Speciation of Lead in Biosurfactant Solutions Using Conductivity Measurement

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Abstract

Lead removal from wastewater was investigated using a UH-biosurfactant. Speciation of Pb into micelle was quantified by direct and conductivity measurements. Conductivity of the solution was related to the lead concentrations in the aqueous and micelle phases.

1. Introduction

Surfactants are used in removing metals from wastewater. When a surfactant is mixed with a lead solution, speciation of lead will take place depending on the micelles of biosurfactant. Some lead ions will be attached to the micelles due to electrostatic interaction and can be filtered out of the solution. In this study, the potential of using conductivity measurement to quantify the speciation of lead in the lead-surfactant solutions was investigated.

2. Objective

The objective of this study was to investigate use of conductivity to quantify speciation of the lead in the UH-biosurfactant.

3. Testing Program

Commercially available standard reference lead solution (1000 ppm ± 1%) was used for the lead speciation study. Lead solutions were mixed with surfactant in a beaker and stirred for several minutes. pH adjustment was done using 1 M of NaOH. Solution was then taken from the beaker and filtered using a 0.2 μm syringe filter to separate micelles containing absorbed lead and lead ions. Filters were then acid washed using concentrated nitric acid to recover the lead from the micelle phase. Lead concentrations in the filtrate and in the filter were measured using a Perkin Elmer atomic absorption spectroscopy (AA) equipped with a flow spoiler (air-acetylene flame, wave length, λ = 217 nm). Conductivity of the solutions was measured using a conductivity meter (Orion Research, Inc., Model 105).

4. Results and discussion

Conductivity linearly increased with biosurfactant concentration showing discontinuity in the slope at CMC. Conductivity with lead and biosurfactant was measured (Fig. 1). Without the surfactant, conductivity for the lead solutions varied from 29 to 10150 μs. The conductivity of the lead solutions was not affected by 0.5 CMC biosurfactant. When more surfactant was added, conductivity decreased. In the case of 10 CMC, the conductivity was independent of lead addition to the solution and was 2000 μs. Conductivity results indicate that with more micelles in 10 CMC solution, less free lead ions were present and, therefore, conductivity was much less than the other solutions

investigated. The relationship between change in conductivity (ΔC) and lead speciation can be presented as follows:

$$\Delta C = k_1X_1+k_2X_2+k_3X_1X_2 \qquad (X_1 >0). \tag{1}$$

Where X_1 is the amount of lead in the filtrate, X_2 is amount of lead in the filter (micelle phase) and k_1, k_2 and k_3 are parameters obtained from the least square fit of the test data and summarized in Table 1. Note that X_2 can be expressed in terms of X_1 using the Freundlich equation ($X_2 = K_F X_1^{1/n}$) and plotted in Fig. 2; hence, by measuring ΔC and using the isotherm, it will be possible to determine X_1 and X_2.

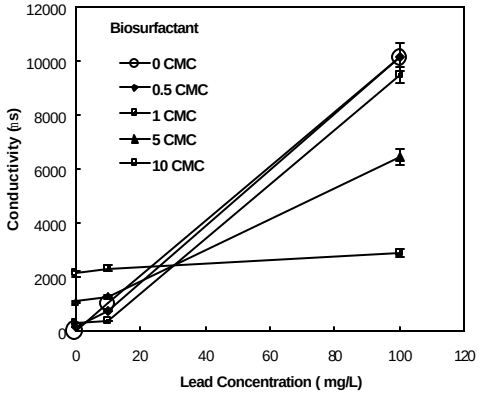

Figure 1. Conductivity of Lead-biosurfactant Solutions

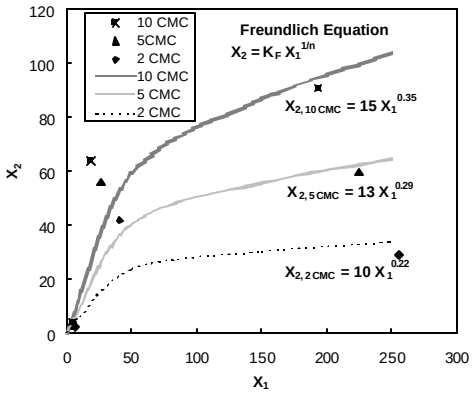

Figure 2. Partition Coefficient of Lead-biosurfactant Solutions

Table 1. Constants with Different Biosurfactant Concentration

Biosurfactant concentration	K_1	K_2	K_3	Remarks
2 CMC	0.052	0.095	0.002	All values are positive
5 CMC	0.17	0.086	-0.0012	k_3 is negative
10 CMC	0.5	-0.023	-0.0042	k_2 and k_3 are negative
Remarks	Increased with increasing biosurfactant concentration	Decreased with increasing biosurfactant concentration	Decreased with increasing biosurfactant concentration	

5. Conclusion

The conductivity was sensitive to the lead and micelle concentrations. Conductivity of the surfactant solutions has been related to the lead concentration in the solution and micelle phase.

6. Acknowledgment

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7. References

Vipulanandan, C. and Ren, X. (2000), "Enhanced solubility and biodegradation of naphthalene with biosurfactant," Journal of Environmental Engineering, Vol. 126, No. 7, 2000, pp. 629-634.