

Firing Tips

IMPROVING KILN UNIFORMITY

Temperature Distribution

Temperature distribution in a kiln can be affected by many different factors including:

- the design of the kiln
- how hot the kiln is being fired
- the load in the kiln
- the rate of heating
- if an automatic vent system is used
- how the kiln switches are adjusted
- if a hold (soak) is used
- the age and condition of the heating elements and kiln

Throughout the firing, hot air rises and cool air falls. As a result, some kilns will fire cooler at the bottom than the top. Today's redesigned kilns generally have improved uniformity, but it is not uncommon to see a full cone difference from top to bottom in the kiln and a half cone difference on a single shelf in a large kiln.

How Heat Moves

In the early stages of firing, warmed air circulates through the kiln. Later the hot kiln elements radiate direct heat onto the ware. Hot air moves through

the ware transferring heat by convection to the ware. Then it is conducted to the inside of the ware.

Firing Temperatures

At higher temperatures, most of the heat is transferred by radiation from hot elements or hot gas. Kilns fired to lower cone numbers tend to be less uniform than kilns fired to higher temperatures (016 vs 6). This is because radiation is more effective in transferring heat.

Load Makes a Difference

With a heavy load, it is more difficult to evenly distribute heat through the kiln. When a kiln has a moderate to light load, low heat can better circulate and radiant heat can reach more of the ware to reduce hot and cold spots.

Kiln Characteristics

How Big is the Kiln

For larger kilns, there is more space (and usually more ware) to heat. It takes longer for heat to be transferred.


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It is not unusual to see even a two cone difference (top to bottom) in a large kiln.

While kiln manufacturers help compensate for this problem, it is not cost effective to fully eliminate top to bottom differences.

What is Element Condition

Aging elements in one part of the kiln will affect heat distribution in that section. At full heat, all the elements should glow red. Elements that do not are likely aging and should be replaced. Check your kiln manual. Some kiln manufacturers recommend replacing all the elements at the same time for best results.

Controlling the Firing

One of the easiest ways to improve uniformity is to adjust the switch settings on the kiln to send more heat to cooler areas. As an example, for a kiln that is cooler in the bottom, turn the bottom switches on earlier than the other switches, or turn them on higher than the other switches. This allows the bottom to heat up more/faster than the rest of the kiln so it doesn't have to catch up later.

If an automatic controller is used, the firing rate can be slowed up to permit the heat to distribute throughout the kiln. Setting a hold time just below the top temperature is also a good way to reduce temperature distribution problems and to help ware mature more evenly.

Kiln Venting Systems

Downdraft kiln venting systems help solve temperature uniformity problems. A small amount of air is pulled in the top the kiln, circulated throughout the firing chamber and exhausted out the bottom of the kiln. As the hot air moves through the firing chamber, it evens out temperatures, often by as much as two cone numbers.

Checking Uniformity

The most reliable way to check heat distribution in your kiln is to use a series of witness cones on each shelf. By examining them after each firing, you can see how firing conditions, including uniformity, affect fired results. Adjustments in switching, loading, etc. can be evaluated for their effect on heat distribution.

Want to learn more?

Read more about Kiln Uniformity in the Orton Firing Line and Technical Tips publications. Each issue is packed full of articles to help you learn more about firing. Members of the Orton Firing Institute receive these publications at no charge. Single copies are available to non-members at a per issue rate. Orton's 80 minute video, *Key Principles of Successful Firing*, is also an excellent resource on firing.

For information on Orton products, see your Orton dealer or distributor. For information on the Firing Institute or publications, contact

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