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The following is exerted from my book, *Clay: A Studio Handbook*

Salt and Soda Firing

In the salt and soda atmospheric firing processes, sodium-bearing chemicals are introduced into the firebox at or near the maturing point of the firing. The chemicals vaporize in the intense heat, and the resulting sodium vapors condense on the wares, combining with silica and other materials in the clay to form a durable sodium silicate glaze. As the wares are vapor-glazed, the interior of the kiln also absorbs considerable salt or soda, and cannot be used for other firing processes without experiencing some salt/soda effects on the wares. In fact, in a well-seasoned salt kiln, very light *residual salt* effects can be achieved by firing in a well-seasoned salt kiln without charging any additional salt relying solely on the revolitization of sodium deposited on the kiln hotface. This is referred to as a *residual salt firing*.

The salt-firing process has a powerful corrosive effect on fragile refractories, so salt kilns must be constructed with dense high-duty hardbrick. Soda firing is a little less corrosive, and some potters have reported good results with IFB kilns sprayed with a refractory protectant/sealant. Heavily-used soda kilns should be all hardbrick on the hotface.

When introducing salt or soda into a kiln, the process is called *charging* the kiln, and the measured or timed injections of salt or soda are called *charges*. Charging is sometimes done through the burner ports, but this is very hard on the burners. It is far better to provide dedicated charging ports where the charges may be sprayed or dumped directly into the firebox. In salt firing, the charges are generally moistened rock salt dumped into the firebox from an angle-iron charging trough. In soda firing the charges are usually sprayed into the firebox as a hot saturated soda-ash (sodium carbonate) solution dispensed with an ordinary pump-up garden sprayer.

Wadding, Shelf Wash, and Door-Sealing Mixture

In salt, soda, and woodfiring, small balls or rolls of a special clay mixture called *wadding* must be used to separate all contact surfaces between posts and kiln floor, between posts and shelves, under all the ware, and between lids and vessels. For both salt and soda, wadding and shelf wash are made from the same recipe – 40 EPK, 10 OM-4, and 50 Alumina. All contact surfaces on kiln posts and on hinged doors or door bricks should be coated with this shelf wash, and re-coated as often as needed. Conventional silicon carbide shelves should be coated with this shelf wash and maintained in a normal fashion. Nitride-bonded silicon carbide shelves do not need to be coated with shelf wash, and are easily scraped clean after firing.

To mix wadding, put all the dry materials in a bucket or bowl and add water a little at a time, mixing with your hand. When it reaches plastic clay consistency, wedge well to ensure thorough blending. Mix a generous amount and always save any extra because alumina is expensive. If you are going to be firing again soon, store the damp wadding in a plastic bag. If you are not going to fire again for a while, let it dry out. Because of the high-content of non-plastics, it absorbs water quickly and is easily rehydrated. Because wadding is expensive, never use it to seal cracks in a stacked kiln door. Instead, use equal parts recycle slurry, cheap builder's sand, and fine sawdust mixed to soft plastic clay consistency.

Making and Using Draw Rings

Draw-rings or *draw-trials* are small rings that stand up vertically and are removed during salt or soda firing to gauge the deposition of sodium on the clay. Always use draw rings in salt and soda firing. When making draw rings, use the same clay as in the wares. Roll out coils about 3/8" in diameter, wrap them in a loop with a 1" hole, overlap the ends, and press down with your finger inside the hole so that the overlapped ends make a wide, stable base and the rings stand up vertically. Always bisque-fire the draw rings before use. If you are planning to do a lot of salt or soda firing, make a big supply and include them in your next bisque fire. Before loading the kiln, coat the bottom surface of your bisque-fired draw rings with kiln wash.

Salt and soda kilns are generally designed with extra-large spy-holes to accommodate both viewing cones and pulling draw rings. Generally the cone pack is placed slightly off to one side, with a row of six draw rings next to it extending away from the spy hole, so that the removal of a ring reveals the one behind it. I have never pulled more than four draw rings from each spyhole during a salt or soda firing, but you always want to have more than you need.

Charge the kiln at least twice before pulling the first draw ring. When pulling draw rings, wear gloves and protective tinted goggles or glasses, and use a long, thin steel rod with a very small hook bent on the end to snag a single draw ring and withdraw it from the kiln. A length of 1/8" steel gas-welding rod works well. Have a plastic bucket of water handy, and lower the draw ring into the water. Give it a few minutes to cool, and then dry it completely and check the surface for glaze deposition. Draw rings give no indication of fired clay color or flashing, because they have been cooled instantly. Clay that normally flashes beautifully in salt or soda firing will be a dull, cold gray on a quick-cooled draw ring. Draw rings serve only as an indication of salt or soda deposition.

Loading Salt or Soda Kilns and Wadding Furniture and Wares

In salt, soda, and wood firings it is always best to use brick pieces as furniture to guarantee stability, as mentioned earlier in the section on kiln furniture. Use two parallel 3/8"-diameter rolls of wadding below and above every kiln post, and don't let the wadding extend beyond the edges of the kiln post or shelves.

Consider the aesthetics of wadding, since it leaves distinct, visible marks. Place your wads carefully, and use wads of an appropriate size for the piece being wadded. Use wads about 3/8" to ½" in diameter for all small and medium-sized vessels, and larger or other-shaped wads as needed. Vertical forms like mugs, cups, bottles, vases, covered-jars, pitchers, etc. generally only need three wads. Larger-diameter forms like sculptural pieces, flat slab pieces, plates, casseroles, and bowls must be supported by more wads according to their size in order to avoid warping.

Bottoms that require only three wads can be wadded ahead of time. Dispense some white glue into a jar lid or other appropriate small dish. Dip each wad into the white glue and press it into place on the vessel bottom or the lid seat. Any form that requires more than three wads on the bottom must be wadded as you load the kiln so that the damp wads will settle down a bit and support the piece evenly when it is placed in the kiln.

All lid-to-lid-seat surfaces can be wadded ahead of time. Very small lids (2" or smaller) can usually be supported by three wads, but all other lids need more wads in proportion to their size. Use small rolls (sometimes slightly flattened) rather than round balls when wadding lids. Make sure that the wads really do support the lid and provide at 1/8" clearance from its seat. If a lid has an overhang that extends beyond the body of the pot, it generally does not need to be wadded at all in soda firing unless you are doing a fairly heavy soda effect.

Don't pack the kiln too full. Normal oxidation and reduction firings benefit from a tight set, but salt, soda, and woodfirings need more room for circulation of atmospheric effects. Leave at least ½" between wares. As long as you leave adequate spacing, don't hesitate to place wares close to the arch, because that will just help to pull the vapors through the set. If you have small items and want heavy soda accumulation, an option is to wad and place them right on the bagwall. Do not place ware in the flue. Wherever you place wares, consider the movement of vapors through the kiln and consider the way one piece can be placed in the "shadow" of another, affecting how it is impacted by the vapors.

Salt and soda vapors will not penetrate internal spaces, even on bowls and cups, so these areas must be glazed in a conventional fashion. Similarly, plates cannot be placed on very-closely-spaced shelves as would be possible in normal oxidation or reduction firing, because vapors will not glaze the upper surface of the plates.

The exterior of wares is frequently left unglazed, often with only slip or underglaze decoration in order to take maximum advantage of salt/soda effects. At the same time, others use glazes and allow the vapors to modify the glaze. Avoid using glazes that are very fluid, because the added fluxing power of the sodium vapors will likely cause the glaze to flow right off the ware. Matt glazes often do nice things in salt and soda firing.

Seashells packed with wadding have become a popular alternative for plain wadding in situations where glaze will inevitably contact the wadding. In the firings the shells turn into calcium oxide and would collapse if not packed with wadding. Calcium oxide is highly refractory and resistant to absorption of glaze, and any glaze that comes in contact with the shell surface conforms to the shape and pattern of the shell. After the firing, residue of shell adhering to the glaze will disintegrate when soaked with water and is easily scrubbed away. Usually the shell impression must be lightly ground or sanded around the perimeter to get rid of sharp edges. This technique is most often used in salt, soda, and woodfiring where there is expectation of heavy glaze accumulation, but also works in special circumstances where a piece must be glazed all-over, as long as you don't mind the shell impressions in at least three places in the glaze surface.

Issues of Toxicity in Salt/Soda Firing

It was once thought that salt and soda-firing produced toxic fumes, but recent research has shown this to be false. This is a good example of toxic scare supercharged by supposition with no basis in rational fact or scientific evidence. Salt kilns are charged with sodium chloride. The sodium goes to the pots, so that leaves chlorine, which is highly reactive and unstable. Research proves that the chlorine combines with water vapor to form hydrogen chloride gas. In both salt and soda firing, excess sodium combines with oxygen and hydrogen to form sodium hydroxide fumes, and while hydrogen chloride and sodium

hydroxide gases are respiratory irritants, neither is considered toxic. Both condense on metal surfaces and cause serious corrosion in the immediate vicinity, but that is no more an indication of toxicity than corrosion caused by salt spray at the seashore.

Regulating the Damper While Charging Salt or Soda

If you specifically want asymmetrical unidirectional soda effects on your ware, open the damper an additional inch or two while charging to create a more directional path from firebox to flue, and accept the fact that a significant portion of vapors will escape out the flue and it will take more salt or soda to achieve the desired effect as gauged by the draw rings. If you want a more even effect, keep the damper closed most of the way during charging. That holds the sodium vapor in the kiln longer and circulates it more evenly. In either case, after a minute or two return the damper to its previous position to regulate atmosphere and temperature climb.

Charging the Kiln

Charging is generally done as you approach the target temperature as specified below for salt or soda kilns, but be sure to monitor temperature carefully. Charging can sometimes stall the kiln a bit, which is not a bad thing, but you must be monitoring the cones carefully. Keep in mind that whenever you charge a salt or soda kiln, you are glazing all surfaces inside the kiln that are not resistant to sodium deposition. When charging a new kiln, it will take a great deal more salt or soda for every firing until the kiln gets seasoned, and you must carefully monitor the deposition of glaze on the draw rings to determine the appropriate amount of glaze on your wares.

Charging a Salt Kiln

Charging takes longer in a salt kiln and is begun when the warning cone is starting to bend. For a good salt effect in a thirty cubic foot salt kiln, it usually takes fourteen to twenty pounds of rock salt divided into two-pound charges, but if the kiln is very full or not very well-seasoned, it might take up to thirty pounds. A length of 2x2x1/4" angle iron works great for charging, and for the best tool, weld on a straight pipe handle with a short "T" on the end so that the open angle is facing upwards when the tool is resting on the ground. Distribute the desired charge of rock salt along the appropriate section of the angle iron, and dribble water over the salt to moisten it, which greatly accelerates the volatilization. Insert the angle iron in the charging port, and quickly twist the angle iron to invert it in the direction the kiln wall rather than the bag wall. Observe the stack, and wait until the atmosphere is mostly cleared before charging again. This usually takes five to ten minutes. Monitor

Charging a Soda Kiln

Charging is faster in a soda kiln and is usually begin when the target cone begins to bend. For a good soda effect in a thirty cubic foot soda kiln, it usually takes from two to six pounds of soda ash (sodium carbonate) dissolved in hot water. A standard garden sprayer with a metal spray wand works best, and it does not matter whether the reservoir is metal or plastic, but in any case always test it in advance to make sure it is working properly. Wait until cone-5 is bending in a cone-6 firing, or until cone-9 is bending in a cone-10 firing before you prepare the soda mixture, because if it cools, the soda ash will start to crystalize out and can clog the sprayer. Most garden sprayers hold about three gallons, but you must leave air space to compress when you pump up the sprayer. Put two gallons of hot water in a plastic bucket and add the desired amount of soda ash, and stir with a drill impeller mixture until the

solution is transparent. To charge, poke the nozzle into the charging port quickly and immediately squeeze the valve to start the spray. The nozzle will overheat very quickly if it is not being cooled by the soda solution passing through it. At the same time, try to minimize the amount of soda sprayed on the walls of the charging port. As soon as you insert the wand and start spraying, fan the sprayer back and forth in order to avoid spraying in just one place, which can cause the refractory to pop and scatter particles on your wares. Fan the soda spray across the firebox floor and up and down the inside wall of the kiln on the side where the burner ports are located. If you spray soda towards the bag wall you risk heavy deposition directly on the wares. Just think about where the soda is going as you spray. Obviously it vaporizes very quickly, but most intensively where the stream of soda solution hits a solid surface. Always avoid spraying any soda on burners or plumbing.

Standard garden sprayer metal wands come with a brass nozzle that is soldered to the tip of the sprayer wand. Almost inevitably the wand overheats and the original nozzle falls off. When that happens, hammer the very end of the brass tube flat and it will deliver a perfectly acceptable spray. It does not need to be precise, as long as it produces some sort of spray rather than just dribbling out of the end of the tube. If the original nozzle falls off while you are charging, just beat the very tip flat with anything handy and continue charging.

When you charge, pump the sprayer up enough that it delivers a good spray. Charge for fifteen seconds as described above, and wait ten minutes or so before charging again. Pull the first draw ring after charging several times, and again after several more charges.

If you want a heavy soda accumulation on a particular part of a piece, position the piece directly inside a spyhole when loading the kiln. When charging the kiln, spray soda directly onto the piece, but just a few quick, short bursts, repeating with each charging as you think necessary. If you choose to do this, be cautious the first few times until you learn the results through a series of firings.