

Operational Guidelines for Crucibles Used in Induction Melting

SELEE® Advanced Ceramics™ Technical Service

“After proper installation of your crucible the last step to extending crucible life is to follow certain operational guidelines while melting.”

Five Important Aspects of Crucible Operation:

1. Curing the Unit

- Curing decreases the likelihood of a thermal shock failure since it heats the crucible slowly and removes any residual moisture.
- Always take time to cure the crucible before the first heat.
 - Use a weighted charge of 2/3 or more metal in the crucible to cure the crucible (mainly large material such as ingots).
 - Avoid wedging the material, as wedged metal will expand more than the crucible upon heat up and can crack the crucible.
 - Use an initial heat up rate of 300°F to 500°F for the first 1 to 1.5 hours.
 - As the charge approaches the melt temperature the top cap, crucible, and backup material will release any remaining moisture.
 - Applying the power too rapidly can cause uneven heating and possible catastrophic failures such as thermal shock and hazardous steam explosions.

2. Thermal Cycling

- Limit the thermal cycling as much as possible by arranging for consecutive heats to maintain a hot crucible.
- When cycling is a must, raise and lower the refractory temperature gradually.
- Allowing a crucible to cool down to room temperature between heats will decrease its life.
 - Stress due to thermal gradients upon cooling causes a crucible to crack.
 - When heated and cooled crucibles go through phase changes, which have associated volume changes that degrade the strength of the refractory.
 - When heated to sufficient temperature liquid phases develop and when cooled they become glass formations within the matrix making the crucible more prone to thermal shock upon the next heat up.
- When cooling a crucible to room temperature always use a refractory blanket on top of the unit to slow the cooling rate.

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3. Mechanical Abuse

- Never install a crucible with cracks.
- Always treat the crucible with care.
- Ceramics are brittle and once damaged will degrade rapidly and fail.
- Minimize mechanical abuse when handling, cleaning, and charging the crucible.
- Do not drop ingots as this can crack the crucible.
- Do not wedge charges since metal expands more than the crucible when heated it can cause a crucible to crack.

4. Moisture

- Store crucibles in a dry place.
- If a crucible gets wet dry them slowly in a dryer or oven.
- Gas lances can be used to dry crucibles but care must be taken in order to heat evenly and slowly.
- Never add wet material to a molten charge.

5. Other Guidelines

- Minimize the use of fluxes.
 - Fluxes can be incompatible with the refractory and cause aggressive erosion.
 - An acidic flux will erode a neutral to basic refractory and vice versa.
- Make sure the metal chemistry is consistent since variations can adversely affect crucible performance.
- Never allow molten metal to solidify in the crucible.
 - A heel of metal can cause the crucible to crack due to the difference in expansion between the metal and the crucible .
- When molten metal is on hold keep the power no higher than required to maintain bath temperature.
- Pour metal as soon as it reaches the required temperature, this will reduce erosion and increase life.
- Turn the power off when the furnace is in the tilt position.
 - When the power is left on in the tilt position it keeps the metal churning. This flow of metal on the one side of the crucible causes uneven wear in the crucible shortening its life.
- Never melt metal in the top cap.

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