

Firing Tips

SUCCESSFUL GLASS FUSING

Probably the most common problem encountered when fusing glass is that it breaks during firing. There are several causes, including:

1. glass incompatibility
2. glass sticking to shelves
3. glass heated too rapidly
4. glass annealed too quickly

Glass Compatibility

To be compatible, glasses must expand and contract at the same rate when heated and cooled. When this does not occur, they are considered incompatible.

If incompatible glass is fused together and then cooled, stresses will occur in the piece. If the stress is excessive, the fused glass will break either immediately upon cooling or months or even years later.

Glasses are rated using a coefficient of thermal expansion scale. This is based on the linear size change or expansion during heating.

What this means is that the amount the glass expands during heating is

measured and compared to a scale. The larger the number, the greater the expansion. Glass with low expansions will have greater resistance to thermal shock and breaking or cracking.

When you purchase glass, be sure all of the materials you are planning to use in a piece have similar expansion (coefficient) numbers.

Glass Sticking

If kiln wash (shelf primer) is applied unevenly or bare patches are left, the glass may stick as it moves (expands) during the firing process. When this happens, the glass can pull itself apart and break.

Kiln wash should be cleaned off and reapplied in a thin even coating to prevent sticking problems. Take care not to use too much shelf primer as it may require sandblasting to remove it from the bottom of the fired piece.

Glass Heating Too Rapidly

Thermal shocking of glass during


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heat up can lead to uneven heating and cracking of the piece. Thermal shocking means that the surface of the glass changes temperature rapidly.

When fusing glass, it is important to control the heating rate between about 150°F and 500°F. For larger or thicker pieces more time is needed. Glass fired in a mold is more susceptible to uneven heating since contacts with the cooler refractory (mold) can lead to uneven heating.

Direct radiant heat from heating elements needs to fall uniformly on the glass or it can cause uneven heating. Most glass firing is done in electric kilns, often with elements above the glass.

Glass Annealed Too Quickly

Annealing is done to reduce stresses in the glass that can result in cracks or breaks. Typically annealing is accomplished by soaking during the cooling cycle (at about 900°F) and then slow cooling between 900°F and 500°F. The amount of time the glass is annealed depends on its thickness. Annealing permits all the glass to equalize in temperature.

When glass is annealed too quickly, stresses can remain that can cause cracking.

When thick sheets or pieces of glass are being annealed, a process called firing down may be necessary. Firing down is done during the slow cooling phase of annealing. Firing down is

used if the kiln is unable to maintain the slow cooling rate required for the piece. The process of firing down involves adding a small amount of heat to the kiln as it cools.

The best way to control cooling during annealing is to use an automatic controller. The desired anneal temperature, soak time and cooling rate are set and the kiln operates automatically. Temperature is displayed. However, even with a controller, the cooling rate set by the operator may be too fast for the kiln to achieve. It is necessary to monitor the temperature change to insure the proper annealing and cooling down occurs.

The thickness of the glass being fired

Want to learn more?

Read more about annealing and firing glass 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, video or publications, contact

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