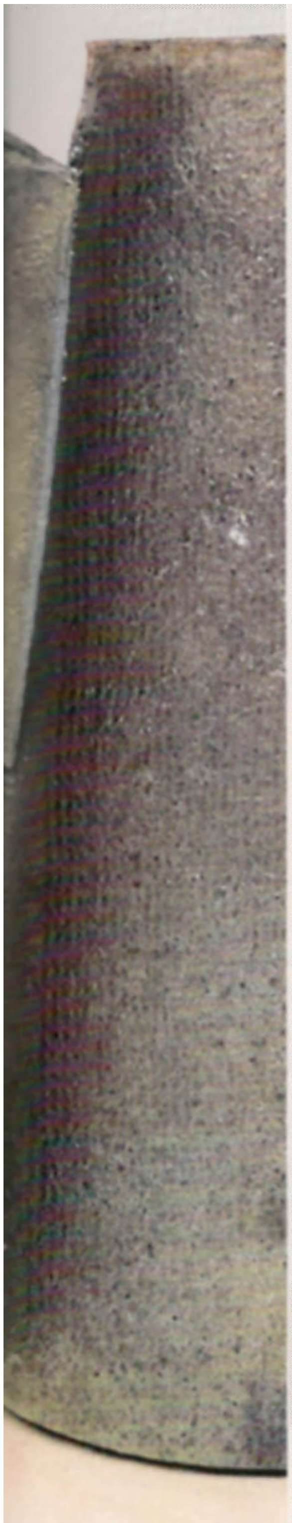
lindsay**oesterritter**

how low to go

There are many ways to approach the firing and cooling of a woodfire kiln, not to mention all of the variables of clay bodies, wood types, firing schedules, glazes and slips. I have had the pleasure to work alongside many reduction coolers, and each has their own thoughts and preferences about when to stoke during the cooling and why, benefits of cycling between reduction and oxidation for subtle differences, criticality of not allowing any air in during the cooling, and of course the importance of the temperature to cool down to. This final point, target temperature during cooling, has been of particular interest to me since I began to investigate reduction cooling. What is that ideal final temperature one should cool down to?



I first learned how to reduction cool at Utah State University. In the programme at USU, it was standard practice to reduction cool to between 760°–788°C (1400°–1450°F). By cooling down to 788°C in a reducing atmosphere, black iron in the clay is not allowed to reoxidize to red iron. I tested many variables: clays, specific woods, water cooling, starting reduction cooling after ending on a hot note, starting reduction cooling without the hot note, starting the cooling with high coal beds in the side stoke, with low beds in the side stoke, etc. However, I always fired down to 788°C.

Currently, in my wood kiln in Virginia, I cool down to 885°C (1625°F). After leaving USU, and firing with people coming to reduction cooling from different backgrounds, I found that the temperatures that others down fire to varied greatly. I also fired a variety of kiln types, and noticed that when I cooled as low as 788°C in newer kilns that were closer to airtight, I was getting kiln loads that were all blacks and greys, with very little of the brighter cranberry reds that are associated with reduction cooling. I really enjoy the blacks, but was looking for more consistent variation. From 760°C, I increased my final cooling temperature incrementally, up to 899°C (1650°F). This seems to be the cut off point. At 899°C some of the kiln load was reoxidized brown pots. Why am I able to stop reduction cooling at 885°C and not get reoxidized brown pots, when the iron should still be reactive to the oxygen in the atmosphere?

During the woodfire conference at Waubonsee Community College in 2016, I fired their small train kiln as part of the pre-conference. I was the third person to fire and reduction cool this kiln. The first person fired to a peak of cone 13 and cooled down to 788°C. The second person fired to cone 10 and cooled down to 788°C. I fired the kiln to cone 10 and then cooled down to 885°C. The first firing, reaching much hotter peak temperatures did affect the stability of the clay. Otherwise, in terms of the reduction cool results, the difference between 788°C in the first two firings, and 885°C in my firing was surprisingly negligible, if noticeable at all. It was a small kiln, relatively air tight, same wood type, and similar loads.

Because the Waubonsee kiln was a small kiln, did the similarities in

Pourers, *by Lindsay Oesterritter, 18 cm in height, 2017. Iron rich stoneware, press moulded. Title page: Surface detail highlighting transition from red to black, 2017.*
Photographs: Lindsay Oesterritter.

Juicers, *by Lindsay Oesterritter, 12.7cm in height, 2017. Iron rich stoneware, press moulded and wheel thrown. From left to right, placement in kiln: front bottom, back top, and middle middle.*
Photograph: Lindsay Oesterritter.

results say something about how fast it cooled? If the natural cooling of the kiln were slower, would the results turn from the reduction cooled blacks to the re-oxidized browns? Could the quickness of the cooling also be the answer to the results I'm getting in my train kiln? In other words, that the kiln has enough unburnt fuel to keep it in reduction to 760°C.

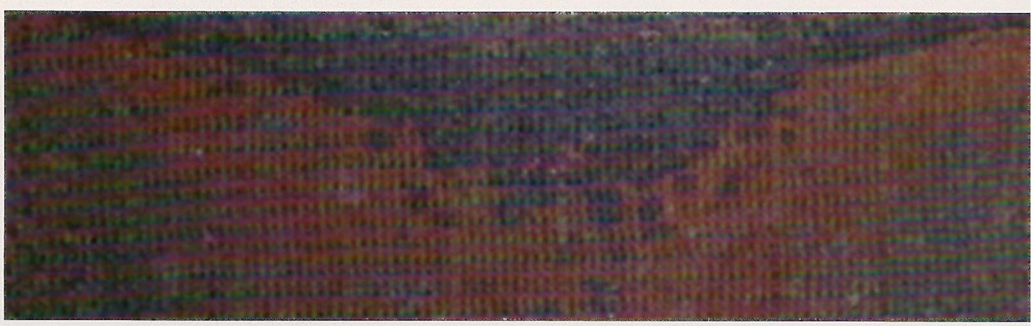
In my September 2017 firing I used an oxyprobe to better understand the atmosphere in the kiln after the final reduction cooling stoke. Maybe not surprisingly, the atmosphere in the kiln essentially followed the same pattern that I had been stoking to in the reduction cooling process, except now I did not stoke to regain a reducing atmosphere. After the last stoke at 885°C, it took roughly 15 minutes for the oxyprobe to read .1 (oxygen rich).

Which brings us back to my original question, more accurately worded; in an oxygen rich environment at nearly 885°C, why does the iron not reoxidize? The strongest possibility is that it has more to do with the clay than the atmosphere. In the iron rich clays that I use in my firings it is likely that the iron has bonded to other elements in the clay that impedes its ability to reoxidize. One way to test this would be to start with a very open clay body, line blend with a feldspar to a vitreous body,

fire the test bodies in the same area of the kiln, and see what the difference is in the colour of the clay body. If the reason the iron is not reoxidizing were related to the clay body, the more open or porous body would reoxidize to a greater extent than the vitreous body.

A comparable study can be drawn from what we know about Athenian Black Figure and Red Figure wares. From their physical chemical analysis it is known that the finished black and red surfaces are made from similar clays with different particle sizes. The black is a finer particle terra sigillata, and the red clay is a coarser body. The wares are fired to temperature (900°/950°C) in oxidation, soaked in reduction (from peak to 860°/850°C) and cooled in oxidation (860°C to resting temperature). The coarser clay never vitrifies and oxidizes to red, however, the terra sigillata forming a glass like structure that traps the iron is impermeable, and remains black.

From the microscopic analysis Hideo Mabuchi has been doing of the wood-fired reduction cooled wares of Dan Murphy, they have come to realize that the reduction cooled reds and the reoxidized browns are actually on the same spectrum. And that the reason for a pot staying black or turning red is more complicated than it being because of the atmosphere in the kiln or the clay body. Their research is showing how the action of holding a pot in a reducing atmosphere is changing the clay surface in two distinct and important ways. The extended reduction is actually microscopically etching the clay surface and simultaneously the smallest iron compounds are evaporating off



Juice Cup, *by Lindsay Oesterritter, 10cm in height, 2017. Iron rich stoneware.*

Below: Dessert Bowls, *by Lindsay Oesterritter, 6.3cm in height, 2017. Iron rich stoneware.*
Photographs: Lindsay Oesterritter.

the clay surface. A small portion of the evaporated iron then recondences back into fine feather like crystals on the clay surface. The action of reduction cooling, and holding a pot in a state of reduction for a period of time is creating the surface that can turn red. The light microscope and electron microscope are revealing that the brighter more distinct reds are a finer particle surface, while the surface I associate with being reoxidized brown colour is a chunkier surface. The results are on opposite ends of the same spectrum. Interestingly, Dan Murphy fires down to 718°C (1325°F) for the best reds, closer to the cooler temperatures that should be impacting iron.

Getting any red result on a reduction-cooled pot does mean that air is being introduced to the kiln's atmosphere during the reduction cooling process somehow, intentionally or not. If there was no air seeping into the kiln during the cooling process, and the kiln was completely airtight, staying in a state of reduction below 760°C, the results would be grey. Another idea that has been suggested is that if one were to fire a kiln to a higher peak temperature than cone 9 – maximum cone 10, that it potentially limits the

Lindsay Oesterritter's train kiln at her studio in Virginia, USA.
Photograph: Jason Vulcan.

clay's ability to gain the reds during the reduction cool. I have not found this to be true, at least with my clay body.

After investigating the variants of cooling temperatures, there is no ideal cooling temperature that will necessarily work for everyone, but rather an ideal temperature range. Iron is no longer reactive when red heat goes to black heat around 677°C (1250°F), however in graduate school, the empirical data proved that 788°C was low enough, and now in Virginia I have shifted even hotter, to 885°C with similar results. Of course this range of 677°– 885°C could increase or decrease slightly when considering the variables: the clay body and percent of iron in the clay body, length of firing, types of wood, accuracy of thermocouple, air tightness of kiln, presence of glazes or slips, the length of time it takes the kiln to cool, not to mention what results are being sought after. These are all factors to consider when narrowing down to one's own preferred final cooling temperature.

Sources:

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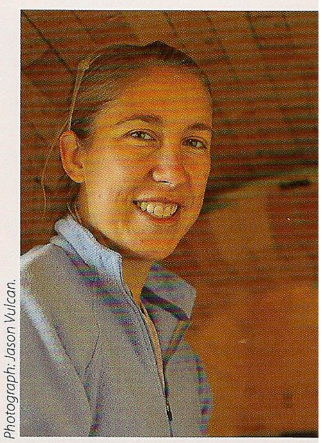

Photograph: Jason Vulcan.