ENZYME TECHNICAL ASSOCIATION™

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Working Safely With Enzymes

INTRODUCTION

This document has been prepared by the Enzyme Technical Association (ETA) to provide information on the safe use of enzyme preparations in industrial setting and for conducting consumer product safety assessments. The ETA is a trade association of companies which represent manufacturers and marketers of enzyme products in the Americas. The ETA has been in existence since 1970.

This document will provide information on the properties of enzymes, health effects, methods to minimize potential exposure through control measures, workplace and medical surveillance, and training. An overview of consumer product risk assessment methodology is presented. More specific information on enzyme safety programs can be found in the Reference section. Information on a particular enzyme can be obtained from the Safety Data Sheet (SDS), technical literature, and/or your enzyme supplier. [1,2]

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WHAT ARE ENZYMES?

Enzymes are proteins produced in living cells of plants, animals and microorganisms. All living organisms require enzymes for growth and for the production and utilization of energy which is essential for life. In the living cell, enzymes act as catalysts to speed up the chemical reactions which control life processes. They accelerate the breakdown or synthesis of organic compounds such as carbohydrates, fats and proteins. Enzymes are highly specialized proteins that are classified by the type of reaction they catalyze. For example, in the human digestive tract there are proteases, carbohydrases, and lipases that break down proteins, carbohydrates and fats, respectively, into smaller substances that can be absorbed into the bloodstream. The unique catalytic properties of enzymes make them useful in a wide variety of industrial processes and product applications.

HOW ARE ENZYME PREPARATIONS USED COMMERCIALLY?

Enzyme preparations are used in a wide range of manufacturing processes such as:

- Production of foods, such as in the dairy, wine, brewing and distilling, starch, and baking industries
- Ingredients in animal feed to enhance nutritional availability
- Detergent formulations to break down various stains, extend the wearable life of clothes, and save energy by allowing lower temperature washing
- Enhanced processing in the textile and paper industries
- Diagnostic reagents in the pharmaceutical
- Advanced biofuels such as cellulosic ethanol

HOW ARE ENZYMES PRODUCED FOR COMMERCIAL USE?

While enzymes are produced by living organisms, they are not living substances. Commercial enzymes are produced from the fermentation of specially selected nonpathogenic, nontoxigenic strains of microorganisms or extracted and purified from plant or animal sources. Typically, the enzyme preparation does not contain the production microorganism. Enzyme products are available in a variety of physical forms: liquids, granules, and powders.

HEALTH EFFECTS

When handling enzyme preparations care should be taken to avoid inhalation of aerosols and contact with skin and eyes. Inhalation of enzymes may elicit an immune response in susceptible individuals. Repeat exposures over time may result in respiratory allergy. When enzymes are inhaled in the form of dust or aerosols, allergic antibodies may be produced. It is important to note that enzymes are not food allergens or skin sensitizers. However, skin and eye irritation may occur upon contact with proteolytic enzymes. Fortunately, enzymes can be used safely without any adverse health effects, through the use of good work practices, engineering controls, and appropriate personal protective equipment. Implementation of these control measures has resulted in a long history of safe use in occupational

settings. The specific allergy and irritation symptoms associated with enzyme exposures are detailed below.

SYMPTOMS OF ENZYME EXPOSURE

ALLERGY

As with any protein allergen, such as pollen, mild to severe symptoms may occur such as sneezing, nasal or sinus congestion, coughing, watery eyes, and runny nose. More serious symptoms may occur with the progression and onset of occupational asthma such as tightness of the chest, wheezing, and shortness of breath. These symptoms may develop during work hours or can be delayed, occurring even two or more hours after work exposure. Symptoms may occur after inhalation of enzyme aerosols by allergic individuals, and usually disappear within hours. There is no evidence to indicate that skin contact with enzymes will cause allergic contact dermatitis. Aside from allergies, no long-lasting effects from working with enzymes have been found.

Ordinary seasonal allergy symptoms may resemble enzyme allergy. If symptoms appear more often during working days but dissipate on the weekends or holidays, they may be due to enzyme exposure and should be investigated. A person exhibiting allergic symptoms should report their symptoms immediately and seek evaluation by a physician.

IRRITATION

While respiratory allergy is the primary health hazard associated with enzymes, contact with proteolytic enzymes can cause skin and eye irritation. The more concentrated the enzyme preparation, the greater the potential for producing irritation upon contact. This irritation is caused by the catalytic activity of the proteases and is not an allergic response.

Nonproteolytic enzymes have not been shown to cause skin and eye irritation. However, skin and eye contact with all enzymes should be minimized as part of personal hygiene practices. Please consult the manufacturer's SDS for information on the hazards associated with other ingredients of the enzyme preparation.

EXPOSURE CONTROL MEASURES

The risks associated with enzyme exposure can be controlled using a well-accepted hierarchy of controls: engineering controls, safe work practices, and personal protective equipment. The implementation of these controls will depend on the likelihood and severity of enzyme exposure potential associated with the work task and is dependent on factors such as: product form, potential for aerosolization, frequency and duration of the tasks, results of monitoring, and process design factors. A combination of controls should be used to minimize the risk of enzyme exposures. The sections below provide details on control measures.

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ENGINEERING CONTROL MEASURES

Implementation of engineering controls such as isolation and containment are the best methods to minimize exposures. Isolation techniques are used to completely segregate the enzyme product from the employee and workplace by creating a barrier (e.g., closed dosing systems, direct tote connections). Some operations cannot be isolated, and in these cases ventilation enclosures can be designed to contain the enzyme product (packaging and rework areas). Local exhaust ventilation (LEV) should be used to extract air close to the source and capture enzyme particles and aerosols (e.g., near tank sample points). Mixing and product transfer operations should be contained as much as possible. It is important that all engineering controls be properly maintained and tested for efficacy through routine enzyme monitoring and maintenance procedures.

SAFE WORK PRACTICES

Safe handling of enzyme preparations can be accomplished through proper work practices in conjunction with, engineering controls, and use of protective equipment. It is also important that workers are trained on the health hazards of enzymes, understand the symptoms of enzyme allergy, and follow safe work practices to minimize the risk of exposures.

When working with enzyme preparations, work practices should not generate aerosols or result in direct skin contact. Aerosols are formed through high-energy operations such as mixing, grinding, and some material transfers. Cleaning actions such as sweeping, blowing, steam cleaning, and high-pressure spraying will also generate aerosols and should be avoided.

Personal hygiene is essential to prevent irritation of skin and mucous membranes from contact with proteolytic enzymes. The irritation response on skin is increased in the presence of moisture and when the natural oils of the skin are removed.

The following personal hygiene guidelines are recommended to minimize exposure:

- Hands should be washed with water and mild soap after contact with enzyme materials.
- Change work clothes daily and whenever they are soiled with enzyme material.
- Avoid contact with face and eyes with enzyme contaminated clothing or gloves.

TRAINING

All employees and contractors working with enzyme preparations should have proper training in safe use and handling procedures and contingency measures such as spill clean-up and equipment maintenance.

Such training should be provided as part of the new hire orientation as an element of the hazard communication program. It should also form part of a periodic refresher training for all employees to ensure that new developments and information are communication. Training should be given in work

instructions and operational procedures and compliance with these procedures monitored, especially when the employee is new to the job, or a new task is introduced.

HAZARD COMMUNICATION

The hazard communication standard for most countries is the United Nations' (UN) Globally Harmonized System (GHS). Although different versions of the GHS standard are adopted globally, the pictograms and phrases used are the same. Enzymes are classified as Respiratory Sensitizers.[3] The symbol shown in the pictogram below is referred to as the Health Hazard, and is used to denote Respiratory Sensitizers. Ensure workers are trained on how to read SDS documents and recognize GHS classifications and pictograms.

USE OF PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION

The use of respiratory protection should be considered when engineering controls are not sufficient to control enzyme levels below recommended exposure limits. It may also be used as a secondary safeguard when a specific task could result in high potential risk of exposure. Operations where the exposure is expected to be high may include, spill cleanup, equipment cleaning, and equipment repairing. The use of respiratory protection is usually necessary when the potential for aerosolization is high, such as working with powdered enzymes or open transfer of liquid enzyme products. Respiratory protection should also be used when indicated by your supervisor, safety professional or medical personnel.

Local regulation and industry guidance should be followed when implementing a program for respiratory protection, including fit testing, medical surveillance and training.

When using respiratory protection, the filters should be N100/P100/P3. This filter will provide the appropriate protection level to the user.

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PROTECTIVE CLOTHING

Protective clothing should be worn when there is a potential for skin or eye contact. This clothing may include gloves, safety glasses, and outer garments, such as coveralls or lab coats. Protective clothing is particularly important when working with proteolytic enzymes, which are known to cause skin irritation. Operations that may require the use of protective clothing include spill cleanup, equipment maintenance, and equipment cleaning. Protective clothing should be removed prior to leaving the work area and should not be worn into other areas of the facility (i.e., lunchroom, offices) or to the home. Protective clothing should be defined based on workplace activities and the potential for exposures, for all enzymes types, to ensure that any enzymes remaining are not unintentionally inhaled.

Local regulation and industry guidance should be followed when implementing a personal protective equipment program including selection, training and use. Consult the enzyme manufacturer and/or their SDS for additional information on the selection of personal protective equipment.

MAINTENANCE AND SPILLAGE

MAINTENANCE

Whenever maintenance is to be performed on equipment that has been in contact with enzymes, the equipment should be cleaned before the work is begun. Use wet washing with low pressure water (flooding, wiping) or a vacuum system equipped with a high-efficiency particulate air filter (HEPA) to clean equipment or spills. High-pressure cleaning (steam, air, or water) must be avoided, since these operations are known to cause aerosol formation. Personal protective equipment (gloves, respirators, eye protection) should be used during maintenance operations where there is a potential for exposure or exposure potential is unknown.

SPILL CLEANUP

Spilled enzymes should be removed immediately by central vacuum system, vacuums equipped with a HEPA filter, mopping, or washing with low pressure water. To prevent dust or aerosol formation during cleanup, do not sweep or use high water pressure, steam, or compressed air on spills. Use plenty of water in wet washing to flush all enzyme material away to prevent enzyme dust generation from dried material.

Dependent upon the place and extent of the spill, respiratory protection and protective clothing may be required during cleanup. For large spills, employees should leave the area and not return until equipped with appropriate respiratory protective equipment. Access to the area should be restricted to personnel cleaning up the spill. Disposal of spilled material should be in compliance with federal, state and local regulations.

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MEASURING ENZYME LEVELS IN AIR

Air monitoring techniques are available to measure the level of enzyme dust or mist in the air to assess the effectiveness of engineering controls and the potential for employee exposure. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value (TLV) for only one class of enzymes, subtilisins, of 60 ng/m^3 as a ceiling limit. This exposure limit should be recognized and employed for all enzyme classes.[4] Consult your local regulations for enzyme exposure limits. Both low-flow and high-flow air sampling methods are available for some enzymes. Contact the enzyme manufacturer for additional information.

MEDICAL SURVEILLANCE

A medical surveillance program for workers handling enzymes is beneficial because it may help identify enzyme sensitization before the onset of allergy symptoms. Results of medical surveillance may achieve early detection and may highlight work tasks that may need further evaluation and implementation of additional control measures. The program should include a respiratory questionnaire, lung function test (spirometry) and immunological tests associated with workplace enzyme use. A physician or qualified medical professional should help to administer the program and conduct the testing.

There are two types of immunological tests that may be used to determine if an individual is sensitized to an enzyme. Allergic antibodies can be detected either through a laboratory blood test (such as Enzyme Linked Immuno Sorbent Assay - ELISA) or by a skin prick test commonly used by allergists. If either test is positive, it is an indication that sensitization has developed and allergic symptoms may result unless precautions are taken to reduce exposure. Lung function testing is also a diagnostic tool to identify allergic symptoms. Additional information on allergy test procedures and materials are available in the reference section and from the enzyme manufacturer. [1,2]

FIRST AID TREATMENT

SKIN CONTACT

The exposed skin should be thoroughly flushed with water for 15 minutes and then washed with a mild soap and water. Remove and clean any contaminated clothing. Ensure that the handling of contaminated clothing does not expose another person.

INHALATION

Remove the individual from exposure to a well-ventilated area. Monitor for irritation or allergic symptoms. If symptoms occur, consult a physician. Symptoms may be delayed after exposure.

EYE CONTACT

Rinse the eyes thoroughly with water for at least 15 minutes and then consult a physician.

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CONSUMER RISK ASSESSMENT

Prior to introducing an enzyme preparation into a consumer product, the potential for consumer exposure to the enzyme and possible health effects should be assessed. The consumer risk assessment is the process of identifying the hazard profile of a given material and gauging the likelihood of adverse effects occurring during handling or use. This process is divided into four steps, hazard identification, dose response assessment, exposure assessment, and risk characterization. For more information on this process please see the document titled (Risk Assessment Guidance for Enzyme-Containing Products).[5] Important factors that need to be considered include the following:

- Product use,
- unintended uses
- enzyme concentration
- product form (liquid, powder, granule, foam)
- duration and frequency of exposure
- potential exposure level
- the safe benchmark level for enzyme exposure.

SUMMARY

In this document, information has been presented on safe handling practices for working with enzymes. Enzymes can be handled in the work place without any adverse health effects. Even though there may be no visible signs of dust or aerosols, safety measures should be followed at all times. By following the work practices and engineering control measures discussed, enzymes can be handled safely.

If you should have further questions, please consult your enzyme supplier.

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GLOSSARY OF TERMS

ACGIH American Conference of Governmental Industrial Hygienists

AEROSOLS Small airborne solid or liquid particles suspended in air, ie: dusts or mists.

ALLERGY An immunological condition involving exposure to a material (allergen) which results in development of antibodies in the body against the material.

ANTIBODIES Specialized proteins of the immune system that recognize specific allergens and trigger an immune response.

ASTHMA A medical condition in which the airways of the lung narrow in response to irritation, allergy, or other stimuli. Symptoms may include shortness of breath, wheezing and labored coughing.

CATALYST A substance which speeds up a chemical reaction.

ELISA (Enzyme Linked Immuno Sorbent Antibody Assay) A sensitive laboratory method for detecting serum antibodies resulting from antigen exposure.

GHS (Global Harmonized System of Classification and Labeling of Chemicals) Defines and classifies hazards of chemical products and communicates health and safety information on labels and SDS.

HEPA filter A high-efficiency particulate air filter. A high-efficiency filter is one that is at least 99.97% efficient when challenged with 0.3 µm particle.

MICROORGANISMS Microscopic, living, single-cell organisms such as bacteria and fungi.

NONPATHOGENIC Does not cause the production or development of a disease.

NONTOXIGENIC Does not produce a poison or toxin.

PROTEOLYTIC ENZYMES (Proteases) Enzymes that hydrolyze (break apart) proteins into shorter fragments.

SDS (Safety Data Sheet) SDS are developed by the manufacturer, importer or distributor of chemical substances to provide information to customers on the safe handling of their products.

SENSITIZATION A process by which the immune system recognizes a substance as foreign to the body. When individuals develop antibodies to a protein, they are considered to be sensitized to that particular protein.

TLV (Threshold Limit Value) Concentrations of substances, and conditions under which workers may be exposed without adverse health effects

UN (United Nations) An intergovernmental organization to promote international co-operation.

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