TECHNO FILE

air bubble myth

by Sue McLeod

While pockets of air in clay can exacerbate problems during a firing, the air itself is not the culprit, despite some commonly held and shared beliefs.

Defining the Terms

Bone Dry: The state of dryness of clay at which the maximum amount of moisture has evaporated from the clay, given the relative humidity of the air around the clay.

Water Smoking: When the temperature in the kiln reaches the boiling point of water (212°F (100°C) at sea level) and moisture in bone-dry ware begins to turn to steam. This is a fully reversible process as long as it is complete before the clay is heated above 482°F (250°C).

Dehydration: The driving off of water, chemically bound as hydroxyl or OH- ions, from the clay lattice. This is an irreversible process. It typically occurs when the clay is heated to between 1112°F (600°C) and 1292·F (700°C), according to Robert Fournier in his *Illustrated Dictionary of Practical Pottery*.

The Myth

There's a common belief in ceramics that leaving pockets of air in your clay, either due to insufficient wedging or by creating an enclosed form, leads to explosions in the kiln. The belief is often communicated in these ways: "Poorly wedged clay containing air bubbles will explode," or, "If you create an enclosed form, you need to poke a hole for the air to escape or it will explode."

While it's true that enclosed pockets of air in your clay can lead to explosions, the explosions don't have anything to do with air being trapped and unable to escape. The explosions have everything to do with trapped water. If your pieces aren't 100% dry inside and out, problems can arise during the firing.

What Happens When Water is Heated?

At room temperature, water naturally evaporates. Natural evaporation happens relatively slowly and is dependent on the humidity of the surrounding atmosphere. If the relative humidity of the surrounding air reaches 100%, evaporation stops until the moist air is replaced with drier air, and evaporation can continue.

As water is heated, the molecules start to move faster and evaporation speeds up. If we continue to heat to boiling temperature, water (a liquid) converts to steam (a gas). At sea level, this occurs at 212°F (100°C).

Three important facts about water turning to steam:

1. It expands greatly in size—over 1500 times
2. It can produce a high amount of pressure
3. This all happens at a very high speed

Consider boiling a kettle of water. As the water begins to boil, you hear a faint whistling sound. As more water converts to steam it expands, increasing the pressure in the kettle, which increases the speed at which the steam passes through the tone hole and the whistling sound gets louder.

When the kiln temperature starts to climb, any moisture left in the clay starts to evaporate faster. If that moisture reaches boiling temperature before it has a chance to evaporate, it

A The aftermath of a clay explosion in a bisque firing due to firing wet pots. **B** Check for moisture during candling. When my safety glasses fog up it means there is still moisture escaping and candling the kiln should continue.

will convert to steam. The expansion, pressure, and high speed of water converting to steam within a clay body will cause the clay to explode, unlike the kettle that allows the steam to escape. This is why it's so important for clay to be completely dry before it is fired.

Do Air Bubbles Cause Explosions?

When clay is wet, all the spaces in between the clay particles are filled with water. As the water evaporates, the clay becomes porous, meaning there are tiny pathways of void space (air) in between the solid clay particles. Essentially, bone-dry clay is full of teeny tiny pockets of air. Air within the clay is not a problem. If we make a piece and we leave an air bubble in the clay, that air pocket does not directly pose a risk of explosion. Air is free to move through those tiny porous pathways in the dry clay.

Only water leads to explosions. It's a causation/correlation misconception to say that air causes explosions. While enclosed air doesn't cause explosions, it can prevent thorough drying and trap moisture, which does cause explosions. When we enclose air bubbles within a clay form, that pocket of air provides water molecules with a nice humid place to hang out.

A thin piece of clay with an air bubble will dry and fire without issue. When the clay is thicker, it can feel very dry on the outside while the inside still contains moisture. When the kiln temperature rises, the air pockets fill with water vapor, which builds pressure as water turns to steam. The pressure of the steam causes the clay to explode from the inside (A).

Say you throw an enclosed form or you join two pinch pots together. Poking a hole will promote more thorough drying before the firing by allowing dry air to circulate so evaporation can occur from the inside as well as the outside. The bigger the hole, the faster the piece will dry. During the firing, the hole gives the steam a pathway to exit, preventing pressure from building up and hopefully, preventing an explosion.

But, is it possible to leave air bubbles in your clay and make enclosed forms without holes in them that don't explode in the kiln? The answer is yes! If the clay is 100% dry inside and out at the time it reaches boiling temperature, there is zero risk of explosion. But on the flip side, explosions can occur even when air bubbles are not present if your clay isn't thoroughly dry.

How to Ensure Pieces Are Dry

Two factors contribute to quicker evaporation: one is heat and the other is air circulation.

The most common advice is to candle your kiln, which means you turn the kiln on low and hold it just below boiling temperature until all the moisture has escaped. While this is good advice, it isn't fail-safe, especially with thicker clay. Candling doesn't always complete the drying process in a reasonable amount of time. While I do recommend candling your kiln as a final measure, I would suggest using air circulation initially so your pieces are as dry as possible before they enter the kiln.

Air circulation is effective because evaporation speeds up as the humidity of the surrounding air decreases. If the air is completely still, evaporation will cause a cloud of moisture to form around the piece, slowing down further evaporation. If that moist air is replaced with drier air, evaporation continues. The easiest way to accomplish this is by using a fan to circulate the air around your drying wares.

Make sure your pieces are already fairly dry before putting a fan on them or they may dry unevenly and crack. While the fan is on, periodically turn your pieces over to allow the air to reach all sides. If you can add heat to the circulating air, this will further speed up drying. If your kiln is vented, be sure to turn the vent fan on while candling to help remove the humid air in the kiln.

Moisture Test

Damp clay is cool to the touch, whereas dry clay is room temperature. If your pots feel cool, they're probably not ready for the bisque firing. Be sure to check the bottoms and insides. Once you're sure your pots are thoroughly dry, you can load them into the kiln and start the candling process for good measure. Keep the kiln temperature low until all residual moisture has escaped.

A simple way of checking for moisture escaping the kiln is to hold a piece of glass or plastic (I use my safety glasses) near one of the open peepholes during candling. If it fogs up, this is a sign that there's still moisture escaping the kiln (B). Continue candling until there is no longer any sign of moisture and then proceed with the firing as usual.

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If you love learning about and discussing firing and glazes, check out McLeod's free social learning Facebook group, Understanding Glazes with Sue. The group is full of videos and discussions about firing, mixing glazes, and fixing various glaze issues. McLeod also teaches an online class, Mastering Glaze Consistency. To learn more about it, visit https://suemcleodceramics.com/masteringglazeconsistency.

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