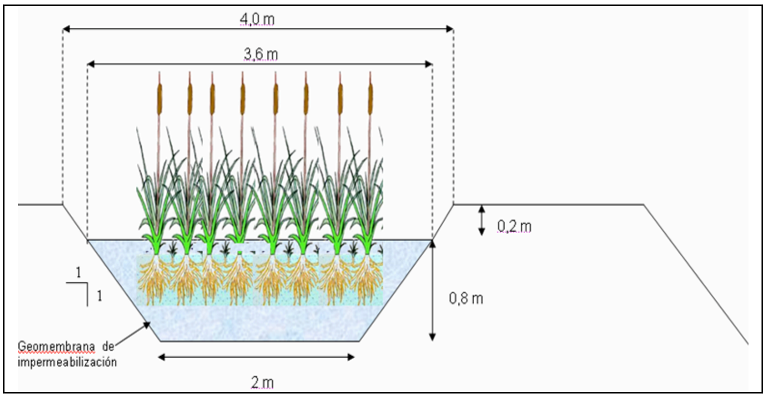

Figure 1. FHS system channel scheme

In this system helophytes remain semi-submerged, being immersed both root system and stem base to the birth of the leaves, due to ballast and soil substrate between the roots, so that the water is about 20 cm above the mat of roots, thereby enhancing the benefits of other similar systems that use floating or emergent plants but eliminating or reducing very significantly its disadvantages. One key objective that is achieved with this system, in addition to improving performance, is to keep the plants upright avoiding turnover, using two possible implementation methods, corresponding to two different patents: 1) Planting in the floor of the channel. Planting is done in the levelled channel bed, reinforced with a plastic net, where biodegradable containers with plants, substrate and ballast are arranged with a density of 16-25 plants/m2, and then remain at the bottom of the channel with low water level until it forms a continuous mat of roots, then the set is raised by filling the channel, because of the low density of the mat. The plants remain semi-submerged by balancing the weight of the mat and ballast to the hydrostatic force, acting the stems as floating stabilizers, and 2) Direct planting on the water surface, using the known TTF system, consisting of basket (1), plant (2), connector (3) and ballast (4), arranged on a plastic net (5), used for example in lakes, ponds, open tanks and channels in operation, or to supplement the initial planting done with the above procedure, (Fig 2).

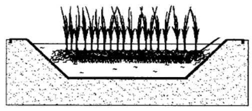

Figure 2. FHS system implementation scheme

Results and discussion

The system has the following advantages over other treatment systems: i) compared with conventional systems, it uses natural elements and renewable energy and achieves greater environmental integration, the aeration system is natural, doesn't uses chemical products, construction and maintenance are low-cost and it solves some major problems of small and medium size conventional treatment plants (load and flow fluctuations, lack of specialized personnel and disproportionately high operating costs, ii) compared with other non-conventional or "soft" extensive type purification systems (ponds, FWS, SFS, free flow system with floating macrophytes such as water hyacinth or duckweed) it offers improved maintenance costs, more economic construction, higher performance and lower land requirement, as the whole system is in contact with water so oxygenation is optimized, greater bacterial support surface, does not produce sludge, does not produce odors, biomass is more easily harvested and overgrowth of plants is better controlled, not silt up risk and not preferential flow channels creation, so the purification power is maintained over time, the plants are adapted to a wide range of climatic conditions and it produces usable biomass, rich in starch, iii) compared with respect to other systems with floating emerging macrophytes, ease, economy and safety in the implementation and maintenance of the mat, uniformly growth without tipping, increased oxygen supply because of the free water surface above the roots mat; more efficient purification, increased elimination of phosphorus because of the addition of clay within the existing substrate in the tapestry, and increased removal of coliforms per impoundment effect, and iv) other benefits of the FHS are long life, low energy consumption, low CO2 and other greenhouse gases emission, low noise generation and public nuisances, the possibility of reuse of treated water, low risk of breakdowns and shutdowns, low environmental risk, easy environmental integration, low need for surveillance, few occupational hazards and accidents; flexibility for variations in flow and load, and ease of expansion.

Conclusions

This is a flexible, effective and low cost system to address mainly the cleaning of small rural communities, compared to other more conventional solutions but with a higher cost especially in maintenance. The system has been developed and patented by the Polytechnic University of Madrid (UPM) and marketed through the company ALVARTIS Consulting and Technical Assistance, belonging to Essentium Holding.

References

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