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ARTS AND CRAFTS ACTIVITIES AS A SOURCE OF INDOOR AIR POLLUTION

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The pursuit of arts and crafts activities has considerable potential for generating organic vapors in the home, through use of such materials as paints, solvents, adhesives, coatings, sealers, and resins. Calculations of these largely unmeasured concentrations can be made based on knowledge of the materials and realistic assumptions of quantities used. Such calculations indicate that unventilated use of these materials poses a very real potential for adverse short term and perhaps long term exposures. An algorithm for estimating exposures resulting from arts and crafts activities involving organic compounds will be presented.

INTRODUCTION

Arts and crafts materials contain many hazardous substances, the most common of which are the organic solvents. Activities as diverse as painting, drawing, sculpture, metal working, wood working, model building, photography, and electronics use solvents that are incorporated into adhesives, paints, resins, sealers and cleaning products. A few examples will suffice to emphasize the range of solvents to be found (1):

Oil paints - mineral spirits, turpentine, xylene, toluene
Rubber cement - hexane
Acrylic resin - methyl methacrylate
Electronics - chlorofluorocarbons
Degreasers - methyl chloroform, trichloroethylene
Paint stripper - methylene chloride, toluene

A common characteristic among many solvent-containing arts and crafts materials is that the solvent is meant to evaporate when the material is used. Thus airborne concentrations of solvents can be expected during arts and crafts activities, but there are virtually no reports of actual measurements of such concentrations. A simple method for making crude calculations of short term and long term exposures will be useful in estimating potential health effects and the contribution to indoor air pollution caused by use of arts and crafts materials in the home (2).

METHOD

Two pieces of data are needed to estimate airborne solvent concentrations - the quantity of material used and the size of the room into which the solvent evaporates. Either of these numbers can be measured directly or estimated from knowledge of the process and the space involved.

The identity of the solvent constituents and their concentrations can occasionally be found on the art material container, but if the information is not recorded there, material safety data sheets can generally be obtained, at least for many of the common arts and crafts materials. From reviewing a number of MSDS, it appears that any material that is sufficiently fluid that it can be poured will contain on the order of 60 to 90% volatile solvent.

The volume of vapor produced from evaporation of one ml of solvent is calculated by applying the following equation, where d is the solvent density in g/ml, MW is the molecular weight in g/mole, and 24,500 is the volume in ml of one mole of ideal gas at 25°C:

$$\frac{\text{Volume of vapor (ml)}}{\text{ml of liquid}} = \frac{d \times 24{,}500}{MW}$$

Thus, acetone (d = 0.79 g/ml; MW = 58) produces 334 ml vapor per ml liquid. Dividing the vapor volume in ml by room volume in m^3 gives the concentration directly in parts per million (ppm). One ml acetone evaporated into a 25 m^3 (about 9x12x8 feet high) room will result in a concentration of 13 ppm, and one liter of acetone would result in 13,000 ppm.

Another method for calculating vapor volumes is to use the extensive table found in *Fundamentals of Industrial Hygiene* (3), which includes vapor volumes for a large number of organic solvents. These volumes are given in ft^3/gallon, which can be converted to ml vapor/ml liquid by multiplying the listed value by 7.5.

The calculation method just described will give an equilibrium concentration based on the assumption that no dilution is taking place. This is realistic for most homes during seasons when doors and windows are closed. It is also useful to evaluate what the actual exposure to the artist or craftsperson might be, considering that solvent vapors are being generated in the breathing zone and will be much higher in that region initially than after equilibrium has been reached within the whole room.

For simplicity, it is useful to consider the breathing zone of an artist at work to comprise about 1 m^3. This breathing zone will include the source of solvent vapor when a person is working on arts and crafts projects. If the one ml of acetone from the previous example is evaporated into a 1 m^3 breathing zone, a short term concentration of 334 ppm will result, considerably higher than the 13 ppm calculated for an equilibrium concentration. The potential for high level short term exposures becomes immediately obvious.

The cases described above lead to the following equations:

$$\text{Equilibrium concentration, ppm} = \frac{S \times V}{R} \quad \text{and,}$$

$$\text{Short term concentration, ppm} = \frac{S \times V}{1\ m^3}$$

where S = volume of liquid solvent in ml, V = vapor volume in ml/ml liquid, and R = volume of room in m^3.

RESULTS

Equilibrium and short term vapor concentrations for a number of common art materials can be estimated using the previous equations. Table 1 is a list of various art materials and their associated vapor concentrations.

As can be seen from the examples in Table 1, a significant potential for high short term exposure may exist from use of even a small amount of solvent-containing art materials. Although the short term exposure levels calculated above are probably overestimated due to rapid movement of vapor away from the breathing zone, the extremely high levels shown for xylene and methylene chloride indicate that undesirable short term exposure is likely to take place with some materials. For example, many people report unpleasant physical responses when using marking pens for drawing on poster board.

It is clear also that some materials can contribute significantly to equilibrium levels of organic vapors in the home. For example, in the use of acrylic paints, it is very likely that considerably more than 5 ml will be used on one project. If 100 ml were used, the resulting unventilated equilibrium concentration would be 40 ppm.

Table 1

Equilibrium and Short Term Vapor Concentrations
Generated from 5 ml of Various Art Materials

Art Material	Equilibrium Conc., ppm[1]	Short Term Conc., ppm	TLV©(4)
Marking pen ink (85% xylene)	34	850	100
Spray photo adhesive (65% methyl chloroform)	31	780	350
Acrylic paint (4% methoxyethanol)	2	58	25
High tack adhesive (47% methylene chloride)	36	893	50
Spray coating (62% acetone)	41	1020	750

[1]A 25 m^3 room volume was used for the equilibrium concentration.

DISCUSSION

The various short-term and equilibrium concentrations calculated via the process described above are conservative estimates, giving the maximum concentration possible for the various parameters. Factors such as diffusion out of the space, ventilation, rate of evaporation, and incomplete evaporation could all serve to lower the actual concentration, and if these are deemed to be significant for a particular space and activity, they should be estimated and folded into the calculation. The concentration of any contaminant in the home will eventually decay to background (outdoor) levels, given enough time to disperse with no new generation. The advantage of this process is that it allows a simple, rough estimate of the potential impact of using arts and crafts materials in the home, without resorting to actual measurements with direct reading instruments.

Listing of the Threshold Limit Value (TLV) in Table 1 is not meant to imply that this is the appropriate standard to use for general exposure to arts and crafts materials; TLV's are established for workplace exposures only, and are not intended to apply to children, the elderly or the infirm, for whom the TLV concentration may be too high. However, there is no similar list of values that has been recommended for personal exposures in the home, and the TLV list is the most useful reference available for comparison. As a mitigating factor, it must be remembered that the TLV list provides 'airborne concentrations to which all workers may be repeatedly exposed day after day without adverse effect'. Thus, TLV's anticipate a 40 hour per week exposure, whereas home use of arts and crafts materials is usually for a much shorter period of time.

SUMMARY

A method for calculating estimated short-term and equilibrium exposures to organic solvents resulting from home use of arts and crafts materials has been presented.

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