Biotechnology of Water Treatment Based on Algae Cultures

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Abstract. In the current article, we will highlight on the role of algae in the treatment of wastewater. Algae cultures are an interesting solution to tertiary and quaternary treatments because of their capacity to use inorganic nitrogen and phosphorus for their growth and to remove heavy metals, as well as some toxic organic compounds, thus, avoiding a secondary pollution. Our experiments were conducted using Chlorella algae for removing lead ions from wastewater. The wastewater treatment efficiency reached a maximum of 86.67% after 80 minutes.

1. Introduction
Organic and inorganic pollutants are released into the environment as a result of industrial, agricultural and domestic water activities. The primary and secondary treatment processes of wastewaters have been used to eliminate the easily settled materials and to oxidize the organic compounds. The final result is a apparently clean effluent which is discharged into surface water. This secondary effluent contains inorganic nitrogen and phosphorus which are responsible for eutrophication and other long-term problems due to heavy metals toxic and organics which are discharged.

Microalgae culture mat represent an important step for wastewater treatments, because they provide a tertiary treatment in conjunction with the production of biomass, which can be used for other important purposes. Microalgae cultures is an interesting solution to tertiary and quaternary treatments because of their capacity to use inorganic nitrogen and phosphorus for their growth and to remove heavy metals, as well as some toxic organic compounds, thus, avoiding a secondary pollution.

The history of the commercial use of algal cultures in wastewater treatment and production of strains as Chlorella and Dunaliella started about 75 years ago and developed in countries such as Australia, USA, Thailand, Taiwan and Mexico [1-7]. Treatment with microalgae is interesting because of their photosynthetic capacity of incorporating nutrients like nitrogen and phosphorus responsible for eutrophication [8]. In the scientific literature is found that the most tolerant eight genera of algae to organic pollutants in are Scenedesmus, Euglena, Chlamydomonas, Oscillatoria,Chlorella, Nitzschia, Navicula and Stigeoclonium [9]. The most tolerant genera contains eight green algae, five blue-greens, six flagellates and six diatoms [10]. Because the land-space necessities of microalgal wastewater treatment systems are large are made huge efforts for developing wastewater treatment systems containing hyperconcentrated algal cultures which proved to be efficient for removing N and P within
short periods of times (less than 1 h) [11, 12]. The algal systems can treat municipal water [13-15], agro-industrial wastes [17-20], livestock wastes [21], and industrial wastes [22].

Microalgal systems were investigated for the treatment of other wastewater such as the effluent from food processing factories and piggery effluent [23-27]. Moreover, algae systems are developed for the removal of toxic metals such as mercury, scandium, lead, cadmium, tin and arsenic [28-31]. The biotechnology of microalgal culture have traditionally been used as a tertiary process [32 ,33], but has been proposed as a potential secondary treatment process [34]. Tertiary treatment process eliminates all organic compounds. It can be achieved chemically or biologically. The biological tertiary treatment perform well in comparison with chemical treatment which are has the disadvantages to be costly to be implemented and can imply secondary pollution. However, each additional treatment step in a wastewater system greatly increases the total cost.

In this article we highlight on the role of algae in the treatment of wastewater and will present some preliminary results regarding the application of green algae for removal lead ions from wastewater.

2. Experimental

2.1. Material

For testing the potential of removal lead ions from water was used as microalga culture Chlorella, cultivated in an installation presented elsewhere [38]. For this method we used two reagents purchased from Merck, namely one containing hydroxylammonium chloride and ammonia solution and another containing potassium cyanide.

The results obtained with the PhotoLab S12 photometer were determined in accordance with ISO 8466-1 and DIN 38402 A51 (10 mm cell) for solutions polluted with lead. To measure the concentrations on the photometer we checked the pH of the sample, the range specified in the method being between 3 and 6. If necessary, we added dilute solution of sodium hydroxide or sulfuric acid to adjust the pH, we added to a test tube 0.5 mL of reagent that contains hydroxylammonium chloride and ammonia solution, 0.5 mL of reagent that contains potassium cyanide, stirred the solution, then we added 8 mL of the solution polluted with lead ions, stirred again, then transferred the solution in a corresponding 10 mm cell.

To calculate the removal efficiency, the following calculation formula was used:

$$\eta(\%) = \frac{C_i - C_f}{C_i} \times 100$$

where: $C_i$ – initial concentration [mg/L]; $C_f$ – final concentration [mg/L].

3. Results and Discussions

The results of the water depollution process in order to remove the lead ions are shown in table 1. Figure 1 shows the variation of the concentration of lead ions in the wastewater during 120 minutes. It can be seen that in the first 20 minutes there was no decrease in the concentration of lead ions, and after 80 minutes of contact the concentration remained constant, the process being ended.

| Time [min] | Concentration [mg/L] | Removal efficiency [%] |
|-----------|----------------------|------------------------|
| 0         | 1800                 | 0,00                   |
| 20        | 1800                 | 0,00                   |
| 40        | 1600                 | 11,11                  |
| 60        | 250                  | 86,11                  |
| 80        | 240                  | 86,67                  |
| 100       | 240                  | 86,67                  |
| 120       | 240                  | 86,67                  |
Figure 1. Variation of lead ion concentration vs. time.

Figure 2 shows the variation of the efficiency of removing lead ions from the wastewater during interval of 120 minutes. The removal efficiency reached a maximum of 86.67% after 80 minutes of treatment.

4. Conclusions

In the current article, was presented the role of algae in the treatment of wastewater. Algae cultures represent an interesting wastewater treatment because of their capacity to remove heavy metals and organic compounds. Our experiments consisted in using Chlorella algae for removing lead ions form wastewater. The wastewater treatment efficiency reached a maximum of 86.67% after 80 minutes.

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