A Primer to Enzyme Activity and Related Terminology

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ABSTRACT

With increasing use of enzymes, it becomes necessary to understand some fundamentals of enzyme activity and related terminology. The basic purpose of the article is to educate the (both present and future) consumers of enzyme about these.

Introduction

The use of enzymes for different unit processes of pulp and papermaking in increasing rapidly. The words like bio-pulping, bio-bleaching, bio-deinking or bio-refining are getting very familiar amongst pulp and paper professionals. But, unlike conventional chemicals, the performance of which can be tested in laboratories using simple testing methods, enzymes need special testing facilities, which, often, may not be easily available in paper mills.

In the similar way, the conventional chemicals can be easily analyzed in terms of cost benefit analysis, as the concentration of the chemicals as well as their dosage is practically fixed. But for a mill using enzymes, this may become a relatively tricky job.

In fact, there is much confusion over enzyme units, enzyme activity and specific activity. This is, therefore, important for any management to be familiar with the enzyme related terminology.

Enzyme Activity

For application in a process, the main interest is activity of enzyme. The activity is a measure of enzyme content that is clearly of major interest when enzyme is to be used in process. The standard definition of the enzyme unit, as adopted in 1964 by the International Union of Biochemistry, is given below[1]-

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1 Unit (1U) is the amount of enzyme that catalyses the reaction of 1 µmol (one micromole) of substrate per minute. (Definition A)[2]

As the above definition, requires labels to be written in fractions of units, some suppliers use the micro-unit as indicated by the following definition-

1 Unit (1U) is the amount of enzyme that catalyses the reaction of 1 nmol (one nanomole) of substrate per minute. (Definition B)

Thus, 1 unit from definition A is 1000 times different than that from definition B. Typically, one unit represents 10^{-6}-10^{-11} kg for pure enzymes and 10^{-4}-10^{-7} kg for industrial grade enzymes[3]. Another unit has been derived as Ketal (kat), which is defined as the amount that will catalyze the transformation of one mole of substance per second. (1 ket = 60,000,000 U).

Specific Activity

Specific activity gives a measure of purity of enzyme. It is the number of enzyme units per ml divided by the concentration of protein in mg/ml. The value of specific activity is quoted in units/mg or $\mu mol.mg^{-1}.min^{-1}$. In fact, enzymes are usually marketed in terms of activity rather than weight. For the same, specific activity (e.g. U/Kg or U/ml) is a more common parameter, rather than percent purity.

Percent Purity

Percent purity[4] is obtained by dividing specific activity of enzyme sample by specific activity of pure enzyme, multiplied by 100. An impure sample has lower specific activity, as some of the mass is not actually enzyme.

How to Compare Enzymes from Different Suppliers?

Enzymes have a vast market potential, of which only a minor share has been tapped so far. In future, when the enzymes will be more readily available the consumer will be more interested to compare enzymes from different suppliers to optimize the cost. For the same, there are several things to consider-

Effect of Process Variables

The efficacy of most of the enzymes is a strong function of process variables e.g. pH, temperature etc. In fact, it is extremely difficult to maintain the conditions as reported by the supplier. Though two different enzymes may indicate exactly same results under standard conditions, it may be possible that at process conditions, which are different than the standard ones, the two enzymes show much variation in results. Furthermore, in some enzymes, there may be an activity loss during transit or storage.

It must also be noted that a cheaper enzyme as compared by above method does not necessarily mean a cheaper alternative for process application. Thus, enzymes should be used only after study of the actual plant operating conditions by the supplier. In most of the cases, the supplier may suggest mill specific enzymes. In fact, the best way of comparison is to compare the enzyme in laboratory under conditions similar to those in plant, or if possible, after a full-scale plant trial.

Cost per Unit

Let us assume a sample contains 1 unit of enzyme using definition A. According to definition B, the same sample can be said to contain 1000 units. So, before comparing enzymes from two different suppliers, it is important to check the units are being used under same definition, or alternatively, are converted into nmol/min or µmol/min. A plant trial is always advisable to reach a concluding decision regarding selection or change in enzyme.

Conclusion

Enzymes, when properly selected, and used in well maintained process conditions may give excellent results. This is, therefore, need of the time to look forward for enzyme trials.

References:

1. http://www.sizes.com/units/enzyme_activity_unit.htm
2. http://www.innovabiosciences.com
3. http://www.isbu.ac.uk/biology/enztech/units.html
4. http://en.wikipedia.org/wiki/Enzyme_assay