Instructions:
Fusing

Fusing glass in a kiln is a fascinating technique that enables artists to create unique and gorgeous projects. The following fusing rules and firing instructions should provide you with enough information to lead your students through a variety of projects, creating an appreciation for the complexities and potential of fused glass, and paving the way for more intricate designs and ideas.

I. Tested Compatible

A. All glass has a coefficient of expansion, or COE.

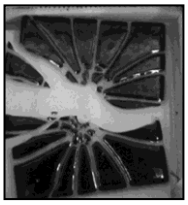
B. Glass manufactured specifically for fusing is often "tested compatible," or guaranteed to be a certain COE.

C. The most popular fusing glasses are either 90 COE (Bullseye, Uroboros, and Wasser) or 96 COE (Spectrum and Uroboros).

D. Always use compatible glass, which is known to have the same COE.

1. When glass is heated it expands, when it cools it contracts. If fusing two or more pieces of glass together, they need to expand and contract at the same rate. Otherwise, when the glass cools, one glass will pull on the other and cause the piece to crack along the seam.
2. If the glass survives the cooling process, there is still a risk that reheating to bend it, or placing it in a sunny window will cause cracking. Stress from incompatible glass is always in the piece. Do not try to re-fire broken incompatible glass.

II. Slower Is Better



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A. You can't heat or cool glass too slowly. Going too fast can result in cracked glass or Thermal Shock (photo 1).

B. A safe rate to heat is 6^{o} per minute (350^{o} - 400^{o} per hour), although stacked glass 2" in diameter and smaller can be heated at a faster rate.

C. Once you have reached your desired temperature you begin the cooling process. A safe rate to cool is 500^{o} per hour (you can program a faster rate but the kiln is insulated so realistically it can't do much more than this). Keep in mind once you reach 960^{o} - 950^{o} you should hold this temperature for 15 minutes to one hour depending on the size of your piece to insure proper annealing.

III. Glass Likes To Be ¼" Thick

A. When heating glass to full fuse, anything with less mass will shrink up, Anything with more will spread out. This movement can be controlled somewhat by fusing slower, and not going to full fuse.

IV. All Kilns Are Not Alike

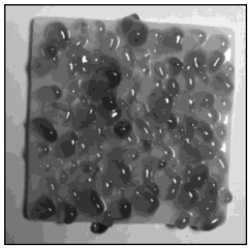
A. There are some variances between kilns, especially mini kilns. Sometimes pyrometers are slightly off, and sometimes current loads vary.
B. Use firing schedules as a guide, but remember to check your piece frequently during fusing, and record changes in schedules as needed.
C. Prepare your kiln by applying kiln wash with a kiln brush. Apply one thin coat in each direction. Don't forget to apply kiln wash to molds, too.

V. Take Good Notes

A. Use a project log to keep important information about your projects.
B. Keep track of what glass was used, how thick the glass was, the firing schedule and the results.
C. This helps repeat good performances and prevent bad ones.

VI. Fusing Glass

A. Glass Fusing Stages



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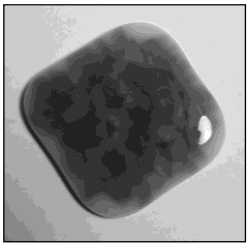

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Common Temperatures	Fusing Stage	Glass Stages
800^0F – 1100^0F	Brittle Zone	Do not open the kiln in this range
1325^0F – 1405^0F	Tack Fuse	Edges are soft, glass is stuck together (photo 2)
1425^0F – 1450^0F	Full Fuse	Glasses combine, uniform thickness throughout (photo 3)

B. Fusing Schedule

Use for any **programmable** kiln for pieces 5-10" in size (larger pieces should be heated and cooled slower to prevent thermal shock).

Firing Segments	Kiln Temp.	Changes in Glass
400 degrees/hr	Until 1000^0F Soak for 10 minutes	Edges of glass begins to round out and soften
600 degrees/hr	Until 1450^0F Soak for 10 minutes	Glass now in a molten state
Cool as fast as possible	Until 960^0F- 950^0F Soak for 30 minutes	This is important for annealing purposes
Cool as fast as possible	Until Room Temperature	You may vent kiln lid at under 500 degrees