A·I·S·E

International Association for Soaps,
Detergents and Maintenance Products

Enzyme Safety Management

A series of web based training and Information Sessions developed and presented by the AISE Enzyme Safety Task Force

A·I·S·E

International Association for Soaps, Detergents and Maintenance Products

The information set forth herein is furnished free of charge and is based on technical data that the AISE and the participating member companies believe to be reliable. It is intended for use by persons having technical skill and at their own discretion and risk. Since conditions of use are outside our control, we make no warranties, express or implied, and assume no liability in connection with any use of this information. Nothing herein is to be taken as a license to operate under or a recommendation to infringe any patents.

Please note that in cases where some brands are included in this presentation:

- *Those provided are only examples*
- *There are other brands on the market that are available with the same technical functions*
- *A.I.S.E. doesn't recommend any brand in particular*

Laboratory Safety

Olaf Holtkötter
Product Safety Manager, Henkel

Christiaan De Vos
Sustainability Manager, DuPont

Content

- Handling of enzymes in the laboratory
- Scope
- Hazard identification
- Roles and responsibilities
- Training and qualification
- Exposure control
- Typical sources of exposure
- Respiratory protection
- Air monitoring/Audits

Handling of enzymes in the laboratory

- Prior to the production of enzyme-containing detergent products, such products are typically developed in small scale in laboratories

- The basic principles with regard to enzyme safety that apply to the production process (*Webinar Session 3*) also apply to the handling of enzymes in the lab environment

- However, specific considerations have to be made due to the characteristics of development projects and lab work

Scope of this presentation

Recommendations made in the following do only relate to ready made liquid or granulated enzyme preparations customized for use in laundry and home care products as they are typically delivered from enzyme suppliers.

Not covered are unmodified fermentation products or enzymes delivered as powder because measures for safe handling of these preparations will vary.

Hazard identification

- Respiratory sensitization is the most relevant hazard when handling enzymes in the laboratory (see Webinar session 2)

- Irritation after direct exposure to skin can occur especially with proteases but is of less relevance considering the average personal protection and hygiene procedures usually used in laboratories

Roles and Responsibilities I

Employer

- Provides financial and organizational resources to prevent any health risk for employees.
- Ensures supervisors and their employees clearly understand and follow safety and hygiene standards; this is typically achieved by delegating this responsibility to company's laboratory supervisors and safety advisors.

Laboratory supervisor

- Informs about risk and safety measures related to working with enzymes or enzyme containing products; controls compliance with safety standards.
- Considers safety standards for enzyme handling in the lab's SOPs; ensures availability of up-to-date safety data sheets of enzymes and enzyme-containing products.
- Ensures enzyme handling processes are designed to reduce risk of generating airborne dusts or liquid aerosols.
- Considers implementation of appropriate air monitoring programs in the laboratory
- Ensures participation of lab workers in the medical surveillance program
- Ensures appropriate information/training of lab visitors like e.g. cleaning teams; the job's risk level (high/low) should be reflected in the extent of information and training.

Roles and Responsibilities II

Safety advisor

- Controls compliance to safety standards for enzyme handling.
- Build capability of supervisors so they can deliver safe conditions and reinforce safe behaviours in a consistent way.
- Spotlights any technical failure in the lab environment and any insufficient process of enzyme handling to the supervisors to achieve immediate improvement.
- Enforces implementation of appropriate air monitoring programs in the laboratory

Employee

- Participates fully in the safety management system and in the delivery of all control measures.
- Follows all procedures and practices.
- Takes part in medical surveillance program.
- Acknowledges that specific tasks are of varying degree of risk (high/low)
- Spotlights any technical failure in the lab environment and any insufficient process of enzyme handling to the supervisor to achieve immediate improvement.

Training and Qualification

The average training and qualification level of lab workers in handling hazardous substances is considered high, however, it must be brought to mind

- the specific hazard of enzymes
- the way that exposure to enzymes in both routine and non-routine situations can take place and how it is avoided
- the expectations for cleanliness standards
- the necessary personal protective equipment

It has to be borne in mind that not only trained lab workers will enter the laboratory but especially cleaning teams who need appropriate training too.

Exposure Control

Irrespective of enzymes being handled in large production facilities or in small labs, the basic measures to reduce exposure are

- isolation
- enclosure & ventilation
- local exhaust ventilation
- personal protection equipment.

However, these measures are of different relevance, considering that in laundry and home care laboratories only ready-made enzyme preparations, e.g. granulates or liquid preparations, are used (in contrast to powdered enzymes)

Exposure Control

Laboratory work is restricted to laboratory rooms which are by default specifically designed to have an increase air exchange rate.

However, sufficient ventilation must also be ensured for rooms which are not directly associated to the specific lab work, e.g. any room in which enzymes are stored, and in which enzyme dust might be brought in or out; or the scullery in which dusty material might be deposited and wait for cleaning; and any place where enzyme containing waste is stored or disposed.

Exposure Control

Exposure control does not only mean provision of technical equipment but inevitable requires effective installation and use!

As shown on the right hand picture, wrong location of LEV results in increased exposure since emerging aerosols are forced to pass the breathing zone of the worker.

Exposure Control
Biosafety cabinet Class II-B2 BSC

For some activities which are prone to excessive generation of enzyme dust or liquids (e.g. particle size analysis (cleaning of sieves), Heubach dust measurement, etc), more efficient LEV than just the labs standard air exchange rate is required. One option is the use of a biosafety cabinet (Class II-B2 BSC):

- A Class II-B2 BSC is a total-exhaust cabinet; no air is recirculated within it. This cabinet provides simultaneous primary biological and chemical containment.

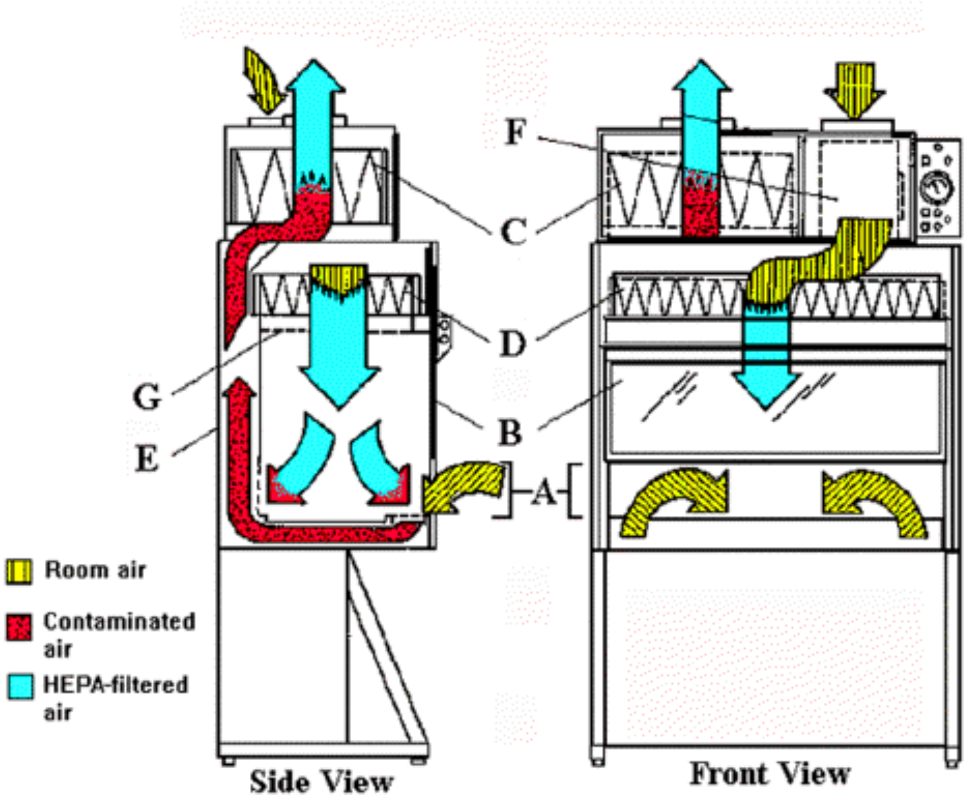
- The building or cabinet exhaust system draws air through both the rear and front grills, capturing the supply air plus the additional amount of room air needed to produce a minimum calculated or measured inflow face velocity of 0,5 m/sec

- All air entering this cabinet is exhausted, and passes through a HEPA filter (and perhaps some other air-cleaning device such as a carbon filter) prior to discharge to the outside. Exhausting as much as 2000 m^3/hr of conditioned room air makes this cabinet expensive to operate

Exposure Control
Biosafety cabinet Class II-B2 BSC
Connection to building exhaust system required.

A. front opening
B. sash
C. exhaust HEPA filter
D. supply HEPA filter
E. negative pressure exhaust plenum
F. supply blower

G. filter screen



Typical sources of exposure

For the identification of critical sources of exposure it should be borne in mind that the hazard of concern of enzymes is their potential of respiratory sensitization. A prerequisite for getting sensitized via the airways is the inhalation of an amount of enzyme high enough to trigger sensitization. Hence, for any lab work with enzymes, the ultimate goal is

- **to avoid the generation of enzyme dust or aerosols**

Or, if enzyme dusts or aerosols cannot be avoided

- **to protect individuals from inhaling dusts or aerosols by adequate means.**

Typical sources of exposure

It is a standard requirement in laboratories to keep work places and equipment clean, and lab hygiene should be especially stretched when working with enzymes:

Surfaces (lab bench/floor)

Enzymes preparations might be accidentally spilled onto the lab bench or the floor. This may give rise to the generation of dust after drying of liquid preparations or when mechanically damaging enzyme granules. Hence, any spill must be removed immediately. Solid spill should be rinsed with water and be taken up with paper towels but care must be taken not to use spray bottles to apply water. Also, if liquid spills should be diluted with water, no spray bottles must be used to avoid generation of aerosols

Typical sources of exposure

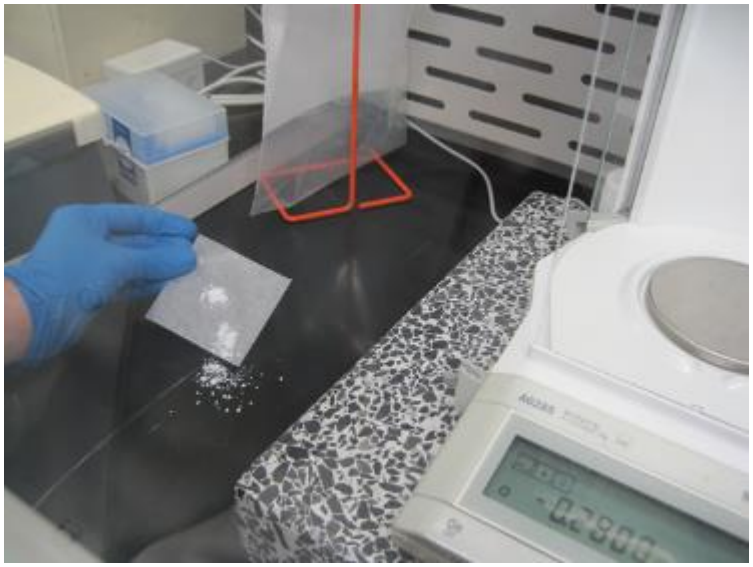
Scales

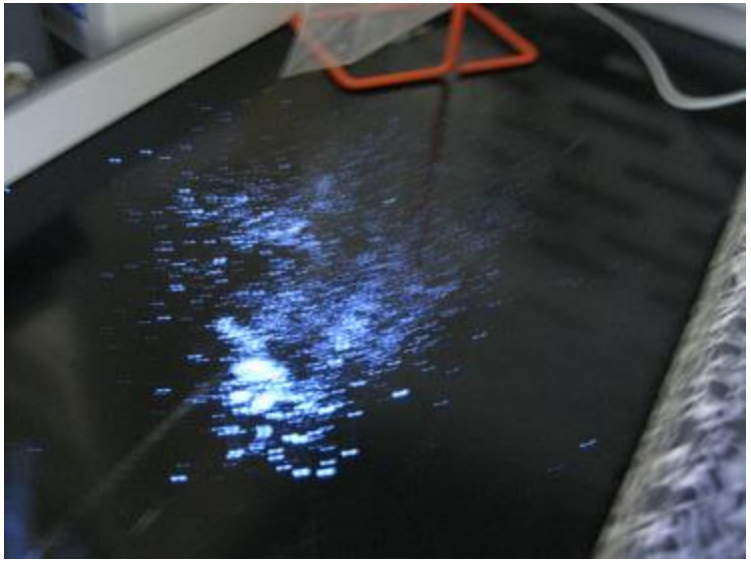
It is advised to use a source capture exhauster arm when weighing solid enzyme preparation. Granulated material should be handled with care to avoid the generation of dust, and the scale must be properly cleaned after weighing to avoid deposition and accumulation of dust.

Typical sources of exposure

Powder contamination demonstration

Enzyme powders can disperse throughout a lab and contaminate work surfaces if housekeeping and operational discipline practices are not followed





Simulation of contamination with fluorescent powder/light

Typical sources of exposure

Lab equipment (flasks, forceps, spoons, spatulas etc.)

Lab equipment that came into contact with enzyme preparations must be cleaned directly. Typically water is sufficient for cleaning but depending on the viscosity of the enzyme containing material, a solvent like ethanol might help. Formation of aerosols during cleaning must be avoided.

In case a spill dried-in it might be preferably removed by using a detergent solution for cleaning.

Flasks should be pre-cleaned e.g. by rinsing with water before storing them for the main cleaning.

Spoons, spatulas and any comparable equipment must not be left dusty and liquids should not be allowed to dry on them.

Single-use material should be wasted directly after use.

Typical sources of exposure

Lab routines with liquids

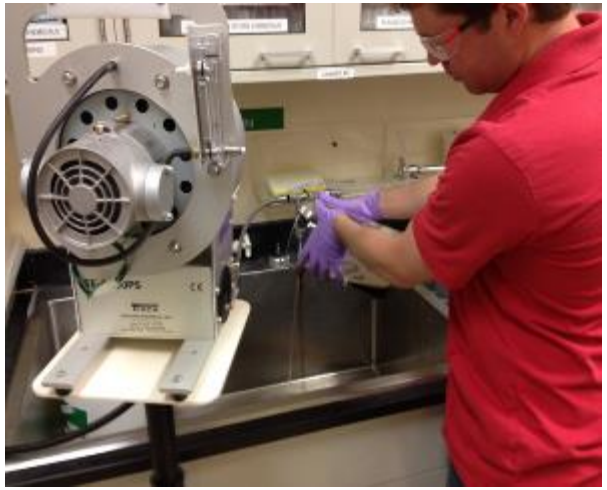
Typical handling of liquids in a lab, like pouring, stirring or mixing, can be a source of measurable enzyme exposure and should be performed with care. Several good practices can help to reduce the formation of aerosols, e.g.

- using funnels when pouring liquids
- leave lids on flasks during stirring
- keep containers closed and give aerosols at least 5 min to settle after vigorous shaking processes or sonication

Typical sources of exposure

Waste

Liquid waste can be disposed via the sink, however, this way of disposal is considerable prone to the generation of aerosols if not sufficient care is taken. An LEV at the sink where liquid enzyme waste is disposed is strongly recommend.



Solid waste that contains or is contaminated with enzymes should be disposed in bins with bin liners (with sealable lids and/or bin liners) that do not give rise to the generation of dust. Be aware that some bin/lid designs may be prone to create an airflow that can carry fine dust out of the bin. Sealed bins or bin liners should be brought to waste incineration.

Typical sources of exposure

Performance experiments

Performance experiments are typically conducted with product formulations that can be sold to the consumer. However, due to the exaggerated conditions in such studies exposure is considered higher compared to the use situations of average consumers. Hence, appropriate measures to reduce exposure, e.g. sufficient LEV, must be used. Care must be taken especially when using spray products, as extended testing in a lab environment might result in exceeding safe exposure limits. Preferably such experiments are performed under a fume hood or a comparable protective environment (see also “Exposure measurements of enzymes for risk assessment”; *https://www.aise.eu/cust/documentrequest.aspx?DocID=1923)*

Medium/high throughput automatization

Specific lab operations allow for automatization, e.g. automatic samplers or overhead shakers. Such equipment must be designed in a way that release of enzyme aerosol or dust is avoided in the use phase. In this regard, also filling and emptying of the equipment is considered being part of the use phase. Again, direct cleaning of the equipment after use is mandatory

Respiratory Protection [RPE]

RPE is not considered the preferred primary protection against enzyme inhalation in the R&D laboratory.

RPE should only become necessary in cases of accidental exposure that is linked to the generation of enzyme dust or aerosol , e.g. due to spillage* or technical failure of automatic lab equipment or lab ventilation. In these cases, RPE is the last resort to reduce the risk of inhalation.(* small spillages might not require RPE but can be removed as indicated under bullet point “surfaces)

It must be borne in mind that the RPE’s efficiency depends on the filter material and accuracy of face fit, as well as on storage conditions, maintenance and proper use (see Webinar Session 3)

Air monitoring/Audits

Air monitoring is typically applied to control achievements in exposure control within production processes. However, air monitoring should also be regularly (at least yearly), applied in laboratory facilities to ensure that exposure is in control. In addition to the regular controls, air monitoring should be involved when new equipment or new processes are installed in a laboratory.

It is also strongly recommended to regularly audit labs with a specific focus on enzyme handling and measures taken to reduce exposure.

Audits

Auditing lab activities requires observation of potential unsafe acts/conditions. Critical conditions might be encountered at unexpected places:

- Concentrated enzyme formulation are transported via an airlift system
- In such system, leaking containers may create aerosols
- Accidental exposure can be avoided by e.g. using double containers

Audits

Sample preparation and cleanout of Heubach equipment

- Lab was using compressed air to clean out the sample cylinder
- Compressed air cleaning is a documented risk factor for enzyme exposure

Average of two air samples taken during sample preparation and cylinder cleanout was significantly exceeding the acceptable threshold concentration

We Will Appreciate Your Feedback or Further Questions to:

giulia.sebastio@aise.eu