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EXTENDED ABSTRACT

Evaluation of Microalgae Performance in Different sectors of Wastewater Treatment Plant Using Statistical Analysis

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1. Introduction

Industrialization and growth of population during the last century has led to destruction of many ecosystems used by mankind. Entrance of different kinds of sewage to open water and rivers is known as the first factor reducing the quality of water resource available for mankind. The volume of pollutants in the sewage including total suspended solid, biological oxygen demand and chemical oxygen demand, reached tens of thousands milligrams per liter (Chan et al., 2009).

Generally, in order to achieve sustainable economic development, water resources and wastewater management are necessary. Hence, it is necessary to use cost effective methods beside practical methods. Using microalgae for treatment of different kinds of municipal, agricultural and industrial wastewater is an affordable method (de Godos et al., 2010; Di Termini et al., 2011; Muñoz and Guieysse, 2006). Nowadays using microalgae in wastewater treatment has gained lots of attention, since microalgae can produce large amounts of biomass in order to attain valuable products and energy besides wastewater treatment and also prevent carbon dioxide from entering the atmosphere. Furthermore, treatment of different kinds of wastewater by means of microalgae is an environmental friendly method, because in this process no secondary pollutant is produced. The produced biomass is also recycled and used (Olguin, 2003; Rawat et al., 2011).

2. Methodology

Algae used for this study was Chlorella vulgaris strains, which was isolated from Tajan River and transferred to the laboratory of Faculty of Environment University of Tehran, for examination and cultivation.

Wastewater was obtained from four different sections of Shahrak-Qods sewage treatment plant including input, primary sedimentation, secondary sedimentation, and output before chlorination. The aim of choosing these four sectors is to find the right place for cultivating algae, in which it could have a high amount of both cell mass and growth rate and the most possible efficiency for pollutant removal.

Before choosing the most suitable medium for the considered microalgae cultivation, it is necessary to consider the characteristics of the microalgae aborigine culture media. Due to the geographical conditions and required nutrients, BG-11 medium was selected.

Finally, using initial algae species and prepared culture medium, the algae was started to be cultivated up to the amount required for use in the treatment process.

The device applied for microalgae cultivation was a bubble column photo-bioreactor. It should be noted that, in order to prevent entry of the additional materials into the photo-bioreactor, Para film was used as the cylinder cover.

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Studies were also conducted for photo-bioreactor designing such as system lighting, mixing, and aeration.

After several investigations for minimizing the destructive factors for algae growth and in the presence of sufficient algae for wastewater treatment, it was concluded that the appropriate mixture volume is 20% algae versus 80% waste water. In fact, before the initial disturbance of wastewater and microalgae, the solution was placed in an autoclave for wastewater sterilizing.

To correctly perform the tests, it is essential to separate microalgae from the culture medium or wastewater. Consequently, the solutions were directly transferred to the centrifuge and the biomass was separated from the solutions by centrifugal force.

3. Results and discussion

During the microalgae photosynthesis process, carbon dioxide is consumed; therefore, the treatment ponds become alkaline.

TP content in four sections of input, primary sedimentation, secondary sedimentation, and output, respectively, decrease from 16.7, 7.1, 1.6 and 1.5 to 3.13, 1.68, 0.9, and 0.78. The maximum removal reaches 81.25% which is in the input and much higher than the values reported in other studies. The removal rates can be related to the high ability of this microalgae species against the high amount of phosphorus.

Nitrogen reduction arises from the use of nutrients by both algae and bacteria during growth. Volatility of some ammonia nitrogen forming at high pH is another reason for nitrogen removal. This study showed that Chlorella species can consume ammonium or nitrate, the primary source of nitrogen for many organisms (Wang et al., 2010). TN rates also decrease from 36, 25, 28, and 20 in four parts of inputs, primary sedimentation, secondary sedimentation, and output to 7, 5, 6, and 4 which is equal to 87.5%, 86.49%, 76%, and 83.33% removal rate. The maximum amount of nitrogen in the wastewater is ammonia nitrogen, which can be easily used by algae.

The amount of ammonia nitrogen in these four sections changes from 50, 35.5, 22.5, and 20 to 0.3, 0.24, 0.63 and 0.16 respectively. Reduction of ammonia nitrogen from wastewater using algae is due to the direct consumption of ammonia nitrogen and NH_3 (Tam and Wong, 1990).

Ortho-phosphate levels also decrease from 18.4, 15.4, 6.8, and 6.6 to 2.4, 2.7, 1.8, and 2.1 in the four sections of input, primary sedimentation, secondary sedimentation and output, respectively, which was 86.95%, 82.47%, 73.53%, and 68.18% removal rate. Maximum removal rate was during the first 5 days and in input and primary sedimentation sections.

4. Conclusions

Comparing the results obtained from different parts of the treatment plant indicates that this treatment method is mostly effective for input and primary sedimentation. Also, due to the high levels of nutrient particulates used by microalgae for their growth in the input, the proportional ratio of N:P for microalgae growth, and economical methods used for separating microalgae in the input, the most suitable place for cultivation and breeding microalgae is the input of the treatment plant.

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