Furnace Technologies Pty Ltd abn : 47 063 407 581 ,
15 Weatherburn way Kardinya 6153
Phone 61 (8) 9314 6858 Fax 61(8) 9314 1251

Centre for Safety in the Arts
5 Beekman Street, New York, New York 10038 Area 212/227-6220

Electric Kiln Emissions

By Monona Rossol, M.S.,M.F.A.

Another lawsuit involving an art teacher came to our attention recently. In this case the teacher claims to be disabled by respiratory ailments brought about by classroom exposure to unvented electric kiln emissions.

Courts have heard other suits of this type, but this one is especially interesting because the teacher also claims to have developed a debilitating formaldehyde sensitivity from kiln emissions. A state Occupational Safety and Health Administration (OSHA) survey supports the teacher's contention. It found one part per million (1ppm) of formaldehyde in the air near the kiln, and nowhere else in the area, thus ruling out other sources for the substance.

OSHA considers 3ppm the Threshold Limit Value (TLV) for the workplace. But in this instance the 1ppm reading is significant because classroom levels of toxic airborne materials should be much lower than the workplace TLV's. These TLV's are designed to protect healthy adult workers. Classrooms, however, usually contain "high risk populations" such as children, teachers, and children with pre-existing health problems, mainstreamed handicapped and retarded children, and even pregnant teachers. Industrial exposure levels simply should not be applied to these more vulnerable groups.

Besides, formaldehyde is not only toxic, it is known to be a powerful sensitizer. Some people exhibit symptoms of formaldehyde exposure at tens-of-parts per billion levels.

Formaldehyde's ability to provoke such sensitivities and its ability to cause cancer in animals recently prompted the federal government to ban urea formaldehyde home insulation. This insulation is hazardous because formaldehyde gas can be released from the insulation into homes.

Formaldehyde can also be released from the resins and glues found in plywood, paneling, fibreboard, rug adhesives and new textiles. Formaldehyde is commonly used as a preservative in cosmetics, shampoos and many other products including some ceramic glazes.

Furnace Technologies Pty Ltd abn : 47 063 407 581 ,
15 Weatherburn way Kardinya 6153
Phone 61 (8) 9314 6858 Fax 61(8) 9314 1251

However, the amounts of preservatives usually used in glazes are not large enough to cause a reading of 1ppm near a kiln. In fact, it is not common to test electric kiln emissions for formaldehyde. Kiln emissions usually are tested for sulfur dioxide, lead, cadmium, carbon monoxide, chlorine, fluorine, nitrogen dioxide and ozone. These are some of the inorganic compounds likely to be produced when inorganic clay and glaze chemicals are heated. How, then, is formaldehyde – an organic chemical – released during kiln firing?

The teacher's lawyer claims to have found an expert with the answer. According to the lawyer, the expert is prepared to testify that during firing certain organic compounds in commercially prepared slips and glazes decompose to produce formaldehyde.

Sources for organic materials in clays and glazes might include glaze and clay deflocculates, stabilisers and thickeners (such as carboxyl methyl cellulose, propylene glycol, gum Arabic, etc.); colouring agents (some glaze companies artificially colour their products); preservatives (including formaldehyde and orthophenylphenol); lustre glaze oils, resins, and waxes; natural organic impurities found in most clays; and organic materials in specialty products such as wax resist and decals.

Obviously, there is no shortage of organic compounds in kilns. And all these organic compounds decompose with heat. One common decomposition product for many organic compounds is formaldehyde. But which chemicals form formaldehyde at what temperatures, and how much formaldehyde is formed are some of the questions which could use some clarification. This is an area ripe for formal study. Until appropriate studies can be done, I suggest that ceramic materials manufacturers begin to evaluate the organic components in them with respect to their decomposition products. And industrial hygienists should include tests for formaldehyde when they survey kiln emissions. If formaldehyde is indeed found to be a significant kiln emission, then even further study is needed because other toxic chemicals may appear as other emissions. This can occur because organic chemicals subjected to heat break into smaller molecules. The size of these smaller molecules, their number, and chemical class depend on the heat at which the decomposition takes place, and the size and chemical class of the original chemical. With so many sources of organic compounds in clays and glazes, and the range of kiln temperatures (from room temperature to about 1300° C), a vast array of chemicals could be created. Some conceivably could be even more toxic than formaldehyde.

Certainly some decomposition products other than the well-known sulfur oxides are obvious in the odours and smokes of some kiln emissions and perhaps some of the organic chemicals in these emissions contribute to the respiratory distress and irritation reported to us by teachers, students and ceramists.

Furnace Technologies Pty Ltd abn : 47 063 407 581 ,
15 Weatherburn way Kardinya 6153
Phone 61 (8) 9314 6858 Fax 61(8) 9314 1251

Kilns, Furnaces and Ovens For Industry

Besides the possible release of formaldehyde and other organic chemicals commonly found in kiln emissions can affect health. These include:

Sulfur oxides:

These oxides will be released from almost all clays during bisque firing and from some glaze chemicals. Sulfur oxides are strong lung irritants because they combine with water (either in the lungs or with water vapour present in the kiln) and form sulfurous and sulfuric acid mist or droplets. Repeated inhalation of this material can cause chronic lung diseases such as chronic bronchitis or asthma. Anyone who doubts the strength of the corrosive action of these acids can observe it in the destruction of the metal kiln parts, especially around doors and ports.

Carbon monoxide:

A product of incomplete combustion, carbon monoxide usually is formed early in the firing when organic decomposition begins. However, it may be formed later in the firing if the oxygen in the kiln is removed artificially. (Some hobby magazines have suggested burning wood or other materials in the kiln during firing to reduce oxygen and change the way glazes function). Carbon monoxide is a poison which enters the blood stream through the lungs and inactivates the oxygencarrying haemoglobin in the blood. Symptoms of low level carbon monoxide exposure include headache and fatigue.

Metal fumes:

Metal fumes are formed when metals volatilise at high temperatures. It is not possible always to predict whether or not a metal will volatilise during firing. There is a common myth among many ceramists that metals do not volatilise (fume or evaporate) until they reach boiling points. Actually, metals vaporises (evaporates) well below its boiling point – even at room temperature. In addition, complex reactions and molecular rearrangements of metals with other glaze components occur in molten glazes. Some of these changes may cause metal fumes to be released at unexpectedly low temperatures while other changes may blind metals at temperatures above their boiling points.

Some metals which commonly volatilise during firing are lead cadmium, antimony, selenium, copper, chrome and nickel. All these metals are toxic. Nickel and chrome fumes are also considered carcinogens.

Furnace Technologies Pty Ltd abn : 47 063 407 581 ,
15 Weatherburn way Kardinya 6153
Phone 61 (8) 9314 6858 Fax 61(8) 9314 1251

Kilns, Furnaces and Ovens For Industry

Metal fumes are actually exceedingly fine particles of metal oxides which can escape from the kiln. These particles drift and eventually settle to become part of the dust in the room. Toxic metal dusts can accumulate in areas where kilns are fired regularly. Then they can remain as a source of ingestion or skin contact, or they can be stirred up on air currents and be made available for inhalation later.

Fluorine and chlorine gases:

These gases are released when fluorine and chlorine containing glaze chemicals such as fluorspar, iron chloride, and cryolite are fired. Both chlorine and fluorine are very irritating to the respiratory tract. Fluorine also is associated with bone and tooth defects.

Nitrogen oxides and ozone:

These compounds irritate lungs. They may be produced by the action of heat and/or electricity on the air in the kiln. Nitrogen oxides also may be produced by decomposition of nitrogen-containing chemicals in clays and glazes.

Other emissions:

One never can be sure what will be omitted from kilns, since unusual things often find their way into them. I personally have found paint, plastic packing materials, cloth sponges, leather, coffee grounds, and a diamond ring in clay.

Experiments suggested by pottery text-books, and magazines often result in the firing of nails, plastic, cardboard, wood, paper, wire and many other items. One hobby magazine advocated throwing mothballs into hot kilns to produce a reduction atmosphere. This practice would release a number of highly toxic organic chemicals, including benzene which has been associated with a plastic anaemia and leukemia. The firing of nitrogen-containing plastics such as nylon or polyurethane will release hydrogen cyanide gas.

Unpredictable emissions constitute one of the strongest arguments for kiln ventilation and it will be interesting to see how the judicial system decides in the case of just one alleged emission-related illness.