The Potter's Book of Glaze Recipes

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Introduction

As potters our first experience with glazes comes from either ready prepared glazes sold by commercial firms and mixed by experienced teachers or from glaze recipes culled from potter friends, teachers, books and magazines. From these we work out which glazes we like, what sort of glazes suit our particular requirements or taste, and concentrate on these, using them, experimenting with different glaze thicknesses, adjusting firing temperatures and trying different clays. This book of over 500 glaze recipes and glaze variations is for the potter and student who wants to start with a variety of glazes from which a wide range of effects can be developed. Some are for 'functional' use giving good reliable workable glazes, others offer the potter the opportunity to experiment with a range of glaze effects and decorative surfaces.

Just as the good cook starts with a recipe and then when familiar with it makes it 'individual', so the good potter learns how to handle, control and develop a glaze recipe. Most potters, especially when they are starting out, find the whole process of glazing very difficult. The apparently mysterious ingredients, the intricacies of kiln firing and the sheer spectacle of the dull dry powdery mixtures being transformed by terrific heat into attractive, or sometimes unattractive, glazes seem overwhelming. Some teachers and potters also have a puritan attitude which insists that potters should develop their own glazes; such an argument ignores the fact that potters have been developing glazes for centuries and from them we learn a great deal and build upon their knowledge. What better starting point than a book of glaze recipes?

From recipes we can learn how materials behave, what effect the ingredients have on each other and on the various colouring oxides. By simple adjustments with the ingredients the glaze can be made either more shiny, more matt, more opaque: maturing temperatures can be lowered or made higher.

In this book the glazes are divided into 5 sections according to the firing temperature required. Within each section the glazes are further divided into various groups according to how they appear when fired – that is in transparent, matt, opaque, coloured and other glaze groups, so that the potter can refer easily to the section required. Some glazes require such materials as wood ash and natural local clays, and where these are unobtainable similar substitutes must be made: the recipes here act as useful starting points, for potters must first test out their own materials and results will inevitably vary. However, such glazes often have rich decorative surfaces unobtainable by any other means. As such the recipes give the potter a well tried basic recipe with which to work.

There is also a large group of glazes which gives good results over a wide temperature range. With the increased awareness about dwindling fossil fuels and the increased cost of obtaining them, potters, along with other members of society, are very conscious of the need for energy conservation. Most potters prefer to fire to stoneware temperature when the body becomes vitrified and stronger and the glaze effects more varied, but they also want to achieve these effects at as low a temperature as possible. For this reason, this wide firing range of glazes is of particular interest. At 1200°C (2192°F) most bodies are almost vitrified and all these glazes give good workable results. At higher temperatures the glaze changes, but sometimes not drastically so, and these glazes extend the glazer's range in many ways.

All potters' materials vary slightly from batch to batch, and from source to source. The suppliers take great care to provide materials with as consistent an analysis as possible, but even they cannot eliminate all the slight 'impurities' nature has introduced. For this reason it is sensible to test all recipes with your materials before large batches of glaze are made: if inconsistencies occur then a slight adjustment may be necessary. In the chapter on glaze preparation and adjustment, guidance is provided on how this can be done successfully.

All the recipes given in this book include descriptions of the glazes. Some are full and detailed, others are much shorter where no further explanation is necessary. But they are my own descriptions and may not match up to the glaze as it comes out in other firings. The earthenware glazes have been fired on a red earthenware body, the medium stoneware glazes on a red earthenware body, a medium stoneware body and on porcelain. All the stoneware glazes have been fired on a medium coloured stoneware body and on porcelain. Descriptions relate to these fired results. On lighter or darker coloured bodies colours and surface qualities vary. However precise the recipe and however careful the description and preparation, it is always necessary for each potter to test the glaze using his own glaze materials, clays and kilns before mixing up big batches.

The Glaze Materials

Almost all the materials used in this book have been obtained from pottery suppliers and are generally reliably obtainable though materials do vary from supplier to supplier and from batch to batch. Few potters are able or find it necessary to collect their own materials, though there are locally available materials (such as wood ash) which the potter does like to use. Glazes are made up of three different sorts of materials – fluxes which make the glaze melt, the amphoteric or stabilizing materials which give the glaze 'flesh', and acidic oxides which are the glass forming part or 'bone' of the glaze. With only a few exceptions, most glaze materials are mixtures and combinations of materials from each of these groups, and a check through the recipes will show that most glazes include them. From the point of view of economy, the range of materials has been kept to a minimum, but many minerals do offer their own qualities, though substitutes can often be made.

All the glaze materials supplied by the pottery manufacturers are washed and finely ground. Some come as a fine powder (most have been passed through a 300 mesh sieve), some as lumps, but all are ready for use. Other materials like wood ash, granite or local clay need special preparation, and this is explained below, but other materials can be used as supplied. They should be stored in containers, clearly labelled with the name of the material as well as the date on which it was bought, and the name of the supplier.

Materials which come about naturally and can be collected and prepared by the potter have a fascination both for their cheapness and their unique qualities, yet, it is these qualities which make them unreliable to quote in glaze recipes. For this reason tests are always essential. It is not possible here to describe all the variations and the different effects that can be obtained, but there are a few useful points about their preparation.

Wood Ash

Wood ash is perhaps the most variable – and most useful. The sort of tree, shrub or plant, the soil in which it was grown, and even the time of year at which the plant was cut down are all factors which will affect the content of the ash. Ideally ash should be well burnt – either in a hearth or bonfire, and all the fine particles collected and carefully stored in a lidded container.

The ash can be used as an ordinary glaze ingredient in this unwashed state with the bits of carbon and unburnt wood still present. Most of these will be removed when the glaze is sieved, and this ash will make a much more speckled glaze. Alternatively the ash can be carefully prepared by washing and sieving beforehand by putting it carefully into a large bucket of water and stirring well. The unburnt wood and carbon will float to the top and the fine ash will slowly settle. After a few hours the water will dissolve the soluble salts of potassium and sodium and become a pale yellow colour; the water should be poured or syphoned off.

This procedure needs to be repeated three times if the ash is to be washed properly. This mixture, using plenty of water, should be passed through an 80 mesh sieve and allowed to settle. As much of the water should be removed as possible, and the ash sludge should be allowed to dry out; a good method is to place it inside a biscuit-fired bowl. The dry ash should be stored inside a labelled lidded container. Mixed ash from bonfires or hearths is most common (and this is what has been used in these recipes), but occasionally it is possible to obtain 'single' ashes like oak, apple or privet, all of which give distinct qualities in the glaze.

Local Clays

Local clays are prepared in much the same way. They should be dried out completely, broken up into small lumps and these dropped into plenty of hot water. When they have slaked down, the clay slip should be thoroughly mixed up and the mixture put through an 80 mesh sieve. When this has settled, which will be a slow process (about 2-3 days) depending on the fineness of the particles, the water should be removed and the slip put to dry.

Most local clays, particularly those rich in iron (average 8%) make excellent glaze materials – Albany slip clay, found near Albany, New York, is a famous example. A good clay slip will melt on its own at around 1250°C (2282°F) to form a dark coloured (usually brown or black) shiny glaze and can be used in glaze recipes to excellent effect. Unfortunately few local clays have the necessary small particle size to melt so well. This can be remedied by grinding the dry clay in a pestle and mortar – a slow process. A better method, if the equipment is available, is to mill the clay in a ball mill from three to four hours, which makes the clay much more fusable. The Fremington clay used in these recipes was ball milled for four hours.

Rocks

Rocks, particularly granites or slates, are another cheap and often fascinating source. These are best collected from granite quarries where fine dust often lies around sawing machines. When collected this is often sufficiently fine to use as it is. Otherwise it requires grinding or ball milling. Different outcrops will of course vary in composition and each batch must be tested.

Glaze Temperature and Classification

There are many different ways of classifying glazes – according to the ingredients, the colour, the opacity of the glaze or even the use to which the glaze will be put. The most common method and perhaps the clearest and most easily understood is to divide the glazes up according to temperature at which they mature, which is the method I have used here. Glazes fall into three main groups – low temperature 1000°C–1150°C (1832°F–2102°F) for earthenware pots, medium temperature 1200°C–1220°C (2192°F–2228°F) for stoneware, and high temperature 1250°C–1280°C (2282°F–2336°F) for stoneware and porcelain. A fourth group includes those glazes which have a wide firing range 1200°C–1260°C (2192°F–2300°F). Most glazes can successfully be coloured or stained by additions of metal colouring oxides: where this has resulted in attractive effects this will also be mentioned and many of the possibilities listed, but not all the recipes have been tested with every variation of colouring oxide, and potters could experiment with prepared glazes for other effects.

Within each group, glazes are divided under sub-headings starting with transparent and semi-transparent, opaque and matt, coloured, and iron glazes. Glazes which are not easily classified have been added at the end of each section as 'special effects'.

Colouring Glazes

Many potters when they have discovered a range of good workable glazes often prefer to experiment with them rather than keep trying out different glazes. For instance, a reliable shiny clear glaze can be easily opacified by the addition of tin oxide or zirconium silicate. Such a glaze can also be coloured by adding metal oxides, underglaze colour or glaze stain. This section describes how various effects and colours can be obtained. It is necessary to point out, however, that glaze colours are affected very much by different conditions and factors. In the first instance the colour depends on the body of the pot, and how much iron it contains. Accordingly this will either darken or brighten the glaze. On white firing and porcelain bodies, colours will generally be brighter. Some bodies 'suck in' the colour and glaze to leave a roughish surface, while others, particularly the highly vitrified bodies, will render these glazes smooth and even.

The glaze colour and quality are also affected by the firing atmosphere of the kiln, whether it is oxidized or reduced. These differences in effect are described in the recipe notes.

The temperature reached, the length of firing and the thickness of the glaze application are also important considerations which affect the final appearance of the glaze. It is, therefore, essential to test the glaze with your own materials, on your own clay, and in your own kiln, to find out exactly how it will respond to individual conditions.

White Glazes

Tin oxide (SnO_2) will make most shiny glazes opaque, and an addition of 8%–12% will give a clear, cool blue-white.

Zirconium silicate ($ZrSio_4$) ('Zircon'), which is a less refined form of zirconium oxide, is used as an opacifier; 6%–15% is required to give a neutral or cream white.

Coloured Glazes

Chromium oxide (Cr_2O_3) in most glazes gives an opaque green glaze with additions of 0.5%–2%. In some glazes crimson red is obtained with the chrome-tin-pink combination.

Cobalt carbonate ($CoCO_3$) produces a smooth blue glaze varying from pink mauve (in a dolomite glaze), and vivid blue in an alkaline glaze to midnight blue in a feldspathic glaze; additions range from 0.5%–3%, and results are not affected strongly by reduction or oxidation atmospheres.

Cobalt oxide (CoO) gives colour similar to cobalt carbonate but is, weight for weight, more powerful. The oxide tends to be less evenly distributed in the glaze and can cause blue specks.

Copper carbonate ($CuCO_3$) produces colours which range from pink (in dolomite glazes) and red (in reduction atmospheres) to green (in lead glazes) or brilliant turquoise (in alkaline glazes). Amounts required in the glaze range from 0.5% (for copper reds in reduction) to 2% (for alkaline turquoise in oxidation) to 4% for strong greens (in lead glazes).

Copper oxide (CuO) is almost exactly the same as the carbonate but is weight for weight much more powerful. Note that both copper carbonate and copper oxide tend to encourage the release of lead in lead glazes during the glaze firing making the lead soluble in acid solutions. For this reason lead glazes, particularly those with copper addition, should not be used on the inside of vessels used for holding food and drink of any kind.

Iron oxide, Black (FeO) and Red (Fe_2O_3) The black iron oxide is, weight for weight, more powerful than the red, but in most glazes better results are achieved with the synthetic red iron oxide. Depending on the amount of oxide added to the glaze (1%–15%) and the firing atmosphere, the colour may range from pale blue green to brown black red in reduction, and range from pale honey to olive brown or black red in oxidation, in feldspathic glazes. In the dolomite glazes colour tends to be more muddy and muted. Iron oxide can act as flux, particularly at the higher temperatures, and may cause glazes to run. A substitution of weight for weight iron oxide and a flux will combat this, but often the quality of a black brown tenmoku glaze depends on it 'running' on the pot.

Manganese carbonate ($MnCO_3$) gives pink mauve colours in alkaline and dolomite glazes and browns in feldspathic glazes, using 1%–8%.

Manganese dioxide (MnO_2) gives results similar to the carbonate but is, weight for weight, more powerful.

Nickel oxide (NiO) gives colours ranging from ice blue (with zinc oxide glazes), yellow (with zinc oxide and titanium dioxide), pink and mauve (with barium carbonate and zinc oxide) to muted greens and greys in most ordinary glazes. Amounts added range from 1%–3%.

Rutile ($FeTiO_3$) (Light, medium and dark), sometimes called rutile sand, is an ore containing titanium with iron oxide. It gives buff or brown colours in oxidation in glazes which can be mottled or crystalline, and it opacifies the glaze. In reduction rich blue grey colours can be achieved. Amounts added may be 2%–15%.

Titanium dioxide (TiO_2) gives glazes a matt creamy white colour in oxidation, and is often used in crystalline glazes. In reduction it gives a rich blue grey mottled effect; 2%–10% can be added.

Uranium oxide (U_3O_8) gives yellows and reds in amounts of 2%–5%. Being slightly radio-active, it needs storing in a metal container.

Vanadium pentoxide (V_2O_5) gives colours ranging from yellow to brown and tends to break up the glaze, added in amounts of 3%–8%.

Yellow ochre (Fe_2O_3) is a natural form of 'iron' oxide containing clay, and gives similar effects in the glaze.

Mixing the Glaze

For the sake of safety it is best if all ingredients are stored in clearly labelled bins, buckets or jars with lids. This means that dust is controlled and half-empty packets or sacks of material do not issue clouds of their powdery contents when disturbed. Potters need always to bear in mind the toxicity of the glaze materials they use. Most are perfectly safe but some are poisonous if eaten or inhaled even in small quantities. For instance any form of lead, most metal oxides and barium carbonate should all be labelled 'poisonous'. Good housekeeping – wet washing of surfaces and tools, regular vacuum cleaning, smooth surfaces and so on will also reduce or eliminate any possible hazard. Common sense, care and control in the handling and use of glaze materials as well as with other materials cannot be emphasized too strongly.

Glazes are made up by carefully mixing weighed ingredients into water, then passing the mixture through a fine sieve to break up the lumps and provide a thorough homogeneous mixture. For ease of mixing and comparing ingredients all the recipes total 100 parts: oxide additions are listed as percentage additions to the total. Depending on the amount of glaze that is required, the quantities can be interpreted as grams or ounces; 100 grams will produce enough glaze to fill a small glass jar or yoghurt pot, 1000 grams will be enough for a large bucket.

Scales need to be sufficiently large to hold good sized amounts of materials. Balance kitchen scales are more accurate than spring scales, especially for measuring small amounts. For weighing out quantities for test glazes a small accurate balance is required – chemical or photographic balances are ideal, though special balances, usually quite expensive in price, are marketed by the pottery manufacturers. But any accurate set of scales will suffice. Occasionally old fashioned confectionery scales can be purchased cheaply in second-hand or junk shops.

Plastic buckets or bowls are ideal for mixing and containing the glaze – they are light in weight, quiet in use and easy to clean. Sizes vary from small 'honey tubs' (often cheaply obtainable from confectioners) to a standard household bucket. For glazes required in large quantities small waste bins or plastic dustbins can be purchased from hardware stores. Quantities of glaze are important for they determine the way pots are to be glazed. For instance the workshop potter will probably prefer to dip the pots in glaze, so a good sized barrel with plenty of glaze is required. For the potter working on a small scale smaller amounts of glaze may seem more desirable, but this does limit the method of glaze application which can only be applied either by pouring the glaze or painting it on the pot. Glaze can also be sprayed but this does need specialist and expensive equipment. All these methods are discussed in the section on glaze application.

To mix the glaze weigh out the dry ingredients and gently add these to water. Tick off the amounts on the recipe when they are added to the water; this helps to eliminate mistakes while mixing. The water helps to break up the ingredients, which should be left in the water to 'slake' down. Lumps will break down and within a few hours a thick uneven sludge will form in the bottom of the barrel. Mix this up with the liquid so that a thinnish watery mixture is formed. This mixture should now be put twice through an 80 mesh sieve using a glaze brush or a domestic washing-up brush. This process will break up any tiny lumps and form a homogeneous, evenly mixed glaze. Ensure that as much glaze material passes through the sieve as possible.

At this stage the glaze, too thin to use on pots, should be allowed to settle. To test this for glaze thickness, dip a finger or a piece of biscuited pot into the well stirred mixture. If the glaze runs off it is too thin. Allow the glaze to settle so that the ingredients sink to the bottom. Depending on the ingredients of the glaze this will take from one to twenty four hours. High clay glazes for instance are slower to settle, while materials high in non-plastic ingredients like frits will settle quickly.

Remove plenty of clear water from the top, either by carefully ladling it out or by syphoning it off with a rubber tube. Thoroughly mix up the glaze using either your hand or a large kitchen swish. Again test for thickness. For pouring or dipping the pot, the glaze should have the thickness of single cream. It should give the hand a good coating and as a general guide it should form a thickness of glaze on the pot which, when dry, can be scratched to leave a clean and identifiable mark.

Different glazes require different thicknesses; choice will depend on personal preference. Some glazes change in colour and texture when they are thicker and it is always worthwhile checking this with a single and a double thickness. Potters who want a more scientific test of glaze thickness can use a hydrometer which measures the density (known as the specific gravity, SG) of the mixture. A simple instrument can be made by weighing a length of wood about 30 cm (12 in) long at one end. Drop this into the mixed glaze when it is at the consistency required and mark on the stick with waterproof paint the point where it goes into the glaze. On subsequent occasions if the glaze is too thin the mark will disappear below the surface; if it is too thick the mark will be above the surface.

An alternative method is to check the weight of the glaze. An empty glass jar with a volume of 1 kg or 1 lb is first weighed and then filled with glaze of the correct consistency and weighed again, then the original weight of the empty jar is subtracted. For an average glaze, for use on porous biscuit, 1500 grams to a litre (31½ ounces to a pint) is approximately correct. For glaze which is to be applied to a more vitrified body a higher density, about 1600 grams to a litre (34 ounces to a pint) is necessary. These weights are only approximate guides, for it is the prepared thickness which is important. Equally a glaze which is to be applied raw to unfired pots may have to be even thicker.

All glazes listed in this book have a quantity of a plastic material such as ball clay or bentonite in the recipe to help glaze suspension and to help bind the glaze when it is dry but not yet fired. This makes the glaze easier to handle as it is less likely to chip or dust off the surface. Some glazes, particularly those with large amounts of non-plastic materials like nepheline syenite or Cornish stone, settle in the glaze barrel very quickly and may form a hard layer which is difficult to break up. Such glazes will often be made easier to handle by the addition of a few drops of water in which either calcium chloride or sodium chloride have been mixed. Only small quantities are required. This mixture has the effect of 'thickening' the glaze, but add this very carefully as too much will turn the glaze into an unusable jelly-like consistency.

Glazes should be stored in lidded containers and of course should be clearly and properly labelled. Some potters make little 'button' glaze tests on round clay discs and tie these onto the bucket as a visual reminder of the glaze qualities. This is particularly useful for the experimental potter who is constantly involved in glaze tests.