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APPLICATION OF A NOVEL OSCILLATORY FLOW SCREENING MICRO-REACTOR TO A BIOTRANSFORMATION IN A TWO-PHASE MEDIUM

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A novel screening reactor based on oscillatory flow technology [1] composed of 4.4 mm diameter tubes with smooth periodic constrictions (approx. 4 mL of volume) was recently presented by Harvey et al. [2] as a new technology for bio-reaction engineering applications. Experimental studies using Particle Image Velocimetry (PIV) [3] showed that this micro-reactor improves fluid mixing and is also able to keep polymer bead-supported biocatalysts (with a wide range of sedimentation velocities) completely suspended. Further experiments allowed to conclude that gas bubbles retention can be prevented by configuring the tubes at appropriate angles and that the reactor is able to keep an oil-in-water emulsion stable as long as oscillatory flow is maintained. Optimum operation conditions for applications at the bioengineering field were established in relation to four parameters: 1) fluid mixing, 2) residence time characteristics, 3) particle suspension [4] and 4) (oxygen) mass transfer rates. A single reactor consisting of a series of tubes can be configured to perform sequential biochemical reactions by keeping different particles suspended in different parts of the reactor.

This work particularly concerns with the application of this micro-reactor to a model system consisting of the batch production of an aroma compound (gamma-decalactone) through the biotransformation of methyl ricinoleate which is a hydrophobic (lipid) substrate [5]. This substrate is degraded by the strictly aerobic yeast *Yarrowia lipolytica*, which stands in the aqueous phase. This fermentation medium is an emulsion and, in such a medium, bio-reaction rates can be improved with an increase of the contact area between the two phases. The principle of operation of the novel micro-reactor allows a stable, fine emulsion to be formed, in which the size of the oil droplets can be controlled by altering the oscillatory conditions (oscillation frequency and amplitude), thus favouring the formation of (gamma-decalactone.

The performance of the process in this new bioreactor was evaluated by comparing the specific gamma-decalactone production obtained with that previously achieved in a stirred tank bioreactor. In order to do this, biomass concentration was followed by direct counting on a Neubauer cell, gamma-decalactone concentrations were assessed by liquid-liquid extraction with diethyl ether followed by gas chromatography and state-of-art fibre-optic technology (using a fluorescence micro-probe dip-coated with a ruthenium complex immobilised in a sol-gel matrix) was used for on-line monitoring of dissolved oxygen concentration.

The results obtained give new perspectives to the study of bioprocesses based on two-phase media. In particular, due to its very modest size, the novel bio-reactor presented here constitutes an invaluable tool for screening purposes.

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