Micro- Plant and Wastewater Treatment: Review of Practical Aspects

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Abstract: - This review analyzes the state-of-the-art of a Duckweed in biological wastewater treatment that uses Duckweed and microalgae (and several prokaryotic photosynthetic cyanobacteria), with emphasis on removing nutrients with the support of microalgae growth-promoting bacteria. Removal of other pollutants by this technology, such as heavy metals and industrial pollutants, and technical aspects related to this specific subfield of wastewater treatment in to the open pond technology. These study present a general perspective of the field with most known examples from common literature, emphasizing a practical point of view in this technologically oriented topic.

Key Word: - Economics, Open pond, Algae, Duckweed, Pollution, Wastewater treatment

I. INTRODUCTION

Cities consume large amount of water and produce large amount of waste water. With these increasing rate of the population should be problem for the quantity of wastewaters generated and for the treatment, these increasing rate of the generation of the waste water beyond the treatment capacities of the wastewater. These wastes is treatment and disposal are increasingly becoming a problem because cost of treatment is high. Agriculture has always been an intrinsic part of Indian cities. In many Indian cities, recycling of waste and sewage water used to be a mechanically operated waste water treatment plant. These methods are being renamed as urban agriculture which are found to be providing employment, food and nutrition and helping in land management and environmental improvement (Arceivala, 1981). The traditional practices of recycling domestic waste water passes through screen chamber, Grit chamber, Primary settling tank, secondary settling tank, Activated sludge process, being basically biological processes and tertiary process, have been in used in several countries. The domestic waste water is passes through some other treatment such as algae, duckweed pond, fish pond based treatment, these practices has been on the recovery of nutrients from the wastewater. Taking ideas from these practices and deriving from the new databases in different disciplines of wastewater management, aquaculture is being proposed and standardized as a tool for treatment of domestic sewage (CIFA, 1998). Fish production in a water body is mainly based on the food available in the Waste water, which in turn depends upon the nutrients available in the water. It has been considered that nitrogen and phosphorous are the two nutrients mainly responsible for the production and growth of fishes. So the enrichment of these nutrients would increase the fish production. But if it exceeds certain limit, it may cause nuisance algal blooms, subsequently depletion of dissolved oxygen (DO) and fish kill etc. (Edwards et al., 1990).

Proper design of an aquaculture farm is required for efficient use of the resources available in the sewage water. By the proper design only, we can use more effectively and more efficiently the available water resources and the land area. In India a lot of fish farms are running by using sewage water but there is no proper designed sewage-fed aquaculture farm, in the laterite soil zone, is available. This study was formulated to make a proper design of an aquaculture farm by using sewage water in laterite soil zone. There is a tremendous need to develop reliable technologies for the treatment of domestic wastewater in developing countries. Such treatment systems must fulfill many requirements, such as simple design, use of non-sophisticated equipment, high treatment efficiency, and low operating and capital costs. In addition, consonant with population growth and increase in urbanization, the cost and availability of land is becoming a limiting factor, and “footprint size” is increasingly becoming important in the choice of a treatment system (Ghosh et al., 1995). The use of constructed wetlands to treat non-point pollution and wastewater has been investigated in numerous general studies (Hammer, 1989; Cooper and Findlater, 1990; Olson and Marshall, 1992; Moshiri, 1993; Kadlec and Knight, 1996; and references therein). More concrete problems have been researched recently (e.g. Pant et al., 2001; Gómez Cerezo et al., 2001; Braskerud, 2002a,b; Söderqvist, 2002; Pant and Reddy, 2003). Most of the key processes involved in the macrophyte-based wastewater treatment are well documented: organic matter retention (e.g. Nguyen, 2000), nutrients removal (e.g. Mitsch et al., 2000; and...
references therein) and pathogen reduction (e.g. Perkins and Hunter, 2000). Different technologies have been successfully used; each one is unique (Reddy and DeBusk, 1985; Mara et al., 1992, 1998, Kadlec, 1995; Cadelli et al., 1998; Younger et al., 1998)

II. LITERATURE REVIEW

Serious interests in natural methods for wastewater treatment have reemerged. The use of aquaculture systems as engineered systems in wastewater (domestic and industrial) treatment and recycling has increased enormously over the past few years, they are designed to achieve specific wastewater treatment and can simultaneously solve the environmental and sanitary problems and may also be economically efficient.

Lagoon-based wastewater treatment systems have been used around the world for both municipal and industrial applications. These systems are attractive due to their low operating cost, in-situ solids storage capabilities, and low operator attention requirements. Where land availability and proper topography permit, lagoon-based systems are the preferred process solution for secondary treatment, which reduces both biochemical oxygen demand (BOD) and total suspended solids (TSS) of the wastewater (Vikram M Pattakine, et.al. 2006). In this paper presence of algae in the aerobic and facultative zones is essential to the successful performance of facultative ponds. In sunlight, the algal cells utilize CO$_2$ from the water and release O$_2$ produced from photosynthesis. On warm, sunny days, the oxygen concentration in the surface water can exceed saturation levels. Conversely, oxygen levels are decreased at night. In addition, the pH of the near surface water can exceed 10 due to the intense use of CO$_2$ by algae, creating conditions favorable for ammonia removal via volatilization. This photosynthetic activity occurs on a diurnal basis, causing both oxygen and pH levels to shift from a maximum in daylight hours to a minimum at night. The oxygen, produced by algae and surface re aeration, is used by aerobic and facultative bacteria to stabilize organic material in the upper layer of water. Anaerobic fermentation is the dominant activity in the bottom layer in the lagoon. In cold climates, oxygenation and fermentation reaction rates are significantly reduced during the winter and early spring and effluent quality may be reduced to the equivalent of primary effluent when an ice cover persists on the water surface. As a result, many states in the northern United States and Canada prohibit discharge from facultative lagoons during the winter (Leslie R. Kryder,2007). In this paper it is well known that microalgae play an important role in the treatment of domestic wastewater with maturation ponds or municipal wastewater with small and middle-scale facultative or aerobic ponds. In this study, and the aim of the work was to study the feasibility of removing nitrogen and phosphorus by algal-based immobilization technology ( Shengbing He, et.al.,2010). In this study, the growth of duckweed was assessed in laboratory scale experiments. They were fed with municipal and industrial wastewater at constant temperature. COD, total nitrogen (TN), total phosphorus (TP) and ortho phosphate (OP) removal efficiencies of the reactors were monitored by sampling influent and effluent of the system. Removal efficiency in this study reflects optimal results: 73-84% COD removal, 83-87% TN removal, 70-85% TP removal and 83-95% OP removal (Nihan Ozengin et.al.,2007).Vegetation plays an important role in wastewater treatment wetlands. Plants provide a substrate for microorganisms, which are the most important processors of wastewater contaminants. Plants also provide microorganisms with a source of carbon. Stands of vegetation reduce current velocity, allowing solids to settle out of the water column. Plants assimilate nutrients, but as the plants senesce, some nutrients are released back into the water. A portion of the nutrients is retained in the undecomposed fraction of the plant litter and accumulates in the soils. Plants oxygenate the root zone by release of oxygen from their roots, and provide aerobic microorganisms a habitat within the reduced soil (Hans Brix,2003). A pilot plant experiment was carried out to assess differences in environmental conditions and treatment performance in two systems for wastewater treatment: algae-based ponds (ABP) and duckweed based (Lemna gibba) ponds (DBP) (O.R. Zimmo, et.al.,2002). In these study observed that phosphates, nitrates, pH, biological oxygen demand, iron, conductivity, chemical oxygen demand, turbidity, total dissolved solids and total suspended solids are reduced in the permissible limit except phosphorous (J.M. Dalu, et.al.,2003). A duckweed-based pond, conventional algal-based ‘open’ pond, and rock filter are attached in the treatment process are advanced pond treatment system (M.D. Short, et.al.,2010). This study was conducted to investigate the efficiency of duckweed (Lemna gibba) in treating a domestic wastewater and to develop an integrated kinetic model for organic and nutrient removal by duckweed-based wastewater treatment (K.C. Bal Krishna, et.al.,2008). In these study observed that following parameter in limit BOD, COD, Temp, Ph, DO. In these process Algae and Duckweed pond are Harvested and it is disposed of as sewage sludge i.e. composting and Biogas (L. Bonomo, et.al.,2008). In these study integrated pond system,
consisting of duckweed and algae ponds, was investigated for duckweed production and for further treatment of an aerobically treated domestic wastewater (Peter van der Steen, et al., 1998). In these research a second-stage processing, included duckweed lagoon as a polishing stage, as an appropriate technology for treating the domestic wastewater generated by small communities in the economical (G. Badatians Ghohikandi, et al., 2009). In these study for Wastewater recycle for irrigation purpose used, because of algae are photosynthesis process and they are economical (Madiha Zakria, et al., 2011). Microalgae culture culture are generally automatically developed in waste water treatment process and the treatment process are converted to the tertiary biotreatment and their process outcome higher sides NPK values (N. Abdel-Raouf, et al., 2012). Algae harvesting is recycled and the lots of energy recovered from that algae harvesting (James W. Richardson, et al., 2012). In these study the Settled able solids in pond are used for fishes food and the parameter such as BOD, DO are reduced with in limit (Peter Aderemi Adeoye, et al., 2012). Using of fishes the waste water treatment and recovery of NPK values (Miroslav Colic, et al., 2012). In these study the discussion regarding the temperature condition are vary from some degree then it is affected to the treatment process (Evonne P. Y. Tang, et al., 2012). In these paper studied about the removal toxic element by Algae (a red marine macroalgae,) (Ahmed El Nemr, et al., 2010). The algal beads used as bioreactor and effectively achieved complete removal of NH4+–N (M. S. Abdel Hameed, 2007).

Algae were cultivated in artificial wastewater tank and then these culture observed under different lighting condition (Kwangyong Lee, et al., 2001). In these study they are used stabilization pond in three stage plant is designs and they are used aquatic plant i.e. Algae (Gemma Ansola, et al., 2003). The constructed wetland (CW) has been purification of waste waters and efficiently reduce high waste water COD and BOD( Dani Vrhovsek, et al., 1996). This paper is studied that economically treatment of waste water by algal turf scrubber treatment technology (24. C. Pizarro, et al. 2006). This study based on cleaning of water and remove CO2 from the atmosphere (Walter Adey, et al. 2008). These study on Aquaculture and their used in treatment process for cost saving (John Todd, et al., 2008). In these study that the Non conventional treatment plant and the process by fish, phyto-synthesis process (M D Ansai, et al., 2010). In this study, the use of algae and duckweed ponds as post-treatment for textile wastewater has been evaluated under the hypothesis that differing conditions such as pH, redox potential and dissolved oxygen in these ponds would lead to different heavy metal removal efficiencies (Christain B. Sekomo, et al., 2012).

This paper investigates the influence of recycling gravity harvested algae on species dominance and harvest efficiency in wastewater treatment High Rate Algal Ponds (HRAP) (J.B.K. Park et al., 2011). A UASB-septic tank followed by three parallel pond systems each consisting of three stabilization ponds of equal depth and with the same hydraulic retention time (HRT). The setting was intended to investigate the effect of pond depth on the performance of algae-based ponds (ABPs). The depth of the ponds in the first, second and third systems (Ashraf A. Isayed, et al., 2008). Microalgae are mostly suspension-type microorganisms and very efficient solar energy converters that can produce massive blooms. For decades, they have demonstrated that they can produce a great variety of useful secondary metabolites (Lebeau and Robert, 2006; Moreno-Garrido, 2008). Potentially useful as treating agents for wastewater (de-Bashan and Bashan, 2004). An immobilized cell is defined as a living cell that, by natural or artificial means, is prevented from moving independently from its original location to all parts of an aqueous phase of a system (Tampion and Tampion, 1987). Six different immobilization types have been defined: covalent coupling, affinity immobilization, adsorption, confinement in liquid–liquid emulsion, capture behind semi-permeable membrane, and entrapment in polymers (Mallick, 2002). Immobilization can be grouped as “passive” (using the natural tendency of microorganisms to attach to surfaces – natural or synthetic – and grow on them) and “active” (flocculant agents, chemical attachment, and gel encapsulation) (Cohen, 2001; Moreno-Garrido, 2008). Immobilization in chitosan protected the cell walls of Synechococcus sp. against NaOH toxicity. Immobilized cells showed better growth than free cell cultures (Aguilar-May et al., 2007). Microalgae are beneficiaries of immobilization. Immobilization in alginate of the wallless marine microalga Dunaliella tertiolecta in hypersaline medium produce significant amounts of glycerol (Grizeau and Navarro, 1986). Immobilization of Dunaliella salina in agar–agar significantly improved production of glycerol, in comparison with free-living cells (Thakur and Kumar, 1999). Immobilization of the marine diatom Haslea ostrearia in a tubular agar gel layer increase synthesis of marenmin, a blue–green pigment involved in commercial culturing of oysters (Lebeau et al., 2000). Removal of phosphates can also be achieved by air stripping CO2 from anaerobic effluents (Kalyuzhnyi et al., 2003). A Biological removal of nutrients involves bacterial and microalgal processes. The
only commercial biological process is the Enhanced Biological Phosphorus Removal (EBPR) process by bacteria (de-Bashan and Bashan, 2004). The use of constructed wetlands to treat non-point pollution and wastewater has been investigated in numerous general studies (Hammer, 1989; Cooper and Findlater, 1990; Olson and Marshall, 1992; Moshiri, 1993; Kadlec and Knight, 1996). Microalgae have high capacity for inorganic nutrient uptake (Talbot & de la No‘ue, 1993; Blier et al., 1995) Duckweed is one of the most promising facultative macrophyte for use in the sustainable wastewater treatment (Korner et al.).

III. CONCLUSION

Duckweed species perform differently on different types of wastewater, with fat duckweed and great duckweed showing practical potential on wastewater treatment (de-Bashan and Bashan, 2004). The use of constructed wetlands to treat non-point pollution and wastewater has been investigated in numerous general studies (Hammer, 1989; Cooper and Findlater, 1990; Olson and Marshall, 1992; Moshiri, 1993; Kadlec and Knight, 1996). Microalgae have high capacity for inorganic nutrient uptake (Talbot & de la No‘ue, 1993; Blier et al., 1995). Duckweed is one of the most promising facultative macrophyte for use in sustainable wastewater treatment (Korner et al.).

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