Book of Abstracts
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Oxygen mass transfer to emulsions in bubble column contactor

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1. Summary

Present work includes an exhaustive study about the oxygen absorption process by the analysis of volumetric mass transfer coefficient and the corresponding value of interfacial area between gas phase and liquid heterogeneous medium generated in a rectangular bubble contactor. The system studied has been composed by water, methyl ricinoleate and Tween 80, since it is the base of the medium used for an aroma production from the biotransformation of ricinoleic acid by the yeast *Yarrowia lipolytica.*

Keywords: oxygen mass transfer, absorption, bubble column, biphasic systems

2. Extended Abstract

Nowadays, the understanding of gas mass transfer by absorption processes when a heterogeneous system is employed as absorbent medium is an important tool with growing interest. Gas-liquid-liquid systems are encountered in many reactions, such as in homogeneous biphasic catalysis and in numerous biotechnological processes based on the development of microorganisms within a biphasic medium (Pulido-Mayoral et al, 2004). Oil-in-water emulsions are found in aerobic culture media where an inert hydrophobic compound is used with the purpose of improving oxygen transfer rate (Amaral et al., 2006) from the gas to the medium, but also in bioprocesses where the oil phase is the substrate of the biological reaction (Aguedo et al, 2005).
The influence of Tween80 presence and concentration upon interfacial area and mass transfer coefficient has been studied and the experimental results indicate that an increase in surfactant concentration in the liquid phase produces a clear increase in the value of bubble diameter that produces a decrease in interfacial area. Also, using the interfacial area values, mass transfer coefficient could be calculated observing a continuous decrease in its value due to the reduction in liquid surface renewal caused by the accumulation of surfactant molecules at gas-liquid interface.
Using the highest Tween80 concentration and adding different quantities of methyl ricinoleate to the liquid phase, the gas-liquid interfacial area has been determined by

the same photographic method previously employed. The experimental results obtained are shown in figure 1. The bubbles diameter distribution for the different liquid phases employed indicates that the presence of methyl ricinoleate in liquid phase produces a decrease in bubbles diameter that is related with a decrease in interfacial area. This behaviour is due to the reduction in the free liquid surface surfactant concentration by the transference to organic medium. This reduction in Tween80 concentration in aqueous medium produces the previously commented increase in bubbles diameter.

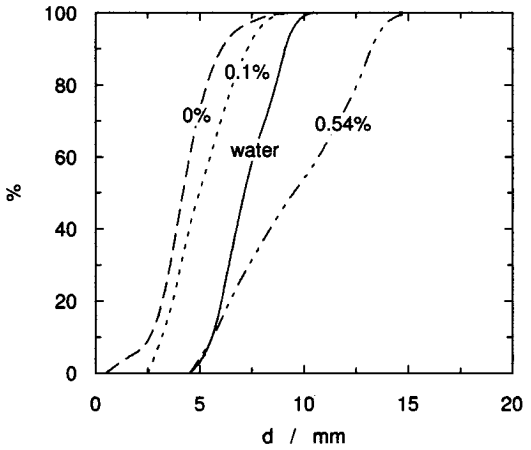

Figure 1. Influence of methyl ricinoleate concentration upon bubble size distribution. Medium section. Q_g = 0.5 L·min^{-1}. [Tween80] = 0.093% (v/v).

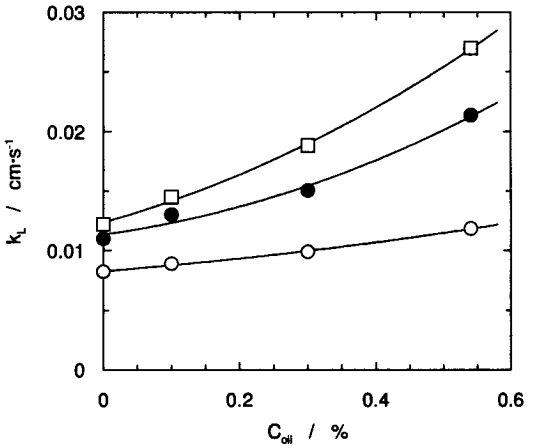

Figure 2. Influence of methyl ricinoleate upon mass transfer coefficient. (○) Q_g = 0.25 L·min^{-1}; (●) Q_g = 0.5 L·min^{-1}; (□) Q_g = 0.7 L·min^{-1}.

The interfacial area values determined employing the bubble size distribution shown in figure 1 were employed to calculate the mass transfer coefficient that inform about the mass transfer process without the influence of interfacial area upon oxygen absorption. Figure 2 shows a resume of obtained mass transfer coefficient data and the influence of organic phase concentration and gas flow-rate. Both variables produce an increase in mass transfer coefficient, in both cases due to the increase in the liquid surface renewal. In the case of gas flow-rate, it produces an increase in turbulence while methyl ricinoleate presence decreases the surfactant surface concentration implying that the reduction in surface renewal is lesser than the corresponding to the system without methyl ricinoleate.

References

Pulido-Mayoral, N., Galindo, E. (2004) *Biotechnology Progress*, 20, 1608-1613.

Aguedo, M., Gomes, N., Garcia, E. E., Waché, Y., Mota , M., Teixeira, J. A., Belo I. (2005) *Biotechnology Letters*, 27, 1617-1621.

Amaral P.F.F., Rocha-Leão, M.H.M, Marrucho, I.M., Coutinho, J.A.P., Coelho, M.A.Z. (2006) *J. Chem. Technol. Biotechnol.*, 81:1368–1374.