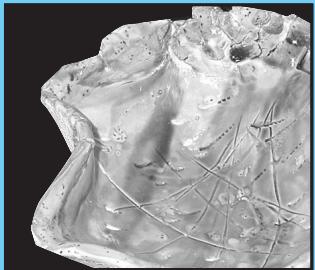


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# Ceramics 101

*An Introductory Course  
on the Basics of Ceramics*



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*Presented by Mayco*

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## **A Word from Mayco...**

This booklet is designed to give you a general overview of the ceramics process. We have outlined the recommended use and application for products, but keep in mind that this is a guideline; often you can achieve successful results by breaking the rules. Ceramics 101 is meant as a starting point so you will know how and when to bend the rules to fit your needs.

Mayco has been manufacturing high quality ceramic products for over 50 years. Our products are enjoyed by different ceramic enthusiasts all-around the world: hobbyists, potters, educators, contemporary studios and finished-ware producers.

We work very hard to provide you with consistent, top performing glazes in a broad range of color in both non-toxic and health caution formulas. Our engineers have established very strict quality control procedures to ensure that the product you receive performs to the very highest standards. All products are tested by an independent toxicologist and are properly labeled for conformance to ASTM and FDA guidelines.

This guide is designed to provide you with basic information on how the ceramic process works. For more in-depth product usage information, see our publication, *The Mayco Book*, for a complete reference on all of Mayco's high quality products. Of course, our technical service and education departments are available to work with you to achieve better understanding, maximizing the performance of our products. For any questions, please contact us at 614-876-1171 or email your questions to [technical@maycocolors.com](mailto:technical@maycocolors.com).



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# Health & Safety

## Preparation, Application and Firing

Ceramics is one of the most rewarding and enjoyable of all hobbies, and one of the safest, if some simple common-sense precautions are taken. As with any activity, responsibility must be taken for safe practices.

General rules of good housekeeping and common sense should be applied when doing ceramics. Following simple rules will ensure your safety and help you produce great results when creating a ceramic project.

Our "Health and Safety Bulletin" is available for that purpose. It is available on our web site at [www.mayco-colors.com](http://www.mayco-colors.com). In addition to this bulletin, we urge you to read other health and safety information, and to talk to your dealer, distributor or certified ceramics teachers about the safe use of ceramic products. MSDS (Material Safety Data Sheets) are available on our website or can be obtained by contacting Mayco Customer Service Department.

All Mayco products are properly labeled for material safety. Read labels with care. In ceramics, as in all areas of human activity, proper usage of products ensures safety. It is the responsibility of the user to read and understand the product label and to follow the guidelines for safety. Anyone not able to understand and follow the label instructions and safety guidelines should have an adult, competent of doing so, supervising the application and usage of all Mayco products. This includes the preparation, application and firing of these products. The person firing a kiln should have complete knowledge of and understand the specific instructions for operation of the kiln as provided by the manufacturer. The user should know any local ordinances applicable to the installation of the kiln.

### To ensure your health and safety, follow these simple rules:

- Keep work surfaces and shelves clean by wiping down with a wet sponge.
- Clean up spills when they occur. Do not allow to dry.  
**Keep dust under control at all times.**
- Work on a newspaper or paper towel for easy clean up and disposal.
- Do not smoke, eat or drink when working with hazardous ceramic materials. **Do not put your brush or brush handle in your mouth.**
- Wash your hands before you begin. The natural body oils and salts on your hands may affect the finished piece. Any open cuts should be properly covered.
- Wash your hands thoroughly when you are through working.
- Use a smock when working with ceramic materials. Wash often and separately from other garments.
- Keep children away from kilns and out of glaze dipping rooms. Only a qualified adult should operate a kiln.
- Children should not use lead-containing glazes or other hazardous ceramic materials.
- Do not intermix dinnerware safe glazes containing lead.
- If pregnant or contemplating pregnancy, tell your physician about your work with ceramics.

- When using solvent-containing ceramic materials, work out doors, in a locally exhausting hood or with an exhaust fan. Do not use or store near kilns, other heat sources or an open flame. Dispose of used rags in an airtight metal container.
- Do not spray apply any product.
- Do not fire kilns in an enclosed area. Use a kiln ventilation system. Carbon monoxide fumes can build up and present a danger. Consult with your kiln supplier or manufacturer for more information.
- If you should ingest ceramic products, seek medical help immediately.

### A neat work area should include the following:

- A table covered with several layers of newsprint and a comfortable chair.
- An old towel under the newsprint - this will cushion the ware.
- Only the products and pieces that you are working with at one time to avoid contaminating other pieces.
- Proper ventilation.

The labels on a product are very important and give you a wealth of information. Read the label for information on proper product use and hazards, if any.

Ceramic glazes are manufactured using a variety of raw materials. Most of the ingredients are mined and extracted from the ground. Some of these materials can be classified as toxic and if misused can be harmful. The key to safe use of all art materials starts with professional education and training. Contact your Mayco distributor for information on seminars in your area.

### Non-Toxic Glazes

Non-Toxic glazes are formulated without the addition of lead. They are tested for safety by an independent toxicologist. They meet FDA standards and those for the Arts and Craft Material Institute for which the non-toxic seal is assigned. You can use these glazes and products with confidence and ease. These products contain no materials in sufficient quantities to be toxic or injurious to humans or to cause acute or chronic health problems. This does not mean that any less care should be given while handling these products.

### Dinnerware Safe (Food-Safe) Glazes

Many glazes are formulated to be safely used on surfaces that come into contact with food or drink.

- If surfaces will come into contact with food or drink, use only glazes that are labeled food or dinnerware safe. Follow label instructions closely.
- Do not mix lead-containing dinnerware safe glazes, as the balance of ingredients in each glaze will be disrupted. Each mixture would have to be re-tested by an approved laboratory to determine if the mixture is also food safe.
- It is the responsibility of anyone making pieces for resale to have them tested by an approved laboratory for lead release.

- Proper firing of dinnerware safe glazes is critical. Use shelf cones on the kiln shelves to ensure that the pieces are fired hot enough, even if the kiln is electronically controlled or has an automatic kiln sitter. Always fire in accordance with manufacturer's instructions. If crazed or under fired, these glazes may not be food safe. Too heavy an application of glaze, fast firing or not firing to the proper shelf cone listed on the label may result in a glaze that does not meet the FDA standards.

## Lead and/or Cadmium Containing Glazes

Lead and cadmium are used in many ceramic glazes. Cadmium is used to produce brilliant reds and yellows. Lead gives a brilliance to the glaze and allows the glazes to mature well at lower firing temperatures (shelf cone 06).

Glazes containing lead and/or cadmium should be handled with respect. The dust from such glazes should not be inhaled. Anyone who is pregnant or contemplating pregnancy should only use these glazes with professional supervision. Use good personal hygiene when working with these types of glazes and keep them out of the reach of children.

## Sprays, Solvents and Overglazes

These products are easy to use safely and will present no problems as long as these important rules are observed:

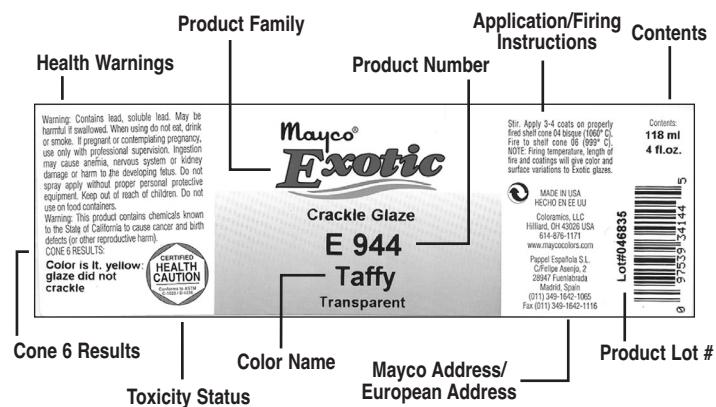
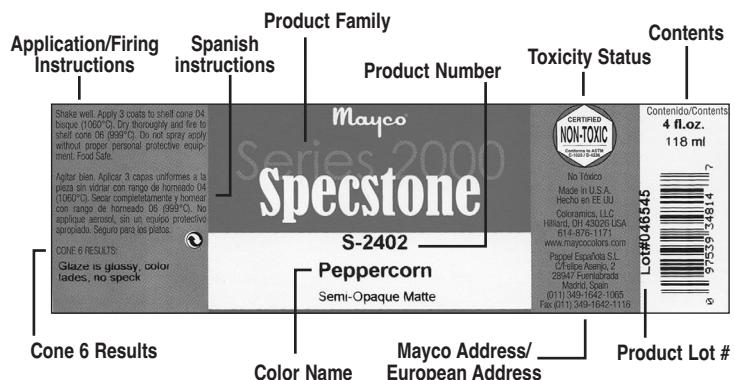
- Containers should be kept tightly closed when not in use.
- Keep out of reach of children.**
- Aerosol sprays, solvents and solvent-based overglazes should be used outdoors, with a locally exhausting hood or spray booth or a window exhaust to assure adequate ventilation.
- Do not use near an open flame or heat source.
- Clean up after use and dispose of products properly in a metal container designed for disposal of flammable materials. Contaminated materials can be washed or placed under water until final disposal.

## Slip

The mixture of any fine powder like slip requires the use of a safety mask approved by OSHA. The work area should be well ventilated with a system that draws all dust. This area should be away from other working areas so as not to spread the fine dust particles. Good housecleaning habits are necessary when mixing and pouring slip. Wipe up spills immediately. Do not sweep the area. Chronic lung damage may result from prolonged inhalation and exposure to the clay dust.

## Labeling Information

The labels on a product are very important and give you a wealth of knowledge. Read and understand the label for product's use and hazards, if any. Ceramic hobby glazes are manufactured with a variety of raw materials that are mined and extracted from the ground. Some of these materials can be classified as toxic and if misused can be dangerous. The key to safe use of all art materials starts with professional education and training. Location of information on labels may vary slightly due to space limitations.



# What is Clay?

## Clay & Clay Bodies

Clay is a compound of minerals and organic material resulting from the natural decomposition of certain igneous rocks (for example, feldspar and granite are two common sources of clay minerals). As these mineral deposits age and get moved around by natural forces (wind, water, glaciers), chemical changes occur which cause the materials to become clay.

The two major classes of naturally occurring clay deposits are primary clays and secondary clays. Primary clays are those that remain at the physical location where the parent rock decomposed. These clays tend to be the most pure, but tend to be less plastic than secondary clays. Secondary clays are deposits that have been transported by wind, water, or glacial activity. These clays, while still very pure, generally have had other materials introduced into their basic composition that change their performance characteristics (color, plasticity, etc.)

### Types of Clay

Clays can be grouped or classified several ways: according to the way they are found in nature, by their physical and chemical properties, by the way they are used to make finished products, and so on. One of the first ways to classify clay is by the methods used by Mother Nature to create clay deposits. The major types of naturally occurring clay are as follows:

#### Kaolin or China Clay

Chemically known as  $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$  this clay is almost pure white as a primary clay and slightly less white but more plastic as a secondary clay. These clays are a major component of most high-fire porcelain clay bodies and are frequently used in stoneware to lighten the fired color.

#### Ball Clay

These are secondary clays that have been transported to swampy areas where organic acids have broken down the mineral particles to ultra fine size. These clays are extremely plastic – if used alone they will shrink quite a bit, causing severe cracking.

#### Earthenware Clay

Earthenware is the most common surface clay found throughout the world. These clays usually contain high amounts of iron, which gives the fired wares the characteristic terra cotta color. True earthenware clay cannot vitrify, which means the clay body remains porous after firing.

#### Stoneware Clay

Stoneware tends to be kaolins that contain more impurities - usually calcium, feldspar, and iron - resulting in clays that have finer particle sizes and higher flux content. The flux materials cause the clay to vitrify at lower firing temperatures.

#### Fire Clay

Similar to stoneware clays, fire clays generally contain less flux (especially calcium and feldspar). Fired alone these clays won't fully vitrify – even at high fire temperatures.

#### Bentonite Clay

Bentonite is formed from the decomposition of volcanic ash. Bentonite has the finest particle size of any natural clay. It is very useful as a plasticizer but it must be used in moderation – too much of it in a clay body will result in cracking during the drying process.

#### Slip Clay

These are naturally occurring clays that have a high iron content. At high temperatures these clays melt to form a glaze; no additives needed.

Pure natural clays almost always have shortcomings – in a potter's eyes. The production processes and ultimate use of the piece dictates the properties the clay needs to have – either during the forming stage or as a finished piece. A clay body is a mixture of clay and other materials designed to meet the needs of the user. Design objectives for a clay body may involve making it more plastic during the throwing stage, improving the body's stability in large-scale work, helping the body resist thermal shock from firing, and improving general properties such as vitrification and density.

The “other materials” in a clay body perform a specific function to make the final product work better for the clay user. A general description of each component and its purpose are discussed below.

#### Components of a Clay Body

All clay bodies involve combining clay (many recipes call for several types of clay) with non-clay additives. The basic types of additives and the purpose for each are as follows:

#### Flux

These materials act as melting agents, helping to lower the maturing temperature and assist in the formation of glass – the essential binder in all ceramics. Some clay contains higher concentrations of fluxes naturally—feldspar and iron are the most common.

#### Glass-Formers

These materials react with fluxes to form glass. The most common glass-former is silica. Pure silica melts at very high temperatures – the proper mix of flux materials and silica allows for glass to be formed at more manageable temperatures. This balance must be carefully achieved – too much flux produces a weak glass, too much silica can lead to reduced thermal shock resistance.

#### Refractories

These materials stabilize the body, providing the physical

structure or binding material for the flux and glass-formers to bind together. The primary refractory material is alumina. Rather than add pure alumina high alumina clays, such as fire clay or kaolin, are blended into the clay body to increase the alumina content.

## Fillers

These gritty, granular materials that improve a clay body by enhancing the forming strength, decreasing shrinkage, provide for more even drying and greater thermal shock resistance. A common filler material is grog – a material formed by grinding previously fired clay into a sandy grit.

## Plasticizers

Occasionally a clay body will need accessory plasticizers to improve the moldability and flexibility of the clay. Certain porcelain bodies and pure kaolins benefit from additives such as bentonite, Veegum T, or macaloid.

The combination and proportion of these ingredients will affect the general properties of the clay – how it will behave prior to firing and perform after firing.

## Clay Materials Properties

It is a common practice of materials scientists to classify and evaluate materials by the properties the material contains or exhibits when manipulated and used. Every material can be evaluated by objective criteria, such as chemical, electrical, physical characteristics and behaviors.

There are two fundamental properties that really defines a clay: its ability to be molded and shaped and how it fires. Some clays are more flexible, or plastic, than others, some can be fired to high temperatures while others cannot. Other attributes one may consider include color (of the clay body itself), porosity, vitrification (firing characteristics), glaze fit, shrinkage, maturing temperature, and so on. Some of the terms and concepts used to describe clay follow:

### Plasticity

Refers to the ability of a clay to be molded and shaped. There are several factors that affect clay's plasticity: mineral particle size, acidity levels, amount of water, amount of non plastic additives, etc. The state of clay particles "sticking together" or "separating" has a technical, chemical explanation. Rather than digress into a scientific discussion on positive or negatively charged particles let's just come to understand these opposite processes as follows:

### Flocculation

The process of adding an acidic substance which causes clay particles and minerals to attract one another (flock together). This process increases the stickiness or plasticity of a clay body.

### Deflocculation

The process of adding an alkaline substance to a clay mixture that causes the particles to repel one another. While not commonly added to clay compounds deflocculants are used to help liquefied clay (slip) stay in suspension and flow

better.

### Vitrification

The process under which the clay body experiences chemical and physical changes during firing. The changes that take place during firing take place in stages. During the first firing stage the clay is fired to a red heat and the particles are now stuck together permanently - but the glass-forming processes have yet to begin. The clay body is said to be sintered. A sintered body is considered fired – it has now become bisque. Bisque bodies have strength – not has much as a vitrified body – and are very porous. At this stage the clay can no longer be slaked down (reconditioning dry clay to a more moist state by adding water). For some clay bodies this stage IS the final stage of firing. Earthenware, for example, matures at low temperatures and does not vitrify. Earthenware clays remain porous when bisque fired, requiring glazing to make a waterproof surface.

As temperatures climb past the sintering stage the fluxes and glass-formers begin to interact - the particles actually fuse together, forming glass between and around the mineral particles. The glassy materials strengthen the sintered connections between the refractory particles and gradually consume the air spaces in the clay body. When almost all the air spaces are filled and the glass-forming stage is complete the body is said to be vitrified. A vitrified body is impervious to water, very strong and dense (a vitrified body shrinks and condenses as the air spaces are filled with glassy material).

Each clay body has a maximum firing range whose top temperature, if exceeded, will result in deformations. Bloating, warping, slumping, or complete loss of structure are the physical signs of an overfired body.

### Porosity

Porosity refers to a material's ability to absorb moisture (absorption is the common term used by clay users). Porosity can easily be measured by weighing a mature fired but unglazed piece of clay or clay body, then place the sample in a pan of water, bring to a boil, let cool overnight. Blot off the excess water and weigh again. The percentage increase in weight represents the porosity of the clay. Earthenware typically has an absorption rate of 5% to 14%, stoneware 2% to 6%, and porcelain 1% to 3%.

### Shrinkage

Shrinkage occurs in all clay bodies as they are dried and fired. Considerable shrinkage occurs as water evaporates from the wet greenware stage to the bone-dry greenware stage. The more plastic the clay body, the greater the drying shrinkage. A typical shrinkage rate for wet greenware is between 4% and 10%. Shrinkage from the firing of a clay body in a large part depends on the flux content and size and quantity of refractory materials. A pure kaolin clay or clay body can shrink as much as 8% during firing, whereas refractory bodies may have extremely low shrinkage. The addition of grog material can greater aid in reducing the shrinkage due to firing of a clay body. Grog is finely ground up bisque added to the clay to reduce the shrinkage or for thermal shock.

## Classifications of Clay Bodies

Two common methods of classifying clay bodies are according to the firing temperature range of the clay and by composition.

### Pyrometric Cones

The evolution and history behind the development of pyrometric cones is interesting – any practitioner of ceramics or pottery should be well acquainted with their purpose. Perhaps the best resource on pyrometric cones in the U.S. would be the Orton Ceramic Foundation ([www.ortonceramic.com](http://www.ortonceramic.com)). A non-profit organization dedicated to the ceramic industry Orton publishes many handbooks and guides on proper firing and kiln operation. Their publication, “Cones and Firing” is a mandatory read and reference for every clay user. A brief overview of cones is all that is needed at this time.

A pyrometric cone is a small pyramidal-shaped composition of clay, frit and binders that bend at a specific temperature. They are the standard method for determining the maturing temperature of a clay body. Just like the clay bodies they monitor, cones respond to temperature, duration, and atmosphere. As the firing progresses and reaches maturity the tips of the cones begin to bend down, forming an arch. When the tip of the firing cone reaches the bottom of the cone the firing is complete.

The lowest cone number is a cone 022 which “bends” at around 1080° F, while the “hottest” cone is a cone 42 – a cone used in advanced ceramic industry and a temperature you’ll never want to experience.

Clay and glazes are commonly classified according to their firing range. Low-fire clays mature between cones 010 and 06 – referred to as the bisque-fire range; mid-range clays mature from cone 4 to cone 7; high-fire clays mature at cone 8 to cone 11 – occasionally higher.

### Clay Body Compositions

Earthenware – traditionally red or buff colored, these clays are rich in iron. To offset the flux properties of the iron a good earthenware body will include fair amounts of grog or sand – to give the body structure – and fireclay or stoneware to help improve the body’s ability to take higher temperatures without bloating or deforming.

Another type of earthenware clay body that is more “designed” than found in nature is the whiteware body. These bodies generally exclude the use of natural earthenware clays and are comprised of talc and ball clays. These clay bodies are often white (hence the name) and are popularly used for dinnerware.

### Porcelain

Porcelain is most commonly known for their whiteness and for having some degree of translucency. They are pure and vitreous, which gives them their inherent glaze, fit quality, hardness, and durability. The whitest porcelains usually feature up to 50% kaolin as the primary clay component with additives such as bentonite or macaloid to help improve plasticity.

True bone china is so titled due to the addition of bone ash

(calcium phosphate). The calcium reacts with silica to develop a very glassy material, giving the finished product the traditional translucent look.

### Stoneware

These clay bodies use natural stoneware clay and/or fireclay, with ball clay, kaolins, flint, fluxes and grog or sand as additives. The choice of additives is truly an issue of material design and use. For example, adding sand or grog gives more structure reduces slumping. Clay users who want to hand build or throw taller wares with thinner bodies may opt for this type of body. Silica and feldspar may be added to help control the maturing temperature and glass-forming characteristics of the body.

Stoneware clay bodies produce durable ware and generally react favorably to the kiln environment during reduction firings (reducing or restricting the amount of oxygen in the kiln, which causes carbon and hydrogen to build up inside the kiln, altering the appearance of the clay and glazes used in such a firing).

### Refractory

These clay bodies are used for making firebrick and kiln furniture (A refractory material is one that can withstand high temperatures). A hot-face fire brick might include up to 80% grog and 20% plastic fireclay or low-iron ball clay. While there are many types of refractory applications, the higher temperature bodies will require reduced amounts of flux.

*\*The above information was compiled from  
“Clay: A Studio Handbook” by Vince Pitelka.*

## Determining Which Clay is Best for You

When looking for clay, compare the temperature range used for the glaze. For example, if using Mayco’s Series 2000, which is 06-04 glaze, look for an 06-04 clay body, which is Earthenware clay. This will ensure the best glaze fit.

## Suggested Clay Bodies for Teachers

While any earthenware clay is ideal for teachers, white earthenware is the most time-efficient clay to use - since teachers do not have the time to fire long. Although red clay gives beautiful results, many teachers do not like iron in their classrooms or on students’ clothing.

It is easier to achieve bright glaze colors with white earthenware. This clay body will work for all grades and projects. A slight addition of grog can be helpful to aid in crack problems and the capacity of the clay to take on a variety of forms.

While earthenware clay is suggested, it is important to remember that they do not totally seal or become impermeable to water. Earthenware clay absorbs moisture even after fired to temperature and is not weatherproof or frost-proof. When left outside and exposed to extreme temperatures and weather conditions, glazes applied to Earthenware clays can craze and crackle.

If someone is looking for weatherproof clay, stoneware or porcelain clay are better choices as the body is vitrified after firing. These clays are typically fired to cone 6 or higher. They can be used outdoors and for functional uses.

## Storing and Reprocessing Clay

It is necessary to store clay in a sealed plastic container. Purchase some large plastic bins. When doing a project you wish to return to later, store the project in the bins to keep them damp and organized by class. If the projects seem to dry out, damp paper towels or a damp sponge can be placed in the bin and will help keep projects moist.

Teachers often have left over clay or inherit clay from a previous teacher or program. Clay left over from a project can sometimes get a little too dry, but doesn't need a total reprocessing effort. Divide the clay into pieces no larger than a golf ball (students can assist with this

process) and use a mist bottle to moisten the clay when it is put into the bag. Seal the bag and it will be ready for the next day, although it will stay soft longer than normal. If clay is too wet, pull off bag and expose to air for appropriate amount of time. Determine appropriate amount of time by evaluating room temperature, humidity, etc.

If a block of clay has gotten too dry it does not work to dump water into the bag. This will only make the outside slimy and not penetrate the interior of the block.

Instead, use one of these two ways:

- If the clay is firm, but not totally dry, unbag it. Cut it into quarters using a wire. Wrap these blocks with a very damp to wet terry cloth towel. Rebag it and set aside for a day or two. It can be left longer, but may get moldy if left for an extended period of time.
- Unbag the clay and cut into thick slices (approximately 1 1/2" – 2") thick. Use your finger (or if too firm, something similar in size) to poke deep holes without going through the bottom. Fill these recessions with water, stack and rebag. This needs to sit for at least overnight.

If clay is totally hard or bone dry it will need to be completely reprocessed. Bone-dry clay reprocesses faster and more evenly than leather hard clay. You can always get a student to help break up this piece of dry clay.

To reprocess:

- Get a large trash can and add clay. Cover with water. Let this sit for a few days, if possible. Dig the clay out in large handfuls, letting water drain. Place on a dry plaster slab approximately 2" thick. If you don't have a slab, use a thick piece of wood. These materials will absorb water from the clay. When it is the consistency you desire, remove it and place in plastic bags. This clay may take some kneading before or after it is bagged to prepare for projects.

*\*The above information was compiled from Kathy Skaggs at Atlantic Beach Pottery and Craig Freiburger at Armadillo Clay.*



**Dry Cleaning garment bags are a good source for wrapping clay in and protected projects from drying out. Students can bring in discarded laundry bags from parents.**

## Unusual Ideas for Creating Texture

When creating a clay piece there are several items you can use to create texture. Once you start brainstorming, the ideas are endless. Some unique items, many of which you will find around the house, are:

- Tire Treads
- Burlap cloth
- Paper towels
- leaves, branches
- meat tenderizer
- garlic press
- rubber stamps
- cookie cutters
- lace or doilies
- bubble wrap
- jello molds
- waffle iron
- crinkle cutter (for vegetables)
- corn cob (with hard kernels)
- wood
- brush
- comb
- whisk
- toothbrush
- rocks
- dough cutter
- sponge
- beads
- decorated silverware handles
- scouring pads
- screen

# Get Creative! The possibilities are endless!

# All Fired Up . . .

## Kiln Firing and Operation

Many kiln operators feel that opening the kiln after the firing is more exciting than Christmas morning. However, firing is as big of a responsibility as it is a pleasure. It is the most essential step the ceramist has in producing the finished "objets d'art."

Successful kiln firing requires knowledge and understanding of the equipment, what happens in the kiln during firing, and the various reactions of the different items and materials placed into the kiln. Learning these necessary fundamentals are easily obtained with reading and first hand experience of the kiln. First of all, read and understand the kiln manual. If you do not have one, write to the manufacturer and they will send the materials needed to operate your kiln.

There are several types of kilns available. Basically, kilns are specially designed ovens used for firing (baking) ceramic objects to a very high temperature. This oven converts the raw materials into ceramics by subjecting them to high temperatures. While the electric kiln is most commonly used kiln, there are also other types of kilns fueled by oil and gas. The gas and oil are the least practical, due to their fuel source and their interaction with the types of glazes used with whiteware.

Kiln installation should be done by a qualified electrician. Check with your electric company for peak power demands that can affect your firing. If fuses or circuit breakers trip during firing, lower amounts of voltage will go to the kiln, causing the kiln to perform incorrectly. The location of the kiln should:

- Be on level concrete flooring or an asbestos pad.
- Be located in a well vented room.
- Be located in a protected area, away from foot traffic.
- Allow easy access to the kiln opening, controls and peepholes.
- Be near the correct electrical outlet. Check the manufacturer's requirements for voltage needs.
- Do not allow the pigtail cord or power supply cable to rest on the side of the kiln.

### Pyrometric Cones

The kiln operates using degrees of heat more commonly referred to as cone numbers. There are several types of cones and numbering systems for ceramics throughout the world. The one most accepted in ceramics is the Orton cone, determined at the National Bureau of Standards. There are other types and standards that may be applicable in countries other than the United States.

The pyrometric cone is a small elongated triangular pyramid composed of clay and other materials. These cones are a self deforming ceramic piece, that when subjected to heat and time, signal the kiln sitter (see below about kiln sitter) that the kiln has done the necessary work. When the cone has deformed to its specifications, the objects in the kiln have reached the equivalent of the needed temperature and length of time to mature the products used.

Cones are a necessary, vital tool in ceramics, signaling the user that time and temperature have been obtained. While an extremely slow firing or fast firing can fool the cone into deforming at a different temperature, cones are still a very important part to the success you have creating beautiful pieces.

### Fast Firings

Fast firings or rapidly increased temperatures should be avoided. The rate of temperature should be approximately 250° to 350° per hour. The temperature rate should never exceed 500° per hour. Most automatic kilns are in the 350° to 400° rate per hour range. This is important factor for you to know. Too fast of a firing will not allow the piece or the glazes to mature. The result will be lackluster color, chalky surface or immature bisque that can cause problems later in firing. Although a cupcake can be cooked within minutes of putting it into the oven, a fruitcake will take several times that to fully cook; a hotter oven would simply burn the outside and leave the inside uncooked. The same applies to ceramics.

### Types of Cones

There are two types of cones: small cones (1 ½ inch) are used in the Dawson Kiln Sitter (see page 8 for explanation of kiln sitters) that allow the kiln to shut off when the ware has matured. This can be a triangular pyramid or a bar. The large cones (2 ½ inch) are called shelf or witness cones. These two types of cones are not interchangeable in their usage; each has special needs in order for them to perform as designed.

### Shelf or Witness Cones

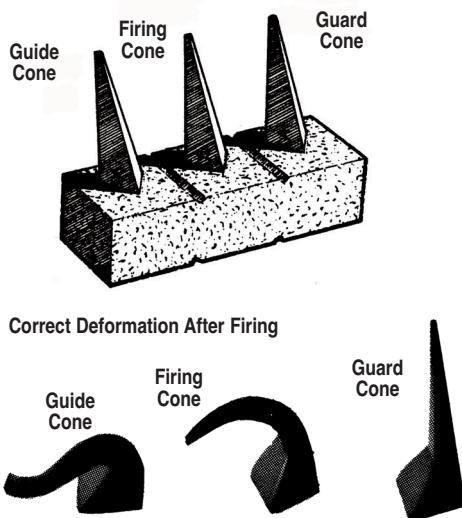
The large cone commonly referred to as the shelf cone (or witness cone) is the back-up system to the kiln sitter. These cones are placed throughout the kiln during firing to show what is happening during your firings.

Check the cones when they are broken apart from one another. If there is a hollow spine on the cone, **do not use it**; the cone will deform incorrectly during the firing, giving you a misreading. Shelf cones can be self-supporting or held in place with some form of holder, as long as they are at an 8 degree angle. The self-supporting cones eliminate any error of a wrong angle. Ideally cones should be placed in the middle of the kiln shelves with a clear visual path to the peepholes and to the element behind the cone for ease of viewing during the yellow-hot temperatures. Even if the ideal is not obtainable, shelf cones should be placed throughout the kiln on shelves out of a draft and three inches from the kiln elements.

Shelf cones are used in a series of three:

- The **Guide Cone** is one cone cooler than the desired firing temperature.
- The **Firing Cone** is the cone temperature you wish to achieve.
- The **Guard Cone** is one cone hotter than the desired cone.

## Firing



These photos are from W.P. Dawson, Inc. Kiln Sitter Operating Manual. If you did not receive a manual with your kiln, we recommend you obtain one from the manufacturer.

Shelf cones enable you to get to know the personality of your kiln. Yes, they do have one, believe it or not. A good cook knows that their oven performs with different characteristics, as does your kiln. As the kiln fires, there may be areas of the kiln significantly cooler or hotter, affecting the outcome of your fired pieces. It is highly recommended that shelf cones be used with every firing and at various placements on shelves to develop a graphic picture to the heating peculiarities of your kiln. Keeping a record of firing times, cone placement and degree of deformation can alleviate many heartaches down the road. These records will help you make adjustments to the firing process. A half cone difference throughout the kiln chamber is considered very good.

### Cone Numbering System Relative to Temperatures

Cone manufacturers produce firing cones for every conceivable heat treatment involving maturing clays and glazes. The chart that follows lists the cones and the temperature where, under specified conditions, they would bend. The numbering system may appear confusing, but it is similar to a thermometer. Increasing numbers above an imaginary zero cone represent higher temperatures, while increasingly minus numbers below zero represents lower temperatures. Minus numbers (and lower temperatures) are indicated by "0" preceding the number. For example, Cone 06 is lower (cooler) than Cone 05. The zero is very important when reading and following firing directions for the materials used.

Shelf cones numbered the same as the small cones used in the sitter are designed to deform and mature at a given degree of heat. They are not interchangeable in use for the shelf or sitter. The smaller cones can not be used as a shelf cone because they require a hotter temperature to deform. Smaller cones would give inaccurate indication of the kiln

firing. Concurrently, a large shelf cone forced into the sitter would damage the mechanism.

### Kiln Sitter

The W.P. Dawson Kiln Sitter is the control for the kiln and is the most widely used one today. There are newer types of kilns with computer controls that will be discussed later. We highly recommend installing a sitter on your kiln for it enables you to have more consistent firings with less chance of misfirings.

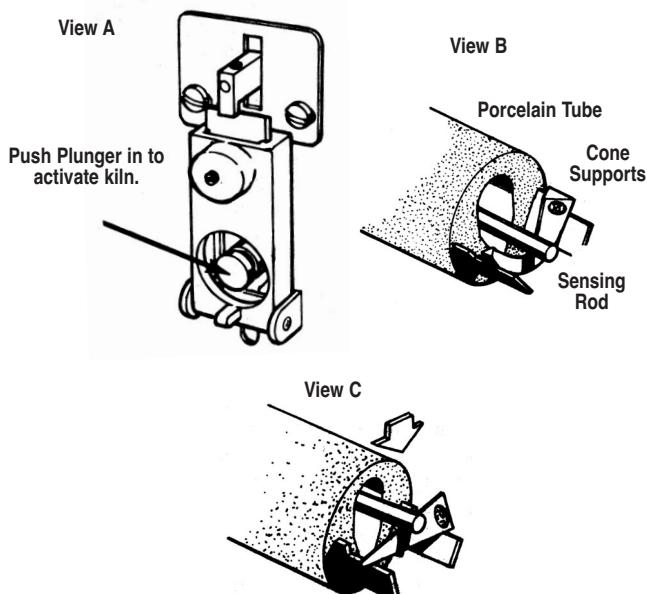
Place a small cone in the cone supports and the sensing rod, as illustrated in View A. Try to center the cone in the sitter, for it can make a few degrees difference in the firing. The sitter is activated at the beginning of firing manually, outside of the kiln (View B), and turned off by the deformation of the small pyrometric cone on the inside of the kiln (View C). Do not jar the kiln sitter and tube assembly during loading or firing; it could result in overfiring or misfiring of the kiln.

Make sure to keep your kiln sitter clean. The cone supports and porcelain tube assembly should be vacuumed before the first firing and periodically with use. If a piece explodes during firing, thoroughly clean and vacuum the tube assembly and the whole kiln (walls, floor and elements) before the next firing.

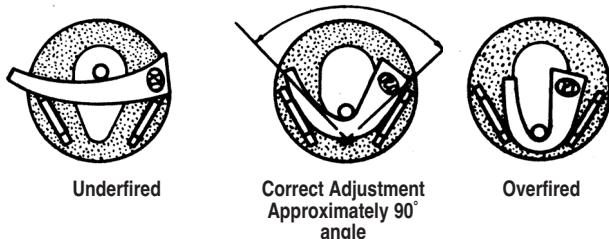
Cone Numbering System				
Cone #	108° F*	270° F†	Kiln Color ■	Ware Type++
10	2345	2381	White	Commercial
9	2300	2336		Porcelain
8	2257	2305		
7	2219	2264		
6	2194	2232		Hobby Porcelain
5	2151	2185		& Stoneware
4	2134	2167		
3	2106	2134		
2	2088	2124		High Fire Glaze
1	2077	2109		Semi-Vitreous
01	2043	2079		Ware
02	2014	2048	Yellow	
03	1987	2014		
04	1922	1940		Earthenware
05	1888	1915		
06	1816	1830		Low Fire Glazes
07	1783	1803		
08	1733	1751	Orange	
09	1679	1693		
010	1629	1641		
011	1627	1641		
012	1591	1623		
013	1586	1566	Cherry Red	
014	1533	1540		Semi-Melting Glass
015	1454	1479		(Bottle Sagging)
016	1407	1458		
017	1341	1377		Decals
018	1285	1323		Metallics,
019	1234	1261		China Paint & Lustres
020	1157	1175	Dull Red	
021	1116	1137		Glass Colors
022	1085	1112		Glass Decals

\* If rate of heat increase is 108°F per hour.  
 † If rate of heat increase is 270°F per hour.  
 ■ Color of objects in kiln at this temperature.  
 ++ Follow manufacturer's directions when choosing correct cone number.

## Firing



Proper Formation of Cones in Well-Adjusted Kiln Sitter



During normal use of the kiln, corrosion will occur on the metal surfaces, which can cause the kiln to misfire. The tube assembly should be replaced periodically depending on the amount of firing done. To extend the tube assembly life, keep the lid propped during the early stages of firing and do not close all the peepholes. It is also normal for glaze to accumulate in the tube assembly; check this periodically.

Kiln sitters, safety timers and computers cannot fully replace the operator. Mechanical devices do fail, even though they appear to be in perfect working condition. To minimize errors, always use shelf cone. Avoid leaving the kiln unattended, so you can catch costly mistakes.

### Eight Common Problems

The cost of the kiln and firing is very high relative to the cost of the cones. Here are eight good reasons for using shelf cones in addition to using a kiln sitter, kiln timer and/or computer.

- Something can fall onto the sensing rod.
- Crumbs from exploded ware or from the firebrick can get into the tube assembly.
- Kiln wash on the cone or tube assembly can prevent the cone from bending.
- Using the wrong (or a previously used) cone can be

mistakenly placed into the sitter.

- A cone can become dislodged or allowed to come in contact with the porcelain tube.
- Cones mishandled roughly, dropped or moistened will crack and bend too early.
- The weight (hammer) of the sitter may not have engaged the claw when the cone is placed in it.
- Something can get in the way and prevent the weight (hammer) from falling when the cone bends.

### Safety Timer

The safety timer is a back up shut off device that turns the kiln off if the kiln sitter fails. This clock shuts off the kiln after a given time, insuring that severe damage does not occur. Set the safety timer for approximately 30 minutes longer than the estimated firing time; this allows for power influxes and the size of the load. If the timer is set at more than an hour, it will not turn the kiln off in time to prevent damage from occurring. To ensure the life of your kiln and pieces, safety timers are worth the small initial investment when you purchase your kiln.

### Controllers

Kiln controllers automatically fire a kiln using an electrical signal from a thermocouple (sensor) located in the kiln. The signal is converted into a temperature and compared with a program, allowing the controller to decide when to send current to the heating elements and for how long.

Benefits of using a controller include:

- Automatic, repeatable and accurate control of kiln
- Uniform kiln temperatures with zone control
- Easy to use with many features

### Pyrometer

A pyrometer is a device that measures **temperature only**. It **cannot** replace a pyrometric cone, because both time and temperature are required to ensure the "heatwork" of the kiln. A pyrometer is useful in determining the inside temperature of the kiln for advancement of switches or gauging the cooling process.

### Kiln Furniture

Kiln furniture consists of the posts, shelves and supports (stilts) that are used during firing. These pieces are high temperature resistant refractory materials that provide support to the pieces during the firing. Use three posts in a tripod formation to evenly hold a shelf. Each half shelf should rest on three posts as well. Posts of proportional size should be used for added height to ensure stability. Do not use cracked shelves or posts as they could break apart during the firing, ruining several layers of ware and the kiln. If a crack should develop in a shelf because of a hard blow, finish breaking it and use it as a partial shelf.

### Kiln Wash

Kiln wash is a protective coating applied to the top surface of the shelves. This coating provides a layer of protection against glaze and other higher firing clays from adhering to the kiln shelf.

Apply three thin coats (milk consistency) to the top of each kiln shelf with a large house brush. Allow to dry completely before firing. Kiln wash is **not** applied to the lid, sitter, elements, or the undersides of the shelves. Kiln wash will last many firings and it is not necessary to reapply unless the surface has flaked or has a lot of glaze build up on them. Simply scrape off any buildups of glaze with a putty knife. If glaze remains on the shelf, use a belt sander with coarse grit to remove it and then reapply kiln wash. A new application of kiln wash is required prior to firing any glass in the kiln.

### Peepholes

Peepholes are exactly what the name infers: openings in the kiln wall that allow you to view inside the firing chamber. They allow air circulation into the kiln chamber and permit fumes and gases to escape during firing.

Peepholes can have either plugs or hinged coverings. The top peephole should never be closed in a standard bisque, glaze or luster firing until the kiln has shut off. The lower peepholes should always remain closed throughout the firing, as they can cause two things to happen. An open peephole can chill the shelf cone causing it to perform inaccurately. Leaving the peepholes open during any kind of firing can cause a piece to fracture due to a draft onto the ware. When firing glass, all peepholes should be closed during the entire firing to prevent cold drafts from fracturing the glass.

### Stilts

Stilts are bisque platforms with nichrome wire points that keep the glaze pieces from adhering to the shelf. They come in various sizes and heights, allowing the best heat and air circulation to the ware during firing. Most stilts are composed of a three prong configuration to give the best degree of stability to the ware. There are also multi-pronged stilts for accommodating larger items. Use the largest stilt to fit the size of the piece to ensure support. Taller stilts should be used for bright bisque red and orange glazes for better air circulation.

Maintain your stilts by cleaning the points regularly with a pair of pliers; if the stilt has a glaze-like surface, it needs to be replaced. Use of old stilts can discolor the glaze on the piece.

### Firing's Four Basics

Understanding the basic equipment now leads us to what happens during the firing process. There are four very important factors required to complete a properly fired piece: **Time, Temperature, Air Circulation and Ventilation.**

Other factors that happen during the firing are: air expansion, ware shrinkage, and how all these factors interact.

- **Time** is the length that the piece is subjected to heat.
- **Temperature** is the degree of heat required to mature the piece. Time and temperature combined are referred to as "heat work." This is a very important term to know and understand.
- **Air Circulation** is the way movement of air occurs in the firing chamber.
- **Ventilation** is the removal of the fumes and gases during the firing. Air circulation and ventilation are

independent and are often confused.

### Venting Systems

New kilns come equipped with mechanical ventilation systems; older kilns can be retrofitted with them. Systems that pull the air through a hole(s) in the top of the kiln maintain a more even temperature throughout the firing chamber. The oxygen that is pulled through the opening(s) allows the glazes to develop better during firing. Never place a piece directly below one of the top vent holes; it can cause a cold spot on the piece, making it crack during firing.

### Firing Preparation

- Maintain your kiln by vacuuming on a regular basis, and making sure the kiln sitter is adjusted, as they can become out of line over time.
- Glazed ware or greenware with trapped air pockets (for example, hollow arms or handle attachments) should be vented.
- Greenware and glazes should be bone dry. Unnecessary moisture can affect the glaze or ware, creating bubbles, craters, glaze crawling, or explosion of the piece.
- Pieces glazed inside and out take longer drying time.
- Turn kiln to OFF.

### Loading the Kiln

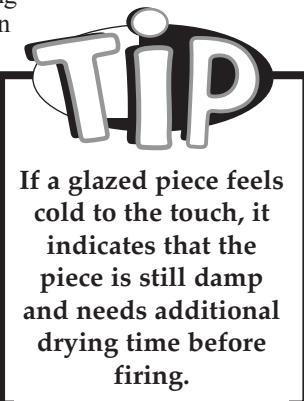
Keep the four basics of firing (time, temperature, air circulation and ventilation) in mind when loading the kiln.

When arranging the ware, consider the heat penetration. Air and heat cannot circulate on the kiln floor. Therefore, the first thing to do is create a "false bottom" on the kiln floor. Place three  $\frac{1}{2}$ " posts under a kiln shelf; this shelf will remain in the chamber at all times. The improved air circulation and heat distribution helps overcome stress

in the pieces and other problems in subsequent firings, like crazing, pinholes, cloudy glazes and ware warping.

Heating every piece evenly requires you to load a variety of pieces on each shelf when possible. Never put all of the same shape on the same shelf.

- A good rule to follow when placing pieces in the kiln is a minimum of two finger spacing for greenware and three finger spacing for glazes (approximately  $2\frac{1}{2}$ ".) Increase spacing to four fingers (approximately  $3\frac{1}{2}$ ") for glass firings. If you are firing a smaller load, increase the spacing and spread the ware evenly around the kiln.
- Lids should be placed on the piece during a greenware firing. Never put pieces inside larger pieces during firing.
- You may prevent warping by "boxing" cups and placing them rim to rim on top of one another during a greenware firing.



If a glazed piece feels cold to the touch, it indicates that the piece is still damp and needs additional drying time before firing.

- Do not place the rims of large plates and bowls next to an element: this will heat the piece unevenly.
- Flat pieces should be placed on shelves above the bottom two rows of elements for even firing. In this instance, it's better to use two half shelves, leaving a small 3/8" to 1/2" gap between them to promote better heat and air circulation.
- Generally larger pieces go toward the top of the kiln.
- Large volume pieces should be centered in the chamber with smaller pieces surrounding the ware.
- Flat objects are never set on end and should be set flat on a shelf with no overhanging parts.

While electric kilns are designed for optimum heating throughout, a heavily filled kiln will not fire accurately. For a bisque firing, allow at least one inch between the tallest piece and the shelf above it. During glaze firing, a two inch or more clearance is best before the shelf is put in place. At times when you have only a few items to fire, compensate by "false loading" the kiln with a few extra shelves and/or posts to act like other pieces in the kiln.

If you suspect that you are firing too fast and the ware is not receiving the proper heat work, check your firing by placing a shelf cone in the center of the kiln shelf and cover it with an unglazed greenware or bisque bowl or pot. After the firing, examine the cone to see if it has deformed properly. If it did not, you are firing too fast and need to slow the rate of firing.

Kiln firing has some basics. If you have switches that read Off, Low, Medium and High or have numbering from 0-100, the following schedule will help you. The switches are not turned up concurrently; this would cause an overfiring in the top and an underfiring in the bottom of the kiln. The switches are stepped up in stages to compensate for the heat rising. An hour between turning up switches is a common time frame.

Switches		Settings					
		1	2	3	4	5	6
		Lid Propped		Lid Closed			
Top	Off	Low	Low	Med	Med	High	
Middle	Low	Low	Med	Med	High	High	
Bottom	Med	High	High	High	High	High	
Top Peep Hole Open / All Others Plugged							

While every loaded kiln and cone temperature is different, you can modify the firing schedule. A heavier load or heavier types of ware may take longer in the early advancement of the switches. This timetable can be modified to fit any kiln by any kiln manufacturer. The manual for your kiln should give you guidelines for firing rates and advancement of the switches and/or dials. After your first few firings, the personality of your kiln will dictate your schedule. Remember that over time the kiln's personality can change; using shelf cones will help you monitor this. The time table below may sound like and

extravagant scheme for firing, but it will give reliable results, whether it is a low fire glaze, high fire glaze or greenware.

If you have a computer programmable kiln, follow the simple directions as it queues you. Generally the directions are on the side of the kiln. Remember that a 250° to 350° acceleration rate is best. Do not allow yourself to be tricked into thinking that the computer automatically performs correctly, always use shelf cones to verify the heat work of the kiln.

## Kiln Soaking

There are times when you need to "soak" the kiln load. This is where the kiln, after it has shut off, is restarted and the switches are turned back to medium for 30-45 minutes. This can be achieved by pushing the plunger back in on the kiln sitter. After the duration of this time, it is shut off again by pushing down the hammer to turn off the kiln. If you do not have a timer, this must be watched carefully. This can be done with a manual or computerized kiln. Check your kiln manual for more information.

## Changes that Happen During Firing

It is important to understand what happens to the ware in each firing. During the early stages of firing (at approximately 100°-300°), physical water is driven out of the clay and glazes. Rapid temperature increase could trap water molecules in the ware or glaze; a long slow advancement period during this temperature range is quite beneficial. At this stage, the kiln lid should be propped three to six inches to allow the water vapor to escape.

As the temperature rises through the 500° to 1300° range, impurities in the clay and organic matter are burned out of the ware. Chemically released water and gases are driven out of the ware as well. Good ventilation is very important during this time; if there is not adequate ventilation, glazes may become discolored during this stage.

At around 660° to 700°, greenware transforms from bisque and can no longer change back into a lump of clay. This term is referred to as "soft bisque." The ware can still be cleaned and handled, but does not crumble as before.

At approximately 1000°, quartz inversion takes place, turning the quartz in the clay into a crystalline structure. During this time, pieces actually move in the kiln. As with everything that is subjected to heat, the ware expands, subsequently shrinking as it cools. When you compare a greenware piece to a bisque piece, the difference is the "shrinkage rate" of the clay. With most whiteware, the shrinkage rate is 4%-10%. Poorly balanced pieces can topple during this stage. Using kiln wash on the shelves helps the pieces glide on the shelves during this expansion and shrinkage. This stage produces the most stress on the piece and happens every time a piece is fired. This conversion of the quartz should take place at a slow rate, both during the acceleration and cooling.

## Overfiring

All clays have a maturing point; once the temperature

exceeds this point, the clay actually starts to soften or become liquid-like. Although the overfiring may not be noticeable to the naked eye, some indications are that the bisque is hard to glaze, underglazes appear darker or fainter, or glaze colors seem washed out. The ware will also seem denser or smaller than normal, due to shrinkage.

### **Underfiring**

The complete opposite of overfiring is underfiring. Underfiring may not be evident until the ware has been glazed and used. Greenware or bisque can sound hollow or brittle. A glaze that performs poorly maybe caused from underfired greenware or even underfired glaze. Problems that can occur are: blistering, crazing, pinholes, gray discolorations and black specks in the ware or glaze surface. Fractured pieces can be directly associated with underfired bisque.

### **Bisque Firing**

Firing low-fire whiteware greenware to mature the clay is called a bisque firing. Mayco glazes should be applied to bisque that is fired to a minimum of one cone hotter than the glaze, but a good rule to follow is to fire two cone numbers hotter to assure that the minimum of one cone hotter is reached. During the bisque firing, the organic material in the greenware or clay is burned off as gas. If the bisque firing is not at least two cones hotter than the following glaze fire, additional gases may be produced and show up as glaze defects such as pinholes, blistering and/or craters. Utilitarian items should be fired to a minimum of two cones hotter to make the ware denser and more durable. Check with your clay manufacturer to make sure it can withstand these temperatures; some clays start to deform at Cone 03 or 02.

Greenware can be safely set on the shelf if no color has been applied. Generally greenware is not stilted during bisque firing; if placed on stilts it may soften and deform at the higher temperatures. Greenware prefers to be fired as it naturally sits. Cups and pieces with handles or protruding extensions may distort during a higher bisque firing (cone 02 or higher). Pieces that are thin at the top and heavy at the bottom, (i.e. a heavy footed bowl) may fire better inverted upside down. Porcelain and stoneware are never stilted in any firing.

Opaque and translucent underglazes are applied to greenware and mature at the same temperature as the bisque. Underglazes are clay with color pigments added that are formulated to shrink and develop during the bisque firing temperatures. If an underglaze seems not dark or rich enough, it may be underfired. Underglazes that seem dark may be overfired. Applying underglazes on bisque can lead to disappointing results, such as faded color or as a defect called "shivering," where the underglaze has not shrunk at the same ratio as the ware.

### **Glaze Firing**

All glazes all have a maturation point to which they should be fired. This is stated on each jar on the label. The important thing to remember is that a glaze firing is a minimum of one cone lower (cooler) than the bisque firing temperature. However, a two cone difference is recommended to avoid glaze

defects, as discussed above. Glazes that are labeled dinnerware safe are only dinnerware safe when the shelf cone stated in the instructions has been reached. Glazes that are underfired may appear cloudy or milky and lack the proper sheen to the surface. Sometimes glazes can be manipulated to accomplish a specific effect by firing to different temperatures.

All glazed objects need to be stilted when possible, excluding stoneware and porcelain. Stilts should be fitted to the size of the object being stilted. Undersized stilts can cause the ware to shift in the kiln and could cause the piece to deform. Dry-footing should be discouraged at all times (excluding stoneware and porcelain, where it is required.) Dry-fooding is the removal of the glaze on the bottom surface where the ware touches the kiln shelf. While some pieces cannot be stilted, dry-fooding is a last resort procedure.

Glaze is like sugar that is being made into candy. Think of the sugar starting out as fine granules. As heat is applied to the sugar it starts to melt, bubbling and boiling, as glaze does on the ware. This is why the heat work is so important. The glaze needs to come to a boil and then smooth out to a hard crystalline surface, just like candy. If the firing procedure is interrupted at any point, problems can occur, such as pinholes, bubbles trapped in the glaze or blisters in the surface. If the cooling is too rapid, these problems do not have a chance to heal themselves.

Mayco glazes are referred to as oxidation glazes; they require oxygen to develop fully in the kiln environment. The absence of oxygen can change the color greatly, especially for bright reds. Give glazed pieces plenty of room to breathe during the firing. Giving reds a bit more room than normal aids their development. If glazed pieces are put too close to one another the oxides in the glaze react with the adjacent color; this is referred to as fuming, flashing, blushing or shadowing. It may also appear as a yellow cast on light colored glazes.

Unlike some competitor's glazes, all Mayco glazes can be fired with one another, including green and reds. Mayco's bisque glazes, bright reds, and oranges due not require a special firing when mixed with other glaze colors like greens. However these pieces should be put on higher stilts to allow for better air circulation. Give them wider berths in their kiln placement, including the placement of shelves over those pieces. The use of other companies' colors used in conjunction with Mayco colors can not be assumed or ensured; test fire their compatibility prior to applying colors on a project.

Whether firing whiteware (earthenware), porcelain, stoneware or glazes, make certain you have a thorough knowledge of what you are placing in your kiln. The proper precautions and actions will ensure a product you will be proud of. Now you are all fired up to operate your own kiln.

### **Tips for Firing and Surviving in the Classroom**

#### **Bisque Firing**

Dry greenware can touch in a bisque kiln. Bowls and cups are best stacked rim-to-rim or foot-to-foot. Stack smaller pieces in larger pieces. Don't stack objects that are a tight fit together or have projects touch the elements.

## **Glaze Firing**

Many of the low fire glazes work on greenware (unfired) projects. Most all clear glazes work well, test others. These pieces need to be absolutely dry after glazing and fired like a bisque firing. The good news is you save one firing. The bad news is that if something explodes in a kiln, the exploded glazed piece sticks to other pieces. This can only be removed with a grinder or Dremel tool.



**If a teacher does not have enough kiln space for separate bisque and glaze firing, save time by doing a single firing when using Stroke & Coat®. Many other Mayco products can be used in a single fire process. Test them individually.**

**If you need to combine a glaze fire and bisque fire, place the glaze pieces in the cooler part of the kiln and the clay pieces in the hotter part.**

Cadmium reds can be very temperamental. If not applied or fired incorrectly they turn a transparent gray. The mauve, rosy colors are less temperamental, but if you feel the need for red and it doesn't work for you try:

- A heavier application of glaze
- Leave more room around pieces or peeps out, as they like oxygen.
- Fire faster

## **Cracks and Breakage:**

Greenware is extremely brittle. Repairing student work can be tricky. Mayco, as well as many other manufacturers, sell products to repair greenware.

Cracks do not automatically happen. It is usually

because the project has a thick and thin piece attached together. The thinner piece dries and shrinks away from the other. If you are making thick animals with 4th graders they may need to be hollowed out from the underside with a loop tool. Poking holes with a needle tool or bamboo skewer may also help in drying and firing.

## **Explosions in kilns are usually from one of two things:**

- The work is not completely dry. The dryer the better. If there is a small particle of water on the interior of a clay project, it has to migrate to the surface to evaporate. If it doesn't have a chance to evaporate, it will turn to steam when fired and the piece will break in the kiln.

- Air Pockets. If students put two pieces together with air trapped between them, it is necessary to pierce the work with a pin tool to let the air out. This can be a very small hole in a place that is not visible. If the air pocket is trapped when the kiln is fired it will expand while the clay contracts and the piece will break when fired in the kiln.

# Putting Down a Foundation . . .

## Underglazes

Underglazes, originally, was a term used to refer to ceramic colors used under-the-glaze, like a foundation. The term has now become a general term and a specific material meaning. Generally the term refers to a product put on greenware that is covered with a clear glaze. This can be a translucent or opaque type of material. The translucent types are referred to as "One Strokes" and are usually covered with a glaze as well.

The use and application of both opaque and translucent underglazes are varied. They can be intermixed in each separate category or intermixed between the two. An oversimplification is: Opaque Underglazes are mostly clay with pigment and One Strokes are mostly pigment with little clay. The amount of clay determines the opacity of the product and requires the product to be applied to greenware so that the products shrink at the same rate in the firing.

### Application of Opaque Underglazes

- Applied to greenware.
- Lightly dampen ware with water before painting; this allows better adhesion to the ware and helps alleviate pinholes.
- Shake the jar well before applying. It should be the consistency of melted ice cream.
- Applied with a soft brush. Ox hair or Sable brushes are best. Can be applied with other methods, see below.
- Use the largest brush for the area covered.
- Apply three even smooth coats at right angles to one another.
- Do not thin for general application.
- Can be intermixed to get more colors.
- Can be tinted with One Strokes.
- Fired to shelf cone 04.
- Water soluble.
- Thin with Mayco Media or water.
- All are non-toxic
- Generally a clear glaze finish is applied after firing to bring out the true color and vividness of the product.

Underglazes can be used directly from the jar, but should be put out onto a tile. Make sure the consistency is the proper thickness, like melted ice cream. Dip the dampened, blotted brush into the color. Fully load the brush without dragging the brush on the side of the tile. Apply the color in a flowing motion, if it starts to drag, reload the brush. The clay will absorb the moisture from the color, so care has to be used in the application. As you flow the color on, avoid any ridges and runs. Brush these flaws out as you are applying the color. On an embossed piece do not allow excess color to build up. Brush the excess out of the crevices as you apply the underglaze. Apply the first coat; when the dark wet look has left, apply the second coat at a right angle to the first; the third is applied at a right angle to the second coat. This will assure smoother coverage.

### Sponging Opaque Underglazes

A sponge is used to apply underglaze to greenware when texturing a surface, when graduating colors, or when blending two or more colors on the same piece. A sponge can be used on an embossed piece. It works well on large surfaces to get a more even coverage.

A natural sponge works best for applying the color. Make sure the sponge is not worn out or has been exposed to hot water. It should have a general spring to it. The color thickness should be the same as for general brushing. A slightly dampened sponge is used and the color should be put out onto a tile for better application and absorption into the sponge. Pat the color onto the surface in an up and down motion, with quick motion to avoid smearing or overloading of the area. Place one dab next to and slightly overlapping of the previous one completing the piece in a systematic way. The sponge should be reloaded often. Apply four to five coats of color to make up the difference of not using a brush.

### Other Application Methods

There are several ways of applying underglazes other than the two previous methods.

**Banding:** The color is applied onto a surface using a banding wheel. The color should be slightly thinner to carry it from the brush to the ware. Naturally the piece is round and bands or stripes of color are applied while the wheel is turning. The ware is moistened so the color does not grab from the brush and the color can be thinned slightly with Mayco Media to lessen the color from grabbing the ware.

**Spattering:** The color is spattered onto the ware giving a speckled look. Using a spatter brush or stiff brush, the color is loaded into the brush, then the handle end of another brush is drawn towards you over the bristles of the loaded brush. Make sure you protect the work surface because the speckles can travel great distances to other projects.

**Stippling:** Thin the color slightly and spread it onto a tile. Load a stiff brush and wipe off the excess color. Test on a piece of paper each time the brush is loaded. Hold the brush so that only the tips of the bristles will touch the surface of the ware. Pounce the brush up and down, gently tapping the color into place. This technique is used for smaller and tighter areas when needed. This is good for rims of plates or to fill in design areas.

**Embossing:** The color is thinned slightly to flow out of the detailing brush so that several coats can be applied. This will give a dimensional look to the design. Three coats will be needed to build color depth.

### Polishing Underglaze

While the application of an Opaque underglaze can be applied to ware in many ways from brushing to sponging, there is an interesting technique that is very old. One of the most striking looks is by polishing the surface of the color to produce a soft sheen. This technique is unobtainable by any other method and is unique to opaque underglazes. While the surface is somewhat sealed, it is not waterproof. It is only

used on decorative items and is not suitable for food or drink. Design work done in translucent One Strokes can be completed and then spot glazed to the design, giving a contrast of texture and surface.

Polishing is accomplished by buffing the opaque underglaze while it is still damp. A smooth surfaced piece works better for polishing underglaze than an embossed piece. Care must be taken to avoid removing the color from sharp angles and rims; it is easy to scratch the ware accidentally with your fingernails. Apply the color carefully; any ridges or buildups of color will affect the end result. Using a silk sponge to apply the color will help overcome some of these problems. Some colors polish better than others. Those that dry with a frosty look are less than successful.

- Apply three coats of underglaze with a brush in usual manner to assure all over coverage. Apply the colors evenly and smoothly. Do not allow prolonged drying time between the coats.
- Thin the same color, half and half, with Mayco Media and mix well. Prepare a ball of soft facial tissue or soft T-shirt material. Apply the mixture to a small area at a time. An area about the size of the palm of your hand is about right. When the shiny wet look disappears and the color will not stick to the pad, polish that area briskly. The pressure should be light and the movement fast. It is the friction that develops the sheen.
- Continue to apply the color mixture to a small area at a time, each one slightly overlapping the previous one, until all of the piece has been polished. Now buff the entire surface again, without wetting, until a high sheen is developed. If the color looks blotchy, this will disappear as the piece dries.
- If you wish to add a design with underglaze or One Stroke, be careful not to mar the surface. Use a soft cloth to hold the piece. Wait until the piece has thoroughly dried before tracing the design so the surface is not marred by the pressure of the transferring.

### Translucent Underglaze

Mayco's One Strokes are translucent underglazes that have a light, airy look and brilliancy of colors. Mayco's One Strokes look almost the same color in the bottle as on the finished piece. This allows mixing, shading and blending with them to be done with minimal complications. They can be compared to the artist's water colors. The "see-through" characteristics of one strokes allow shading of one color over another to achieve depth and dimension.

As the name states, One Strokes infers one stroke of the brush. While this does not bind the artist, it does make the one generous stroke of color the most beautiful aspect of the product. When multiple colors are applied, the thinning of the color and thinner layers of the product allow the product to be used to its full advantage. The thinning of the One Strokes and the amount of the application is adjusted to the number of times a color is used on a given area. The final depth of color should be no more than a generous stroke of the brush with unthinned One Strokes.

Concentrated translucent colors are designed for relatively

thin applications that naturally result from ONE brush stroke. Very heavy applications of color can lead to problems of dry areas, cracking or bare spots where the One Strokes may pop off, taking the clear glaze with it. Bleeding of darker colors of blue and black may occur, but is generally the result of not firing the color before glazing or too heavy an application of the top clear glaze.

If the color is applied too thinly, the color will seem to disappear under the top coat of clear glaze after firing. The One Stroke has to be thick enough so the top glaze does not "cannibalize" it and yet feed the glaze to produce the final color. Thinning with water minimizes the danger of heavy application, but over-diluting can cause the loss of color. Darker colors can withstand more thinning than lighter shades. The use of Mayco Media helps suspend the color without diluting it.

Use a palette knife to thin the color onto a tile to the consistency of light cream for most applications, such as large areas, creating bold designs, for sponging and dry brushing with a flat shader brush. The product should be the consistency of very light cream for banding wheel work and decorating over unfired glazes. For washes of color, spattering or full brush shading over one color with another color, the consistency should be like milk.

### General rules for One Stroke application:

- Generally applied to greenware Sometimes applied to bisque, for special techniques like color washes or Majolica (on top of an unfired glaze).
- Dampen the greenware slightly before applying.
- Shake bottle well and if necessary thin with Mayco Media and/or water.
- Can be intermixed to get more colors.
- Can be used to tint opaque underglazes, glazes and slip.
- Fired to shelf cone 04.
- Water soluble.
- Non-toxic.
- Generally a clear glaze finish is applied after firing to shelf cone 04 to bring out true color and vividness of the product.

### Brushing Translucent Underglazes

Because of the translucent quality of One Strokes, the direction of the brush stroke is apparent. This makes them ideal for artistic detail work and designs.

Although One Strokes will not give a solid coverage, generally they can be used satisfactorily on large areas if applied in the described manner. Thin the color to the thickness of whole milk, applying with a flat brush sized for the area. More than one coat of color thinned properly will produce a more opaque look.

### Sponging One Strokes

A sponge can be used in a variety of ways with One Strokes, achieving a totally different look each way. Unlike the opaque underglazes that block out color beneath, One Strokes allow every overlap of the sponge to show. A light, airy look is accomplished by choosing a sponge with a specific pattern to it, rotating the sponge and using lighter

mixtures of color, allowing the bisque to show through by Several colors can be blended into the sponge at one time.

Usually One Stokes are thinned to the consistency of light cream for sponging. Darker shades will block out lighter colors underneath, while lighter shades applied over darker ones gives a shadowing to the area.

### Color Washes and Antiquing

This technique is done on bisque. Dampen the bisque surface with water so the color applies more evenly.

Create a wash mixture the consistency of milk. Use a large brush to apply to the embossed area where it flows into the recesses and crevices. The color will have a natural tendency to be darker in the recesses while automatically highlighting the embossed areas. Mixing the one stroke with Mayco Media makes the colors brighter and more evenly distributed.

To antique, apply the color and then remove most of the color using a damp sponge, leaving little color in the embossed recesses. The consistency of the color is of light cream. Too thin of color will cause runs and make the color penetrate the bisque, staining it in a seemingly unsightly manner. When the color is too thin, it can also cause the color to shiver off with the glaze after firing. Too thick of color will not allow it to get into all of the embossed areas and can actually repel the top coat of clear glaze during the firing. It may cause the color and glaze to pop off.

Allow the color to dry before removing it from the raised areas with a damp sponge. Follow the contour of the design on the piece. Wiping the wrong direction will cause you to remove too much color, defeating your goal. Rinse the sponge often to keep the highlighted areas crisp and clean. Too much pressure on the sponge will also remove excessive amounts of color.

You can also antique over a fired underglaze. This can be done to a piece that has several colors applied to the surface, tie the piece together for an even look.

The underglazes should be fired to shelf cone 04 before doing this technique. Antiquing with a clear glaze is most effective, but is also quite effective with a speckled or clear art glaze.

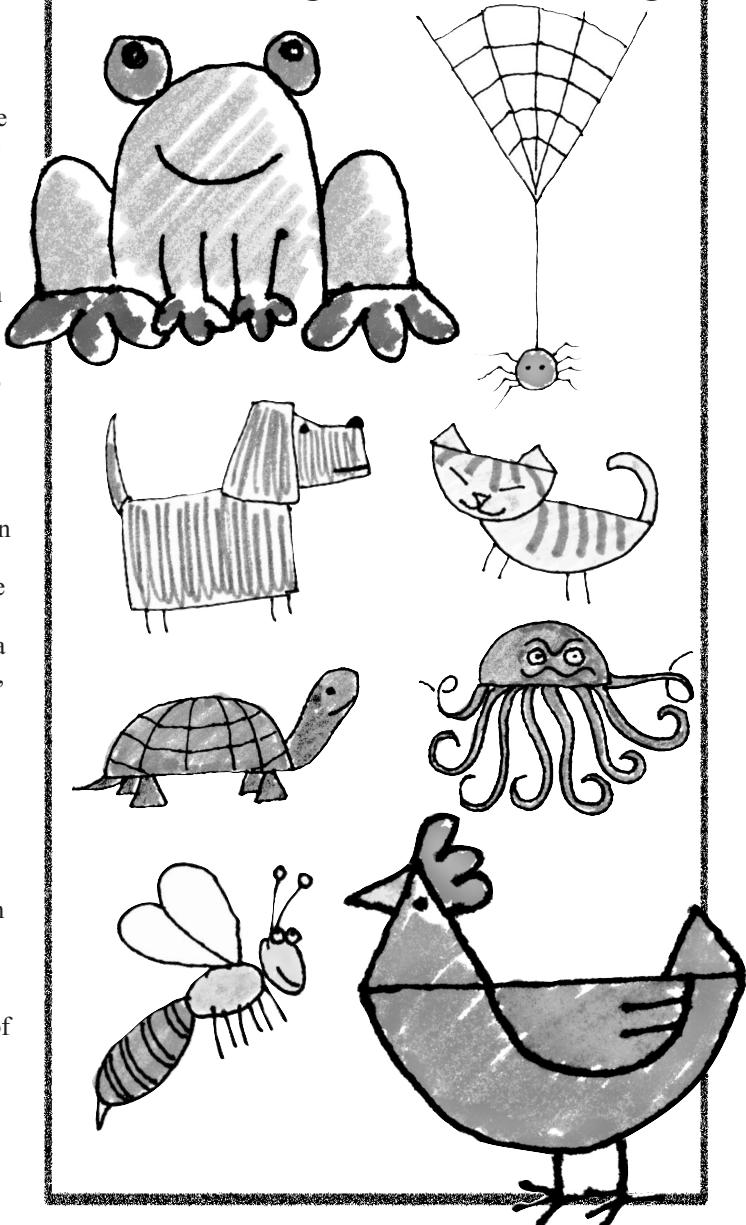
**TIP**  
For a velvety finish to the fired underglazes, eliminate the second firing and application of clear glaze. Or apply a unique look. Apply Stroke & Coat® in a Majolica technique

moving glaze. Now Majolica most often refers to the use of one strokes over a glaze, a procedure that gives more predictable results. This type of decoration is used when a desirable color or type of glaze is needed that would mute, mire or discolors the one stroke decoration if it were done under the clear glaze.

Apply the desired glaze surface evenly with the proper amount of coats for the glaze. Thin the one strokes to the consistency of light cream or lighter. Two thin applications are better than one heavier one to produce the desired effect. Thickness of the color is very important for this technique.

Translucent One Strokes and Opaque underglazes are interchangeable with most techniques. Creating patterns, banding, spattering and stippling can all be done equally well with either product. Keeping in mind that One strokes are transparent and regular underglazes are opaque. Two techniques that you cannot interchange products with are polishing and Majolica.

### Use geometric shapes to make these fun animals:



# This is Going to Come Out Green?

## Glazes

Ceramic glaze is a glass covering that provides a protective finish for a porous clay object. Over-simplified, it is a combination of raw materials that reacts to heat to produce a glass coating on ceramic pieces. Colored and textured glazes have minerals and additives that produce exciting colors and effects. While the unfired glaze may look dull, drab, uninteresting and a totally different color than before it is subjected to the intense heat of the kiln, it transforms itself like a butterfly. Some glazes may contain dyes that are used to better see where they have been applied and burn out during the firing. Glazes make ceramics leak-proof, easy to clean, and beautiful. Glazes come in various colors, surface textures and can be used alone or in combination with others. Glazes provide one strokes and opaque underglazes with the protective coating that brings life to the underlying colors.

Satisfactory glaze finishes result from proper glazing techniques which are proofed in the kiln. The kiln is the second largest factor in determining the final outcome of the glazed pieces. Glaze is not a paint, but is a combination of chemicals and raw materials. For this reason, mixing two or more glazes or varying the thickness of application will not always give dependable results. Mixing a blue and red glaze does not produce a purple colored glaze. Sometimes the mixing of two matte glazes may not produce another matte, but a gloss glaze. Similarly the mixing of two dinnerware safe glazes does not make a dinnerware safe glaze.

Glazes are sometimes referred to as being "soft" and "hard." These terms refer to the amount of movement during the firing and to the final surface of the glaze. One would think that all fired glazes would be considered hard, but some may be easily cut with a knife on a dinner plate, while others withstand repeated use. Other types of glazes produce special effects like snow, raised designs or metallic looking finishes. Just remember that if you are experimenting with combinations of glazes that you may be creating surfaces and textures that behave quite differently than when you first started.

### Applying Glazes

Before discussing the unlimited choices of glazes, glaze combinations, glazing techniques, and potential glazing problems and solutions, we should establish the procedure of applying an all over coverage of glaze. There are several methods of applying glaze, but the most common method used is brushing.

Choosing the right brush ensures the job will have a better finish. The hair of a good glaze brush should feel soft to the touch when dry. Don't be misled by the starch the brush manufacturer puts in the brush for display. The brush should have uniform hair texture regardless of the type of bristles. Stiff bristled brushes or ones with a mixture of stiff and soft hair can detrimentally affect the final glaze surface. When wet, the brush should be resilient enough to return to its original shape after pressure has been applied. Stiff fan

brushes, bamboo and stain brushes should not be used for general glazing of a piece. The brush should be sized for the task that it is being used for; a small brush used to cover a large area will give unsatisfactory results. Do not use brushes previously used with stains. Glaze can be discolored by remaining traces of stains held in the brush.

Condition of the raw glaze is as important as even application and the choice of brush. Usually a few shakes of the jar is all that is needed to condition the glaze fully. However, there are times when a jar of glaze is too full; at times glaze may need to be removed from the jar to help mix the glaze. Never thin a glaze prior to vigorously shaking it. If a glaze should require thinning, use small amounts of distilled water or Media. For brush application, the product should be the consistency of ketchup. If the glaze is so thin that it runs out of the brush before applying it to the ware, the addition of one or more coats may be needed to get the equivalent of one coat. Wipe the rim and lid of the jar after use to alleviate dried glaze from accumulating in the jar. The glaze should be strained prior to use if this occurs.

The first loading of the brush is the most important step in glaze application. Dampen the brush and remove the excess water. This will ensure the glaze brush is completely clean and will allow the brush to accept the glaze, making it easier to flow the glaze onto the ware. The brush can be dipped into the glaze, then pressed against the side of the jar lid or tile to spread the hair and cause them to accept the glaze. Jiggle the brush up and down a few times to the ferrule in order to fully load the reservoir. The brush should look considerably larger and fluffier than it did before. Do not empty the brush by wiping the glaze out again on the rim of the jar. If it is necessary to prevent a drip, barely touch the rim of the jar. It is important to approach the piece with a fully loaded brush.

The brush should always be well loaded and saturated so that the glaze flows onto the bisque with sufficient thickness. Hold the piece and the brush so the color flows down the hair of the brush. Stay up on the end of the brush, especially on detailed embossed articles, so that you can "squiggle" the glaze into the recessed areas. If too much pressure is applied to the brush and bends the hairs, you will be removing more glaze than you are applying. The glaze should ease into place. Do not scrub, but flow the color onto the piece.

When the brush is properly loaded, start flowing on three or four strokes, going in one direction only. Now, your brush is empty. There is still glaze in it, but the reservoir is going dry. While the brush is nearly empty and the glaze is still damp, look at what you have done. If there are any ridges or glaze pile-ups in the embossed areas, use the brush to pick them up, without taking away too much glaze. Reload the brush and continue to glaze until the piece is completed.

Each coat of glaze should be allowed to completely dry before applying each successive coat. Wet ware does not accept glaze as readily as dry ware. A glaze is dry when it feels dry, not necessarily when the shiny wet look is gone.

If it is not dry, the brush may pick up the glaze, rather than put it down. If the glaze starts to shift or crawl while painting, then more drying time is needed. Crawling can also be caused by over fired bisque or bisque that has been sitting around too long, collecting a greasy film. Do not force faster drying with hair dryers; this can cause the glaze to perform badly. If a quicker drying time is needed, use indirect heat or a fan to dry the piece.

When possible, each successive coat of glaze should be applied at a 45° angle to the previous coat to help prevent streaking and unevenness. Do not be afraid of applying too much glaze. The problems are more varied when glaze is applied too heavily, but too thin an application is a much more common error. Apply the number of coats recommended on the jar or the technique that you may be following.

It is difficult to establish exactly what is meant by a "coat" of glaze. The personal traits and work habits of an individual vary the application. What does three coats mean in glaze application? Usually a glaze requires three flowing coats for the proper thickness in order for the glaze to perform to the desired finish. Three coats could translate to four coats for someone who is termed a light glazer. While some people may only require two flowing coats to achieve the right deposit of glaze onto the surface of the ware, some people will need more than three coats of glaze. If glaze is applied according to the flowing method just described, you should have the right amount for a coat. A good rule to follow is to apply one coat and if there is still bisque showing through the glaze, do not consider it the first coat. When the bisque is fully covered in appearance then that would be the first coat. The next two coats would fill the requirements of the three coat term. The thickness of a post card is about the recommended thickness for proper coverage after 3 applications. You will learn through glazing pieces over time whether you are a light or heavy glazer and will adjust the application of glazes to fit your individual habits.

Clear glazes require two coats only, unless lusters or fired metallics are used over them. Using more than two coats of clear glaze on top of underglazes and one strokes can cause the color to float up into the glaze. When two coats of clear glaze have been applied and allowed to dry completely, it should not be cold to the touch nor should you be able to see through the glaze. If you cannot distinguish the colors underneath, then sufficient coverage has been made.

Occasionally you will run into problems when you are glazing your ware. Hard spots in the bisque are areas that resist glaze. Do not try to continually apply glaze to this area. Flow one heavy coat on, letting it dry completely before attempting to apply more glaze. With successive coats, glaze the area with a fully loaded brush and a light touch. Each coat must dry thoroughly or the previous coat will be lifted.

Application of glaze with a sponge is sometimes beneficial, especially when a textured look is desired or when an extra smooth application is necessary. For best results, use a silk decorating sponge with spring to it. Synthetic or sea wool sponges do not work well for all over glazing; they produce a texture or a mottled look.

To apply glaze with a sponge, dampen the sponge and remove the excess water with a paper towel. Pour the glaze

onto a tile, then dip the smoothest area of the sponge into the glaze. Pat the glaze into place, overlapping slightly with each pat. A light touch will apply glaze; a heavy touch will pick up glaze. Pounce the sponge up and down in a straight motion. Do not slide the sponge across the bisque surface as you would a brush. Keep the sponge full. Before you reload the sponge, look over what you have done to see if a heavy deposit needs to be picked up and redistributed. Four to five coats applied with a sponge is needed to achieve the three brushed coats required for most glazes.

Textured looks are obtained by applying all the coats with a sea wool sponge, allowing the glaze to dry thoroughly between each coat. Non-flowing glazes will actually be textured after firing. Flowing glazes will look pebbled, but feel smooth to the touch.

Semi-transparent glazes tend to appear streaked and uneven on very smooth pieces if all the glaze is applied with a brush. If the glaze is applied entirely with a sponge, a pebbled look will happen. The best way to achieve a perfect finish for semi-transparent glazes is to alternate sponging and brushing the coats to the surface. Apply four coats with this method.

### **Rolling A Glaze**

For hard to reach spots inside containers, pouring or rolling a glaze in the inside surface is a simple alternative to glazing with a brush. The inside must be free of any debris and clay dust. Any clay particles left inside the piece can cause crawling problems. Excessive glaze in or on the bottom of the piece can cause it to split, pit or crawl. These problems can be overcome by making sure the excess glaze is removed by inverting the piece as the glaze dries.

### **How to Roll:**

- Choose a gloss glaze if possible. Smoother application is easier and allows better cleaning of the fired surface.
- Thin the glaze to the consistency of light cream using distilled water or Media. Mix enough glaze to completely cover the area. More glaze is absorbed by the bisque during this method due to the extra water. The glaze will be thicker after rolling it into the inside due to absorption of the bisque. Save all excess glaze and mark it accordingly.
- Dump the diluted glaze into the piece and rotate the piece with a continuous motion, covering the entire inside surface with glaze. Drain out the excess glaze and continue to rotate the piece momentarily to avoid glaze pile ups in any one place. Keep the piece inverted to dry. This helps avoid the piece splitting during the firing and avoids pitting of the glaze
- When the glaze is firm, turn the piece upright and check for possible missed areas. Glaze these areas with a brush. If a colored glaze was used, apply one or two light coats with a brush to the top areas that may show. Wipe off any glaze on the outside surface with a damp sponge.
- After the correction has been made, allow the piece to dry before completing the rest of the glazing. You may notice the dye from the glaze migrating to the outside of the piece. There is no need for alarm as it fires away; the glaze is not moving to the outside surface.

## Choosing a Glaze Finish

When you glaze a piece you are enhancing its utilitarian and decorative function, not simply covering it. There is more to consider than color; the form and function of the piece should be considered. Choosing the wrong type of glaze detracts from your piece; the right one enhances the form.

The glaze chosen determines the final character of the clay shape, but the reverse is also true. A glaze may look one way on a highly embossed shape and entirely different on a slick, plain surface. Crystal glazes on a vertical shape smooths out during the firing. On a plate, the crystals may pit or bubble.

Variation in the heat treatment during the firing of the kiln can also affect the performance of a glaze. A heavily loaded kiln, a soak period, a hotter temperature, and a refire will all cause glazes to flow a little more than usual and could affect the color stability. This can be a curse or a blessing depending on the glaze used and the look that is being achieved.

## Using More than One Glaze

Many times a ceramic shape suggests a finish of colors placed side by side. Some beginners get the idea that such color placement is limited to underglazes. You are not limited to glaze finishes being placed side by side due to their gloss or matte finish. The majority of Mayco's glazes, if applied correctly, do not flow out of control when fired to shelf cone 06. Series 2000 Gloss glazes flow, but only within themselves; they level out but do not bleed together. However, extremely heavy applications of these glazes or prolonged or repeated firings can cause excessive flowing.

**Butting glazes** is a term used to describe the method of applying glazes side by side when no color blending is desired. To butt glazes, you must avoid overlapping glazes. A line drawn with an ordinary pencil on the bisque will determine the precise placement of the glazes. While the mark will burn away in the firing, it does nothing to control the glaze. Only care facilitates exact application of the glaze. In butting glazes, the brush is used like a push broom at a 45° angle to shove a small ridge of glaze up to, but not over, the pencil line as the first coat is applied. This small roll of glaze should give sufficient coverage to the perimeter of the area so that special care with successive coats is not necessary; they can be applied in the usual manner.

Butting should be all that is needed to control the flow of the glazes unless the glaze application is unusually heavy. On vertical pieces added safety can be added by cutting through the glaze while the glaze is still wet. Use a sharpened greased based pencil, following the original pencil mark. The glaze will flow to meet the one glaze and the grease in the pencil provides enough of a resisting barrier to keep the glaze in place.

**Glaze combinations** or the use of one glaze over another exploits the differences and characteristics of the wide range of glazes.

When two or more flowing (or soft) glazes are used one over another, a blending of the two colors results. The glaze next to the bisque will always dominate the piece because it has a stronger footing or hold on the bisque. Usually, the

glossier the glaze is, the more it moves in the firing. Heavier applications of these glossier glazes will produce more dramatic intermingling of the colors. Not all glazes used in combination need to be so free moving. A non-moving glaze will retard the movement of a more active glaze. For example, applying three coats of a moving glaze on the bisque, then applying two coats of a non-moving glaze on top, the top glaze will break up into little islands of the matte color. Using a tuffy or chore boy sponge to apply leftover amounts of glaze will create a look similar to crystal glazes. Base coat with a moving glaze, apply another glaze on top of the first one, then tuffy sponge the third glaze on top of the previous two.

**Antiquing with glazes** can be a lot of fun.

- It hides flaws in the bisque.
- The transparency of the glaze adds dimension to the piece.
- Great effects are achieved by antiquing with a matte glaze under a gloss glaze, as well as the reverse.
- Use a highly embossed piece to allow the glaze to fill in the crevices.
- One of the glazes used should be non-moving for best antiquing results.

To antique a piece with glazes, apply one flowing coat to the entire surface and let it dry. Using a damp sponge, wipe off the highlights on the piece. Apply two coats of the top glaze over the entire piece while concentrating the last coat on the higher points of the embellishments.

**Majolica** is accomplished by applying a non-moving glaze to the entire surface, then doing design work on top of the unfired glaze with other glazes. This technique makes the design look less rigid and the colors are usually lighter.

There are a number of things to consider when choosing colors for a majolica technique. Consider the transparency of the colors. Lighter colors lose their distinctness over darker colors. Also consider the intensity of the colors being applied over one another. The thickness of all the colors combined onto the surface should be taken into the decision. How the glaze moves during firing should be noted. The shape of the piece can influence the final outcome as well; a flat piece versus a vertical piece could dramatically affect the outcome.

## Food Safety

With the fun of doing ceramics, comes the responsibility of making pieces that could be used for holding food or drink "food safe." While you may not plan on a piece being used for food or drink, it should be finished in a food safe manner if the shape is such, that it could someday be used for food or drink. Knowledge of who or how the piece will be used in the future is lost once it is out of your sight.

The condition, shape, glaze finish and firing procedure should all be considered if a piece is food safe. Whether it is cast ware or hand formed, there should be no areas where food bacteria can build up and be difficult to clean, like open hollow handles or undercuts inside the bottom of an object. Areas left intentionally unglazed, whether covered with an acrylic stain or some other covering, make it unsanitary and not food safe. The glaze and bisque firing come back into play to make a piece food safe. Improper firing of either the bisque or glaze could result in crazed glaze, which is unsafe

for food and drink. However, this may not be apparent until months later when the glaze has delayed crazing of the surface. All glazes should be from reputable manufacturers. They should have the proper seals from the ASTM guidelines for food containers. Remember that food safe glazes, when mixed together or applied one over the other, combine chemically and could produce a finish that is not food safe. Glazes that do not meet food safe requirements will only release contaminates when in contact with acidic foods. Some glazes do meet the government's tests but are unsuitable for dinnerware due to their texture or glaze surface.

Make your piece safe for food and drink by following these three rules:

- Choose only dinnerware safe glazes.
- Use acceptable bisque pieces that are smooth and in good condition.
- Fire the piece to the recommended temperatures during the bisque and glaze fire.

A glaze is safe for food when it passes the U.S. governments test for lead and cadmium release. A glaze that is unsuitable for inside surfaces because of their texture can be used on the outside of containers. It is only the surfaces that will come in contact with food that need to receive extra caution.

### Opacity of a Glaze

There are times in the decorating process when there will be a need to know the opacity or translucency of a glaze. Few colors are completely transparent, and since they are a form of glass, few are completely opaque, but there are lots of stages in between. There will be times where a glaze containing speckles or with slight coloration is preferred. Then there are the times when you have totally changed your mind and want to cover up completely the underlying colors. Darker colors applied heavily are more opaque. Opaque glazes applied thinner are still more opaque than lighter colors applied heavily. This can also be an indication on how carefully to apply the glaze when used alone.

- Clear glazes add no color and will tolerate more variation of the thickness of the application.
- White glazes applied over white clay bodies do not show overlaps of color.
- Dark and opaque glazes seldom show the unevenness of the color's application.

The surface also comes into play when applying the glaze. Transparent or semi-transparent colors appear to flow into the crevices and accentuate the details. On a smooth surface these glazes should be applied carefully or the unevenness will show up as colored patches. Applying the three coats at right angles to the previous one will help alleviate this condition.

The codes for the opacity of glazes are:

**Clear:** the glaze adds only a wet, glossy look and brings out the true colors underlying on the piece.

**Transparent:** the color underneath is slightly tinted with the overlying glaze changing the appearance only a little bit.

**Semi-transparent:** the underglazes underneath these are identifiable, but are changed by the tone of the glaze over them.

**Semi-opaque:** light underglaze colors will not show through and dark colors will be muted. This can be very effective for shadowing on animals, faces, etc.

**Opaque:** most colors will not show through.

### Oxidation

The glazes used in ceramics are termed oxidation glazes. This means they need oxygen to develop their color during the firing. Oxidation also describes a chemical reaction to the glaze with the fired metallic lusters put over them. This change is due to the amount of copper involved in the coloration of the glaze. Some colors with little copper in them might only slightly affect the fired metallic luster. Sometimes dramatic effects can be made by deliberately putting the fired metallic on the glaze.

### The Basics of Applying Glazes

- Generally applied to shelf cone 04 bisque. Check for exceptions under individual glaze categories.
- Wipe the piece with a damp sponge before starting.
- Shake jar well before using. The thickness should be about like ketchup.
- Use either an Oval Mop or Flat Glaze brush to apply most glazes.
- Apply 3 flowing coats unless otherwise noted on jar. Clear glazes require only 2 coats. Check individual glaze categories for exceptions.
- Use food safe glazes on all containers for food and drink.
- Fire to shelf cone 06 unless otherwise noted on jar.
- All are water soluble.

### Sponging is as Easy as . . .



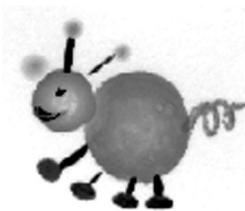
#### Pre-Cut Sponges

Create complicated-looking patterns easily! Dampen sponge, squeeze out excess water and blot on paper towel.  
Brush color onto sponge.  
Press onto piece.



#### Sponge-on-a-Stick

Make perfect circles with these sponges. Dampen sponge with water, press out excess. Dip sponge lightly in color. Place on piece and lightly twist.



# Oops, Now What Do I Do?

## Problems, Causes and Solutions

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From time to time there are problems that arise during the completion of a piece. This chapter is designed to help you quickly diagnose the problem, learn the cause and if possible, correct the mishap. The problems are listed in groups of categories. The problem may be listed more than once in slightly different ways to help you get to the solution.

### **Glazes**

<b>Problem</b>	<b>Cause</b>	<b>Solution</b>
Glaze crawls on inside vase.	Usually caused by deposits of clay dust in bottom of piece.	Check the inside before glazing and remove any dust from inside the vase. Sometimes can be corrected by thinning glaze and reapplying to bare spot and re-firing to original shelf cone.
Vase, cup or tall vertical piece cracked in kiln.	<ul style="list-style-type: none"> <li>a. Thermal shock or expansion of two or more glazes.</li> <li>b. Incompatible glazes from different manufacturers.</li> <li>c. Too heavy of glaze in bottom of the piece.</li> </ul>	<ul style="list-style-type: none"> <li>a. Try to use the same type of glaze inside and out when glazing. It's better to use gloss glaze inside pieces, even if matte is used outside. Do not use matte glaze inside and a gloss outside. Exceptions are Series 2000.</li> <li>b. Use glazes from the same manufacturer to assure compatibility.</li> <li>c. After rolling glaze on inside of piece, invert piece to drain excess glaze.</li> </ul>
Crackle glaze piece splits after or during firing.	Same as above in #3	When applying crackle glaze to the outside of a piece, bring (apply) the glaze over into the inside about 1 inch to help alleviate this problem.
Clear glaze shows green, brown and/or black specks after the glaze fire.	<ul style="list-style-type: none"> <li>a. Dirty or corroded ferrule of the brush.</li> <li>b. Brushes used for stains and then glazes.</li> </ul>	<ul style="list-style-type: none"> <li>a. Black and brown specks are from iron rust; green is from the nickel coating on the ferrule. Do not allow brushes to stand in water.</li> <li>b. Do not use the same brushes for metallic stains and glazing a piece. Metallic particles left in brush can contaminate the glaze.</li> </ul>
Glaze crawls and leaves bare spots.	<ul style="list-style-type: none"> <li>a. Caused by dirt, dust or oil.</li> <li>b. Color is too old to use.</li> <li>c. Color has been frozen.</li> <li>d. Too heavy an application.</li> </ul>	<ul style="list-style-type: none"> <li>a. Make sure piece is clean before painting by wiping down with a damp sponge. Keep hands clean.</li> <li>b. Color preservative has deteriorated with age. Do not use old product.</li> <li>c. Sometimes freezing of the product will destroy the makeup of the glaze. Do not use glaze after it has been frozen.</li> </ul>

## Problems & Solutions

<b>Problem</b>	<b>Cause</b>	<b>Solution</b>
Pinholes in glaze.	<ul style="list-style-type: none"> <li>a. Primarily caused by underfired bisque. Can also be underfired glaze or a combination of the two firings.</li> <li>b. Improper glaze application.</li> </ul>	<ul style="list-style-type: none"> <li>a. Fire bisque to shelf cone 04 or hotter and at a slower ramping temperature. Fire glaze to shelf cone 06. Ware needs a two cone difference in bisque and glaze firings.</li> <li>b. Try "Polishing" the dry glaze with the heel of your hand before firing. Sometimes pieces can be saved by reglazing and refiring.</li> </ul>
Colored glaze is streaky.	<ul style="list-style-type: none"> <li>a. Not enough coats applied; coats brushed on instead of "flowed" on.</li> <li>b. Color not stirred.</li> <li>c. Coats not applied at right angles to each other.</li> </ul>	<ul style="list-style-type: none"> <li>a. Apply the proper coats per label instructions using an Oval Mop brush. Flow the glaze on evenly.</li> <li>b. Shake and stir the glaze before use.</li> <li>c. Apply the coats at right angles to one another, allowing adequate drying time between coats. Sometimes the piece can be saved by warming the piece; reglazing with a heavy coat and re-firing.</li> </ul>
Craters, Fisheyes, Bubbles, or large pinholes appear in fired glaze.	<p>Caused by gases escaping of during firing.</p> <ul style="list-style-type: none"> <li>a. Underfired bisque.</li> <li>b. Firing glaze while it is wet.</li> <li>c. Piece not fired hot enough or piece was fired or cooled too fast.</li> </ul>	<ul style="list-style-type: none"> <li>a. Make sure bisque is fired to shelf cone 04 or hotter. A two cone difference between bisque and glaze is required.</li> <li>b. Allow glazes to dry 24 hours prior to firing.</li> <li>c. Fire glazes to shelf cone 06 or recommended cone. Glazes need an even steady ramping of temperature and cooling as well. Check firing section. File down craters and reglaze, refire.</li> </ul>
Clear glaze has green or yellow tint in bottom of bowl, plate, pitcher etc.	Clear glaze was applied too thick.	Generally brushing clear glaze needs only 2 coats. If glaze is rolled inside, thin the glaze slightly and then invert the piece upside down to drain excess. No correction once fired.
Glaze blisters or bare spots appear on embossed pieces.	<ul style="list-style-type: none"> <li>a. Air pockets in glaze where it meets the bisque when applying the glaze.</li> <li>b. Grease spots from body oils.</li> </ul>	<ul style="list-style-type: none"> <li>a. Use a flat glaze brush when applying the glaze to embossed ware.</li> <li>b. Clean hands before glazing and wipe down piece with a damp sponge before glazing. Touch up bare spots with glaze and refire. File down blister; reglaze and refire.</li> </ul>

<b>Problem</b>	<b>Cause</b>	<b>Solution</b>
Reds fade in the firing, turning white to dark gray.	<ul style="list-style-type: none"> <li>a. Glaze was applied too thinly.</li> <li>b. Insufficient ventilation in kiln during firing.</li> <li>c. Fired too hot or slow.</li> </ul>	<ul style="list-style-type: none"> <li>a. Reds need 4 coats of glaze. If this has happened to you before, start applying the extra coat before firing. Allow to dry completely between coats.</li> <li>b. Allow extra room around the piece in the kiln. Vent the kiln until the kiln has been turned or gone to high.</li> <li>c. Fire quicker than normal to shelf cone 06. Sometimes can be reglazed and re-fired to correct.</li> </ul>
White or black spots in red glaze.	Contamination from salts or something in the brush.	Make sure your hands, the brush and the piece are clean before glazing. Do not use the same brush for stains and glazes. Reserve brushes specifically for red glazes. This is difficult to correct after firing.
Clear Matte is milky.	Glaze was applied too heavily.	Thin the glaze to a milk consistency and apply 2-3 coats. Sometimes firing hotter will reduce the milkiness, but the matte glaze will be shinier.
Dipping glaze has purple or green line down piece.	Dipping glaze too heavy in one spot, where glaze has been overlapped while dipping.	Dip each side to a 1/4" of each other and brush the clear glaze together with a fan brush.
Glaze rolls back.	<ul style="list-style-type: none"> <li>a. The glaze was applied too heavily, without sufficient drying time between the applications of color.</li> <li>b. Piece was fired when it was too wet.</li> <li>c. Glaze not adhered to previous coat(s).</li> <li>d. Oil or grease on piece.</li> </ul>	<ul style="list-style-type: none"> <li>a. Allow glaze to dry between coats, applying thinner coats.</li> <li>b. After glazing allow 24 hours before firing.</li> <li>c. When applying dots make sure color has made sufficient contact to piece.</li> <li>d. Make sure the surface of ware is clean; wipe down with a damp sponge before decorating and make sure hands are clean. Sometimes corrected by sanding down rollback, reapplying color, reglazing and refiring.</li> </ul>
Purple Stroke & Coat colors are discolored or gray looking.	<ul style="list-style-type: none"> <li>a. Water vapor escaping during the firing process is trapped in glaze.</li> <li>b. Use of non-toxic clear glaze on top of colors.</li> </ul>	<ul style="list-style-type: none"> <li>a. Allow the piece to dry completely before firing. Use a slow ramp speed for the temperature.</li> <li>b. Some non-toxic clear glazes react with purple, producing a white hazy look. Sometimes refiring will help clear up the color. To achieve the best color development, clear glaze with either a leaded clear glaze or Mayco's non-toxic, lead-free dipping glaze, SC-209.</li> </ul>

## Problems & Solutions

<b>Problem</b>	<b>Cause</b>	<b>Solution</b>
Dipping glaze is too thick.	Dipping glaze loses water with use through evaporation.	Add small quantities of distilled water to glaze after dipping multiple pieces. Cover glaze when not in use.
Smeared colors after firing.	<ul style="list-style-type: none"> <li>a. Colors not dry prior to dipping or brushing.</li> <li>b. Color dragged or disturbed while brushing clear glaze.</li> <li>c. Incompatibility of other manufacturer's product.</li> </ul>	<ul style="list-style-type: none"> <li>a. Allow colors to dry completely before dipping or brushing.</li> <li>b. Remove excess water from brush before dipping in glaze. Water creates a barrier between bristles and glaze. Water softens the underlying colors, enabling it to smear as it is brushed.</li> <li>c. Some manufacturer's glazes are heavier and as a result, pull the colors down into the glaze during the firing.</li> </ul>
Pencil marks or lines left in fired color.	<ul style="list-style-type: none"> <li>a. Pencil too sharp and carves into surface of ware or color.</li> <li>b. Wax type of pencil used.</li> <li>c. Pencil or marking instrument was used on wet greenware or color.</li> <li>d. Top color did not cover or fill in design.</li> </ul>	<ul style="list-style-type: none"> <li>a. Never use a freshly sharpened pencil. Dull the tip on a piece of paper by scribbling several times.</li> <li>b. Some pencils have a waxy base which cause the colors resist (i.e. red marking pencil.)</li> <li>c. Apply design on top of dry color or greenware. Use a # 2 soft lead pencil for best results.</li> <li>d. Make sure when you fill in a design, you go over the design line slightly.</li> </ul>
Grit in glaze.	Fired or unfired clay dust in glaze.	<ul style="list-style-type: none"> <li>a. Before the bisque firing, remove excess dust with a dusting brush and a slightly damp sponge. Wipe down ware before decorating with a damp sponge.</li> <li>b. Strain dipping glaze using 80 mesh or finer sieve. Keep glaze tank covered when not in use.</li> </ul>
Fine black specks in flat ware.	<ul style="list-style-type: none"> <li>a. Dirty thermocouples.</li> <li>b. Soot being trapped glaze.</li> <li>c. Aluminum filings from drying racks.</li> </ul>	<ul style="list-style-type: none"> <li>a. Clean and vacuum kiln, wipe down thermocouples periodically.</li> <li>b. Allow more space between kiln shelves. Vary the size and shapes of pieces on the shelves.</li> <li>c. Use non-metal shelving for drying ware. As the shelves are pulled in and out, the metal surfaces grind and deposit filings on flat surfaces .</li> </ul>
Dipping glaze too thin.	Dipping glaze over thinned. Dipping glaze not stirred well.	Only add small quantities of distilled water to thin glaze. Do not add chemicals to thicken; let water evaporate to thicken the glaze. Mix for 10 minutes using a mechanical drill with glaze mixing blade.

**Firing**

<b>Problem</b>	<b>Cause</b>	<b>Solution</b>
Blisters, craters and pinholes in glaze.	<ul style="list-style-type: none"> <li>a. Bubbles formed and glaze cooled too quickly.</li>   <li>b. The glaze was fired on immature bisque.</li> </ul>	<ul style="list-style-type: none"> <li>a. Allow kiln to cool slowly, soaking the kiln. (Turning the kiln back on low for 1 hour after the kiln has shut itself off.) This allows the glazes to heal after the kiln has shut off. Do not leave kiln unattended.</li> <li>b. Bisque should be fired two cones hotter than the glaze.</li> </ul>
Reds develop darker spots in the color.	<ul style="list-style-type: none"> <li>a. Too heavy of application of color.</li>   <li>b. Insufficient amount of oxygen for the glazes to develop during firing.</li> </ul>	<ul style="list-style-type: none"> <li>a. Four coats of color is required for proper application.</li> <li>b. Keep kiln propped until the kiln goes onto high. Allow extra room around all pieces, including the stiltling of the piece and the shelves above. Do not place all like sized articles on one shelf during the firing.</li> </ul>
Plates have dark gray areas in the middle.	Unburned carbon not removed from the ware.	Do not stack pieces inside one another during the firing. Allow for proper ventilation and air circulation during the firing process. If piece has not been glazed, can be corrected by refiring the piece to one cone hotter. Then glaze as normal.
Greens migrate to light colored glazes.	Called oxidation (fuming, shadowing or flashing) where the oxides in the glaze migrate during firing.	Allow the pieces extra room when loading the kiln. Fire greens on top shelf when possible. Some colors are more susceptible than others, make a test to ensure this does not happen. Do not mix color companies' products without a test first.
Reds have turned gray.	<ul style="list-style-type: none"> <li>a. Insufficient amount of glaze on piece.</li> <li>b. Poor ventilation and air circulation during firing can greatly affect the color.</li>   <li>c. Overfiring of piece.</li> </ul>	<ul style="list-style-type: none"> <li>a. Apply 4 heavy coats of color.</li> <li>b. Allow proper ventilation and placement of pieces in the kiln during firing.</li>   <li>c. Fire reds to shelf cone 06. Do not soak or slow fire the colors if possible.</li> </ul>
Gloss glaze is matte.	This is underfired glaze.	Fire to the shelf cone mandated on glaze label. Do not fast cool the glaze firing.
Glaze crackles or crazes after firing.	<ul style="list-style-type: none"> <li>a. Immature bisque.</li>   <li>b. Glaze and body fit problem. This is called "coefficient of expansion" of the glaze to the clay.</li> </ul>	<ul style="list-style-type: none"> <li>a. Make sure the bisque is fired to the appropriate shelf cone for that clay to mature the ware.</li>   <li>b. Make sure glaze can be fired on that type of clay.</li> </ul>
Pieces melted during the firing.	Kiln overfired.	Check kiln system to make sure everything is in working order. Kiln should be cleaned before each firing. Go periodic checks and maintenance of the tube assembly and shut off hammer. Never leave kiln unattended while to avoid this problem.

# What's in a Word . . .

## Glossary

**Absorption** - The ability of a porous object such as plaster or bisque, to absorb water; the amount of moisture that will soak into an item.

**Accenting** - Emphasizing a portion of a design with highlights. A brighter color; outlining or partial outlining.

**Added Spare** - Cylinder of metal or plastic used to increase the volume of slip a mold can contain.

**Aesthetic Center** - A point in a picture that is just off of dead center.

**Aging** - Letting newly mixed slip or clay set for a prescribed time (days or weeks) without disturbing it. Allows the slip and clay time to blend and align the clay particles properly.

**Air Brush** - A spray gun used for applying glaze or color with the use of compressed air. Available in several varieties for work ranging from overall coverage to fine detail. Use care and proper safety equipment when air brushing.

**Airlock** - An air bubble which can interfere with the delivery of color through an airbrush or prevent slip from draining from a mold.

**Alcohol, Wood** - A solvent for cleaning blanks prior to overglaze decoration, or to clean your brushes with dried acrylic in them.

**Alumina** - One of the essential ingredients in all clay and glazes. Makes clays plastic and gives glazes their stiffness, preventing the glaze from running.

**Analogous** - Similar or comparable in certain respects; in color, neighboring colors on the color wheel.

**Annealing** - To hold at a specific temperature to prevent cracking. Glass must be annealed.

**Antiquing** - Wiping down applied color, leaving a darker tone in the crevices to accent details; to give an antique look to an object.

**Applique** - To apply some material decoration to ware: lace, yarn, clay, etc.

**Backing** - Paper on which decals are mounted.

**Balance** - The equal ratio of objects and/or color on two halves of a picture.

**Ball Mill** - A porcelain jar filled with flint pebbles and rotated with either a wet or dry charge of chemicals. It is used to grind and blend clays and glaze ingredients.

**Bands** - Rubber bands or adjustable straps used to keep the sections of a mold from opening during the pouring process.

**Banding Wheel** - A turntable, operated by hand or electricity, to facilitate decoration or hand building.

**Bar** - Type of pyrometric cone used to measure the heat work in a kiln and then allows the kiln sitter to operate.

**Binder** - Gum Arabic used to make glazes adhere to the ware.

**Bisque** - Ceramics that have been fired to the maturing point of the clay.

**Bisque, Soft** - Ceramics that have been fired to Cone 018 to give added strength or to set a color. Clay is still workable but can not go back into solution.

**Blistering** - Bubbles on a ceramic glaze surface.

**Blunger** - A container with an agitator for mixing slip.

**Body** - Refers to the basic material used to make up a piece. The clay. The body can be a mixture of material such as talc, clays, flint, feldspars and others. Bodies are often described by their composition, as a porcelain body, a white ware (talc) casting body, a jiggering body, a shale body.

**Bone China** - Clay to which bone ash has been added for translucency. Fine china tableware.

**Bone dry** - Greenware that is completely dry, containing no moisture.

**Boxing** - Firing two cups or bowls on top of each other, rim to rim, to prevent warping.

**Brush Cleaner** - Type of soap used to clean brushes; removes color and conditions the brush.

**Burnish** - To polish; term refers to a type of fired gold luster that has to be burnished to achieve its true color.

**Burnishing Brush** - A type of brush containing glass fibers bound together in a cylinder; used to burnish Roman Gold luster.

**Burnishing Sand** - A very fine textured English sand used to polish Roman Gold Luster.

**Camel Hair** - Term used for a very soft brush, usually made of squirrel or pony hair. Name comes from the man who made the brush.

**Casting** - The art of pouring slip in a plaster mold; also the object thus formed.

**Casting Slip** - A liquid clay used for casting a mold.

**Center of Gravity** - The point that would be reached at the base of an object if a weighted line could be dropped from the top center.

**Ceramics** - In broad terms, any type of clay that is fired into a permanent shape in a kiln. Any fired body.

**China** - A translucent body, usually imported.

**China Blanks** - Usually refers to commercially made white undecorated china used for china painting.

**China Painting** - Decoration of china using a type of overglaze colors and enamels.

**Clay** - Earth that is relatively pure alumina and silica; one of the material used in the manufacture of china and pottery.

**Clay Carbon** - Specially treated paper that will transfer a mark or pattern to a piece of ware.

**Clean-up Tool** - Tool used to clean (fettle) the seams on greenware.

**Cold Spot** - Area in the kiln that is cooler than the rest of the kiln.

**Color Wheel** - An arrangement of the primary, secondary and tertiary hues and tones.

**Combustion** - The process of burning.

**Complimentary** - Those colors that are directly opposite each other on the color wheel.

**Composition** - Arrangement of the parts of a design.

**Cone** - see pyrometric cone.

**Cone Plaque** - A cube of refractory material used to hold a pyrometric cone at 8° angle for proper deformation.

**Core Mold** - This mold has two or more cavities, but all are poured through the same pour hole.

**Crackle Glaze** - A glaze that has been specially formulated to produce a pattern of hairline cracks.

**Craters** - Bubbles that break and set as the kiln cools. Some times referred to as Fish Eyes.

**Crawling** - Glaze pulls together or beads up, leaving bare spots on the bisque.

**Crazing** - Refers to a glaze defect of hairline cracks that appear in a fired glaze. Can also be used to describe the hairline cracks forming in a crackle glaze.

**Critical Temperatures** - Room temperature to 212°F; 660°F to 930°F chemically combined water is driven out of the ware; 1000°F quartz inversion takes place; 1060°F lowest visible red heat; 1650°F orange to yellow heat in a kiln.

**Cross Hatch** - Criss-cross scratched marks where two piece of clay are to be joined. Also refers to the application of glaze at 45° angles to the previous coat.

**Crystals** - Specially formulated colored glazes that have been fired and ground up into various sized bits that melt into a glaze, forming bursts of colors.

**Decal** - A picture or design, usually overglaze color, sandwiched between a backing paper and a protective coating; the decal is slipped from the backing to the ware after a water treatment.

**Decorate** - To apply a design.

**Deflocculate** - To thin or increase the flowing quality of slip without adding water.

**Deformation** - Bending of a cone or object.

**Dehydration** - Loss of water through drying, evaporating or firing.

**Density** - Proportion of plaster to water; weight of any fluid as compared to the weight of water.

**Divitrification** - To take away or destroy the glassy qualities of; to make opaque, hard and crystalline by prolonged heating. Glass surface that has a wavy rippled quality to it.

**Dominant** - The most important part.

**Double Pour** - Casting the outside of a piece in color and the inside in another color of slip.

**Drain** - To empty, as in draining a mold.

**Drape Mold** - A plaster over which a rolled out slab of clay is draped to make free form dishes, bowls, etc.

**Draping** - To apply lace or other material to a figurine.

**Drybrushing** - Producing a feathery effect by using a dry brush with wet color; used also for animal fur. Can be done with One Strokes or Acrylics in similar techniques.

**Dryfooting** - Removing glaze from the portion of a piece that comes in contact with the kiln shelf during a glaze firing.

**Dunting** - Breaking of ware in the kiln from trapped air in the piece or from thermal shock from uneven heating or cooling.

**Earthenware** - Non-vitreous (porous) body made from low firing clays.

**Earth tones** - Buff, red, brown.

**Egyptian Paste** - Soluble sodium salts mixed with clay. During drying a salt deposit is left on the surface of the clay, which makes the clay self-glazing during firing.

**Electrolyte** - A substance which can have both a negative and positive reaction; Substance which causes the deflocculation of slip.

**Elements** - Wires that carry the electric current that heats the kiln.

**Elephant Ear Sponge** - Thin, fine grained natural sponge shaped like an elephant ear.

**Embossing** - Creating a raised design.

**Emery Stone** - An abrasive stone used to remove stilt marks from the bottom of ware.

**Emphasis** - Making one portion of a design more important than the rest of the design.

**Englobe** - A prepared slip which is half way between a glaze and a clay; contains clay, feldspar, flint, flux and colorants.

**Essence** - Solvent used for thinning gold and lusters.

**Etch** - To produce a design with the use of acid or mechanical means.

**Exfoliation** - To come off in layers, flakes or scales.

## Glossary

**Extrude** - To draw out; force or press out; force through a narrow opening, as clay.

**Face** - The outside surface of a mold.

**Fat Oil** - A china painting medium produced by the evaporation of gum turpentine.

**Ferrule** - The metal band that holds the bristles of the brush and the handle together.

**Fettle** - To trim the spares from cast pieces or the seam lines from greenware.

**Fettling Tool** - A soft knife or hard blade knife to trim and remove the mold spare or seam line.

**Filler** - Any material that will promote drying and lessen shrinkage of clay, i.e. grog.

**Finger Tool** - Needle fine sawtooth tool for cleaning the fingers of figurines. A fine steel tool for the same purpose.

**Fire Brick** - A refractory brick which withstands high temperatures; used in building kilns.

**Firing** - Maturing ceramic products at recommended heats.

**Firing Chamber** - The interior of the kiln.

**Fit** - The adjustment of glaze to the clay; the shrinkage rates are the same for the glaze and clay to be compatible. Improper fit results in shivering of the glaze(s).

**Fitch Hair** - Hair used in making stippling brushes. Hair is stiffer than Camel hair.

**Fixative** - A coating used to seal or fix colors.

**Flashing** - A reaction of one glaze onto the surface of another; cause by chrome in the glaze fuming during the firing.

**Flint** - A form of quartz; a refractory material.

**Flocs** - Thin, flat oval crystals that cling together and form a compact mass, as in clay.

**Flow** - To move in firing.

**Flux** - A substance which will lower the melting point of ceramic products.

**Foot** - Base of ware.

**Free form** - Having no specific geometric form.

**Frit** - Glass which has been melted, cooled and ground to a fine powder; used in glaze and enamels.

**Fuse** - Join by melting together.

**Fusion Point** - Degree of heat at which particles will melt together.

**Gang Mold** - Several castings can be produced at the same time in one mold; each casting has its own pour hole.

**Glassification** - Melting into a glass; i.e. Glaze.

**Glaze** - A glass coating on a ceramic piece.

**Glaze Butting** - The specific placement of two glazes together so they do not run together. a.k.a. Controlled Glazing.

**Glaze, Dipping** - Type of glaze especially designed for a dipping process.

**Glaze trailing** - The placement of a glaze or color through a squeeze bottle.

**Gloss Glaze** - A shiny glaze with a high reflective surface, unlike a matte or satin glaze.

**Gold, Dry** - Chemically pure gold.

**Gold, Glass** - Gold formulated to flux at cone O22 maturing the color.

**Gold, Liquid Accent** - A form of gold held in colloidal suspension; fires bright but has less carat content of the gold.

**Gold, Liquid Bright** - A form of gold held in colloidal suspension; fires bright, high carat content of gold. A brighter and more reflective surface than Accent Gold

**Gold, Paste** - Has a higher gold content than liquid Roman; fires dull, must be burnished.

**Gold Roman** - Fires dull, must be burnished.

**Graining** - Creating a wood grain with glaze or acrylic stains; opaque or translucent.

**Graphite Paper** - Similar to carbon paper; used to transfer designs to china.

**Greenware** - Clay item before it is subjected to bisque firing.

**Grid** - A series of uniform squares.

**Grind** - To eliminate grit from powdered color by mixing with flat side of a palette knife.

**Grit Cloth** - An abrasive cloth for cleaning greenware.

**Grit Pad** - A foam backed abrasive pad used in sanding or cleaning.

**Grog** - Finely ground up bisque added to clays to reduce the shrinkage or for thermal shock.

**Gum Arabic** - A water soluble gum obtained from several acacias; used in adhesives as a binder.

**Gum Tragacanth** - A tasteless odorless white or reddish gum obtained from several shrubs; used in glazes to keep material in suspension.

**Hard Paste** - Refers to a type of very hard fine porcelain.

**Hard Spot** - A spot on the greenware that resists decoration. Can follow through to the bisque.

**Hard Bisque** - Term given to bisque that is fired to its hottest temperature before it goes liquid.

**Harmonious** - A color scheme chosen by some numerical sequence.

**Haze** - A cloudy deposit on gold or luster cause by insufficient ventilation during firing.

**Horizon Line** - Point at which sky and land or water seem to meet, at sea level.

**Horizontal** - Parallel to the horizon.

**Hot Spot** - Any area in the kiln that fires to a hotter cone than the rest of the kiln.

**Hump** - A plaster shape on which a clay slab can be draped to make a free form bowl or dish.

**Hydrometer** - A device to measure the density of a liquid.

**Immature Bisque** - Bisque which has not been fired to the proper temperature to mature the clay and drive all carbons and impurities from the ware.

**Impervious** - Cannot be penetrated.

**Incise** - To cut into the clay or greenware surface making a design.

**Incompatibility** - Ceramic materials that cannot be used together because of undesirable chemical reactions.

**Insulating Brick** - A soft refractory brick which can be easily carved and is used to line hobby kilns. Both firebrick and insulating brick are available in different degrees of refractoriness and should be chosen according to the temperature they must withstand.

**Intaglio** - An incised design in which the carving is done in several depths.

**Jigging** - Forming a pot between a revolving mold which shapes the outside and a template which shapes the inside.

**Kaolin** - A clay used for whiteness in some clay bodies; main ingredient in porcelain.

**Key** - Notches cut on the seams of a mold so that the sections will always fit in the same manner.

**Kidney** - See rubber kidney.

**Kiln** - A heating chamber for maturing clay glazes and other ceramic materials.

**Kiln Furniture** - See furniture.

**Kiln Wash** - A refractory coating for kiln shelves to protect them from dripping glaze.

**Knead** - To condition clay.

**Lace Tool** - A tool with a needle tip to facilitate the arrangement of lace on a figurine.

**Lawn** - To sift dry color through closely woven material.

**Leach** - To cause (a liquid) to filter down through some material; to extract a soluble substance from some material (as lead leached from glaze by an acidic liquid - i.e. orange or tomato juice).

**Lead Safe** - A glaze that has been tested and meets government standards as safe for food and drink containers.

**Leatherhard** - Cast or handbuilt pieces that are firm enough to hold their shape without warping, but can still be cut into easily; stick-ons can still be attached.

**Liner** - A long bristle pointed brush used for lines and scrolls.

**Lint-free** - Any cloth that does not produce lint; silk, old sheeting, etc.

**Lock Washer** - Washer used to keep nuts from loosening.

**Loading** - Filling the brush with color; stacking the kiln.

**Luster** - An overglaze that gives a lustrous iridescent finish to glazed ware.

**Luting** - Joining leatherhard clay sections together with slip.

**Majolica** - Glaze on glaze decoration.

**Marbleizing** - Creating the effect of marble with any color medium.

**Masking** - Blocking out sections of a design that are to be painted.

**Matte** - A dull, non-reflective surface; the opposite of glossy.

**Maturity** - In ceramics, bisque that has been fired to the point where it will no longer expand when absorbing moisture; point where underglaze, glaze and overglaze reveal their true color and state (gloss, matte, etc.)

**Maturing Point** - Temperature where the clay or color becomes fully developed.

**Medium** - Fluid used with colors to facilitate painting.

**Mender** - A product to repair broken greenware, or attach stick-ons.

**Migrate** - Tendency of certain glazes to travel to neighboring pieces during firing; caused by the chrome in the coloring; referred to as Flashing, Fuming or Shadowing.

**Mildew** - A fungus that produces dark spots on damp molds when they are stored without sufficient air circulation; can cause molds to deteriorate rapidly. Also dark spots developing under glaze on china that was not glaze and or fired properly.

**Mishima** - Inlaid slip decoration

**Modeling Clay** - Clay used for hand building or throwing.

**Mold** - A plaster form used to produce identical objects by pouring liquid slip into the hollow cavity, then draining.

## Glossary

**Mold Cavity** - The hollow section of a mold that is a negative of the finished casting. That part which is filled with slip to form the casting.

**Mold Rubber** - Liquid rubber used to make stamps of simple designs or master molds.

**Monochromatic** - A color scheme composed of various tints, shades and tones of a single color.

**Nichrome** - A heat resistant wire.

**Nipples** - Clay bumps left on the bottom of food and drink containers by improper draining of the mold in pouring. Threaded sections of pipe used to connect lamps.

**Non-Toxic** - That which is not toxic. Can be used with little worry as to any contaminants and hazardous material in them.

**Opacifier** - A material used to make a translucent color more opaque. White is an opacifying color.

**Opaque** - Not transparent; completely covers any other color underneath; does not allow light to filter through.

**Open** - Refers to a color that remains the form of an insoluble powder, workable for a long period of time.

**Overglaze** - Any decorating material that is applied on top of a fired glaze and has the firing range of cone 022 to 014.

**Oxidation** - Combining with or reacting to oxygen; iron rust or combining with oxygen; some green glazes may oxidize and turn black during an 018 firing.

**Palette** - Glazed tile or glass on which colors are placed for mixing and painting from.

**Palette Knife** - Flexible knife used for grinding color.

**Parallel** - Two lines that are the same distance from each other throughout their length.

**Peephole** - Openings in the side of the kiln through which you can view a pyrometric cone.

**Perpendicular** - A line that is at a right angle to another line.

**Perspective** - The science of paintings and drawing so that objects represented have apparent depth, distance and third-dimension.

**Pierced Carving** - A type of design formed by cutouts in the ware. Usually done on leatherhard greenware.

**Pigments** - A coloring agent; usually in the form of an insoluble powder, ground with water, oil or acrylic.

**Pinholes** - A glaze defect caused by underfiring, glazing on greenware and/or condition of greenware.

**Plaster** - A white powder made of gypsum; quick setting when added to water which molds are made.

**Plaster Clay** - A non-hardening modeling clay.

**Plasticity** - The pliability of modeling clay.

**Plug** - A cone shaped section of refractory material used to close the peepholes in the kiln during firing.

**Polish** - To buff to a shine.

**Pooling, Puddling** - Glaze which runs to the bottom of a bowl or dishes or fills in the crevices.

**Porcelain** - A high-fire translucent, vitreous body.

**Porosity** - The ability of an object to absorb moisture.

**Posts** - Square, triangular or cylindrical sections of refractory material used to support shelves in the kiln; may be stacked.

**Potters Wheel** - Used for throwing clay pots; may be manually or electrically driven.

**Pottery** - Any low-fire object formed from clay.

**Pounce** - To pat; also the powdered graphite used to transfer pieced patterns.

**Pour Gate** - Area of mold that slip is poured into; area that holds the excess slip to allow for absorption and ensure a proper casting.

**Pouring** - See Casting.

**Press Mold** - Shallow molds used by pressing soft clay in the cavities; may also be used by pouring slip in the cavities.

**Primary Colors** - The three basic colors are Red, Yellow and Blue.

**Prism** - Three sided glass or crystal object that breaks up light into rainbow colors.

**Pug Mill** - A machine for mixing and extruding plastic clay.

**Pyrometer** - An instrument for measuring degrees of heat beyond those shown on the average thermometer.

**Pyrometric Cone** - Pyramids; compounded of ceramic materials controlled to melt at specific time, temperature relationships used to control heat treatment of ceramic products.

**Quill** - A type of brush used for china painting.

**Raw Glaze** - A glaze that contains no fritted material.

**Raised Paste** - An overglaze material used for a base for a raised gold design.

**Red Heat** - Point at which the interior walls of the kiln and the ware glow red; 1060° F.

**Reduction Firing** - Firing with a reduced oxygen supply. Opposite of Oxygen firing, which is what low-fire glazes need to develop.

**Refractory** - Materials that are hard to melt or work.

**Release Time** - Length of time needed before a casting can be removed from a mold.

**Relief** - A raised design.

**Renuzit** - A dry cleaning material used to clean rubber stamps.

**Rib** - A rubber, metal or wooden tool used to facilitate wheel throwing of ceramic forms.

**Rod, Actuating** - That portion of the kiln sitter which drops as the cone deforms, causing the kiln to shut off.

**Rolling Glaze** - Covering the inside of ware by pouring in thinned glaze, rolling it around the inside surface and then pouring it out.

**Rouging** - Applying color lightly with cloth or finger, or with a pounce.

**Rubber Kidney** - A kidney shaped piece of hard rubber used in shaping wheel-thrown pieces.

**Running** - The fluidity of a glaze at its maturing point and before it cools and hardens.

**Rhythm** - The flow and movement of lines and color in a design.

**Sagger** - A refractory support for firing porcelain plates and other shapes that might warp from their own weight; also a support for firing glass.

**Sable** - Animal hair used to make the finest, most resilient brushes. Red sable is considered the finest of the hair types.

**Satin** - A glaze that produces a soft sheen between a gloss and a matte surface.

**Saturation Point** - Point at which an object can absorb no more moisture.

**Scoring** - The marking into the surface of the piece.

**Scum** - A haze that forms on fired gold and luster from insufficient ventilation in the kiln.

**Sealer** - A coating which closes the pores of bisque or other porous materials.

**Seam** - The ridge left on greenware at points where the mold sections join. The surface areas of a mold that meet when the mold is banded together.

**Secondary** - Those colors on the color wheel that are made by mixing two primary colors together; green, violet and orange.

**Set-Up-Time** - Length of time that casting slip must remain in the mold to form the wall of the casting.

**Setter** - A refractory holder on which porcelain dishes are fired to prevent warping; see saggers.

**Settle Out** - Particles of color settle to the bottom of the jar when the water balance is disturbed.

**Sgraffito** - Cutting through color or a layer of colored clay to produce a design.

**Shade** - Any hue that has been deepened by the addition of black. See tints and tones.

**Shelf Cone** - Pyrometric cone used to tell the temperature at which the temperature on the shelf has been completed using heat work. The actual cone temperature.

**Shelf Support** - See Post.

**Shivering** - Where glaze peels off from the ware because the ware shrinks more than the glaze; a body fit problem.

**Short** - Stiff clay body caused by low moisture content; lacking plasticity.

**Shrinkage** - Decrease in the size of the clay object as a result of drying and firing. About 5 percent in low-fire.

**Silica** - One of the basic ingredients in glaze.

**Silicate of Soda** - Water glass. See Sodium Silicate.

**Silk Sponge** - A fine textured sponge used for decorating.

**Sitter** - A device that is activated by the deformation of a pyrometric cone, causing the kiln to shut off.

**Slab** - A rolled out section of clay.

**Slake** - To reclaim dried up clay; it is pounded into small pieces and covered with water; only completely dry clay can be slaked. All modeling clay may be reclaimed. However, reclaiming clay to return to the slip batch is a dangerous practice and should be avoided.

**Sling** - Burlap used to cradle clay to make a slab bowl.

**Slip** - A fluid suspension of clay and other chemical materials in water.

**Slip Trailing** - Decorating leatherhard greenware with slip applied from a bulb or bottle with a narrow nozzle.

**Slurry** - A clay body of creamy consistency; used for joining moist clay together.

**Soak** - To hold a kiln at one temperature for a period of time.

**Soda Ash** - A deflocculant.

**Sodium Silicate** - Water Glass; a deflocculant.

**Soft Fire** - Greenware fired to cone 018; accepts underglaze color in the same manner as greenware but is more durable.

**Soluble** - Able to be dissolved in water.

**Solvent** - Any fluid that will dissolve or remove color.

**Spare** - The scrap of clay that is cut off of every casting an area of the mold that increases the volume of the mold; see pour gate.

**Sponge** - See specific types of sponges; seawool, silk or elephant.

**Spatter** - Method of applying flecks of color, usually with a bristle brush

## Glossary

**Spray** - To apply color by means of some type of air supply.

**Sprig** - A clay trim, made in a press mold and attached to a leatherhard casting with mending slip.

**Spur** - A metal tripod used to stilt glazes ware during the firing.

**Stack** - To load the kiln.

**Stain** - Acrylic type of non-fired paint used to decorate bisque; a clay or glaze pigment.

**Stamp** - A raised rubber pattern used to transfer or apply a design; a fired clay cylinder used to texture clay slaps or pots.

**Stamping Oil** - Medium used with rubber stamps to hold dry color to design.

**Stencil** - A cut-out pattern used to apply a design by brushing, sponging, stippling or spraying.

**Stick-On** - Handles, knobs, sprigs or any attachment to a casting.

**Stilt** - A refractory tripod or bar with nichrome wire prongs used to raise ware off the kiln shelf during a glaze or overglaze firing.

**Stipple** - To apply color with a series of tiny dots.

**Stippler** - A brush used to produce a series of tiny dots; also used to blend colors.

**Stoneware** - A clay to which a high percentage of grog has been added; Needs to be high-fired to vitrify.

**Strength** - The percentage of pure color in a shade, tint or wash.

**Stylus** - A pointed instrument for writing or drawing. Used to transfer a design.

**Subdominant** - Less important part of a design.

**Talc** - Used as a flux for clay; also used as a mold release.

**Tint** - Hue made with the addition of white.

**Tipping** - Involves touching tip of loaded brush with other colors for muted shading or accenting

**Thermal Shock** - The abrupt change of temperature to the ware.

**Template** - A pattern or guide.

**Tone** - Color plus a neutral gray.

**Toxic** - Poisonous.

**Translucent** - Able to transmit light as frosted glass, parchment, sheer fabric. Diffuses the color or light.

**Transparent** - Easily seen through as glass. No interruption of light or color.

**Underglaze** - A mineral color, usually containing some clay and binder; regular underglazes are opaque and contain a higher

percentage of clay than One Strokes; most One Strokes are translucent.

**Utilitarian Ware** - Any object that will hold or contain food or liquid drink.

**Vanishing Point** - A point on the horizon line at which the lines of an object appear to converge; see perspective.

**Venting** - Propping the lid of the kiln open to slight degree or leaving out peephole plugs until moisture and carbonaceous impurities have been burned out of the greenware. ( Usually until temperature reaches red heat). Also the piercing of any portion of a casting in which air could be trapped. ( Trapped air expands with heat and can cause the piece to explode or swell).

**Viscosity** - The thickness of a liquid; internal friction of a fluid, cause by molecular attraction; resistance to flow.

**Vitrified** - A body which fuses sufficiently during firing so that it is water tight without glazing.

**Vitreous** - Water tight.

**Warping** - Deformation of a clay shape cause by uneven stresses during shaping, drying or firing.

**Wash** - A color diluted with water or suitable solvent used for shading and antiquing.

**Water Glass** - Silicate of soda; mender and deflocculent.

**Water Smoking** - The firing period during which all water is driven from the ware. Room temperature to 212°F.

**Webbing** - Material used for making straps.

**Wedge** - To condition and work clay into a bubble free mass for throwing or handbuilding.

**Wheel** - Turn table operated by foot or electricity for producing round pots.

**Witness Cone** - See shelf cone.

**Wool Sponge, Sea** - A very open texture and very absorbent natural sponge. Used for uneven textures and veiling techniques.

# Mauco® Quick Reference Guide

## CLAY

Product	Surface	Fired Color	Firing Range	Uses	Types of Clay	Notes
<b>Earthenware Pottery or Ceramic Clay</b>	Not Vitreous	Usually white-to-off-white	Shelf cone 06-02 Opaque after firing	Ornamental and Dinnerware pieces	Pug Clay, Wet and Dry Slip	<ul style="list-style-type: none"> <li>Least expensive of all clays.</li> <li>Most common and easiest to use.</li> <li>Bisque must be glazed to make watertight; earthenware is a low-fired porous body.</li> <li>Dinnerware has a greater tendency to chip and craze than vitreous ware.</li> <li>Can be used with both fired and non-fired finishes.</li> <li>Can be used in a slip form for casting molds, for hand-built items and for wheel throwing.</li> <li>Shrinks very little during firing.</li> <li>Fired in 5 to 7 hours</li> </ul>
<b>Stoneware</b>	Not Totally Vitreous	Buff or Gray in Color	Shelf cone 06 – 10 Opaque after firing	Ornamental and Dinnerware pieces	Pug Clay, Wet and Dry Slip	<ul style="list-style-type: none"> <li>Most hobbyist can not fire stoneware to a totally vitreous state so food and drink containers must be glazed.</li> <li>Stoneware is much stronger and more chip resistant than earthenware.</li> <li>Shrinks in the firing by at least 15-20%.</li> <li>Can use a leaded glaze on surface as high degree of heat attained combines the lead in a form that is not released or leached out by food or drink.</li> <li>Can be used in a slip form for casting molds, for hand-built items and for wheel throwing.</li> <li>Can also add grog to strengthen clay for larger pieces.</li> <li>Needs to be fired slowly, in no less than 10 hours.</li> </ul>
<b>Porcelain</b>	Vitreous	Normally white; can come in some colors	Shelf cone 2-10. Some industrial porcelains may reach cone 30. Translucent after firing	Dinnerware and Fine Detail Items	Pug Clay, Wet and Dry Slip	<ul style="list-style-type: none"> <li>Does not need to be glazed, pieces that are to be used for food or drink are glazed for sanitary reasons.</li> <li>When clear glazed, porcelain becomes china.</li> <li>Will shrink in the firing up to 20%.</li> <li>Needs to be fired slowly in no less than 10 hours.</li> </ul>

# Mawco® Quick Reference Guide

## FIRING

Product	Time	Cone	Temp. & Ramping Rate	Vented Kiln	Non-vented Kiln	Notes
<b>One Strokes Opaque Underglazes Astro Gems</b>	6-8 hrs. for shelf cone 04 8-10 hrs. for shelf cone 6 or higher	Shelf cone 04 - 6. Check Higher than 6 testing for color hold should be done.	1940 with 350 Ramping Speed; Mid-range cone 6 - 2194 to 2232 High-fire to cone 9-10.	Close and Fire	Top peephole left open throughout firing.	<ul style="list-style-type: none"> <li>Pieces should not touch when loading the kiln.</li> <li>Astro Gems: remove large crystals from bottom of ware and lids.</li> <li>Do not stilt greenware unless have too. Never stilt when high firing.</li> <li>If opaque underglazes and one strokes are not as dark as the chip chart, they may be underfired.</li> </ul>
<b>Glazes</b>	5.5-8 hrs.	06 - 6	1830 with 350 Ramping speed	Close and Fire	Top peephole left open throughout firing.	<ul style="list-style-type: none"> <li>Pieces can not touch when loading kiln.</li> <li>Pieces should be finished on bottom unless doing stoneware or porcelain.</li> <li>Should stilt pieces before firing unless firing to cone 6 or higher.</li> <li>If piece is underfired, glaze may appear milky or cloudy.</li> <li>Can refire.</li> <li>If high fired glazes should be applied to greenware or pieces fired to 04 then fire to bisque.</li> </ul>
<b>Lusters</b>	3 1/2-4 hrs.	022 018 015	11112 1323 1479 350 Ramping Speed	Close and Fire	Top peephole left open and lid propped throughout firing.	<ul style="list-style-type: none"> <li>Read product labels as to firing instructions and temperature.</li> <li>Too hot a firing can cause defects.</li> <li>Too low of a temperature can result in color wiping off after firing.</li> <li>Stilt all pieces.</li> <li>Products need extra venting room when loading kiln.</li> </ul>
<b>Greenware/ Earthenware</b>	5-8 hrs.	04	1940 350 Ramping Speed	Close and Fire	Top peephole open for first hour of firing.	<ul style="list-style-type: none"> <li>Should not load ware when wet and moist.</li> <li>Should never touch another piece during firing.</li> <li>Remove all excess dust prior to firing.</li> <li>Do not stilt unless necessary.</li> </ul>
<b>Stoneware</b>	8-10 hrs.	6-10	2232 – shelf cone 6 350 Ramping Speed	Close and Fire	Close and Fire Top peephole open for first hour of firing.	<ul style="list-style-type: none"> <li>Should not load ware when wet and moist.</li> <li>Should never touch another piece during firing.</li> <li>Remove all excess dust prior to firing.</li> <li>DO NOT STILT.</li> <li>Must use separator on box lids and pieces that will touch.</li> <li>Use porcelain sand or alumina hydra as separator.</li> <li>Better to slow the firing down than to fire fast.</li> </ul>
<b>Porcelain</b>	8-10 hrs.	6-10	2232 350 Ramping Speed	Close and Fire	Close and Fire Top peephole open for first hour of firing.	<ul style="list-style-type: none"> <li>Should not load ware when wet and moist.</li> <li>Should never touch another piece during firing.</li> <li>Remove all excess dust prior to firing.</li> <li>DO NOT STILT.</li> <li>Must use separator on box lids and pieces that will touch.</li> <li>Use porcelain sand or alumina hydra as separator.</li> <li>Better to slow the firing down than to fire fast.</li> </ul>

# Mayco® Quick Reference Guide

## PRODUCTS FOR GREENWARE

Product	Health Status	Mayco Book	Firing Range	Applied By:	General Application	Notes
<b>Opaque Underglazes</b>	Non-toxic Non-moving when fired.	Pg. 19	Shelf cone 04-6. Some colors can hold to shelf cone 9-10. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Greenware only. Can be used to antique detailed bisque.	<ul style="list-style-type: none"> <li>Ready to use from jar.</li> <li>Apply in three even coats, if color streaky not enough color applied.</li> <li>Generally used as an all over coverage.</li> <li>Can be polished, does not have to be glazed.</li> <li>Intermixable</li> <li>Apply clear glaze after 04 firing to bring out true color of product.</li> <li>Fire to shelf cone 06.</li> <li>UG-84, 85 &amp; 86 will all fire to shelf cone 10.</li> <li>If surface not glazed, use Repellent Sealer AC-301 to make soil resistant</li> </ul>
<b>One Stroke™ Translucent Underglaze</b>	Non-toxic Non-moving when fired.	Pg. 22	Shelf cone 04-6. Some colors can hold to shelf cone 9-10. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Can be used on greenware and/or bisque. Can be used for design work on top of non-moving glaze for Majolica technique	<ul style="list-style-type: none"> <li>Must thin before use; highly concentrated color. Use AC-304 Media or water to condition or thin.</li> <li>Translucent</li> <li>Used for brushstroke designs, in one stroke of the brush; can be used in all over coverage with multiple coats.</li> <li>Can add to Opaque Underglazes, Astro Gems, glazes and liquid slip to tint color.</li> <li>OS 44, 45 and 46 will fire to shelf cone 10.</li> </ul>
<b>Astro Gem® Textural Glaze</b>	Non-toxic Non-moving when fired.	Pg. 24	Shelf cone 04-6. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply to greenware or bisque. Greenware preferred due to drying time and fit.	<ul style="list-style-type: none"> <li>Apply in three even coats.</li> <li>Intermixable</li> <li>Surface is stone-like with matte finish. Contain two sizes of tiny crystals.</li> <li>Can use on outside of food containers but not inside.</li> <li>Piece must be stilted, if you wipe off large crystals after application of each coat piece does not need to be stilted. Do not stilt stoneware or porcelain; dryfoot the piece if using Astro Gems on the bottom surface.</li> <li>Can use Mother of Pearl. If using fired gold, apply and fire clear glaze on the area where gold is desired.</li> <li>Porous surface, use Repellent Sealer (AC-301) for water-resistant surface</li> </ul>

# Mayco® Quick Reference Guide

## GLAZES: NON TOXIC

Product	Health Status	Mayco Book	Firing Range	Applied By:	General Application	Notes
<b>Series 2000 - Gloss, Speckle &amp; Stoneware-like Glazes</b>	Non-toxic Non-moving when fired.	Pg. 16	Shelf cone 06-6. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply to properly fired 04 bisque. If firing to cone 6 or higher, apply to the clay in the greenware or low fired bisque-04 stage.	<ul style="list-style-type: none"> <li>• Apply 3 to 4 coats.</li> <li>• Intermixable</li> <li>• If doing majolica technique with mattes, best to apply an additional coat. When handling you wipe off color.</li> <li>• Very important that bisque be fired 2 cones hotter than glaze firing.</li> <li>• Series 2000 Clear glazes and Speckled Clear glazes should be applied in 2 coats.</li> <li>• If pitting occurs, can be refired one cone cooler than original firing for smooth surface.</li> </ul>
<b>Elements</b>	Non-toxic Non-moving when fired.	Pg. 14	Shelf cone 06-6. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply to properly fired 04 bisque. If firing to cone 6 or higher, apply to the clay in the greenware or low fired bisque-04 stage.	<ul style="list-style-type: none"> <li>• Apply 3-4 flowing coats.</li> <li>• Intermixable</li> <li>• The shape of the object, application, firing temperature, kiln load and firing time all affect the flow pattern.</li> <li>• Natural earth tones.</li> <li>• Surfaces vary from gloss to matte.</li> </ul>
<b>Classic Crackles</b>	Non-toxic Non-moving when fired.	Pg. 12	Shelf cone 06-6. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply to properly fired 04 bisque. These glazes are more fluid at cone 6, apply two coats only.	<ul style="list-style-type: none"> <li>• Apply 3 even flowing coats.</li> <li>• Can work under Classic Crackle using Stroke &amp; Coats or One Strokes. If applying more than 2 light coats this technique will change the cracking pattern.</li> <li>• Can work on top of the Classic Crackle with Stroke &amp; Coats and One Stroke, but test design first as color will fume.</li> <li>• Cracks need to be stained after firing for cracks to show up. Can use ink, translucent stains, shoe polish, etc.</li> </ul>
<b>Crystallites</b>	Non-toxic Non-moving when fired.	Pg. 13	Shelf cone 06-6. Check High Fire Guide for color changes at shelf cone 6.	Soft Fan Brush	Apply to properly fired 04 bisque. If firing to cone 6 or higher these glazes become more fluid. Do not add crystals any closer than 1/2" up from the outside bottom edge of high fire pieces.	<ul style="list-style-type: none"> <li>• Apply 3 flowing coats. First coat- shake jar then apply coat of color. Second coat: shake jar and apply coat. Third coat: stir the jar and shake before applying.</li> <li>• Crystallites do not flow, they just spread or bloom out.</li> </ul>

# Mayco® Quick Reference Guide

## GLAZES: NON TOXIC

Product	Health Status	Mayco Book	Firing Range	Applied By:	General Application	Notes
<b>Stroke &amp; Coat® Wonderglaze for Bisque</b>	Non-toxic Non-moving when fired.	Pg. 11	Shelf cone 06-6. Some colors can hold to shelf cone 9-10. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply 1 to 3 coats to properly fired 04 bisque. If firing to cone 6 or higher can be applied to the clay in the greenware or low fired bisque-04 stage.	<ul style="list-style-type: none"> <li>One, two or three coats governs the fired color.</li> <li>Intermixable</li> <li>Can use on top of non-moving glazes for Majolica.</li> <li>Can be used as an antique under non-moving glazes.</li> <li>Product is a glaze. Can clear glaze; if using 3 coats do not need to clear glaze.</li> <li>Unfired color is basically true to the fired results.</li> <li>Colors can be layered to build depth in design.</li> <li>Shiny when used under a gloss glaze.</li> <li>Shiny when used over a S-2000 opaque glaze.</li> <li>Shiny when used in multiple coats or heavily over a matte glaze.</li> <li>Matte when applied in washes or light coats over matte glazes.</li> </ul>
<b>Speckled Stroke &amp; Coat®</b>	Non-toxic Non-moving when fired.	Pg. 11	Shelf cone 06-6. Some colors can hold to shelf cone 9-10. Check High Fire Guide for changes at shelf cone 6.	Brush/Sponge	Apply to properly fired 04 bisque. Same as Stroke & Coat®	<ul style="list-style-type: none"> <li>Speckles have a variety of speck colors.</li> <li>Also correspond with a Stroke &amp; Coat® color.</li> <li>All other features same as Stroke &amp; Coat®</li> </ul>
<b>S-2000 Wonder Clear Dipping</b>	Non-toxic Dinnerware Safe	Pg. 25	Shelf cone 06-6.	Dipping	Apply to properly fired 04 bisque	<ul style="list-style-type: none"> <li>Lightens SC-13 Grapel and SC-33 Fruit of the Vine.</li> </ul>
<b>SC-209 Clearly-the-Best Dipping</b>	Non-toxic Dinnerware Safe	Pg. 22	Shelf cone 06-6.	Dipping	Apply to properly fired 04 bisque	<ul style="list-style-type: none"> <li>Dries faster, uses less product.</li> <li>Does not lighten purples of Stroke &amp; Coats.</li> </ul>

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Pottery Coat	Non-toxic Non-moving when fired	Pg. 15	Shelf cone 06-6. Check High Fire Guide for color changes at shelf cone 6.	Soft Fan Brush	Apply 3 even coats to properly fired 04 bisque.	<ul style="list-style-type: none"> <li>• Shake jar well before application.</li> <li>• Apply coats at right angles to minimize brush marks.</li> <li>• To use on a functional item, such as dinnerware, you must apply clear glaze to seal the surface.</li> <li>• Used alone, Pottery Coats are porous and not recommended for use with dinnerware or other functional items.</li> <li>• Not overglaze compatible.</li> <li>• Best looks are achieved when used as a base coat in combination with Pottery Cascades and a flowing non-toxic glaze, such as Elements.</li> </ul>
Pottery Cascades	Non-toxic Moves when fired	Pg. 16	Shelf cone 06-6. Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge/ Squeeze Bottle	Apply 1-3 coats to properly fired 04 bisque. Do not apply below the halfway point of the piece.	<ul style="list-style-type: none"> <li>• Can be applied over, under and in between other glazes and dabbed on at random, evenly or unevenly to create different flow patterns.</li> <li>• Should be used in conjunction with other non-toxic glazes</li> <li>• Clear Cascade moves more than White, Amber and Black Cascade when fired, allowing the color of the base glaze to show through.</li> <li>• Shape of the piece affects the performance of the glaze.</li> <li>• Overglaze compatible.</li> </ul>
Pottery Coat Stucco	Non-toxic Non-moving when fired		Shelf cone 06-6. Check High Fire Guide for color changes at shelf cone 6.	Soft Fan Brush	Apply 3 even coats to properly fired 04 bisque.	<ul style="list-style-type: none"> <li>• Stir Pottery Coat Stucco using a stir stick. Recap jar and then shake well.</li> <li><sup>a</sup> After applying three even applications, check the piece to make sure the texture is evenly distributed. Apply texture in areas that may have been left bare.</li> <li>• Used alone, Pottery Coat Stuccos are porous and not recommended for use with dinnerware or other functional items.</li> <li>• If piece is to be placed on furniture, apply felt tabs to the bottom to protect furniture from the rough texture of the glaze.</li> </ul>

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## GLAZES: LEADED

Product	Health Status	Mayco Book	Firing Range	Applied By:	General Application	Notes
<b>Art Glazes</b>	Foodsafe glazes are marked with a star* symbol	Pg. 27	Shelf cone 06-6 Check High Fire Guide for color changes at shelf cone 6	Brush/Sponge	Apply to properly fired 04 bisque. If firing to cone 6 or higher, apply to the clay in the greenware or low fired bisque-04 stage.	<ul style="list-style-type: none"> <li>• Apply three full flowing coats unless noted differently on the jar.</li> <li>• Glaze that produces lustrous finishes, dual coloring, multi or single colored specks, gold or metallic flecks, or a grained or metallic look is classified as an Art Glaze.</li> <li>• Great to use in glaze combinations and can be applied one, two or three coats.</li> <li>• Apply smoothly to plain surfaces to avoid a spotty finish.</li> <li>• If applying to stoneware or porcelain, may need to thin product and apply less color.</li> </ul>
<b>Bisque Glazes</b>	Not for Food Items	Pg. 32	Shelf cone 06. Will not high fire cone 6 or higher.	Brush/Sponge	Apply to properly fired 04 bisque.	<ul style="list-style-type: none"> <li>• Apply four full flowing coats, allowing each coat to dry between applications.</li> <li>• Make sure hands and brushes are clean.</li> <li>• Can intermix these colors except Imperial Yellow.</li> <li>• Needs more oxygen during firing to develop.</li> </ul>
<b>Clear Art Glazes</b>	Not for Food Items	Pg. 31	Shelf cone 06-6 Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply to properly fired 04 bisque. If firing to cone 6 or higher, apply to the clay in the greenware or low fired bisque- 04 stage.	<ul style="list-style-type: none"> <li>• Glazes in this series are not totally clear.</li> <li>• Two coats of glaze are sufficient over opaque underglazes.</li> <li>• If applied too heavily may craze.</li> <li>• If applied to an embossed piece, color will change in the embossed areas due to more color in these areas.</li> </ul>
<b>Exotic Glazes</b>	Not for Food Items	Pg. 33	Shelf cone 06-6 Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply to properly fired 04 bisque. If firing to cone 6 or higher, apply to the clay in the greenware or low fired bisque-04 stage.	<ul style="list-style-type: none"> <li>• The shape of the piece, glaze application, firing temperature and kiln load all affects the final surface.</li> <li>• Can be used when doing glaze combinations to aid in the flowing pattern.</li> <li>• Apply three or more flowing coats.</li> <li>• Re-firing will also bring out more of a pattern change.</li> <li>• Some colors have a combination of both matte and gloss surfaces.</li> </ul>

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<b>Jungle Gem™ Crystal Glazes</b>	Not for Food Items	Pg. 26	Shelf cone 06-6 Check High Fire Guide for color changes at shelf cone 6.	Brush/Sponge	Apply to properly fired 04 bisque. If firing to cone 6 or higher, apply to the clay in greenware or low fired bisque-04 stage	<ul style="list-style-type: none"> <li>Most crystal glazes require three coats.</li> <li>Avoid a larger concentration of crystal towards the bottom of the ware.</li> <li>Do not use on the inside of food containers.</li> <li>If doing container, inside color should be a leaded glaze.</li> </ul>
<b>Roll-a-Coat Tintable Glaze</b>	C-210 Non-Toxic C-110 Food Safe	Pg. 18	Shelf cone 06-6 Check High Fire Guide for color changes at shelf cone 6.	Rolling	Apply to properly fired 04 bisque. If firing to cone 6 or higher should be applied to the clay in greenware or low fired bisque-04 stage.	<ul style="list-style-type: none"> <li>Tint Roll-a-Coat with Stroke and Coat or One Strokes.</li> <li>Measure 1-2 Tablespoons of Stroke and Coat per 2 oz. of Roll-a-Coat.</li> <li>If tinting with One Strokes use 1-2 Teaspoon measurement.</li> <li>Pour color in, roll with a continuous motion and pour color out.</li> <li>Place ware upside down to drain. When dry, wipe excess color.</li> </ul>
<b>C-100 Clear Dipping</b>	Dinnerware Safe	Pg. 25	Shelf cone 06-6	Dipping	Apply to properly fired 04 bisque.	<ul style="list-style-type: none"> <li>Needs to be mixed frequently.</li> <li>Dip in, shake off excess and dry.</li> </ul>
<b>C-101 Blue White Clear Dipping</b>	Dinnerware Safe	Pg. 25	Shelf cone 06-6	Dipping	Apply to properly fired 04 bisque.	<ul style="list-style-type: none"> <li>This product is the match to C-101 brushing glaze.</li> <li>Needs to be mixed more frequently than C-109.</li> <li>Thinner than C-109 Dipping</li> </ul>
<b>C-109 Wonder Clear Dipping</b>	Dinnerware Safe	Pg. 25	Shelf cone 06-6	Dipping	Apply to properly fired 04 bisque.	<ul style="list-style-type: none"> <li>Very easy to use.</li> <li>Do not need to stir frequently.</li> <li>Stir about every 15 to 20 minutes.</li> <li>Faster drying time</li> </ul>

**Mayco®**

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