OXYGEN MASS TRANSFER STUDIES IN THE SCALE DOWN OF A THREE-PHASE PARTITIONING BIOREACTOR (WATER-IONIC LIQUID-AIR)

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Introduction. The biotechnology industry had a great interest for the atomatization of mini and micro bioreactors that allow monitoring and take the control of parameters as pH, temperature and dissolved oxygen [1]. Micro-scale process technics promise to improve the bioprocess design and cost reduction [2]. The system characterization in terms of the oxygen mass transfer coefficient (k_La) for bioprocess design at different scales is simplified by the use of bioreactor micro titer plates, allowing high-throughput varying operating conditions [3]. In partitioning bioreactors, oxygen transfer rate could be the limiting step in the bioconversion process under certain operating conditions [4]. Further enhancement of oxygen transfer rates requires proper selection of the bioreactor operational conditions.

The aim of this work was study the oxygen mass transfer through k_La, during the scale down of a partitioning bioreactor based in geometric similarity and dimensional analysis criteria.

Methods. Two stirred tank bioreactors were used for the study. A bioreactor of 1000 mL (Model ADI 1025, Applikon) with 9.5 cm of internal diameter, operating volume of 700 mL (H_L/D_T=0.96). The bioreactor was fitted with a single, 6 flat blade Rushton turbine with a diameter of 4.5 cm (D_i/D_T=0.46), and equipped with 2 equidistant baffles 1.0 cm in with. And, a glass jacketed mini-bioreactor of 100 mL (UAM-I, Mexico) with an internal diameter of 4.75 cm and an operating volume of 70 mL (H_L/D_T = 0.87). The bioreactor was fitted with a single, 6 flat blade Rushton turbine, D_i = 1.9 cm (D_i/D_T = 0.40). The bioreactor was equipped with 4 equidistant baffles, 0.5 cm width, to enhance mixing. The operating conditions was established through regime analysis criteria and a full face-centered central composite experimental design, taking into account three independent factors, each one at three levels with 3 centre points and 15 runs. The methodology of oxygen mass transfer and the empirical correlation for k_La used were according to [5].

Results. The operating conditions for 1000 mL bioreactor were: 1000 rpm, 1 vvm and 0.05 ionic liquid fraction, and the homologous operation conditions for the 100 mL bioreactor were: 1950 rpm, 1.4 vvm and 0.05 ionic liquid fraction. The k_La values obtained were twofold in the 1000 mL bioreactor (180 h^{-1}) than in 100 mL bioreactor (90 h^{-1}) (Figure 1).

For both scales, empirical correlations were used for predicted k_La using: calculated gassed power input per volume unit (P_g/V), superficial gas velocity (Vs), and the ionic liquid fraction (φ). The experimental values obtained were fitted to a empirical correlation [5] using Polymath™ 5 software.

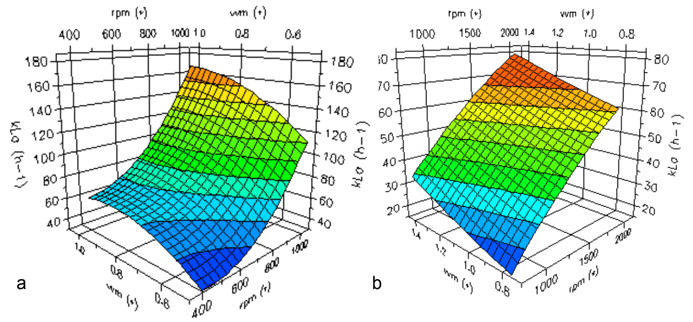

Fig.1 Maximum k_La values obtained during the scale down. (**a**) 1000 mL and (**b**) 100 mL, in both cases the ionic liquid fraction was 0.05.

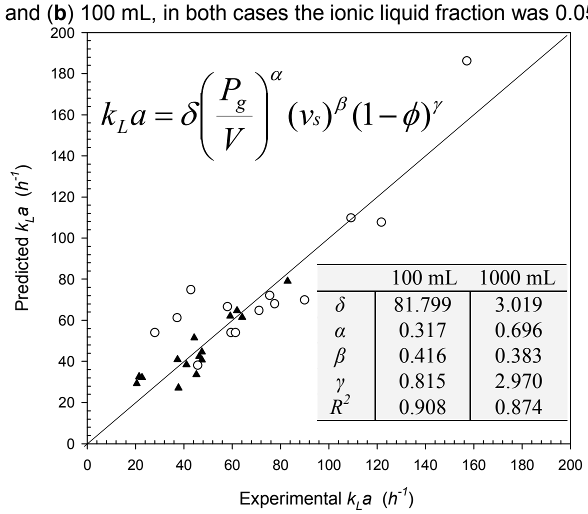

Fig.2 Parity plot of experimental *versus* predicted k_La values from the empirical correlation (▲) 100 mL, (○) 1000 mL.

The correlation coefficients (R^2) indicate good agreement between experimental and predicted values. However, the coefficients and exponents values were different between both scales (Figure 2) may be due to small differences in the bioreactors geometry (vessel flat base and baffles position).

Conclusions. The scale down criteria used promises to establish appropriate operating conditions for bioprocess in three-phase partitioning bioreactors.

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References.

1. Lye, G.J., P. Ayazi F. Baganz, P.A. Dalby, J.M. Woodley. *Trends in Biotech*, 21: 1, 29 (2003).
2. Micheletti, M., G.J. Lye. *Current Opinion in Biotech*, 17: 611 (2006).
3. Willoughby, N. *J. of Chem.l Tech & Biotech*, 81**:** 12, 1849 (2006).
4. Melgarejo R., Torres D., Gutiérrez M., Gómez de Jesús A., Lye G, Huerta S. *Biochem. Eng. J*, 58-59: 87 (2011).
5. Torres D, Melgarejo R., Gutiérrez M. Aguilera C., Micheletti T., Lye G.,Huerta S. *Biochem. Eng. J.* 45 (2009) 209–217.