



Association of Manufacturers of Fermentation Enzyme Products

Guide to the safe handling of microbial enzyme preparations

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INTRODUCTION

In this paper, Amfep provides information on the safe handling of enzyme preparations for industrial use.

This paper discusses the characteristics of enzymes, the hazards that are inherent to enzyme preparations and possible risks involved in case of exposure. Ways to minimize these risks are presented.

A purpose of this paper is to provide a general guidance for supervisors in training employees who handle enzyme preparations. For more specific safety information on a particular enzyme preparation, please refer to the relevant Enzyme Material Safety Data Sheet and to the warning label required by Directive 67/548/EEC, as amended, on “Dangerous Substances” and Directive 1999/45/EC, as amended, on “Dangerous Preparations”.

Furthermore, the enzyme suppliers can advise or provide more detailed information related to the specific enzyme preparation and the handling and use situation.

WHAT ARE ENZYMES?

Enzymes are special proteins composed of the amino acid building blocks found in all other proteins. Proteins in general are natural substances produced by all living cells. All living organisms – be they man, animal, plant or microorganisms – require enzymes to conduct virtually all physiological processes which are essential for growth and life.

Enzymes act as catalysts, substances which in very small amounts are able to accelerate the rate of specific chemical reactions a million times or more. Consequently, enzymes are able to speed up the building up or breaking down of organic matter such as carbohydrates, fats and proteins. Enzymes are highly specialized in their catalytic properties. Each enzyme acts only on a restricted number of compounds (substances) and, when acting, catalyses only one specific reaction. For example, proteolytic enzymes (proteases) present in the human digestive system, break down proteins into smaller forms which can then be absorbed into the blood stream.

The properties of enzymes make them very useful in catalyzing desired reactions in industrial processes. Consequently, enzymes are extensively used in several industries within the technical (e.g. detergent, starch, textile, fuel alcohol), food (e.g. dairy, baking, brewing, wine and juice) and animal feed area.

Commercial microbial enzyme preparations are derived from bacteria, yeasts or fungi. Industry uses pure cultures of selected non-pathogenic and non toxin producing strains of microorganisms to produce specific enzymes by fermentation techniques.

POSSIBLE RISKS INVOLVED IN CASE OF EXPOSURE

Like most substances used in industrial processes, enzyme preparations have certain health hazards. However, the health risks involved can be minimized by appropriate product formulations, engineering control methods and safe-handling procedures

- **Allergy by inhalation**

Like many other proteins, enzymes may act as allergens. When allergens are inhaled in the form of dust or aerosols they may give rise to the formation of antibodies specific to them. This process is called sensitization. People that are only sensitized do not experience any adverse reactions, but upon a further exposure to the allergen they may develop respiratory symptoms similar to those of hayfever or asthma. When this condition is due to exposure in the working environment, it is called occupational allergy.

The respiratory symptoms of an allergen may include itching of nose and eyes, nasal and sinus congestion and sneezing. Coughing, hoarseness, tightness of the chest and shortness of breath are indicators of asthma. These symptoms may occur during or after working hours and they will disappear within hours or a few days after exposure has ceased. Allergy symptoms may resemble those of the common cold, and if symptoms occur frequently in the work place and only rarely at week-ends or on holidays, they may be due to enzyme exposure.

The risk of developing such an allergy mainly depends on **two** factors:

1. The susceptibility of the individual

Some individuals are more prone to become sensitized than others. These persons are called atopics. Although atopics may develop an allergy more easily than others, not all atopics will become sensitized to enzymes. Conversely, non-atopics can also develop allergic symptoms.

Smokers have a markedly increased risk of becoming sensitized and developing allergy symptoms.

2. The duration and level of exposure

Normally respiratory sensitization may develop upon repeated significant exposures. However, there is some experience that a single, very high dose (e.g. as result from an accident) may induce sensitization as well. The symptoms of an allergy can be elicited by very low dosages (in already sensitized people).

As the risk of sensitization correlates to the dose of inhalable particles, the formulation of the enzyme and the handling of it is very important. Liquid enzyme products can be handled with very low release of inhalable aerosol particles, but improper handling may create significant amounts. Granulated powders must be handled properly to keep the dust levels at low concentrations. Powdered formulations should be handled with care and under very strict precautions to avoid inhalation of the powder.

- **Other forms of allergy**

Apart from allergy brought about by inhalation, people can become sensitized by skin contact or acquire an allergy by ingestion (food allergy). However, there is no scientific evidence that enzymes are a cause of sensitization by skin contact or ingestion.

- **Irritation**

Enzyme preparations containing proteolytic enzymes are capable of causing eye and skin irritation.

The risk of developing such irritation depends on the following factors:

1. The type of enzyme preparation

According to currently available information, only those preparations containing certain proteolytic enzymes are able to cause irritative effects to eyes, mucous membranes and skin. When these enzymes are combined with surfactants, irritative effects may be stronger than can be accounted for by the individual contributions of its constituent parts.

2. The duration and level of exposure

Although irritation of the eye may occur fairly quickly after exposure, skin irritation develops only after prolonged skin contact. The more concentrated the enzyme material, the greater the potential for producing irritation.

3. The body area which is exposed

Skin irritation is most likely to appear in body areas where perspiration occurs, such as hands, armpits, groin and feet or under a face mask. Areas from which the natural skin oils have been removed also become irritated more easily.

- **Consumer exposure assessments**

The potential for consumer exposure to enzymes when using products that contain enzyme preparations needs to be evaluated prior to marketing the product. The exposure routes include both skin and inhalation. The intended use and possible misuses need to be assessed.

Important considerations include:

- Enzyme concentration in the product
- Potential for skin contact and dust and aerosol formation
- Potential exposure level
- Duration of exposure
- Frequency of exposure
- No-effect level of enzyme exposure

GOOD WORK PRACTICES, WAYS TO MINIMIZE RISK

- **General**

Since the risks of developing a respiratory allergy or irritation by enzyme preparations depend on the duration and level of exposure, these risks can easily be minimized by technical measure, careful handling of the product and personal protective measures. Although the above risks also depend on the type of enzyme preparation, it will be easier for employees to adopt and become used to good work practices if all enzyme preparations are treated in a uniform way. General rules for industrial and personal hygiene should therefore be maintained.

- **Control of enzyme exposure**

The generation of airborne enzyme dust or aerosol needs to be controlled to prevent the development of enzyme allergies.

Minimization of the level and duration of exposure can be achieved by taking the following precautions:

1. **Technical measures**

Airborne dust and aerosols may be formed through high-energy operations, such as mixing, grinding, washing with water-pressure or steam and when using compressed air for cleaning operations¹. Dust or aerosol formation can be limited by using equipment designed to minimise damage to enzyme granulates. Rooms and locations where enzymes are handled should be well ventilated. At mixing and filling sites and other operations that can create dust and aerosols, local exhaust ventilation should be installed, and ventilation systems should be equipped with filters or other proper control of the exhaust. Process equipment should be enclosed to limit aerosol spreading.

In the case of certain enzyme preparations methods may have been developed to measure the levels of these enzymes in air. Where these techniques exist, air monitoring should be used on a regular basis to conform the effectiveness of the control measures that have been adopted.

Cleaning should be conducted exclusively with low pressure water and equipment should be designed to exclude splashing. For “dry” cleaning, vacuuming with equipment fitted with high efficiency filters (HEPA-filters) is recommended.

2. **Personal protective equipment**

Exposure to enzyme dust or aerosol can be minimized by the use of respiratory protection. Under most operating conditions, when sufficient engineering control measures are in place, such protection is unnecessary. However, after spillage, during cleaning or repair of machinery contaminated with enzymes or when air sampling has indicated a high enzyme level, use of respiratory protection may be necessary. In such cases, respiratory protection approved and selected for use against dust or aerosol should be used. The respiratory protection must be checked for proper fit and function each time it is used.

¹ * Compressed air should not be used for cleaning operations; instead use wet cleaning with low water pressure or vacuum equipped with high efficiency filters.

3. Careful handling

In order to avoid exposure to enzyme preparations it is important to use handling practices that do not generate dust or aerosols. Dust or aerosols can develop during spillage, material transfers, cleaning with high pressure water, milling or grinding of large particles into smaller ones, exposure of larger particles to mechanical force, pumping of air through a liquid, vigorously stirring of a liquid, allowing a liquid to dry out after spillage, etc.

Sweeping, blowing, splashing, steam cleaning and high pressure water flushing must therefore be avoided. Any operation which might create dust or aerosols should take place in areas that are provided with adequate exhaust or other forms of mechanical systems.

4. Cleanliness

Even if no dust is visible, it is important that containers, surfaces and equipment that have been in contact with enzymes are cleaned by wet washing or vacuum-cleaned with a high efficiency filtered vacuum system.

High pressure cleaning should not be used. Work clothes should be changed daily and whenever they are grossly contaminated (e.g. after a spill) with enzyme material.

• **Precautions against skin and eye irritation**

In order to minimize the risk of irritation to eyes and skin, the following precautions should be taken:

1. Personal protective equipment

Under normal handling procedures, safety glasses and simple cotton clothing is recommended and will give the necessary protection. When handling slurries and during maintenance, repair and cleaning-up major spillages under wet conditions, protective clothing, safety glasses, impermeable gloves and respiratory protection (face mask) is recommended.

2. Careful handling

It is important to use handling practices that prevent direct contact with the skin. Operations which may create spillage and splashing must therefore be avoided. Rubbing of the face and eyes should be avoided when wearing protective gloves that are soiled with enzyme.

3. Cleanliness

Equipment, containers and surfaces that have been in contact with enzymes should be cleaned. Personal cleanliness is also essential to prevent irritation of skin and eyes. Therefore, hands should be washed with cold water and mild soap before and after each visit to the lavatory, before leaving the work area and immediately after coming into contact with the enzyme materials. Clothes and undergarments should be changed daily and whenever they are soiled with enzyme material.

MEASURES IN CASE OF ACCIDENTS

- **Spillage**

Spilled enzymes must be removed immediately by vacuum equipped with a high efficiency filter, mopping or washing. In order to avoid dust or aerosol formation during cleaning, do not sweep and do not use high water pressure, steam, or compressed air on spills. Use plenty of water to flush all enzyme material away in order to prevent enzyme dust being generated from dried-up material. Depending upon the place and extent of the spill, respiratory protection and protective clothing should be used during cleaning.

- **Machinery malfunction and repair**

In case of machine maintenance, cleaning should be arranged before repair work is commenced. Respiratory protection and protective clothing may be needed. Cleaning of enzyme-contaminated components should be performed by adequately trained personnel and not by a mechanic.

- **Medical treatment in case of exposure**

In case of symptoms indicate the possible development of respiratory allergy, a physician should be consulted. Simple tests will reveal whether an allergy risk has developed,

In case of direct exposure, the following first-aid rules should be followed:

1. **Inhalation**

In case of inhalation, the individual should be removed from exposure and monitored for irritation or allergic symptoms. If symptoms occur, a physician should be consulted. Allergy symptoms are not likely in previously un-sensitized persons, but may develop as late as 12 hours after exposure. An allergy test for the relevant enzymes should be conducted after 2-3 months or at any indication of allergy symptoms.

2. **Skin contact**

Since most enzyme preparations are water soluble, the exposed skin should first be thoroughly flushed with cold water and then washed with mild soap and water. If clothes are contaminated, they should be removed and the employee should shower and change into clean clothes. Contaminated clothes should be immersed in water and washed as usual.

3. **Eye contact**

In case of eye contact, the eyes should be rinsed immediately with plenty of water. Seek medical advice if irritation occurs.

4. **Ingestion**

If enzymes are swallowed or accidentally come into contact with the mouth or nose, rinse with plenty of water and drink water afterwards. Consult a doctor.

RULES FOR SAFE HANDLING OF MICROBIAL ENZYME PREPARATIONS

Rule 1. Avoid raising dust or aerosols

Rule 2. Avoid inhalation of dust or aerosol particles

To do and not to do:

Do:

- Use wet cleaning with low water pressure (e.g. wet cloth or sponge when cleaning up) or use vacuum equipped with high efficiency filters
- Always use enzymes in well ventilated areas, which are kept cool and dry
- Provide and use engineering controls (e.g. local exhaust systems)
- Wear appropriate protective equipment as needed
- Observe good personal hygiene
- Keep the work area and equipment clean

Do not:

- Use compressed air or high pressure water jets, in cleaning up
- Sweep or blow spillages
- Use enzymes in unventilated areas
- Use vacuum equipment (including cleaners) without proper, high efficiency filters