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High cell density cultivation of recombinant yeasts and bacteria under non-pressurized and pressurized conditions in stirred tank bioreactors

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Abstract:

This study demonstrates the applicability of pressurized stirred tank bioreactors for oxygen transfer enhancement in aerobic cultivation processes. The specific power input and the reactor pressure was employed as process variable. As model organism *Escherichia coli*, *Arxula adeninivorans*, *Saccharomyces cerevisiae* and *Corynebacterium glutamicum* were cultivated to high cell densities. By applying specific power inputs of approx. 48kW m^{-3} the oxygen transfer rate of a E. coli culture in the non-pressurized stirred tank bioreactor was lifted up to values of 0.51 mol l^{-1} h^{-1}. When a reactor pressure up to 10 bar was applied, the oxygen transfer rate of a pressurized stirred tank bioreactor was lifted up to values of 0.89 mol $^{-1}$ h^{-1}. The non-pressurized stirred tank bioreactor was able to support non-oxygen limited growth of cell densities of more than 40 g l^{-1} cell dry weight (CDW) of *E. coli*, whereas the pressurized stirred tank bioreactor was able to support non-oxygen limited growth of cell densities up to 225 g l^{-1} CDW of *A. adeninivorans*, 89 g l^{-1} CDW of *S. cerevisiae*, 226 g l^{-1} CDW of *C. glutamicum* and 110 g l^{-1} CDW of *E. coli*. Compared to literature data, some of these cell densities are the highest values ever achieved in high cell density cultivation of microorganisms in stirred tank bioreactors. By comparing the specific power inputs as well as the k_La values of both systems, it is demonstrated that only the pressure is a scaleable tool for oxygen transfer enhancement in industrial stirred tank bioreactors. Furthermore, it was shown that increased carbon dioxide partial pressures did not remarkably inhibit the growth of the investigated model organisms.

Key-words: Pressure fermentation, oxygen transfer enhancement, high cell density cultivation