Biomass production of *Aspergillus fumigatus* on spent sulphite liquor under non-aseptic conditions

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Abstract

Aspergillus fumigatus was grown on spent sulphite liquor (SSL) in three different reactor configurations to determine which configuration required the minimum feed dilution. Stable monoculture growth under non-aseptic conditions could only be maintained in a continuously stirred tank reactor (CSTR) with a microscreen as cell separator and in a selector/producer reactor chain. The reactor chain required the least feed dilution. Monod kinetics could be used to describe the reactor performance with *A. fumigatus.*

Introduction

Aspergillus fumigatus was selected and cultivated on highly diluted spent sulphite liquor (SSL) using the microscreen process (Pretorius and Lempert, 1993 a; b). This thermotolerant fungus, if continuously grown as a monoculture for single-cell protein (SCP) production, has distinct advantages above fungi which only grow in the mesophilic temperature range. With an optimum growth at 45°C continuous cultivation of this fungus for SCP production could be more economical than with mesophilic fungi, because less biologically generated heat needs to be removed and cooling of the relatively high discharge temperature of the SSL effluent is unnecessary (Pretorius and Lempert, 1993 b).

These properties of the effluent and fungus contribute positively towards the economic viability of the commercial production of *A. fumigatus* on SSL. Due to increased viscosity and decrease in oxygen transfer rates in broths containing more than about 10 *gl'* (dried cells) of filamentous micro-organisms (Wille, 1992) the microscreen process as applied here is essentially limited to substrate concentrations of less than 4 000 mg-^' biodegradable chemical oxygen demand (COD). This means that the already highly diluted effluent (biodegradable COD = 6 to 9 g COD l') should be further diluted with clean water, an action that has a detrimental effect on the economics of the process.

Various reactor and process configurations are possible which will allow the cultivation of A. *fumigatus* on SSL effluent without any additional dilution. In this paper two reactor configurations are compared as to their suitability for the cultivation of *A. fumigatus* on SSL effluent with a reduced need for additional dilution.

Theoretical considerations

In continuously fed suspended growth bioreactors, different flow configurations are available for different applications. The two configurations most often employed in biological waste-water treatment can be compared with a continuously stirred tank reactor (CSTR) without and with cell recycle (Grady and Lim, 1980).

In a CSTR without cell recycle, the cell age (O_c) and hydraulic residence time (T) are the same. As the mass of cells produced per mass of COD utilised (i.e. the yield, Y) is generally less than unity, the cell concentration (X) in the reactor is always less than the inflow biodegradable organic substrate concentration (S_o). Unfortunately the selective pressure (Pretorius, 1987) of the microscreen process is lost in such a flow configuration.

In a CSTR with cell recycle, 0_C and T are separately controlled and the reactor is always operated with 0_C > T. The result is that X is also greater than S_o. The microscreen process can be considered as a CSTR with cell recycle. When *A. fumigatus* as selected micro-organism (with Y = 0,7; Pretorius and Lempert, 1993 b) is grown with SSL as substrate, having a biodegradable COD (S_o) of between 6 and 9 *gl1* X usually exceeds 10 *g-t* At this biomass concentration, however, the oxygen transfer efficiency is seriously limited (Wille, 1992).

By combining the microscreen process in a two-stage flow configuration with a CSTR without cell recycle, the benefit of the selection pressure of the microscreen process is retained while the diminishing need for dilution of S_o for a CSTR without cell recycle is affected. The mathematical modelling of CSTRs in series configurations is fully covered by Grady and Lim (1980).

Materials and methods

Bioreactor types

Two identical reactors were used, one with an unrestricted constant volume outflow (CSTR without cell recycle) and one equipped with a 100 µm pore size crossflow-microscreen (Kiihn and Pretorius, 1989) on the constant volume outlet (CSTR with cell recycle). Each of these reactors was provided with their own variable rate feed supply pumps, air supply and temperature controllers. Biomass harvesting on the microscreen bioreactor was done with a variable speed pump. The two reactors are shown schematically in Fig. 1.

Flow arrangements

The performance of the reactors when operated in three different configurations was evaluated, namely a CSTR without cell recycle (Fig. la), a CSTR with cell recycle (Fig. lb) and a chain of a CSTR with cell recycle followed by a CSTR without cell recycle (combination of Figs, la and lb) as shown schematically in Fig. 2.

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Received 18 May 1992; accepted in revised form 6 August 1992.