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Safe handling of enzymes (dust / aerosol management) (1st edition)

Regulatory affairs committee of Japan Enzyme Association

Introduction

This book was created by the Japan Enzyme Association (JEA) for the purpose of providing information on the safe use of enzyme preparations in industrial environments and the implementation of safety assessments of consumer products. JEA was established in 1954 with the hope of improving our life standard and with the aim of contributing to the development of the enzyme industry.

This book provides information on enzyme properties, health effects, how to minimize potential exposure through management measures, workplace monitoring and health care, and training. It also provides an overview of consumer product risk assessment methods. Information about each enzyme product is available from Safety Data Sheets (SDS), technical literature and / or enzyme suppliers.

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. Enzymes are highly specialized proteins that are classified by the type of reaction they catalyze. For example, there are proteases (protein hydrolyzing enzymes) that catalyze protein hydrolysis, amylase (starch hydrolyzing enzymes) that catalyzes the hydrolysis of starch, and lipase (oil hydrolyzing enzymes) that catalyzes the hydrolysis of fats and oils. The unique catalytic properties of enzymes make them useful in a wide variety of industrial processes and product applications.

Fields of enzyme applications

Enzymes are used in various fields such as:

Industrial field

Industrial enzymes: For textiles, chemical products production, supplement of detergents, feed additives, paper industry, etc.

Food enzymes: For carbohydrate processing, brewing, protein processing, dairy processing, fat/oil processing, etc.

Medical / Research Fields

Enzymes for medical use

Enzymes for diagnostic

Enzymes for research in laboratories

Enzymes 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. Enzyme products are available in a variety of physical forms: liquids, granules, and powders.

Health effects

Enzymes are harmless. However, they can sometimes cause skin irritation (such as dermal irritation), and in susceptible individuals, inhalation of the enzyme can cause an immune reaction or sensitization. Repeated exposure over a long period of time can also produce allergic antibodies and, in more advanced cases, respiratory allergy. Therefore, when handling enzymes, care should be taken to avoid inhalation of fine particles and aerosols and contact with skin and eyes. On the other hand, in handling enzymes, correct work methods and process control, as well as the use of appropriate occupational protective equipment, can minimize adverse health effects and ensure safe operations. These safety measures have led to the safe use of enzymes for many years.

The following section details specific allergic symptoms and irritation upon exposure to enzymes as basic information for proper control.

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.

Safe handling of enzymes

Enzyme manufacturing factory

Exposure prevention measures

Exposure control

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. 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 (Prevention of generation of enzyme fine particles / aerosols)

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.
- Others (additional items)

Protection gear

Workers' risk assessment / Risk prevention (Precautions for use)

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.

When using respiratory protection, choose a filter that provides the appropriate level of protection for the user.

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.

In addition, when selecting work protective equipment, consider the following items.

- Physical form (liquid, powder, granule, foam) and concentration of the enzyme (intermediate / product)
 - Exposure status of the enzyme (intermediate / product), working environment, time, frequency, etc.
 - Potential exposure concentration
 - Safe benchmark concentrations of enzyme-derived dust / aerosol exposure
- Measurement of enzyme-derived dust / aerosol in the work environment
(Actual measurement examples and control values are not mentioned)

In order to maintain a good environment for workers, it is important to carry out engineering management such as regular monitoring of enzyme-derived dust and aerosols through maintenance procedures.

In addition, the management value will be set by each business operator (in each

workplace).

Cleaning and Maintenance of workplace in case of spillage

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.

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 the regulations of each prefecture.

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.

Medical monitoring (regular health checkup)

Health management of workers who handle enzymes is carried out at regular health examinations conducted by each business operator. If you experience any abnormalities in the enzyme handling work, immediately consult an industrial physician of each business operator.

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 communicated. 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.

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.

