**EX4016 Biochemical Engineering 2018-19**

**Enzyme – Assignment**

For EG4016, 20% grade is based on continuous assessment. This is an individual assignment for the continuous assessment of the course. You should be able to start solving it by the end of 2nd teaching week. Submission due date is 26th October 2018 by noon. Please include your university ID number on the submission sheet.

1. Using different online learning resources and the library define the following terms with a few examples where applicable: **[25 Marks]**
2. Chemical Engineering; Biochemical Engineering; Biomolecular Engineering; Bio Engineering. Medical Engineering.
3. Define and classify proteins and give a few examples of each type.
4. Define and classify enzymes with examples.
5. The substrate S is converted into product P by the catalytic action of the enzyme E. Starting with enzyme concentration Eo (given with table), the following are the initial rates in a lab scale batch reactor.
6. Determine the parameters of the Michaelis-Menten model for enzyme kinetics without any inhibitor (*i.e.* I = 0) separately using different methods studied in your course. [**25 marks]**

Compare and comment on the values of the parameters obtained with the different methods.

1. Determine the type of inhibition using the kinetic data with two inhibitor concentrations and Michaelis-Menten kinetic parameters enzyme concentrations in the presence of inhibitor and comment on your results. [**25 marks]**
2. The enzyme, urease, is immobilized in Ca-alginate beads 1 mm in diameter. When the urea concentration in the bulk liquid is 0.5 mM the rate of the urea hydrolysis is υ = 11 mM/ h. Diffusivity of urea in Ca-alginate beads is De= 1.7 × 10−3 cm2/sec, and the Michalis constant for the enzyme is KM=0.3 mM. By neglecting the liquid film resistance on the beads. (i.e., [So] = [Ss])

Determine the following:

Maximum rate/ Vmax, Thiele modulus/ ф, and effectiveness factor/ η. [**15 marks]**

What would be the Vmax, ф and η values for particle size of Dp= 3mm? [**10 marks]**

Hint: assume η=3/ф for large values of ф (ф>2).

*Part b and c require kinetic data. We have included 10 data sets numbered from 0 to 9. Please match the last digit of your university ID number with the data set number and use that for your assignment. For example, for university ID number 5998971****2;*** *dataset number 2 should be used as the ID number ends with 2.You have to use only one data set.*

**Set 0**

At Eo = 0.3 mM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (mM) → | I = 0 | I = 1.26 | I = 1.95 |
| Substrate concentration/ S (mM) ↓ | Reaction rate/ υ (mM.h−1) | | |
| 0.25 | 1.02  1.39  1.67  1.89  2.08  2.44  2.50 | 0.73  0.87  1.09  1.30  1.41  1.82  2.17 | 0.56  0.75  0.85  1.00  1.28  1.39  1.82 |
| 0.33 |
| 0.40 |
| 0.50 |
| 0.60 |
| 0.75 |
| 1.00 |

**Set 1**

At Eo = 0.01 mM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (mM)→ | I = 0 | I = 5 | I = 10 |
| Substrate concentration/ S (mM)↓ | Reaction rate/ υ (mM.min−1) | | |
| 1.5 | 0.31  0.37  0.45  0.51  0.59  0.69  0.78 | 0.28  0.33  0.41  0.47  0.54  0.61  0.68 | 0.26  0.31  0.38  0.43  0.48  0.54  0.60 |
| 2.0 |
| 3.0 |
| 4.0 |
| 5.0 |
| 6.0 |
| 7.0 |

**Set 2**

At Eo = 0.01 µM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (µM)→ | I = 0 | I = 1 | I = 2 |
| Substrate concentration/ S (µM)↓ | Reaction rate/ υ (µM.min−1) | | |
| 1.0  1.5  2.5  4.5  7.0  10.0 | 0.096  0.128  0.175  0.238  0.318  0.416 | 0.049  0.065  0.089  0.122  0.165  0.218 | 0.033  0.043  0.059  0.082  0.113  0.154 |

**Set 3**

At Eo = 0.12 mM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (mM)→ | I = 0 | I = 0.3 | I = 0.6 |
| Substrate concentration/ S (mM)↓ | Reaction rate/ υ (mM.min−1) | | |
| 0.1  0.15  0.2  0.3  0.4 | 0.79  1.11  1.45  2.00  2.60 | 0.57  0.84  1.06  1.52  2.10 | 0.45  0.66  0.86  1.22  1.75 |

**Set 4**

At Eo = 0.1 mM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (µM)→ | I = 0 | I = 1.5 | I = 2.5 |
| Substrate concentration/ S (mM)↓ | Reaction rate/ υ (mM.min−1) | | |
| 20  8.0  4.0  2.0 | 1.83  1.37  1.00  0.647 | 1.37  0.867  0.55  0.313 | 1.05  0.647  0.40  0.207 |

**Set 5**

At Eo = 1 × 10−5 M

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (M)→ | I = 0 | I = 10−5 | I = 10−4 |
| Substrate concentration/ S (M)↓ | Reaction rate/ υ (mM.min−1) | | |
| 3.30 × 10−4  5.00 × 10−4  6.70 × 10−4  1.65 × 10−3  2.21 × 10−3 | 56  71  88  129  149 | 37  47  61  103  125 | 25  34  54  84  101 |

**Set 6**

At Eo = 0.15 mM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (µM)→ | I = 0 | I = 10 | I = 25 |
| Substrate concentration/ S (mM)↓ | Reaction rate/ υ (mM.min−1) | | |
| 7.30  5.00  3.70  2.65  2.21  1.95 | 4.60  4.00  3.45  3.11  2.79  2.65 | 4.38  3.89  3.38  2.96  2.71  2.60 | 4.07  3.55  3.23  2.87  2.66  2.57 |

**Set 7**

At Eo = 0.3 mM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (mM) → | I = 0 | I = 1.26 | I = 1.95 |
| Substrate concentration/ S (mM) ↓ | Reaction rate/ υ (mM.h−1) | | |
| 0.25 | 1.02  1.39  1.67  1.89  2.08  2.44  2.50 | 0.73  0.87  1.09  1.30  1.41  1.82  2.17 | 0.56  0.75  0.85  1.00  1.28  1.39  1.82 |
| 0.33 |
| 0.40 |
| 0.50 |
| 0.60 |
| 0.75 |
| 1.00 |

**Set 8**

At Eo = 0.01 mM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (mM)→ | I = 0 | I = 5 | I = 10 |
| Substrate concentration/ S (mM)↓ | Reaction rate/ υ (mM.min−1) | | |
| 1.5 | 0.31  0.37  0.45  0.51  0.59  0.69  0.78 | 0.28  0.33  0.41  0.47  0.54  0.61  0.68 | 0.26  0.31  0.38  0.43  0.48  0.54  0.60 |
| 2.0 |
| 3.0 |
| 4.0 |
| 5.0 |
| 6.0 |
| 7.0 |

**Set 9**

At Eo = 0.01 µM

|  |  |  |  |
| --- | --- | --- | --- |
| Inhibitor concentration/ I (µM)→ | I = 0 | I = 1 | I = 2 |
| Substrate concentration/ S (µM)↓ | Reaction rate/ υ (µM.min−1) | | |
| 1.0  1.5  2.5  4.5  7.0  10.0 | 0.096  0.128  0.175  0.238  0.318  0.416 | 0.049  0.065  0.089  0.122  0.165  0.218 | 0.033  0.043  0.059  0.082  0.113  0.154 |