World Academy of Science, Engineering and Technology
International Journal of Chemical and Molecular Engineering
Vol:8, No:06, 2014

Evaluation of Mixing and Oxygen Transfer Performances for a Stirred Bioreactor Containing P. chrysogenum Broths

Authors : A. C. Blaga, A. Cârlescu, M. Turnea, A. I. Galaction, D. Caşcaval

Abstract : The performance of an aerobic stirred bioreactor for fungal fermentation was analyzed on the basis of mixing time and oxygen mass transfer coefficient, by quantifying the influence of some specific geometrical and operational parameters of the bioreactor, as well as the rheological behavior of Penicillium chrysogenum broth (free mycelia and mycelia aggregates). The rheological properties of the fungus broth, controlled by the biomass concentration, its growth rate, and morphology strongly affect the performance of the bioreactor. Experimental data showed that for both morphological structures the accumulation of fungus biomass induces a significant increase of broths viscosity and modifies the rheological behavior. For lower P. chrysogenum concentrations (both morphological conformations), the mixing time initially increases with aeration rate, reaches a maximum value and decreases. This variation can be explained by the formation of small bubbles, due to the presence of solid phase which hinders the bubbles coalescence, the rising velocity of bubbles being reduced by the high apparent viscosity of fungus broths. By biomass accumulation, the variation of mixing time with aeration rate is gradually changed, the continuous reduction of mixing time with air input flow increase being obtained for 33.5 g/l d.w. P. chrysogenum. Owing to the superior apparent viscosity, which reduces considerably the relative contribution of mechanical agitation to the broths mixing, these phenomena are more pronounced for P. chrysogenum free mycelia. Due to the increase of broth apparent viscosity, the biomass accumulation induces two significant effects on oxygen transfer rate: the diminution of turbulence and perturbation of bubbles dispersion - coalescence equilibrium. The increase of P. chrysogenum free mycelia concentration leads to the decrease of kla values. Thus, for the considered variation domain of the main parameters taken into account, namely air superficial velocity from 8.36 10-4 to 5.02 10-3 m/s and specific power input from 100 to 500 W/m3, kla was reduced for 3.7 times for biomass concentration increase from 4 to 36.5 g/l d.w. The broth containing P. crysogenum mycelia aggregates exhibits a particular behavior from the point of view of oxygen transfer. Regardless of bioreactor operating conditions, the increase of biomass concentration leads initially to the increase of oxygen mass transfer rate, the phenomenon that can be explained by the interaction of pellets with bubbles. The results are in relation with the increase of apparent viscosity of broths corresponding to the variation of biomass concentration between the mentioned limits. Thus, the apparent viscosity of the suspension of fungus mycelia aggregates increased for 44.2 times and fungus free mycelia for 63.9 times for CX increase from 4 to 36.5 g/l d.w. By means of the experimental data, some mathematical correlations describing the influences of the considered factors on mixing time and kla have been proposed. The proposed correlations can be used in bioreactor performance evaluation, optimization, and scaling-up.

Keywords : biomass concentration, mixing time, oxygen mass transfer, P. chrysogenum broth, stirred bioreactor
Conference Title : ICCPE 2014 : International Conference on Chemical and Pharmaceutical Engineering
Conference Location : Copenhagen, Denmark
Conference Dates : June 12-13, 2014