

Ecological Opportunities to Develop Biological Process for Wastewater Treatment

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***Abstract:** The condition of an ecosystem greatly depends on the different biotic and abiotic factors. As the result of the anthropogenic activity e.g., industrial gas emission, irrigation with polluted water or highly usage of chemical fertilizers and metal-based pesticides causing a significant increase in the concentration of heavy metals in soil. Due to low waste management in industrial and agricultural activities, the global issues are considered to reduce the contamination of land and water systems. Because of these problems, it is important to develop existing technologies. This technique emphasis will be on replacement of agricultural land. The area of biological wastewater treatment plays a prominent role. In this study, a cascade of 8-powered sewage was examined. The existing system creates growing areas. This area shall place the various plants. It examines how to adapt to unusual conditions. The established habitats of plants grow healthily and also, the energy plant named *Miscanthus sp.* reached a similar product of such field cultivation. The water hyacinth operated as a natural substrate. During the pilot testing period (for four months), the cleaning process is accelerated. The nitrification was observed by measuring the gas emissions. In addition to the higher habitats in output occurred. Results clearly showed that the ecological habitats help for the cleaning process.*

***Keywords:** Energy plant; biological wastewater treatment; wetland*

1 Introduction

Over the last years the environmental monitoring, prevention of pollution and the production of clear drinking water are becoming increasingly important. However, two thirds of naturally occurring different materials in ecosystems are normally not investigated although there is no proof of their inessentiality or nontoxicity [1-3]. From the environmental pollution point of view, elements can be classified as noncritical, toxic and relatively accessible, and toxic but very insoluble or very rare ones [4]. 96% of the surface waters comes to Hungary from beyond the

borders of the country and might also be polluted by the Hungarian agricultural, industrial and domestic sources. Urban waste water contributes to the pollution load of aboveground waters significantly. More than 90% of drinking water supply is provided by groundwater resources, therefore their protection has a strategic importance.

Considering the opportunities of waste water treatment, a lot of reviews have been published for the past decade [5-10]. Based on these studies it can be concluded that nowadays 90% of sewage treatment is carried out in activated sludge plants in developed countries of high population density. Although different variations ensure numerous opportunities, the most developed technologies consist of cascade-type living machine systems applying living plants [10].

Depending on the different wetland designs (e. g. surface or subsurface, vertical or horizontal flow), mode of operation (e.g. continuous, batch or intermittent), loading rate and waste water characteristics achieved, wetland plants must meet numerous specific requirements. Ecological acceptability, tolerance to local climatic conditions, pests, diseases, pollutants and waterlogged conditions, ready propagation, high pollutant removal capacity either through direct assimilation and storage, or indirectly by enhancement of microbial transformations, e.g. nitrification (via root zone oxygen release) and denitrification (via production of carbon substrates) are the most important characteristics of the plants which are suitable for constructed wetland (CW) systems. By means of these systems some additional objectives (e. g. aesthetic, recreational and economic) can also be accomplished [11-12]. Different plant species applied in CWs have specific heavy metal removing and accumulating capacity [11; 13]. For example, the pollutant removal capability and natural microbe carrier characteristic of Chinese cane (*Myscanthus sinensis*) can be tested, since species in *Gramineae* often thrive in metal polluted sites [13].

Although during usual non-industrial waste water treatment the presence and immobilisation of pollution with heavy metals are not investigated because their concentration level in e.g. domestic waste water is assumed to be low [13], the number of surveys examining e.g. the accumulation levels of metals from artificial wastewater [13-15] or in a horizontal subsurface flow (HSSF) CW treating domestic wastewater has been continuously increasing [1; 13].

Beside the traditional rhizosphere scene of microbial life, CWs are usually supplemented with artificially formed carriers to increase the internal solid surfaces providing fixed new territories for microbes in biofilms. In the operating circumstances they establish spatially and temporarily stable and optimal environment. Carriers of different sizes and forms can be made of wood, stone, plastic etc.

Biofilms are biological communities in which microorganisms adhere together and embed in a polymer matrix [17]. Naturally formed and artificial biofilms have similar characteristics e.g. dense and architecture such as highly hydrated clusters

of bacterial cells and elaborate structures. Biofilm formation take place in the beginning period of fixed-film reactors [18] and DNA remnants released from decomposition of dead microorganisms plays an important role in development and stability of biofilms [19]. Within mature biofilms, there are channels and microchannels which fluid can fill, permeate or flow through, and microorganisms in pillars can exist [19].

2 Material and Methods

Experimental Site

Wastewater and plant samples were collected in a kind of HSSF CW system which is a biofilm-based pilot-scale FCR system at Organica R&D Centre in Telki, Hungary, during 2013. The pilot-scale FCR system consists of 8 similar, serially connected reactors, with a volume of 2m³ each and an internal recirculation might also take place from reactor 8 to reactor 1. In all reactors Organica Biomodule units are installed in which patented biofiber media designed to mimic the structure and function of plant roots act as artificial biofilm carrier, and plants as natural biofilm habitats are fixed. The resulted self-regulating ecosystem with high operational flexibility has 3-4 times bigger active biomass amount per cubic meter and about 4 times higher species diversity than in typical conventional activated sludge based systems, contributing to land, construction and equipment cost savings [20]. The influent waste water flowrate was 0.9m³h⁻¹ with a residence time of 24hours during the sampling period. At the bottom of each reactor an air supplying plastic tube covered with a membrane filter can be found.

The Possibility of Alternative Production Site

Hungary and the world due to the expansion of the sewerage in cities and migration of the population, more and more waste water generated from the retail site. In the future it will be necessary to establish new water treatment plants as well as modernization and expansion of existing ones. The selection of the optimal treatment technology myriad of factors affect the (waste water quantity, quality, geographical conditions, investment costs, etc.), but the decision must be given alternative functions important role. One of these alternative waste water, as well as the possibility of terroir.

Today, the most widely used and most effective cleaning technology is one of the aeration basins fixed-film activated sludge wastewater treatment. In this system, to

form the activated sludge aeration basin fixed biofilm suitable substrate is placed (Fig.1.), wherein the purification is carried out on the surfaces of microbes colonize. Such plants, the improvement being nitrification occurring in the presence of a greater amount as a result of protozoa smaller sludge production results [7].

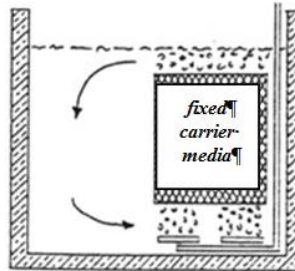


Figure 1
Activated sludge basin, disposal of fixed media [17]

This better sludge greater sludge concentration must allow sedimentation tendency (low sludge index) as a result. The application of the plant roots with natural biofilms as a carrier providing a large surface area. The removal of nutrients in the plant has no significant role in the breakdown of organic matter and nutrients to the microorganisms is carried out. Owing to this excellent living space for six especially high water demand plants. In such a system the roots of the plants can also serve as a carrier for biofilm.

The Biological Wastewater Treatment System

The pilot plant testing of a multi-stage experimental biological wastewater treatment system. The experimental system uses township municipal wastewater from a summer residence. The method of living organisms, and conventional technologies.

The technology combines an activated sludge, biofilm, wetland purification processes. This is accomplished sequentially connected reactors. The biofilm reactors into artificial surfaces and roots of plants installed in the system develops well.

The rhizomes were placed in every second reactor (eight reactors were used in wastewater cleaning system). Plants exposed to pollution were placed onto metal grid, which can be found on the surface of the waste water.

Conditions of Production of Energy Plants

During the experiment, the plant growth and its yield are influenced by three important conditional systems mentioned by the Hungarian researchers. These are:

- number of stems
- bud activity
- cultivation conditions

3 Results and Discussions

This paper shows the results of the activities of plants and the buds. One of the best indicators for emergence of the bud describes how is the environment suitable medium for plant sprouts. Figure 2. shows how the waste water is suitable medium for of plant sprouts.

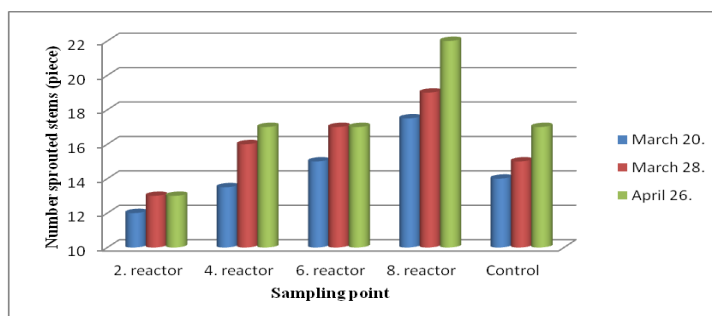


Figure 2
Bud development of *Miscanthus sinensis*

The development of the buds is examined in a multi-stage of experimental biological wastewater treatment system in four points. One reason is that the results obtained it can be conclude that the sewage purification stages, which *Miscanthus* tolerate, and what the optimal phase for them.

The results of the second reactor from the control plants placed visibly lower than both the initial and subsequent stages. The low number of buds can be concluded that the rhizomes for not fully meet the raw sewage close to the water composition, but this is likely to have affected the water temperature is relatively low. Outside this reactor unfortunately failure occurred in (water level fluctuations and occasional foaming), which could apply unwanted stress is.

The fourth reactor plant has been installed have been a better result, but in the early days, even here below from the control the number of sprouts. However, in the subsequent analysis of the number of plants already sprout beyond the control was observed. Here, the higher and lower COD (Chemical Oxygen Demand), ammonium-N has a positive influence on growth.

The sixth reactor installed fertile materials, right from the start it is beyond the control plants. It is clear that at this stage of the biological breakdown of organic

matter in the fall of increased demand for oxygen and micro persistent organic materials ratio has a positive effect on the activity of buds.

In the eighth reactor, where the rhizomal growth is started and the activities of the buds were at the best status. All rhisomes were viability and the number of buds is approximately 25% completed at an early period and better than the control. This suggests that the energy plants sprout formed in the reactor conditions were optimal and owing to show a significant difference compared with the control.

In addition to changes in the number of shoots, the growth rate of shoots showed change over the length measured in expanded clay (Figure 3).

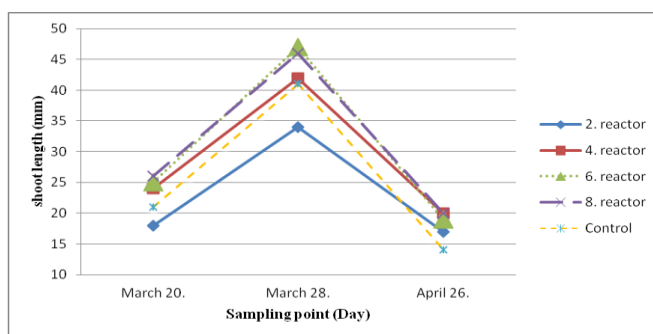


Figure 3
Results of the Miscanthus bud growth

It was found that the growth of the buds did not depend on their numbers. The growth rates of the buds approximately showed the characteristic of the reactor. The above trends were observed in the reactors used in this test method. Among the buds in conditions more favorable growth rates were achieved. Except for the two reactors in the other reactor has exceeded the length of the control plants but the first two sampling times. However, the third sampling has also surpassed the two reactors shoots of the control plants.

The best growth was found in the six and eight reactors of sprouts of miscanthus. For each of the samples was true, however, that the rapid growth of the initial sampling, third dropped. There may be several reasons for this, but the decrease in wet weather (which may be dilutive effect of concentration of waste), the recoverable amount of sunlight or collective impact could cause.

Wetland Habitat Alignment

The wastewater as habitats had several problems. This makes it difficult to design habitats. The wastewater treatment technology is highly influenced by the placement of plants. In our case, this biotope was tried to be developed at optimum.

The cleaning process problems:

- foaming wastewater
- type and concentration of the organic materials
- suspended solids content
- upwelling of wastewater
- the water level fluctuations

The problems of the write length and foaming caused by moisture. To overcome these problems a protective cushion designs were used. The cushion was more variable in size and thickness for each reactor. The plants were tested for 4 months, and the problems in the first two reactors of the strongest. Therefore, the conditions there was determined the trained cushion (Figure 4).



Figure 4
Hyacinth roots, and Enkamat cushion

The “Floating cushion” (FC) sizing of the pilot study, the following dimensions are required:

- Cushion width: 80 cm
- Pillow length: 160 cm
- Slit diameter: 1 x 2 cm

The Advantages of Plant Production

Based on different research activities, production experience and energy required for audits can play an important role in the future. Appropriate production technology and economical climate consciously utilize this energy plants ever. Hungary can produce a large amounts of biomass for energy purposes due to its CW facilities. The energy required for the seedlings propagation and meets the growth of the rhizome, but alternative methods are kept better according to our opinion, than previous applications. Installing the energy required is mainly positioned in areas where no competition for food crops. The condition for successful cultivation of strategic installations (field conditions with tillage), the selection of a suitable reproductive material, plant timed adequately planting, and 90% (9000 plants/hektar or 9 plants/m²) is uniformity of spatial planting distribution of the propagated stand space achieve over the third growing year.

Based on the pilot scale testing and production experience can be a potential alternative to the cultivation of energy required without occupation of farmland. The possibility of growing economic advantage in addition to the possibility of

protecting the environment can be significant. Environmental opportunities to reduce GHG (greenhouse gases) emissions in the wastewater treatment can have a significant potential.

Seeing the results can not doubt that the energy required can be inserted in the biological wastewater treatment. Based on the growth rates could be achieved by a similar product of the development of appropriate mechanization than in the similar field region in cultivation.

In addition to the energy required in the production of waste water a lot of argument among the most important is C4 plant which has a large yield potential that can adapt to these conditions. High-energy plantations are in this type of rooms, at least for 10-15 years, with decreasing expenses. Such utilization mode does not take soil, such a region is not conquered other food plants. Of nearer treatment plants and habitat for the complex, which increases the biological diversity, which results in more efficient cleaning, thus positively affect wastewater treatment processes. Without fertilization, only the wastewater large crowd biomass (20-25 tons / hectare) be able to produce. Pathogen and pest-free plants are the possibility of cultivation will not cause pest problems or other treatments in this direction.

In particular, the feature of this technology is the crop diversification. Such systems for energy crop production, does not affect the food and feed crops market. Our country is marketable technology may be due to efforts to reduce the energy dependency during the utilization of plant product of fossil fuels causes. Our purpose and public consumption (heat production) special benefits can be achieved while reducing the load on air GHG.

Existing technology by means of growing and minimal mechanisation, harvesting was manually but solved the automatization. The harvest work was completed quickly, it requires little additional work. It is important to be expanded wastewater treatment plants profile, built-in environmental education, as well as be a stable source of extra income, reducing annual operating costs. It also reduces the cleaners stench pollution of the natural environment provides a closer plants.

The plants generated excess heat energy (biogas production, gas engine, sewage sludge digestion, composting etc.) be spent to heat the greenhouse, resulting in the continuous production and microbiological processes may stabilize.

Conclusions

Based on the results obtained, it was established that the waste water treatment in the constructed wetlands (CW) supplemented with the energy plants might provide significant opportunities. On a small scale operating conditions the application of the alternative energy plants in water treating processes increased the efficiency, therefore their test application on a large scale operating circumstances is necessary. Although the number of the reactors seems to be

appropriate for the investigated waste water treating process, their supplement with more plants might increase the water cleaning efficiency.

Installing the water hyacinth caused by the letter from the foam released during the drying. This was done to eliminate a pillow Enkamat development. The pillow ball clay filled inhibited plant letter contact with the wastewater. The resulting isolation makes it possible to place the wet paste.

The wetlands help the cleaning process and increase the biological diversity. The number and placement of plants helps to adapt to these circumstances of species living there and created artificial elements to increase the resilience of the species.

Thus, the available natural habitat experienced plant mass. Utilized the water contaminant, such as organic content. In this way, plants can be grown in conventional production plants remained without arable land.

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