

## **Technical Advice**

### Food Safe or Dinnerware Safe Glazes

The phrase, "Food Safe" refers to the fired finish of glazed pottery.

"Food Safe", glazes will pass the "Metal Release Test" for Lead and Cadmium. These are the only two elements tested for in the metal release test for Food Safety.

Leadless or Lead-free glazes which do not contain any Lead or Cadmium can be designated as Food Safe Glaze.

Cadmium containing stains were typically used to produce bright red colours in glazes, these OLD GLAZES will not pass the test. However, in the last few years a specially prepared Zircon encapsulated Cadmium Red glaze stain has been developed and NEW glazes containing these new stains will pass the metal release test limits for Cadmium, so these bright coloured reds available now can also be considered Food Safe.

PotteryCrafts produces a wide range of food safe glazes. We do not need to carry out specific tests on each glaze to determine if the glaze can be considered Food Safe because the MSDS sheet provides us with details of any hazardous substances in the glaze recipe. Section 3, Composition, which declares any hazardous substances and their approximate quantity plus their Hazardous Phrases.

All PotteryCrafts Leadless Earthenware glazes even the bright coloured reds & yellows which contain the Zircon encapsulated Cadmium colours are "Food Safe".

It is also worth considering the surface finish of glazes. When the surface finish is very rough, food particles can become caught in the surface. These glazes finishes are "Food Safe", However a rough surface finish may not be hygienic. Also, some of the metallic effect glazes such as Fools Gold, Bronze and Pewter are Lead and Cadmium free so technically could be considered "Food Safe". However, because the metallic surface effect is only microscopically thick the durability of the metallic effect is very poor and it is easily eroded especially if in contact with acidic fruit juices.

## **Element Wear**

Heating elements supplied by PotteryCrafts are all made from the industry standard, Kanthal A1 type wire and are wound in our Stoke-on-Trent factory. There is no accepted guideline on the number of firings to be expected from elements as there are so many variable; temperature, firing profile and kiln atmosphere radically affects wear. For example, one might get in excess of five hundred firings from elements if fired at low earthenware temperatures in a well ventilated kiln; in contrast, higher stoneware firings with long soaks could dramatically reduce the number of firings to fifty or sixty. The element wire that we use is an alloy of chromium (22%), aluminium (6%) and iron (72%); approximate percentages. During firing a grey crust of alumina oxide is built up of the surface of the element, this crust protects the metal beneath from oxidation so it is important that this is not damaged. Damage can occur if the element is bent or knocked; also a glaze spillage or glaze spitting during firing will attack the surface and can cause it to burn through and break. When an element burns out molten slag is produced and this can contaminate the element groove, this must be removed before replacing the element as it will melt and eat into the new element as the kiln is fired. The surface crust can be corroded by some

fumes especially fluorine and lead vapour and also if reducing atmosphere forms in the kiln. To avoid this corrosion and give elements a longer life the kiln should be well vented in the first part of the firing and if possible throughout the whole firing. Elements are shiny and metallic when first supplied, the appearance of the metal may sometimes differ as they are coloured for batch identification. When fired the shine is soon replaced by a dull matt finish as the oxide layer becomes established on the element surface. Traditionally new elements were first fired to around 1100°C in an empty kiln to help the oxide layer to form more quickly. In practice most people do not bother with this as it is not seen to make a noticeable difference, however if clays or glazes are being used that produce significant volumes of fluorine or lead fume then it would be wise to pre-fire the elements. As elements wear they become more brittle, thinner and greyer, they also distort and slump; in extreme cases they will bunch up and slump so that many of the loops are clustered together. The heat output diminishes with wear causing the kiln to fire more slowly, it may be necessary to reduce kiln temperatures to take account of increased heatwork generated by a longer firing cycle. Elements can sometimes come out of the element grooves, often this occurs in top loaders because they have not been sufficiently stretched to create tension forcing the element to back of the wall. It can also happen if elements are too long. It is possible to correct this but you cannot just bend the element as it is likely to snap. If you first heat the element to red heat with a blow lamp you will then be able to bend it more safely using long nosed pliers. We can supply elements for all kilns made by Pottery crafts including those now discontinued; we can also supply elements for many other makes at very competitive prices.

### **Element Replacement**

- Power supply to the kiln must be turned off at mains and local isolator.
- Only competent people should carry out element replacement.
- Follow exactly the sequence of nuts, washers and insulators on existing elements. If the sequence is wrong it could cause the kiln jacket to become live with dangerous consequences.
- Elements may need to be stretched to exactly fit the element groove. With top loaders it is advised to make the element very slightly longer than the groove just sufficient to create tension that will keep the element pressed to the back of the element groove. Be careful not to over-stretch the element.
- The Connections to the power line must be very tight. If the connection is loose the power will jump the gap causing arcing, a high temperature spark that will melt the wire. Heating and cooling action over time may cause the connection to loosen, it is therefore important to check for tightness from time to time.
- Wiring diagrams are available for all Pottery crafts kilns, please ask if you do not have one.
- If you have any doubts or questions do not hesitate to call our kiln technical staff.

### **Ventilation for Electric Kilns**

Some types of kiln produce a lot of fumes and even smoke as products of combustion, wood, oil and gas fired kilns are in this category and are referred to as moving atmosphere kilns. Electric kilns are quite different as the kiln itself produces no fumes at all in the process of heating. Of course some fumes and vapour is produced from the clay and glaze in electric firings however these do not present a serious problem regarding ventilation. In planning your kiln room you need to consider two aspects: excess heat and fumes.

**Excess Heat** The amount of heat generated in a room by a pottery kiln depends on the length of firing and temperature that the kiln is fired to. During a high stoneware firing the outside surface of a kiln can reach in the region of 120°C, this is too hot to touch but not hot enough to cause ignition. A kiln acts rather like a storage heater gradually releasing heat as it cools down inside. The larger the kiln the more it will heat the room, a large kiln in a small room may raise the temperature to tropical levels. Smaller kilns will have a much lower impact. The size of the room is of course crucial as is movement of air through the room. Smaller kilns in a large room present no problems regarding temperature. The Health and Safety Executive make no recommendation on the number of air room changes per hour for electric kilns, indicative of the low level of problem. At PotteryCrafts we advise that there must be a constant movement of air through the room throughout the firing, though with smaller kilns this may be at a low level such as would be provided by an open window. A domestic extraction fan, such as a bathroom fan 100/150mm diameter would suffice. It is of course essential to have a source of air to replace that extracted from the room by the fan, an open window or airbrick is recommended. Without a source of replacement air the fan will not work.

#### **Fumes - General**

Electric kilns, unlike gas or oil, produce no fumes, it is only the products of combustion and volatilisation from clays and glazes that may produce emissions. Harmful fumes are mostly generated at low levels, there will be traces of a variety of materials and smoke arising from combustion of carbonaceous materials. We quote from "The Electric Kiln" by Harry Fraser published by A & C Black: "...the hazard is lowered on account of the air dilution factor of that fraction (of noxious fumes) which escapes from the kiln and it is probable that the concentration of noxious gases in an unventilated room will be of similar hazard to that encountered walking down a busy high street." Certain materials, for example ceramic transfers and lustres can produce more harmful fumes, the manufacturers of these materials will advise on specific hazards but the volume of any toxic emissions is so small that air dilution will render them safe.

#### **Fumes - Brush-On glazes and colours**

Ceramic colours and glazes supplied in a brush-on form contain organic gums and glaze binders to make the material easier to brush and to keep it in suspension. In the firing these materials are burnt away and they can produce quite strong smelling fumes. Most of these colours and glazes are non-toxic and produce no significant amount of hazardous fume either in the kiln room or in the atmosphere outside. Any fumes extracted to atmosphere do not represent a health hazard.

#### **Emission Test**

There have been several tests on emissions from electric kiln firings, those of Parker C Reist, Chapel Hill, North Carolina USA are typical. Emissions were tested from a 3.5 cubic foot kiln and a 7 cubic foot kiln during firings to bisque cone 04 (1070°C) and glaze cone 06 (1011°C). The kilns were located in a laboratory measuring 12 x 18 x 9ft with one open doorway. Kilns were fired in three ways: with no ventilation, with an extraction fan and with an extraction hood. Air was sampled at 1ft, above the kiln 7" to the side of the kiln, and at 5ft above the floor at a point 2ft in front of the kiln. Eighteen firings were tested, six bisque, six with a commercial glaze containing lead and cadmium and six with a commercial lithium glaze.

The threshold limited value (TLV) recommended by the American Conference of Governmental Industrial Hygienists for carbon monoxide was exceeded only in the unventilated bisque firing. TLVs were not exceeded in any other firings for any other minerals. The largest concentration of carbon monoxide was 400 ppm at the point closest to the smaller kiln three and a half hours into the firing with no ventilation. By supplying simple dilution ventilation through the fan the concentration remained below the recommended TLV.

All emissions measured remained under the TLV recommended levels; sulphur dioxide was 0.1ppm or less, formaldehyde was well below 1ppm limit at 0.59ppm at the highest, (the unventilated kiln). Without exception, metal samples, (lead, cadmium, barium, and lithium) collected from the air around the kilns during the glaze firings showed little if any present. In fact because the fan or hood had little or no effect on metal contamination percentages, it can be assumed the findings represent background sources. Also carbon monoxide levels were not as important a factor during glaze firings as compared to bisque firings, the highest concentration was 27.9ppm for the unventilated kilns.

The conclusion is drawn from this study that providing some ventilation should eliminate concentrations of hazardous elements in kiln room air.

### **Summary**

Pottery crafts have been supplied to craft potters, schools, colleges, hospitals and many types of institutions around the world for many years, we are not aware of any instances of problems relating to emissions occurring during this time. Our accumulated experience together with studies such as the one sited above bring us to the view that an electric kiln in a reasonable sized room represents no hazard from either temperature or fumes as long as there is a movement of air through the room during firing and our guidelines as defined in our Operating instructions are followed. We are always happy to advise on your ventilation problems and on any aspect of kiln firing and installation.

### **Further information**

Safe use of electric kilns in craft and education. Ceramics Information Sheet no. 3 HSE.

The Electric Kiln by Harry Fraser A&C Black ISBN 0-7136-3745-5.

Answers to Potters' Questions. Ceramics Monthly Magazine ISBN 0-934706-10-7

### **Safety Advice for Electric Kilns**

Electric kilns are designed to contain heat; even in extreme situations where a kiln malfunctions and overfires the heat will be contained within the kiln. Electric kilns are therefore not a fire hazard and are safe to operate providing common sense working practices are followed. We hope that the following notes will allay any worries, if you have any concerns please do not hesitate to contact our technical staff at the above address.

### **Legal Requirements**

Electricity at work Regulations 1989 apply to both employed and self-employed persons. In essence the following statutory obligations apply.

- The kiln must be capable of being isolated from the electrical supply by fuses or circuit breaker.
- Control panels to be arranged so as to prevent access to live conductors.
- Kiln doors must be incapable of being opened while power on to the kiln, i.e. through interlock or failsafe switch system.
- Doors on control panels and electrical connection chambers must not be left off during kiln operation.
- Ideally kilns should be sited in a separate room with sufficient ventilation to remove heat and fumes.
- It is recommended that at least two persons should be trained to operate kiln.

### **What is an electric pottery kiln?**

Kilns are chambers designed to contain heat so that temperatures can be achieved sufficient for clay to be converted to ceramic. The source of heat in electric kilns is the heating elements, wire coils that produce heat as a result of resistance to the flow of electricity. They are similar to the

elements in an electric fire. The kiln chamber is constructed from insulation materials that contain the heat reflecting it back into the kiln. A kiln is really a box full of electric fires.

**Potterycrafts Kilns have the following safety features.**

- Over-temperature safety cut-off devices with all kilns.
- Anti-spike electrical surge protection with all controllers.
- Power On light - red warning light illuminated when the kiln powered up.
- Element On Lights - white lights that illuminate when power supplied to elements.
- Fuses - 3amp controller fuses fitted behind front panel of front loaders kilns
- Interlock - switches off power to elements before opening the door, essential safety equipment. Kiln won't work if not in place.

**Safe Practice**

- Interlocks and Lid Safety switches prevent power from reaching elements when the door is opened, these should never be over-ridden or tampered with.
- Door opening - opening when hot, i.e. in excess of 100°C may cause brickwork to crack. Front loaders with taper fit doors are held fast by expansion when hot, if forced open serious damage can be done to the brickwork.
- Ventilation - essential to have moving air for heat and fumes, see below.
- Supervision of firing - always supervise kiln firing whenever possible. It is essential to supervise the first few firings of any new kiln.
- All current Potterycrafts kilns are fitted with over-temperature cut-off devices, which shut down the kiln in the event of a component failure causing the kiln to reach 20°C hotter than the target temperature.
- All current Potterycrafts controllers are fitted with anti-spike devices to help prevent damage caused by electrical surges.
- Despite the safety features, damage can still occur through poor programming, for example, earthenware fired to a stoneware temperature will melt and could destroy kiln bricks and elements.
- Electrical Work - must only be carried out by a qualified electrician.

**Maintenance**

Kilns do not require very much maintenance, it is important that element grooves are kept clean by gently vacuuming up the accumulated dust. Take care not to chip oxide layer on the surface of the elements. Wiring Inspection should be carried out once or twice a year. After isolating the power open the inspection panel and look for blackened wires that might indicate loose connections. Ensure all element connections are tight and that the porcelain isolators are not cracked. Glaze spots should be removed by gently scraping or digging out; if left glaze will melt on each firing and will eat into brickwork and elements.

**Positioning the Kiln**

For front loaders preferred distance from walls 30cm side, 45cm rear to give access for servicing. If walls are of non-combustible material and space is tight, 10-15cm would suffice. Top loading kilns are all fitted with castors so can easily be moved for maintenance. Castors must be locked during firing. Floors should be of non-combustible material, a paving slab or similar will suffice over a wooden floor. At least 1m clearance should be allowed between the top of the kiln and the ceiling.

**Ventilation**

Kiln rooms should have sufficient ventilation to prevent heat building to uncomfortable levels and to exhaust any fumes generated by clay and glazes being fired. An open window is usually sufficient, but a domestic fan extractor will ensure fumes and excess heat are removed more efficiently. Always ensure that there is a source of air to the room to replace air extracted by the

fan. See our separate article on ventilation for electric kilns.

## **Glaze Mixing**

Glazes supplied in powder form are mixed with water to make a "slop" for dip glazing. Every glaze has different characteristics which may affect the amount of water required but as a starting point 1kg of lead free glaze powder needs approximately 500ml water and 1kg low sol (lead containing) glaze needs approximately 450mls water. The glaze powder should be added to the water rather than the other way round to avoid the glaze forming lumps in the mix. Wear a mask to protect against dust when adding the powder. It is also advisable to wear protective gloves while in contact with the glaze. Hold back about a quarter of the water to be added later to avoid making the mix too thin. Use a glaze mixer or paint mixer attachment to a power drill for best results, but avoid whisking air into the mix.

Once mixed, sieve the glaze through a 120's mesh sieve for earthenware or an 80's mesh for stoneware. Glazes mix more thoroughly if left overnight to ensure all the powder is soaked. Clear water will form on the top as the glaze settles, pour off some of this before mixing, this can be added back if required when the glaze is mixed again and tested. Glaze is usually the consistency of single cream, a quick way to check is to see how it runs off your finger nails; it should initially cover the nail for a few moments not run off immediately. A more accurate way to test the glaze is to dip a piece of the bisque and when dry check the thickness by scraping away the edge and measuring it against the thickness of a credit card. Fire some test pieces to be certain that the mix is correct before going in to batch production.

The porosity of your bisque will greatly affect the amount of glaze taken up in dipping; a very porous bisque may need a thinner glaze slop. In general terms transparent glazes tend to be thinner than opaque glazes. Glazes for spraying are generally thinner. When the glaze is perfect record the weight of a specific quantity, this will give you the density (often referred to as the pint weight). Before using always mix the glaze thoroughly as it will drop out of suspension, always check that there is not a layer of sludge in the bottom of the container. To aid suspension, you can add a suspending agent, proprietary brands are available and are used at about 10ml to 5ltr; calcium chloride or bentonite are also effective. Glaze hardeners such SCMC ( R1036 Glaze Binder) can be added to the mix to give a less powdery finish to the dry glaze. This is especially useful if the ware is going to be decorated with in-glaze colours (Majolica technique) before firing. For more advice when mixing Pottery crafts glazes please call our technical department.

## **Manganese**

What is Manganese?

Manganese is supplied as a dioxide or carbonate and is used as a colouring agent producing purples, browns and blacks. In thick applications it produces a matt black metallic surface; thicker layers produce a coppery bronze lustre effect. It is also used in Mocha ware where it creates tree like patterns within the glaze.

There are 4 different chemical oxides of manganese that exist.

Manganous Oxide MnO

Manganese Dioxide MnO<sub>2</sub>

Manganic Oxide Mn<sub>2</sub>O<sub>3</sub>

Manganese Oxide Mn<sub>3</sub>O<sub>4</sub>

We sell P3415 Manganese Dioxide which is the dry ground Pyrolusite ore containing approximately 75% MnO<sub>2</sub>, which is to my knowledge the only commercially grade of manganese that is used in the Ceramics Industry. The technical data sheet for this product is attached. We also sell P3416 Manganese dioxide which is just a coarser ground version of P3415 and is sometimes added to glazes and clay bodies to produce speckle effects.

We also sell Manganese Carbonate MnCO<sub>3</sub>. Manganese Carbonate is has more bulk relative to its staining strength than Manganese Dioxide and therefore gives a more even distribution of colour which is advantageous in low temperature glazes.