SAFETY IN CONFINED SPACES AND HEALTH SAFETY EXPLOSION HAZARD - TOXIC HAZARD 1431

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When paints containing solvents are applied in enclosed or confined spaces, two hazards can exist, explosion and toxicity and precautions must be taken to eliminate them.

General aspects of explosion hazards

The nature of this hazard is explained in detail below. The essential precaution to be taken is that sufficient ventilation air must be provided to maintain the ratio of vapour/air at no more than 10% of the lower explosive limit. The method for calculation is given below and data on minimum ventilation air quantity is given in product data sheets. If the flash point of the solvent is above the working temperature, then an explosion cannot occur. However, it may still be necessary to ventilate to provide a clean working atmosphere or to eliminate toxic hazard.

An explosion is simply very rapid burning of a flammable mixture (in the case of paint, it is the burning of solvent vapour in oxygen contained in the air). The speed of combustion is so great that there is extremely rapid development of heat and pressure (6 to 9 times the original pressure). This can lead to destruction of the compartment and injury to work people. Three factors must be present to create an explosion.

a. The mixture of vapour and air must be between the lower explosive limit (LEL) and the upper explosive limit.
b. The mixture must be at a temperature above the flash point temperature of the vapour.
c. A source of ignition with high enough temperature and energy must be present to initiate the explosion reaction.

These three factors explain the reasons for the safety precautions.

Ventilation to provide an atmosphere below LEL

It is usual to specify that ventilation should be provided to reduce vapour concentration to less than 10% of LEL. This large safety margin is required to allow for variations in ventilation in all parts of a compartment.

The minimum ventilation air in m^3 per minute may be calculated from the formula: $\frac{(P \times A) + (Q \times B)}{t}$

Calculation

P = volume of paint applied in the compartment in litres during time t minutes.
Q = volume of added solvent used in the paint applied in the compartment in litres in time t minutes.
A = ventilation air quantity for 1 litre of paint to reach 10% LEL.
B = ventilation air quantity for 1 litre of solvent to reach 10% LEL.
t = time of application in minutes of volume P of paint.

Example

100 litres of paint (P) plus 5 litres of thinner (Q) are used within 45 minutes (t).
Value A is e.g. 60 m³ (given in product data sheet).
Value B is e.g. 130 m³ (given in product data sheet).

Ventilation air quantity m³ per minute to reach 10% LEL is:

$$\frac{(100 \times 60) + (5 \times 130)}{45} = 147.7 \text{ m}^3 \text{ per minute.}$$

Remarks

This quantity of ventilation air must be maintained throughout the application of the paint and also during the period of evaporation of solvent.
The ventilation must be arranged so that all parts of the compartment are properly ventilated. It is necessary for the applicator or the contractor to check vapour concentrations (in varying positions) regularly with an explosion meter. If the concentration rises above 10% LEL, painting must stop until the vapour concentration is reduced to a safe level again.

Flash point

If possible paints with flash points above the ambient temperature should be used. This often is not possible, particularly in compartments heated up by strong sunlight in summer. In such cases it is even more essential that ventilation below 10% LEL is maintained.

Sources of ignition

Sparks, hot surfaces, flames and all other sources of ignition must be absolutely prevented. Flame proof lighting and electrical equipment must be used, spark proof tools and clothing should be used and all work must be prohibited in adjacent compartments. All equipment, whether electrical or not electrical (e.g. pneumatic pumps, spray tips, etc.) must be adequately earthed to ensure no accumulation of static electrical charge.

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General aspects of toxic hazard

Many solvents used in paint have some degree of toxicity and it is necessary to provide sufficient ventilation air to maintain safe atmosphere below the threshold limit value (TLV). With many common solvents this may be impractical when applying large volumes of paint in a short time. In such cases ventilation to give a clear visibility and safety from explosion will still be necessary. It will also be necessary to provide operators in the compartment with fresh air masks or hoods. Barrier creams and protective clothing may also be necessary. Full details are given below and data for calculation of RAQ (required air quantity) are also provided.

It is necessary to keep certain rules when using any paint since all can be harmful (even ordinary emulsion paints are dangerous if swallowed!). The following are basic safety precautions:

Inhalation of dust and fumes

This must be avoided by the use of ventilation or extraction.

- products should be used in well ventilated areas
- forced ventilation or fresh air masks should be used in confined spaces
- a face mask should be worn when spraying, sanding or blast cleaning

Skin contact

Some substances used in paint may cause irritation after repeated or prolonged contact with the skin and in susceptible cases there is a risk of dermatitis.

- operatives with a history of skin sensitivity should not be employed in processes where skin contact can occur
- prolonged or repeated contact of paint with the skin should be avoided
- barrier cream should be supplied and used
- gloves should be worn
- do not wash hands with solvent
- use a proprietary hand cleanser

Ingestion

The ingestion (swallowing) of paint must always be avoided.

- food should not be brought into or consumed in the work area where coatings are stored or used
- thorough washing of hands and face is essential after applying paint, particularly before eating or smoking
- if paint or thinners should accidently be swallowed, seek medical attention immediately

Eye protection

Steps should be taken to prevent material entering the eyes.

- goggles should be worn whenever necessary
- if the eyes become contaminated they should be irrigated with water; seek medical attention immediately

Theoretical ventilation requirements

In the product data sheets, data are given for the minimum required ventilation air quantity (RAQ) in cubic metres when 1 litre of paint is applied or when 1 litre of thinner is used. The TLV (=threshold limit value) for the mixture of components and solvents in the paint or for the mixture of solvents used in thinners has been calculated.

Calculation

The quantity of ventilation air required in m^3 per minute during application and drying can be calculated from the formula:

$$\frac{(P \times M) + (Q \times N)}{t}$$

P = quantity of paint consumed in litres.
Q = quantity of thinner consumed in litres.
M = min. ventilation air quantity needed to reach TLV of 1 litre of paint.
N = min. ventilation air quantity needed to reach TLV of 1 litre of thinner.
t = application time in minutes.

Example

100 litres of paint (P) are consumed in 45 minutes (t). 5 Litres of thinner (Q) were added to thin down the paint to the prescribed application viscosity. Value M is e.g. 780 m^3 (see product data sheet).
Value N is e.g. 2170 m^3 (see product data sheet).

The ventilation air quantity required during application and drying to reach TLV is:

$$\frac{(100 \times 780) + (5 \times 2170)}{45} = 1974 \text{ m}^3 \text{ per minute}$$

Remarks

In semi-confined areas such as rooms with open doors and windows or the super structure of a ship, natural ventilation will be about 2 to 5 times the content of the room or space per hour, depending on weather conditions.
The amount of fresh air necessary to reach TLV will be approximately 10 to 20 times the amount of fresh air necessary to reach 10% of LEL. When it is impractical to ventilate in such a way that TLV is not reached then fresh air masks must be used.

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Emergency procedure

It may be necessary to enter an atmosphere which is unsafe. (You may have to rescue somebody). Before entering a confined space or tank ensure that:
– you wear breathing apparatus
– you wear a lifeline
– the lifeline is properly tended
– a watch is kept on you
– a means of communication exists
– a system of signals is agreed
– you and everybody else involved understand the signals

You must also make sure that:
– a back-up or rescue squad is equipped to render assistance
– resuscitation equipment is on hand

If you have to keep watch or tend a lifeline:
– keep a careful watch on your men below

If you cannot see them:
– call out to them from time to time
– make sure they answer

If they do not answer repeated calls or if they show signs of drunkenness or unusual behaviour:
– RAISE THE ALARM IMMEDIATELY
– DO NOT ATTEMPT TO RESCUE THE VICTIM BY YOURSELF
– DO NOT BECOME A VICTIM