Development of an empirical correlation for Newtonian and non-Newtonian fluids in a stirred tank reactor, to predict oxygen mass transfer rates

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Abstract:

Most of animal and plant cell cultures present a non-Newtonian behaviour that has a deep effect on the technological performance of bioreactors, affecting the pattern of mixing, the power input required and on the mass and energy transfer as well. In aerobic cultures, the oxygen mass transfer is still a bottleneck, particularly at industrial scale-up, where the high-cell-density biomass and production of metabolites provoke the increase on the viscosity culture, lowering the production yield and eventually losing economical process viability.

The objective of this work was to contribute for the prediction of oxygen transfer rate in no-Newtonians fluids, given its relevance in cell cultures and the fact that the available empirical equations have no universal applicability. The comparison with Newtonians fluids will be also carried on.

The volumetric oxygen mass transfer coefficient (k_La) was determined by the static method in a stirred tank reactor (3 and 7-l) at distinct operating conditions (agitation and aeration), with different impellers, Rushton turbine and marine propeller, in Newtonian and non-Newtonian fluids. It was also measured the K_La, in a stirred tank reactor (STR), with the combination of those impellers. The combination of marine impeller in the bottom position and Rushton turbine on top position in the tank, assured the highest k_La value of 33,8 h^{-1}, being apparent optimal mass transfer rate in the tested operational STR conditions.

Several empirical correlations were tested (Cooper et al, 1944; Ryu & Humphrey, 1972; Ryu & Humphrey modified; García-Ochoa & Gomes, 1998) and the empirical constants influenced by the increasing agitation speed, aeration flows and apparent viscosities were determined. The empirical correlation that fits better the range of k_La values, determined in STR 7-L for Newtonian and non-Newtonian fluids, was the equation proposed by García-Ochoa & Gomez (1998) when was used the porous sparger and the Rushton turbine. The empirical correlation is strongly dependent on the impeller geometry.

References:

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