STUDY OF THE EFFICIENCY OF DIFFERENT FLOCCULANTS FOR EFFECTIVE MICROALGAE HARVESTING

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In recent years, the study of different aspects related to the behaviour of microalgae has received renewed interest due to the wide field of application of these microorganisms. Algae cultures have been principally developed as an important source of many products, such as aquaculture feeds, human food supplements, and pharmaceuticals, and they have also been suggested as a very good candidate for fuel production. The process of recovering the cells from the culture solution is an important factor in the determination of the cost and quality of the products. The harvesting of algal cells by flocculation is a more convenient process than conventional methods such as centrifugation and gravity filtration because it allows the treatment of large quantities of culture [1].

The aim of this work is to study the effectiveness of different flocculants commonly used in the wastewater treatment for the recovery of microalgae. Several experimental conditions have been studied, such as pH, concentration of flocculant, sedimentation time, etc. The microalga used in this study is a *Nannochloropsis sp.* from water of the gulf of Mazarrón (Spain). The flocculants employed in this work were $FeCl_3 \cdot 6H_2O$ and $Al_2(SO_4)_3 \cdot 18H_2O$. Furthermore, chitosan, a cationic polyelectrolyte has been used for the microalgae harvesting. The different compounds have been evaluated at five different concentration of flocculant values ranging from 10 to 170 ppm and each concentration has been tested at three different pH ranging from 6.5 to 10.

Experimental conditions:

-Initial concentration of culture: 0.4 $g_{microalgae}/L$

-Coagulation process: 1 min, 300 rpm

-Floculation process: 3 min, 10-15 rpm

-Sedimentation process: 20 min, 0 rpm

Measure of the top solution turbidity

Determination of effectivity (η)

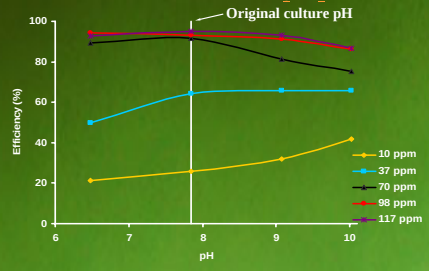
$$\eta = \frac{\text{se dim ented micr oa lg ae (g)}}{\text{initial mi croa lg ae (g)}} \times 100 = \frac{\left(V_o - V_f \frac{C_f}{C_o}\right)}{V_o} \times 100$$

V_o = initial culture volumen (50 ml)

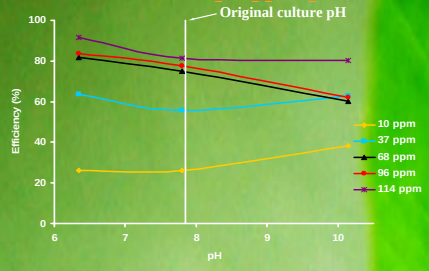
V_f = final culture volumen (50 ml + flocculant volumen)

C_f/C_o = relation between the initial and the final culture concentration (obtained with a calibration curve of different standard solutions in function of turbidity)

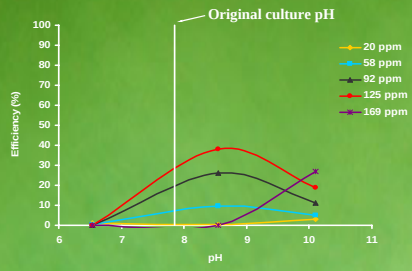
Efficiencies obtained by using $FeCl_3 \cdot 6H_2O$ as flocculant



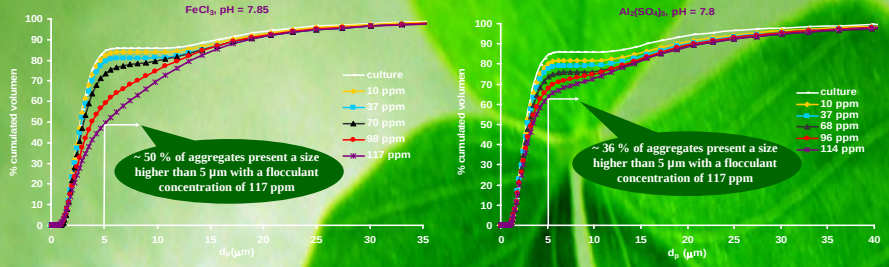
Efficiencies obtained by using $Al_2(SO_4)_3 \cdot 18H_2O$ as flocculant



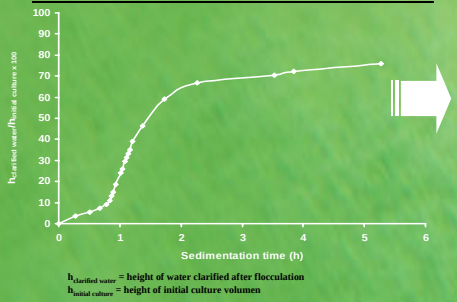
Efficiencies obtained by using chitosan as flocculant



Particle size distribution of aggregates formed with two different inorganic flocculants



Sedimentation rate with the addition of NaOH 1M

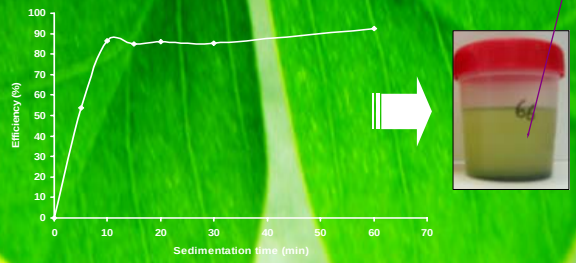


$h_{clarified\ water}$ = height of water clarified after flocculation

$h_{initial\ culture}$ = height of initial culture volumen

NaOH 1 M, pH = 11.4

Sedimentation rate with $FeCl_3 \cdot 6H_2O$ (119 ppm)



Conclusion:

The results indicate that for low flocculant concentration, the activity showed by the two inorganic salts is similar (around 30 % biomass recovery). An optimal concentration of around 70 ppm has been obtained by using $FeCl_3 \cdot 6H_2O$ and $Al_2(SO_4)_3 \cdot 18H_2O$, and an increase of this concentration does not show a significant effect in the biomass recovery. However, the efficiency obtained for $FeCl_3 \cdot 6H_2O$ is close to 90 % at the optimal concentration, while in the $Al_2(SO_4)_3 \cdot 18H_2O$ case, this value is close to 80 %. Two different behaviours have been observed in the study of the influence of the pH on the biomass recovery. For low flocculant concentrations (< 37 ppm), the results show that the maximum efficiency in the microalgae harvesting is obtained for basic pH (around pH = 10). In the case of use high flocculant concentrations (> 70 ppm), the opposite behaviour is observed, and the maximum recovery is observed at pH ranging from 6.5-8. This effect is more marked by using the $Al_2(SO_4)_3 \cdot 18H_2O$ flocculant. The cationic polyelectrolyte, chitosan, shows the lowest activity, only reaching a recovery of 37.7 % at a pH of the culture media 8.5 and 125 ppm. The particle size distribution of aggregates formed confirmes that $FeCl_3 \cdot 6H_2O$ is a more effective flocculant than $Al_2(SO_4)_3 \cdot 18H_2O$.

The sedimentation in the presence of NaOH seems to be slower than in the presence of $FeCl_3 \cdot 6H_2O$, i.e. the evolution of the interface is slower in the presence of NaOH. However, the clarification in the presence of NaOH seems to be complete whereas in the presence of $FeCl_3 \cdot 6H_2O$ at the end of the sedimentation process, around a 10 % of microalgae remains in the top water.

[1] S. J. Lee, S.-B. Kim, J.- E. Kim, F.-S. Kwon, B.-D. Yoon and H.-M. Oh.. Letters in Applied Microbiology, 27 (1998), p. 14.

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