



ENZYME TECHNICAL ASSOCIATION

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Working Safely With Enzymes

INTRODUCTION

This booklet has been prepared by the Enzyme Technical Association (ETA) to provide information on the safe use of enzyme preparations. The ETA is a trade association of companies which represent manufacturers and marketers of enzyme products in the United States. The ETA has been in existence since 1970.

In this booklet we will discuss the properties of enzymes, how to minimize the possibility of exposure through proper handling, and, if exposure should occur, how to minimize the likelihood of adverse health effects. The booklet is designed to provide general information on the safe handling of enzymes. More specific information on a particular enzyme can be obtained from the Material Safety Data Sheet (MSDS), technical literature, and/or your enzyme supplier.

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WHAT ARE ENZYMES?

Enzymes are large proteins and, like other proteins, they are 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.

WHAT IS THE FUNCTION OF ENZYMES?

In the living cell, enzymes act as catalysts to speed up the chemical reactions which control life processes. In industrial processes, they can be used to catalyze desired reactions, such as clotting curds in cheese production and converting starch to corn syrup. Enzymes speed up 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.

ARE ENZYMES LIVING ORGANISMS?

While enzymes are produced by living organisms, they are not living substances.

HOW ARE ENZYME PREPARATIONS USED COMMERCIALY?

Enzyme preparations have been used in the manufacture of foods and in industrial processes for many years. In fact, rennet has been used in cheese manufacturing since biblical times. Enzyme preparations have a long history of being used in the production of foods, such as in the dairy, wine, brewing and distilling, starch, and baking industries. Since the early 1900s, some enzyme preparations have been known to enhance cleaning action. They were first widely introduced into detergent formulations in the 1960s for this purpose. Enzyme preparations are also used as diagnostic reagents and in the pharmaceutical, tanning, textiles and paper industries.

HOW ARE ENZYMES PRODUCED FOR COMMERCIAL USE?

Commercial enzymes are produced from the fermentation of specially selected nonpathogenic, nontoxic 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, slurries, granules and powders.

HEALTH EFFECTS



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When handling concentrated enzyme preparations - as with most substances used in industrial processes - care should be taken to avoid skin contact and inhalation of aerosols. Enzymes can be used safely without any adverse health effects through the use of good work practices, engineering controls, and appropriate personal protective equipment.

SYMPTOMS OF ENZYME EXPOSURE

IRRITATION Prolonged skin contact with proteolytic enzymes can cause skin irritation. The eyes can also be irritated by contact with proteolytic enzymes. As would be expected, the more concentrated the enzyme preparation, the greater the potential for producing irritation upon contact. Skin irritation is most likely to appear in body areas where perspiration occurs, i.e., hands, armpits, groin, and feet, and around tight fitting clothing areas, such as cuffs, waist, collar, and facial areas in contact with face masks. This irritation is caused by the chemical properties of the proteases and is not an allergic response.

Other types of enzymes, i.e., 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. As with any chemical, avoid contact with enzymes if the skin is broken or irritated. Please consult the manufacturer's MSDS for information on the hazards associated with other ingredients of the enzyme preparation. Also, inhaling high levels of enzyme-containing aerosols may result in coughing and/or congestion due to irritation of the mucous membranes of the respiratory tract. Respiratory irritation is a very rare occurrence and should never occur when adequate manufacturing controls are in place.

ALLERGY

As with any protein that is foreign to the respiratory tract, repeated inhalation of enzyme contained in aerosols can cause an allergic response. Predicting who will develop an allergic response or the level and duration of exposure needed to elicit a response is not known at this time.

As with any protein allergen, such as pollen, mild to severe symptoms may occur and may include any, or a combination of, the following: Asthma, sneezing, nasal or sinus congestion, coughing, watery eyes, runny nose, tightness of the chest, hoarseness or shortness of breath. These symptoms may develop during work hours or can be delayed, occurring even two or more hours after work exposure. Symptoms will occur only in an allergic individual if enzyme aerosols are inhaled, and usually disappear within hours or a few days after exposure is eliminated. Currently, 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.



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Ordinary cold or flu symptoms may resemble enzyme allergy. If symptoms appear more often during working days, especially at the beginning of the work week and seldom or never on the weekends or holidays, they may be due to enzyme exposure, and this possibility should be investigated. A person exhibiting allergic symptoms should consult a physician.

ALLERGY TESTS

There are two types of simple medical tests that can be made to determine if an individual is sensitized to a particular enzyme. When a person becomes sensitized to a substance, allergic antibodies will be produced against that substance. Sensitization by itself is not a disease, but rather an indication of exposure to the enzyme that may lead to allergic symptoms. However, not all sensitized individuals develop allergic symptoms. By detecting sensitization early, enzyme exposure can be controlled to prevent allergy symptoms onset.

Allergic antibodies can be detected either through a laboratory blood test (such as RadioAllergo-Sorbent Test-RAST or Enzyme Linked Immuno Sorbent Assay - ELISA) or by a simple skin prick test commonly used by allergists. The laboratory blood test measures the amount of antibody in the blood, with a certain level indicating sensitization to a specific enzyme preparation. The skin prick test consists of pricking the skin with a solution of the enzyme (antigen preparation). In a sensitized individual, a raised, reddened area (wheal and flare) will appear on the skin. If the laboratory blood test or skin test is positive, it is an indication that sensitization has developed and allergic symptoms may result unless precautions are taken to reduce exposure. Pulmonary function testing is also a means to screen whether an individual has allergic symptoms. Consult a physician for advice. Additional information on allergy test procedures and materials is available from the enzyme manufacturer or the Enzyme Technical Association.

WORKING SAFELY WITH ENZYME PREPARATIONS

SAFE HANDLING PRACTICES: Safe handling of enzyme preparations can be accomplished through proper work practices, engineering controls, and use of protective equipment. When working with these preparations, it is important to use work practices that do not generate aerosols or that result in direct skin contact. For each work operation, careful consideration must be given to minimizing aerosol formation and skin or eye contact.

Aerosols are formed through high-energy operations such as mixing, grinding, washing with high water pressure or steam, and using compressed air for cleanup operations. Sweeping, blowing, splashing, steam cleaning, and high-pressure water flushing must be avoided. Mixing and grinding operations should be contained as much as possible, and the areas in which they take place should be provided with adequate local exhaust ventilation.



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When handling enzyme preparations or enzyme-contaminated equipment, avoid direct skin contact. Wear appropriate gloves when there is a potential for skin contact with enzymes. Wash enzyme-contaminated surfaces thoroughly before handling.

USE OF PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION

Under most operating conditions involving enzymes, respiratory protection is not normally necessary. There are some operations, such as spill cleanup, equipment cleaning, and equipment repairing, that may generate aerosols. In these instances, respiratory protection may be necessary. The use of respiratory protection is usually necessary when working with powdered enzymes. Respiratory protection should also be used when indicated by your supervisor, safety professional or medical personnel.

The Occupational Safety and Health Administration (OSHA) respiratory protection standard must be followed in the selection, training and use of respirators. Use only National Institute of Occupational Safety and Health (NIOSH) approved respiratory protection.

PROTECTIVE CLOTHING AND GLOVES

Protective clothing should be worn when there is a potential for skin or eye contact. This clothing may include gloves, aprons, 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. Gloves should be worn when there is a potential for skin contact with any enzyme material. Cotton liners or cotton-lined gloves are recommended to absorb perspiration. 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.

The OSHA personal protective equipment standard (1910.132-138) must be followed in selection, training and use of personal protective equipment. Consult the enzyme manufacturer and/or their MSDS 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 (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



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equipment (gloves, respirators, eye protection) may be required during some maintenance operations.

SPILL CLEANUP: Spilled enzymes must be removed immediately by central vacuum system, vacuums equipped with a HEPA filter, mopping, or washing. 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. Disposal of spilled material should be in compliance with federal, state and local regulations.

PERSONAL CLEANLINESS

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

The following procedures are recommended to prevent irritation:

Hands should be washed with water and mild soap before leaving the work area and immediately after coming into contact with enzyme materials.

Change work clothes daily and whenever they are soiled with enzyme material. Do not wear work clothing home.

Avoid touching your face and eyes with enzyme contaminated clothing or gloves.

Wear cotton-lined gloves to absorb perspiration.

MEASURING ENZYME LEVELS IN AIR

There are air monitoring techniques available to measure the level of enzyme dust or mist in the air. 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/m³ as a ceiling limit. Both low-flow and high-flow air sampling methods are available for some enzymes. Contact the enzyme manufacturer for additional information.

FIRST AID TREATMENT

SKIN CONTACT: Most enzyme materials are water soluble; therefore, the exposed skin should first be thoroughly flushed with water and then washed with a mild soap and water. If clothes are contaminated, remove them, shower and change into clean clothes. Immerse the contaminated clothes in water and wash them as usual.



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INHALATION: Remove the individual from exposure and monitor for irritation or allergic symptoms. If symptoms occur, consult a physician. Symptoms may occur as late as 2 or more hours after exposure.

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

CONSUMER EXPOSURE 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. Since enzymes are respiratory allergens and some enzymes are irritants, both the potential for inhaling the enzyme preparation and for skin contact should be evaluated. Important factors that need to be considered include the following: Product use, potential misuses, enzyme concentration, and product form (liquid, powder, granule, foam), duration and frequency of exposure, potential exposure level and the no-effect level of enzyme exposure.

SUMMARY

In this booklet we have presented information on safe handling practices for working with enzymes. Through the use of proper work practices and control measures, enzymes can be handled in the work place without any adverse health effects. All work with enzymes must be done with care and proper precautions. Avoid generation of aerosols and direct skin or eye contact when handling enzyme materials. Even though there may be no visible signs of dust or aerosols, safety measures must be followed at all times. By following these relatively simple work practices and control measures, enzymes can be handled safely.

It is hoped that the information provided will help answer some of the questions about enzymes and how to work with them safely. If you should have further questions, please consult your enzyme supplier.

GLOSSARY OF TERMS

AEROSOLS Liquid or solid particles dispersed in a gaseous medium (air, usually); includes mists, smokes, fumes, and dusts.

ALLERGY A condition involving exposure to a material (allergen) which results in development of antibodies in the body against the material. When a person becomes allergic, exposure to the material may produce reactions characterized by itching, sneezing, coughing and/or tightness in the chest. Protein substances are often allergens.



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

ANTIGEN A protein, carbohydrate or other substance capable of eliciting an immune response.

ASTHMA A medical condition in which the airways of the lung narrow in response to irritation, allergy, or other stimulus. 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.

ENGINEERING CONTROLS Methods which include the appropriate application of isolation, ventilation and substitution (equipment, process or material) to reduce potential exposure of employees to environmental aerosols.

ENZYME Enzymes are large protein molecules, and like other proteins, they are made up of long chains of amino acids. Enzymes are present in all living organisms, where they perform essential functions of converting food to energy and new cell material.

FERMENTATION A biological process in which one natural substance is converted to another by a microorganism.

HEPA filter A high-efficiency particulate air filter. According to NIOSH, a high-efficiency filter is one that is at least 99.97% efficient when challenged with 0.3 μm dioctyl phthalate (DOP) particle.

MICROORGANISMS Any microscopic animal or plant; especially bacteria and fungi.

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

NIOSH National Institute of Occupational Safety and Health. This government agency was established as the research counterpart to OSHA. NIOSH activities include testing and certifying respirators and conducting research and investigations on the health effects of occupational exposures.

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



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NONTOXIGENIC Does not produce a poison or toxin.

OSHA U.S. Occupational Safety and Health Administration. This agency was established to promulgate and enforce workplace health and safety standards.

PROTEOLYTIC ENZYMES (PROTEASES) Enzymes that hydrolyze (break apart) peptide bonds.

RAST (RadioAllergoSorbent Test) - A laboratory test for detecting and measuring antibodies in the blood of persons exposed to excessive airborne concentrations of specific allergens.

SENSITIZATION Sensitization is an indication of exposure to an enzyme that may lead to allergic symptoms. When individuals develop antibodies to an enzyme, they are considered to be sensitized to that particular enzyme preparation.