Investigation of the productivity of a novel ceramic membrane bioreactor system for steady-state fermentations

Christian Endres¹, Sascha Beutel¹, Sheena Fraser¹, Wade Edwards¹ and Thomas Scheper¹

1) Institut für Technische Chemie, Universität Hannover, Callinstr. 5, 30167 Hannover, Germany
2) Synexa Life Sciences, Cape Town, South Africa

Introduction

Compared to traditional fermenters an important advantage of membrane-based bioreactors is the provision of an artificial environment for an increased biomass density and enhanced productivity of immobilized shear stress-sensitive organisms. The novel Quorus GLS and LS bioreactors investigated in this study consist of ceramic capillary membranes and therefore provide an ideal platform for the immobilization and cultivation of aerobic or anaerobic shear stress-sensitive microorganisms. Due to their design they are suited for steady-state or submerged and oxygen limited cultivation and continuous production of valuable secondary metabolites, recombinant products or toxic metabolites.

Quorus GLS

Mode of operation
- Biomass is grown in the aerated extracapillary space (ECS) with nutrient medium flowing unidirectional from the lumen of the capillary membranes towards the ECS.
- With a sufficient thickness of the biofilm radial nutrient and oxygen gradients are established across the biofilm.
- The nutrient gradient is controlled to support primary growth of the microorganism and to induce secondary metabolite production.
- Secreted products are collected with the medium stream passing the biofilm.

Evaluation of productivity
- Cultivation of the fungus A.niger in a 50 membrane Quorus 2 L bioreactor and monitoring of the production of a secreted recombinant protein.
- Benchmarking in traditional fermentation vessels like shaking flasks, 3 L Biostat A plus, and 15 L Biostat C.
- Stable protein production in the Quorus GLS bioreactor for more than 40 days.
- Quorus GLS space-time-yield is significantly higher than in all other cultivation vessels.

Quorus LS

Mode of operation
- Biomass is immobilized and established on the outer surface of the ceramic membranes in the ECS in a submerged and oxygen-limited environment.
- With a sufficient thickness of the biofilm a radial nutrient gradient is established across the biofilm.
- Nutrient supply is achieved through a continuous feed into the ECS.
- Secreted products and metabolic waste are continuously removed by transportation through the capillary wall into the intracapillary space.

Evaluation of productivity
- Cultivation of the facultative anaerobic bacterium L.lactis PRA290 in a Quorus LS 0.22 L bioreactor and monitoring of the production of recombinant β-lactamase.
- Benchmarking in traditional fermentation vessels like shaking flasks, stationary flask cultures and Biostat A plus.
- Quorus LS space-time-yield and total product output is significantly higher than in all other cultivation vessels.

This project was supported by Synexa Life Sciences