Chemical Exposure

When Are Vapors Harmful To You and Your Students?

Threshold Limit Values (TLV) and Permissible Exposure Limits (PEL) refer to the levels of a chemical above which a person should avoid repeated and prolonged exposure. TLVs and PELs were originally structured to provide guidelines for industrial workers who may be repeatedly exposed to the same chemicals day after day. Science teachers can use these values to provide guidance on which chemicals to use and when to take precautions. TLVs and PELs should be regarded as general standards, since different individuals respond differently to exposure. The amount of exposure and the time period of exposure are the critical issues.

The difference between TLVs and PELs is the agencies from which they come. TLVs are developed by the American Conference of Governmental Industrial Hygienists (ACGIH). PELs are developed by the Occupational Safety and Health Administration (OSHA). They both serve the same purpose and their values are very similar or even identical in many cases. For the remainder of this article, we will refer only to TLVs.

TLVs for vapors or gases are reported in units of either parts per million (ppm) or milligrams per cubic meter (mg/m^3) of air. A cubic meter is approximately the size of a small telephone booth. Exposure limits for dust, particulate matter or mist are always reported as milligrams per cubic meter of air.

Many substances have effects which are acute and fast-acting. A ceiling limit has been established for these items. This ceiling suggests that the limit not be exceeded even for an instant. For example, the ceiling TLV for iodine is 0.1 ppm or 1 mg/m^3.

For those chemicals that are acute or fast-acting through skin absorption, gloves must be worn; the substances must also be handled in either an operating fume hood or a well-ventilated room.

The threshold of smell of many chemicals is usually below that of the TLV. Strong smell may act as a warning that the TLV is being approached. Since human smelling ability can be impaired by some odors, one should not depend on smell as a reliable indicator of a hazard. Chlorine gas, as an example, has a TLV of 0.5 ppm or 1.5 mg/m^3. The odor threshold for chlorine is approximately 0.3 ppm. If you can smell chlorine, you are probably at or near the level of concern.

Biology teachers in particular should note the very low TLV for formaldehyde (0.3 ppm), and make plans to eliminate formaldehyde from their program, use it only under a hood, or be sure the room air in their laboratory is being changed (not recirculated) a minimum of 10–12 times per hour. Fortunately, many preserved materials now contain only very small amounts of free formaldehyde.

The best practice is to maintain concentrations of all atmospheric contaminants to the lowest practical levels. There are three primary steps that will help reduce your exposure to volatile or other airborne chemical substances.

1. **Ventilation.** Ventilation of the school science laboratory should be of paramount importance to the science teacher. Two types of ventilation should be incorporated in the science laboratory. A purge ventilation system (see page 1024) should be available to provide a quick air exchange in the laboratory whenever the level of a hazardous chemical vapor or dust approaches the TLV. Also, fume hoods should be available and used whenever volatile and hazardous materials are used. A reaction that is performed in a properly operating fume hood will not release any vapors into the laboratory.
2. **Substitution.** Use the TLV table on the following page to substitute a less hazardous chemical for the experiment or activity. For example, if an alcohol is required for an experiment and methyl, ethyl, or isopropyl alcohol can be used, the smart choice is to use ethyl alcohol because it has the highest TLV. Another example is melting point determinations. Many teachers have used naphthalene or para-dichlorobenzene, both of which have a TLV of 10 ppm. Why not substitute a less hazardous material such as cetyl alcohol, stearic acid, or t-octyl phenol?
3. **Microscale.** Scaling down the quantity of material used will reduce the amount that will volatilize into the atmosphere. If a typical class (15 lab groups, 280 m^3 room) performs a lab where sulfur is burned to form sulfur dioxide and the lab is microscaled to use only 0.05 g of sulfur, the average level of sulfur dioxide in the room will probably not exceed 3 mg/m^3, below the TLV of 5.2 mg/m^3. However, if 0.2 g or more are used by each group, the TLV would quickly be exceeded.

TLVs are not well-defined limits between what is safe or unsafe. Rather, they should be used as guidelines for the teacher. Most students are in the laboratory for only short periods each week. The teacher's exposure is, of course, much greater. Following the above steps will greatly reduce your exposure to hazardous chemicals.

The following is a list of common school laboratory chemicals and their TLV values. This is not a comprehensive listing. TLV values are subject to change as new information is developed.

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