

Fume Firing Methods Handout

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Here we explore methods of preparing and firing clay works in saggars, mummies, fume kilns, or pits to produce beautiful surface effects resulting from the interaction of clay and fire. I call it fume firing. This is an unpredictable firing technique. There are no guarantees of good results, but be prepared for happy, exciting surprises!

At left: Mummy-fired sculpture, Desert Tree by Judy Nelson-Moore

Overview

When fume firing ceramics, the object is to balance these elements:

- Surface on the pieces conducive to “catching” the fumes
- Proximity of fuming chemicals
- Just the right amount of reducing combustibles
- A temperature suitable to fume effects

In this handout I discuss several different methods and techniques that can be used as is, combined, modified or reinvented to produce fumed ceramic. These ideas come from my own experience and from published experiences of others. See the reference section for some of the sources. Although there are always exceptions and unique techniques, the most common denominators I have identified are these ideas:

1. Hold fuming materials and pieces in close proximity. This usually means using a sagger, covered pit, or enclosed kiln environment.
2. Prepare the surface of the work and the environment in the Sagger/Pit/Kiln to create a fuming environment
3. Add sodium and color-forming chemicals and carbon-burning combustibles.
4. Fire to a low temperature in the range 1200-1800 degrees fahrenheit.



At right, the fuming kiln at Ghost Ranch, 2010.

Steps in a Fume Firing

1. Bisque-fire work to be fumed.
2. Make or find sagger containers. Assemble materials for aluminum foil saggars or mummies. Dig pit and assemble edging/covering materials. Make sure good draft is provided particularly to the bottom of the kiln/pit.
3. Assemble fuming chemicals, combustibles and fuel.
4. Apply terra Sigillata or other slip to surface of work. If desired, spray ferric chloride or apply swamp juice.
5. Form the aluminum foil saggars or mummies
6. Place materials and pieces in the large saggars, kiln, pit.
7. Fire for approximately 2-5 hours. No more than 8 hours, or likely all colors will get burned out.
8. Wait until kiln is cooled to remove pieces.
9. Wash and optionally apply surface enhancers/protectors to the work.

Saggars

A sagger is a container surrounding the ceramic ware as it is being fired in the kiln. Traditionally, saggars are made of clay usually shaped like big wastebaskets. You can also use specially made saggars or "found" saggars from flowerpots, metal cans, clay sewer pipes, shaped slabs, and aluminum foil. I have used sawed-off oil barrels in a pit. Other materials for saggars can include clay-soaked burlap (called mummy firing). You can also build a sagger out of bricks inside the kiln. In a fuming kiln, the entire kiln chamber becomes the sagger.

The purpose of the sagger is to provide an environment for fuming. At the firing temperature, the combination of materials placed in the sagger creates the fuming atmosphere where the chemicals are transferred to the surface of the clay, forming random and serendipitous patterns. The color range is black, gray, pink, maroon, orange, blue, green and other colors depending on what chemicals are used in the sagger and the temperature.



Making Clay Saggars

Make saggars as large round, or oval wastebasket shapes. Make out of well-grogged sculpture clay. Make fairly thick-walled, but not too thick (no more than ½ "). Even thickness is important. I like to put raised stripes on the bottom to lift the pieces off the bottom of the sagger. If you want lighter, patterned pieces, put holes in the sagger sides (small, spaces irregularly and on opposite sites). The number of holes is up to you. Make a lid that fits well. I like to make a lip that comes down on the outside at least 2 inches. Or, you can use an old kiln shelf as the lid. Fire the saggars empty initially to a fairly high temperature...at least cone 1-3.

Another idea for making saggars is to create two thick clay bowls for the top and bottom. Adjust the height by placing rings of thrown clay between the bowls. Punch holes in rims of rings to create airflow.

Making and Preparing the Pieces to be Fired

All sizes and shapes of pieces have been fume fired. I have fired pieces from 1 inch to 5 feet. Smooth shapes and areas tend to show off the fuming patterns better, but sometimes textured areas can also be interesting.

The pieces should not be too thick. Prepare the pieces by firing in a bisque fire. Some people claim that a low bisque (or no bisque) gives the best results, but the resulting pieces are too fragile for my liking. Experiment with firing the pieces higher initially (I have done up to cone 6). These higher fired pieces don't pick up as much color. You can refire sagger pieces that didn't turn out well in the first sagger firing. If you really hate the results put through an electric firing in-between to burn out as much of the carbon as possible, reapply a thin terra sigillata and fire again.

Terra Sigillata (T.S.)

Terra Sigillata is slip made of the very finest (tiniest) clay particles. It can be any color, any clay, although some clays make better Terra Sig than others. When applied to the piece, it can be burnished to give a soft sheen or a high gloss. Historically used as an alternative to glaze by American Indians, Greeks, and other "primitive" potters around the world. We use terra sigillata in fume firing, because it gives a nice sheen and "catches" the fumes better. It is the raw clay particles that fume the best. Terra sigillata applied to bisque is my preferred method. This allows the base piece to be fired to avoid too much breakage that occurs with greenware. Cracks in the terra sigillata when applying to bisque can be avoided by using a THIN coat.

How to Make Terra Sigillata

You can either use a recipe (see recipe section) or...here's the way I do it: Put some hot water in a bucket or large see-through jar. Add some deflocculant: I use Calgon (original formula) or sodium hexametaphosphate. Put some clay in bucket. Use Red Art for red, Jordan (friend claims produces good oranges), KY Ball Clays (not as white as...), Grolleg porcelain (very white). Try local clays. Use about 3-4 times hot water to the amount of clay. Stir well. Let sit for 2-24 hours. Gently and carefully, lift the container and pour off any plain water from the top and discard. Pour off the center cloudy section into another container. Stop pouring before

you get to the thick sludge containing the heavy particles at the bottom (discard this sludge). Save the center portion as the T.S. If too thin, thicken through evaporation. It should be the consistency of milk. Dip a shard into the T.S and see if it looks good. It should be slippery feeling and you should be able to polish the shard to a sheen...how much sheen depends on the type of clay and how good a job you did of getting the smaller particles. If not shiny enough for you, let sit again and separate again, or add more calgon, let sit and separate again. You can find lots of more exact recipes for T.S. in books and on the Internet. Try them if you are dissatisfied with the T.S. you get this easy way.

Add mason stains or oxides for color...10-40%. However, I have found that most colors burn out in a saggar firing. Generally, you should use the colored terra-sigs for regular non-fume firings. Red clay terra-sigs will produce darker fumed effects than white clay.

Applying Terra Sigillata

Apply to your piece by dipping, pouring or brushing, one fairly thin coat. Bug gently but rapidly with fingers covered with clear plastic drycleaning bag.

Materials for the stack

You need the following types of things for the fume firing:

Something to produce carbon

This is the garbage, sawdust, seaweed, straw, wood excelsior, wood shavings, wood chips, charcoal, seeds/feed, dog food, stable sweepings, dried garbage soaked in salt water, etc, etc, etc. My favorites are seaweed and wood excelsior.

If you use only carbon producers with no salt or color chemicals, you will likely get black/gray effects. For totally black with hardly any gray, use a very tight saggar and smother the piece in sawdust. For lighter effects use lighter, open materials like wood excelsior (thin, shredded wood strips most often used as a packing material) or wood shavings.

Something to produce color

I use iron oxide and copper carbonate. These produce yellows, oranges, reds (rust, pink, maroon, and shades in between), green, black, gray, and brown. It's the red tones that excite most people. I've used cobalt carbonate, but it is too blue for my taste. Sulfates (copper and iron) fume well.

Inert Stuff

(this is used as spacers, supports, or fillers to thin out the carbon stuff, or surfaces to paint the fume chemicals on to bring them close to work)

- ☞ Vermiculite. Mix this with sawdust to cut the black effect of sawdust. Be careful as it is toxic.
- ☞ Fire brick pieces can hold things in place.
- ☞ Slabs or Shards (paint with salt/chemical combination)

Salt

- ☞ This volatilizes and carries the chemicals and carbons onto the piece as well as creates interesting patterns. I mostly use table salt, but have also used other forms of sodium.
- ☞ I prepare an iron oxide, copper carbonate, salt and water solution and brush on the inside of the saggars and on shards, as well as dribble around (but not on) the pieces in the saggar. If you put a lot of iron and lots of carbon stuff and salt, you may get black iron crystals. The copper hopefully makes lovely pinks, mauves, reds. The iron can make reds, oranges, browns and black. If the copper makes greens, instead, it's probably because it didn't get reduced. Don't put this solution ON the pots...not pretty!

Pattern Makers

- ☞ Copper, brass or other composition wire for black or other color lines. Wrap around the piece or tape on. Coarse steel wool, copper or steel scrubbies can be added to saggar next to piece or wrapped around or taped on piece.
- ☞ Grasses, corn husks, weeds or paper patterns held tightly against the piece by wire or tape or clay slab or shard may resist the carbon and produce white lines and pattern. If soaked in salt will produced pattern color.
- ☞ Custom-shaped slabs to fit the piece or found shards to lean against the piece. Paint the salt/oxide/carbonate solution on the slab/shard, let dry, and place against the piece to produce a pattern. Put grasses in-between for lines in the pattern.

Fuel

If you are firing in a chamber without gas, you need to add fuel at the bottom and top of the stack. For gas or electric firing, leave out the fuel. See Sumi von Dassow Pit firing notes below for discussion of fuel.

Stacking the Kiln, Pit or Saggar



General

- ☞ Decide if you want color, overall light effects, dark effects, patterning.
- ☞ For light effects, use less carbon stuff.
- ☞ If you want dark effects, put in more carbon stuff.
- ☞ For color, use the salt/copper/iron mix described above. Paint on the inside of the saggar walls and on shards laid up next to each piece.
- ☞ For lines, wrap the piece in wire. Prepare a slab to fit the piece for white (resist) lines.
- ☞ For patterns, put different size/shape of shards, carbon stuff, and salt/copper/iron mix. See special effects below.

Special Effects

- ☞ Black lines. Wrap with copper or brass wire. Thin for thin lines (too thin and it disappears). Thick for big, thick black stuff on your piece. No plastic on the wire, please...that produces unpleasant black sticky stuff.
- ☞ Resist effects. Create a shaped slab. Be careful that the slab around the piece will not break your piece as it shrinks and contracts around the shape. Put grass, wire, paper patterns, tape, or other items next to the piece. Paint the shard inside with salt/copper/iron mixture and LET DRY. Carefully place slab next to the piece in the saggar. If the slab is not quite dry, probably OK for the workshop as the firing will not commence immediately and they will have time to dry out after loading. Don't use plastic stuff...it makes a gummy black mess.
- ☞ White lines. Put grass next to piece and shard or shaped slab next to the piece.
- ☞ All black: If you don't want color, stack the piece totally smothered with lots of carbon stuff (see list above) in a very tight saggar (no holes, tight lid). Sawdust is best for this.
- ☞ Colors. Use salt and oxides or sulfates.
- ☞ Specific patterns. Cut pattern out of paper, tape, form in wire. See resist effects. Wrap wire or shape wire and hold next to piece.
- ☞ Slip resist. Paint entire piece with thick slip. When it cracks, the fuming will go into the cracks and where the slip was solid will resist the fuming. Scrape off the slip after firing to reveal the pattern underneath

Mummy Firing

How to prepare a mummy

- Prepare a slip of any clay. Add paper-pulp for a stronger mummy.
- Put a big plastic sheet on the tabletop.
- Dip a piece of burlap big enough to wrap around the piece into the slip (completely saturate) and lay out on the table. Alternately, put the burlap on the table and butter the slip onto the burlap.
- Cover the burlap with paper to keep slip off the piece.
- Put carbon stuff, chemicals on the paper.
- If desired, put chemical-painted, shaped slab or shard around piece.
- Put the piece in the middle of the pile. Cover with stuff to fume the top and paper to keep the slip from getting on the piece.
- Pull the burlap up around...make sure stuff is on all sides. Butter more slip on outside if needed.
- Wrap with string.
- Let set until firm enough to load into kiln without getting slip on other stuff in the kiln. Wait until completely dry before firing.
- Stack into kiln carefully. The mummy will partially fall off during the firing, depending on how much slip you use, the composition of the slip, and how well it is wrapped.



Aluminum Foil Saggars

Saggars for individual pieces or a few small pieces that are easy to make can be made with aluminum foil. Edgeworth Barnes uses a "Swamp Juice" formula in his saggars (see recipes section). For larger pots he mixes these materials with water to create an evil-looking bubbling liquid and brushes this juice directly onto the sagger to avoid having all the chemicals concentrated only near the bottom of the pot.

The sagger is custom made for each piece with foil that has been crinkled up and then spread back out. Barnes scatters a little coarse steel wool, raw cotton and wood chips on the foil. Next he places moistened seaweed over these materials. Copper wire or pieces of copper dish scrubber can also be added to the mix. Next the pot is placed, usually top down, onto all these items.

More seaweed, cotton, wood chips and steel wool are placed over the pot. Finally, the foil is wrapped around to cover the pot and pressed into close contact.

Firing

Type of kiln



I have done sagger firing in a pit, in gas kilns and in electric kilns. Gas kilns have more reliably produced the best results in the past. Some Dutch potters I talked to did fume firing on bricks in the open at low temperature, fuming with colored papers. Other people with whom I have talked do fume firings in or under oil barrels or barbecue containers.

At left is a gas kiln loaded with saggars and mummies before firing.

Temperature

I usually sagger fire to cone 08. I have tried as low as cone 010 and as high as cone 10. Higher temperatures (above about cone 01) are a totally different look, more burnt, less color. Terra sigillata becomes matt above about cone 01. Some people fume fire at lower temperatures than 08. Sumi von Dassow's pit firings reach 1200-1400 degrees (cone 018).

Opening the kiln

Unlike raku, leave the pieces in the kiln until they are totally cooled. Evaluating the results when opening the saggars is your best learning tool. I recommend taking notes about how you loaded your piece.

At right: same kiln load as above...after the firing. Notice that the mummies stayed together fairly well. There is a hole in the mummy on the left.



Post-Firing Treatment

- **Wash.** Wash the piece in water, even using a soft scrub pad (like dish washing pad) to clean off the stuff that is stuck on there. Use gloves as the chemicals in the firing are on the piece.
- **Seal.** If desired, seal with ½ white glue or matt acrylic medium or Dorland's wax (oil painter's wax) or floor wax or butcher's wax (these are some of the things I have heard of people using or used myself). I like the matt acrylic medium or Dorland's wax best. These will help to bring out the colors and patterns, sometimes amazingly so. I have had pieces that I thought had no fuming, only to have them turn a wonderful orangey with the medium applied. However, these surface preparations may alter the colors and patterns...so if you really, really love it, leave it alone.

Sumi Van Dassow Pit Firing

(notes from Ceramic Arts Daily posting: <http://ceramicartsdaily.org/firing-techniques/pit-firing-video-a-guide-to-gathering-fuels-for-the-best-results-in-a-pit-firing/>)

Pit: 3 feet x 6 feet, looks about 2.5-3 feet deep. Edge of pit is rimmed with bricks. On bottom of pit is rectangular arrangement of galvanized pipes with holes drilled in the pipe every few inches. End of pipe extends out of pit to hook to an electric air blower. This pushes draft into the bottom of the pit.

Materials: Aspen or Cottonwood branches, very dry. Wood shavings, fresh from feed store AND dried used stable sweepings with urine and manure. Dried used coffee grounds. Dried salt-soaked corn husks. Wood scraps from cabinet shop. Salt, copper carbonate.

Stack: Put layers around pipes and on top. 1) clean wood shavings, 2) well dried stable sweepings, 3) used coffee grounds well dried, 4) big pots, 5) smaller pots nestled around big pots (can wrap pots in salt soaked materials), 6) salt-soaked stuff, 7) crumples newspapers, 8) crisscrossed sticks from cabinet shop, smaller ones first, 9) dried branch pieces from aspen or cottonwood. Start fire. Then throw on top copper carbonate mixed with wood shavings. Cover. Turn on blower low.

Firing. Lasts about 5 hours. Cover tightly, let completely cool. Temperature about 1200-1400 or cone 018.

Recipes

Sumi Von Dassow Terra Sig

2100 g water

1000 g Kentucky OM4 Ball Clay

25 g Darvan 7 or 811

Mix together in clear jar. Let set at least 3 hours. Siphon off all but the bottom sludge. Burnish with fingers and auto polishing mitt.

Terra Sigillata (George Tompkins, Yuma Arizona)

15g Calgon (original formula)

500g Clay

1 gal Water

Let stand overnight. Pour or siphon off top $\frac{3}{4}$. Let thicken or boil off water. Should be thickness of milk or $\frac{1}{2}$ and $\frac{1}{2}$.

George Tompkins' Bone (greenware) slip. Can also apply thin to bisque.

50 Edgar Plastic Kaolin (EPK)

25 Nepheline Syenite (Nephsy)

25 Frit #25

George Tompkins' Bisque slip (this makes a velvety matt surface)

25 EPK

50 Nephsy

25 Frit #25

For dark colors, add up to 20% copper carbonate. Spray or brush on Bisque

Edgeworth Barnes' Swamp Juice

Equal Parts copper sulfate

fine sea salt

cottonseed meal

baking soda

1/2 part each copper carbonate

titanium dioxide

For larger pots he mixes these materials with water to create an evil-looking bubbling liquid and brushes this juice directly onto the saggar to avoid having all the chemicals concentrated only near the bottom of the pot.

Warning...when adding water, this REALLY bubbles up and fumes are very toxic.

References

Books

Alternative Kilns & Firing Techniques, James C. Watkins & Paul Andres Wandless. A Lark Ceramics Book. 2004. Has sections on Raku, Saggars, Pit and Barrel firing.

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Sawdust Firing, Karin Hessenberg, University of Pennsylvania Press. Part of The Complete Potter series, edited by Emmanuel Cooper. 1994.

Naked Clay, Ceramics Without Glaze, Jane Perryman, University of Pennsylvania Press. 2004. This book has a chapter "Clay Marked by Fire" which includes fume fired effects by various European and US artists.

Fire Marks: A workbook on Low-Temperature Smoke Firing, Cheryl Herr-Rains. Gentle Breeze Publishing, 2002. Recipes and notes about different methods, techniques and effects.

DVD

Pit-firing and Burnishing with Sumi von Dassow. Order from Ceramic arts bookstore <http://ceramicartsdaily.org/bookstore/pit-firing-and-burnishing/>

Articles

David Ogle's Saggars-fired Porcelain, David Ogle, Clay Times, January/February 2004.

Decorating with Volatile Materials in Saggars, Ruth Allan, Ceramics Monthly, January 1992, Page 75

Low-Temperature Salt/Saggars Firing, R. Bede Clarke, Ceramics Monthly, November, 1988, Page 48

Saggars Firing in a Raku Kiln, Linda Riggs & J.D. Riggs, Clay Times, March/April 1988.

Saggars Firing in a Raku Kiln, Orlene Bates & J.D. Riggs, Clay Times,

Vapor Glazing in a Saggars, Richard Behrens, Ceramics Monthly, June/July/August 1976, Page 60

This article can be obtained on my website (with color pictures) at www.nelsonmoore.com/art/fumeFiringHandout.pdf

NOTES

Record here how you stacked your pieces into the saggars and the results

Piece Description/sketch	How Stacked	Results

Ideas to Improve or change: _____

