Textures
Hand Crafted Silver Jewelry by Hadar Jacobson
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How to Talk to Your Kiln and Why it is Important

I'll answer the second question first. I believe that the secret to successful firing of non-precious metal clays such as copper and bronze is the kiln and the firing schedule. Precious metals such as pure silver and gold are fired in open air. They don't react with the oxygen in the air, and the oxygen in the air ensures the complete removal of the binder.

Base metal clays such as copper and bronze cannot be fired in open air because they do react with oxygen to create oxides, which prevent proper sintering. Activated carbon reduces the amount of oxygen in the kiln and inhibits this reaction. However, most organic binders used in metal clays need oxygen to burn off. If there is not enough oxygen (because it has been reduced by the carbon), the binder will not burn off completely. If the binder is not completely removed, there will be no proper sintering.

So in a way, the activated carbon is both a blessing and a curse. On the one hand it enables sintering; on the other it interferes with the removal of the binder. I believe that with the proper firing schedule we can get around this problem.

But there is another twist to this. Not all kilns fire the same way, and different kilns require different firing schedules. I have been firing in two different kilns and have come up with two reliable firing schedules for them.

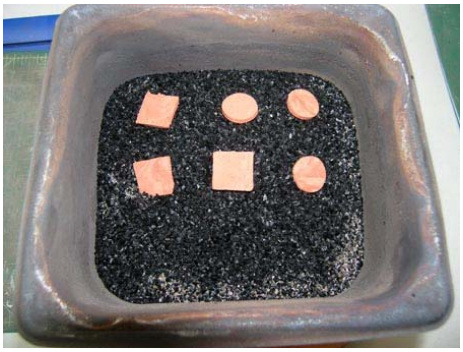
The first kiln is the one most of us use – a kiln with a front door and muffle walls. This kiln has heating elements on three sides only. The temperature near the door is considerably lower then the temperature near the back wall, and the temperature on the bottom is considerably lower than on the top. The thermocouple, which is supposed to sense the temperature in the kiln, is located on the back wall, and the temperature that we see on the control panel reflects only the temperature around the thermocouple. The temperature displayed is not necessarily the temperature near the door, or on the bottom of the kiln.

Moreover, carbon is a poor heat conductor, so the temperature inside the firing box is lower than what is displayed on the control panel.

So how do we fire copper and bronze clay in this kiln? As described in my book *Silver and Bronze Clay: Movement and mechanisms*, this is how I fire:

- In one layer only,
- With pieces separated by ½",
- Away from the door,
- As high as possible in the kiln.

This arrangement allows me to fire about 6 pieces, each about ¾" in diameter, in one firing session.



Second, make sure the thermocouple sticks out into the kiln chamber. If it does not, gently try to pull it further into the chamber. When you place the firing box in the kiln, the box may push the thermocouple back into the wall. To make sure you did not push it back, take the box out, see if the thermocouple is in the same position as before, then put the box back in.

If your kiln is more than 3 years old, your thermocouple may be rusty and needs replacing. This can be checked at a local ceramic store.

Place the box on posts, so it's as close as possible to the top of the kiln. Fill half the box with carbon, and lay the pieces on it. That way the pieces are placed high in the chamber, where the temperature is most likely to be highest. Leave the lid loose to let gasses out. You actually don't need a lid at all! If you have a venting hole, leave it open.

Some of my students report that they get better results with the smaller box.

Firing Schedule For Copper and Bronze Clay Powder

The firing schedule involves 2 phases.

Phase I

Press the left button until you reach a program that is not pre-set. If the left button doesn't bring you there, press the middle button. On some kilns it may be program 6 or 7. On my kiln it says: "User".

Press the left button again. The kiln will say: "Idle."

Translation: "I am doing nothing. Tell me what to do step-by-step."

Press the left button again. (Translation: "OK, start asking.")

The kiln says:
"rA 1" (ramp 1).

Translation: "*How quickly* would you like me to reach the desired temperature the first time around?"

Your answer is "full speed," which means "Ramp up as quickly as you can." (This means by about 2000°F per hour.) Press the up and down arrows until the display says "Full."

Press the left button again. (Translation: "OK, what's your next question?") The kiln says:
"°F 1."

Translation: What is your desired *temperature* the first time around?

Using the up and down arrows answer: "1000."

Press the left button again.

The kiln asks: "HLd1" (hold 1).

Translation: "How long should I *hold* at that temperature?"

Your answer: "Don't hold at all at that temperature. As soon as you reach it, go on to the next step." (To say this, press the up and down arrows until the display reads 0.000).

Press the left button again.

Now the kiln asks: "rA 2" (ramp 2).

Translation: "*How quickly* would you like me to get to the desired temperature the second time around?"

Your answer is: "I want to ramp up by 100° per hour." Use the up and down arrows to display "0100°F"

Press the left button again. The kiln asks: "°F 2."

Translation: “What is your desired *temperature* the second time around?”

Using the up and down arrows answer: “1100°F.”

Press the left button again.

The kiln asks: “HLd2”

Translation: “How long should I *hold* at that temperature?”

You answer: “Don’t hold” (0.000).

The kiln will repeat the questions for the third time around. Keep answering 0.000 for all questions until the display says “Strt” (start).

Press the left button again. The kiln will say: “On.”

After about an hour and 20 minutes the kiln will finish this cycle and beep. The first phase is over. Open the kiln and carefully take out the box using a kiln fork. If there's a lid on the box, remove it using cross lock tweezers. Allow the kiln and the box to cool down below 200°F or to room temperature. If you don't want to touch the kiln while it's hot, just let everything cool inside the kiln. It will take a few hours, though.

Phase II

Now you can plug the venting hole, although it's not necessary.

As before, prompt the kiln for the next question by pressing the left button after each of your answers.

Kiln: "Ramp 1"?

You: "Full speed."

Kiln: "°F 1"?

You: "1550°F."

Kiln: Hold 1?

You: "3 hours."

The kiln will ask the same questions about the third time around. Answer "0.000" for all questions until the kiln says: "On."

After about 3:30 hours the cycle is over and the kiln will beep.

Short Version

Phase I
Full ramp to 1000°F
Ramp at 100°F to 1100°F

Cool

Phase II
Full ramp to 1550°F*
Hold 3:00 hours.

*If bronze pieces blister at this temperature, lower the temperature to 1520°F.

The second kiln is made of kiln bricks and is a top-loader. The heating elements are on all 4 walls. Bricks keep the heat better than muffles. The box fills the whole space, so there is hardly any loss of heat and the distribution of the heat in the chamber is better. This allows us to fire in layers, and because the door is at the top, we can put more pieces in each layer.

The advantage of this kiln is that it allows us to fire more pieces in one firing session. The disadvantage is that it takes longer to warm up and cool down.

Because of this kiln's ability to hold and distribute the heat so well, the firing schedule is slightly different. Here is the **short version**:

Ramp at full speed to 1000°F Hold 1:00 hour Cool Ramp at full speed to 1480°F * Hold 2:30 hours

* If bronze pieces blister at this temperature, lower the temperature to 1470°F.

Adjustments

These two kilns, of course, are not the only ones available, and the firing schedule may have to be adjusted according to the type, size, age, and structure of the kiln.

Adjustments can be made to either of the phases by increasing or decreasing hold time and/or temperature.

Test Pieces

Before you actually fire your work, it's a good idea to make test pieces and do a trial run, to find the ideal firing schedule for your kiln.

To make test pieces, roll layers 3, 6, and 9 cards thick. (It would be best to make test pieces that are as close as possible your style in size and thickness.) Cut several test pieces from each layer. Dry them, and fire according to the instructions.

After firing try to break them with your fingers. If they don't break, try to break them with pliers. After breaking, buff the cross section, where the piece broke. The photo below shows 2 different results:

The one on the right shows a cross section that is full of powder. That means that the binder has not been completely removed. Adjustments may be needed for the first step of the firing.

The one on the left shows a cross section that is all metal. The fact the piece broke with pliers means that the sintering was not complete, i.e., the metal has not reached its highest density. Adjustments may be needed for the second step of the firing.

If pieces don't break, no adjustment is required.

Please bear in mind that with some effort some pieces may break even if they are fully sintered. That in itself is not a problem; after all, any piece of *silver* clay, no matter what type or brand, can be easily broken with either just fingers or pliers, and that never stopped us from making silver jewelry out of clay.

Silver clay has spoiled us all, with its short firing schedule and guaranteed success. However, non-precious metal clay is a different material. Those of us who are fascinated by it will work with it in spite of its challenges. Moreover, I believe that there may be multiple brands of copper and bronze clay available in the future, as is now the case with silver clay. Every brand will have its advantages and drawbacks. Some will have better consistency, some will have shorter firing schedules, and every user can make their choice. It's a big world out there, and there is room for all of them.

I'd like to thank Tonya Davidson for teaching me how to talk to my kiln.

Hadar Jacobson, February 2009.