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Conclusions

The hot ethanol extraction protocol allowed the recovery of the cell associated and intracellular substances that are responsible of conferring hydrophobicity to the hematite surface. The crude biosurfactant recovery was around 0.3 g/L.

Three functional groups where clearly identified in the FTIR spectra of the crude biosurfactant. An intense peak between 1750 and 1620 cm^{-1} characteristic of a kenote vibration (C=O), the peak with a medium intensity at 2929 cm^{-1} correspond to the vibration of a C-H bond and finally an intense peak at 3398 cm^{-1} caused by an alcohol group vibration O-H. The ketone and alcohol vibration may be due to a carboxylic group characteristic of a trehalolipid biosurfactant. The hydrophobic tail may be composed of saturated and unsaturated long carbon chains.

In addition, surface tension measurements estimated a CMC of the crude biosurfactant around 92 ppm, lowering the water surface tension from 72 to 52.5 mN/m. The impurity of the crude biosurfactant may account for the gap comparing with the refined biosurfactant.

Electrophoretic studies of hematite particles before BS interaction, found an IEP of 7.5 and a PZC of 7.6. The modeling of the electric layer applying the Gouy–Chapman model, also know as the diffuse layer model, could describe the electric compression as the concentration of background electrolyte increases. In addition, it provided an electrostatic potential map in function of the pH and distance, where it could be identified the zones of possible biosurfactant adhesion. In addition, after biosurfactant interaction the IEP of hematite was significantly shifted to the left, suggesting specific adsorption. The merged model of Guouy-Chapman and the plate capacitor, allowed to see how the interaction of the electric

potential dropped suddenly at acid pH values, where it was reported a good hematite floatability. Finally, it was demonstrated thermodynamically, how the formation of the electric double layer of the hematite particles is a spontaneous process.

FTIR spectra of the hematite sample before and after interaction with the crude biosurfactant showed the adsorption of three chemical groups onto the hematite surface: A peak at 1631 cm^{-1} characteristic of a kenote vibration (C=O), a peak at 2923 cm^{-1} due to the vibration of a C-H bond and finally an intense peak at 3398 cm^{-1} caused by a O-H bond.

Microflotation tests using the bacteria *Rhodococcus opacus* as reagent showed potential to float fine hematite particles and good foam stability. On the other hand, the maximum hematite floatability was 43.5% at neutral pH with a biomass concentration of 125 ppm. Statistical analysis showed a polynomial model of 4^{th} and 3^{rd} order for the pH and biomass concentration respectively with a correlation coefficient (R^2) of 93.6%. Regarding the hematite flotation tests using the crude biosurfactant, it required less flotation time, requiring of 1 min to achieve a maximum hematite floatability of 95%, at acid pH 3 and 125 ppm of biosurfactant concentration. It was adjusted to a polynomial model of 2^{nd} order on the pH and 3^{rd} order on the BS concentration, with a correlation coefficient of 91.1%, resulting in an expression simpler than the previous model for hematite flotation using biomass. Both models would allow to predict the floatability of the hematite at a determined pH and biomass concentration inside the studied region using the *Rhodococcus opacus* bacteria as well as the biosurfactant as reagent. Finally, it was concluded a better floatability of hematite in the presence of the crude biosurfactant than the bacteria itself at all the pH levels studied.