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Experiment Details

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| Department Name | Biotechnology Engineering |
| Class | Final Year |
| Semester | 7 |
| Subject Name | Bioprocess Modelling and Stimulation |
| Experiment No. | 01 |
| Experiment Name | Modelling and Stimulation of fed-batch bioreactor |

Version History

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| --- | --- | --- | --- | --- |
| Sr. No. | Version Number | Created By | Approved By | Date |
| 1 | 1.0 | Divija Mahesh Bhivate | Miss Bilwa Navre | DD/MM/YYYY |
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# KITCOEK VIRTUAL LAB

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AIM:

To predict dynamics of state variables of fed- batch bioreactor with respect to time and input

THEORY:

Fed- batch is a fermentation method where substrates are fed intermittently to prolong the growth and product formation activities. Biomass, substrates and products are continuously diluted due to addition of fresh media and hence dynamics of fed batch changes with fresh media flow rate and time. The specific rate at which the substrate is used up, qs/x, can be determined as the amount of substrate per cell and unit of time from the growth kinetics

qs/x = 1/ Yx/s µ (1)

In fed-batch operation:

XV= X0V0eµt (2)

X=V= biomass concentration and volume of culture at time t

X0=V0= Biomass concentration and volume of the growth medium at time t=0.µ

The specific rate of substrate uptake qs/x in a fed-batch culture is satisfied by addition on demand. The required volumetric feeding rate, Qs consists of qs/x and the cell density X:

Qs = qs/x x (3)

This is identical to feeding rate

Qs= FS0 / V

F= rate of pumping at the given time t

S0= concentration of the input

V= volume of reaction

The balance in feed- batch fermenter may be described as follows

d(VX)/dt = µXV (4)

From which dX/dt =(µ - D)X (5)

dVS/dt = 0

Since volume increases as a result of the input, dV/dt =F (6)

D (dilution rate as a result of input) is D=F/V (7)

For limiting substrate the following is valid: d(VS)/dt = S0F – [ µXV/YX/S] = 0 (8)

Hence**; F = µXV/YX/S S0 = µ X0V0eµt/ YX/S S0** (9)

Knowing the yield and the volume of the reactor at the end of batch we can find the flow rate required to maintain a given specific growth rate for a given substrate concentration.

PRE TEST:

1. Fed- batch reactor runs at
2. Constant Pressure and Temperature
3. **Constant Temperature and rate of substrate**
4. Constant Temperature and varying rate of substrate
5. Fed- batch system is described as a fixed V?
6. **A varying concentration solution of limiting substrate**
7. A solution of limiting substrate
8. A concentration of solution of limiting substrate
9. Who invented the term fed- batch
10. Burrow et.al
11. Mantis et.al
12. **Yoshida et.al**
13. What is Quasi- steady state in fed-batch?
14. Dilution remains constant
15. **Growth rate changes variably**
16. It remains constant
17. Fed- batch is a system?
18. Open
19. Isolated
20. **Semi- closed**

PROCEDURE:

Note: Monitor the OD as well as concentration of substrate with time and verify whether the exponential phase is maintained.

PART A

1. Dissolve 2g of Antrone reagent in 1000 ml of concentrated sulphuric acid.
2. D. Media composition

For culture medium – Nutrient agar, 28 g/l

Media: Mineral medium used previously for batch cultivation of the bacteria

Innoculum: 10% of fresh *b.licheniforms* culture grown on mineral medium.

For Growth media in flask

|  |  |
| --- | --- |
| **Chemical name** | **Composition g/l** |
| Glucose | 2.0 |
| Potassium Di-hydrogen Phosphate | 0.2 |
| Di- Potassium hydrogen phosphate | 0.8 |
| Magnesium sulphate Hepta hydrate | 0.5 |
| Ammonium Sulphate | 1.0 |
| Calcium Chloride | 0.05 |

Part B

1. Batch cultures are started in the reactor by inoculating the bacteria (*Bacillus licheniformis NRRL B-642)* and the OD was measured at regular time intervals and supernatant stored for glucose estimation.
2. The samples are drawn at 1-2 hours time interval.
3. A feeding rate F according to equation (9) is obtained by substituting values of X0, V0 and S0, S in the fermenter of 1.5 g/L and µ is determined previously from batch kinetics.
4. Samples are withdrawn every one hour and analyzed for glucose and biomass concentration.
5. Feeding will be started at the end of exponential growth phase in the reactor.
6. Calculate feed rate F.
7. Monitor maintenance of exponential growth phase and time profile of biomass and glucose concentration in the reactor under batch and fed batch mode.

POST TEST:

1. What is the unit of substrate feed rate
2. dm3
3. dm3 h-1
4. **g dm -1h-1**
5. In fixed-volume fed-batch culture, volume changes with fermentation time due to the substrate feed.  
   a) True  
   **b) False**
6. In a fixed-volume fed- batch culture μ declines when?  
   **a) Biomass increases**  
   b) Biomass decreases  
   c) Biomass remains constant  
   d) Biomass is equal to zero
7. 11. Organisms in which phase are adapting to the new environment?  
   **a) Lag phase**  
   b) Death phase  
   c) Exponential phase  
   d) Stationary phase
8. In fed-batch culture, the feed solution is \_\_\_\_\_\_\_\_  
   a) Less concentrated  
   **b) Highly concentrated**  
   c) Highly diluted  
   d) Diluted

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