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Comparative Study of Yeast Growth Kinetics in Different Reactors

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Abstract: *This study aims at investigating three different reactors (air-lift fermenter, bubble column reactor, continuous stirred-tank reactor) to evaluate their performance with respect to baker's yeast (Active Dry Yeast powder) growth using YDM (Yeast Dextrose Media) in shake flask culture in the B.O.D incubator under optimum conditions. Conventional methodologies were implemented to investigate different parameters of yeast growth kinetics in the reactors viz., dry cell mass concentration, residual glucose concentration and cell count. It was finally estimated that among the three bioreactors, in the CSTR, running with an agitator speed of 650 rpm, the final dry cell mass concentration attained after 48 hours was 0.162gm/100 ml and almost all of the initial glucose (0.6 gm/100ml) was utilized within first 12 hours*

Keywords: *Airlift fermenter, agitator, bubble column reactor, baker's yeast, CSTR, turbidity (NTU).*

I. Introduction

Long before anyone understood the concept of bioreaction, humans took advantage of its results [4]. Bread, cheese, wine and beer were all made possible through what was traditionally known as fermentation— a little-understood process, successful more by chance than design [1, 2]. The fermentation process, being the precursor to modern bioreactions has been used since prehistoric days, with major advancements in the field of technology as well as biology. By definition, a bioreactor is a system in which a biological conversion is affected. Primarily the bioreactors referred to only mechanical vessels in which (a) organisms are cultivated in a controlled manner and/or (b) materials are converted or transformed via specific reactions [4]. Bioreactors differ from conventional chemical reactors in that they support and control biological entities. The bioreactor systems provide a higher degree of control over process upsets and contaminations, since the organisms are more sensitive and less stable than chemicals. [5] Organisms, influenced by their morphology and the bioreaction medium, are shear-sensitive to varying degrees. A number of bacteria, yeast and fungi cultures that can be relatively tolerant of high-shear environments exhibit a robustness in high-energy mixing vessels.[3] Mixing within the bioreactor is integral to efficient heat and mass transfer during the production phases, which places additional constraints on the suitable agitation mechanism and rheology of the bioreaction medium. In bioreactors, higher selectivity is of prime importance compared to rate [6, 7]. The effectiveness of the bioreactors depends on the suitable reactor parameters, including: controlled temperature, optimum pH, sufficient substrate, gas evolution [10, 11] etc.

1.1 Continuous Stirred tank reactor systems: The defining characteristic of continuous bioreaction is a perpetual feeding process [14]. A culture medium comprising of microorganisms is continuously fed into the bioreactor to maintain the steady state. The reaction variables and control parameters remain consistent, establishing a time-constant state within the reactor [15]. The result is continuous productivity and output.

1.2 Bubble Column reactor systems: Also known as a tower reactor, it has a bubble column containing a draught tube. Air is typically fed through a sparger ring into the bottom of a central draught tube that controls the circulation of air and the medium. [8, 9] Air flows up the tube, forming bubbles, and exhaust gas disengages at the top of the column. The degassed liquid then flows downward and the product is drained from the tank.