

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 make 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, 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 refire broken incompatible glass.

### **II. Slower Is Better**

- 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 15° per minute (900° per hour), although stacked glass 2” in diameter and smaller can be heated at a faster rate.
- C. Slow-cooling of glass or “annealing” depends on the thickness of the glass. If the glass breaks because it was heated too fast; turn off the kiln, allow the glass to cool, push it back together, and try again – at a slower rate. Breaks from thermal shock usually go straight across the piece and have a little hook near the edge. They can usually be repaired by refiring.



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### **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.

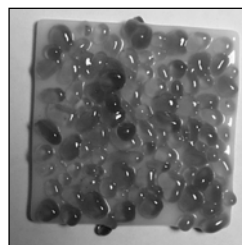
- C. Prepare your kiln by applying kiln wash with a kiln brush. Apply one thin coat in each direction. Don't forget to apply kiln wash to molds, too.

**V. Take Good Notes**

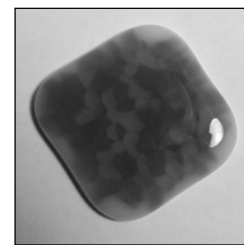
- A. Use a project log to keep important information about your projects.  
 B. Keep track of what glass was used, how thick the glass was, the firing schedule and the results.  
 C. This helps repeat good performances and prevent bad ones.

**VI. Fusing Glass**

A. *Glass Fusing Stages For Mini Kilns*



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Common Temperatures	Fusing Stage	Glass Stages
800 <sup>0</sup> F – 1100 <sup>0</sup> F	Brittle Zone	Do not open the kiln in this range
1325 <sup>0</sup> F – 1425 <sup>0</sup> F	Tack Fuse	Edges are soft, glass is stuck together (photo 2)
1425 <sup>0</sup> F – 1600 <sup>0</sup> F	Full Fuse	Glasses combine, uniform thickness throughout (photo 3)

B. *Fusing Schedule*

Use for table top kilns, pieces ¼” thick, and 3” – 6” in diameter (larger pieces should be heated and cooled slower to prevent thermal shock).

Dial Setting & Time	Kiln Temp.	Glass Stage
2 for 20 minutes (check kiln)	About 500 <sup>0</sup> F	No change in glass
3 for 30 minutes (check kiln)	About 1000 <sup>0</sup> F	Still no change in glass
4 for 10 minutes (check kiln)	About 1500 <sup>0</sup> F	Glass should be slightly more than tack fused
4 for 5 minutes (check kiln)	About 1500 <sup>0</sup> F	Glass should be full fused (see further instructions below)

- C. Once the desired look has been achieved, turn off the kiln.
- To stop the fusing process, flash vent the glass to let the heat out by holding the lid off the kiln about 8 seconds and watching the glass surface turn from orange to blackish (the color will return to the glass as it cools). Repeat the process until the temperature stays close to 1000° when the lid is replaced.
  - Replace the lid and turn kiln on low for 20 minutes. This will keep the kiln approximately 1000 - 1200°, allowing a minimal annealing cycle. Turn off the kiln and cool naturally to room temperature.
- D. If more melting is desired, turn dial to 5, but do not leave kiln.
- It is easy to over fire glass at this temperature and ruin the piece. Let the kiln heat to 1600° and turn the dial back to 4. This will allow the kiln to get slightly hotter, without continuing to gain heat.
  - Check the piece every 3 minutes and try not to let the kiln go above 1600°. When the desired look is achieved, follow the instructions above.

### VI. Basic Supplies

*Listed with Delphi item numbers for quick reference*

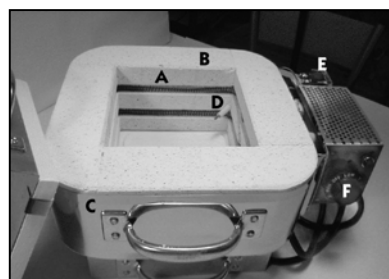
1. #HB120 Table Top Kiln
2. #7441 Ceramic Kiln Shelf – 6”
3. #7465FM Kiln Wash
4. #7466 Haik Brush
5. #FIREUPS Tested compatible glass – Uroboros Glass Pack, 90 COE
6. Glass Cutting Supplies
  - a) #5104 Glass Cutters
  - b) #5068 Running Pliers
  - c) #5066 Breaker/Grozer Pliers
7. Variety of Bending Molds
  - a) #7433 4 ¼” Shallow Dish Mold
  - b) #J4 Belt Buckle/Barrette Mold



### VII. Kiln Parts

All glass fusing kilns have basically the same parts:

- A. Elements (high temperature coiled wire)
- B. Firebrick insulation
- C. Stainless steel cover
- D. Thermocouple (high temperature wires covered by ceramic rings)
- E. Pyrometer (temperature read out dial)
- F. Infinite Dial – some kilns simply have an on/off switch; the Hot Box pictured has the Infinite Dial



Photography and instructions from *Glass Fusing Made Easy* book #5981. For more information and project ideas refer to this book and Delphi’s fusing favorites:

#### Fused Glass Handbook #6430

Fusing guru Gil Reynolds presents 25 projects with easy to follow instruction for mold-making, creating pattern bars and many other hot glass techniques.

#### Kiln Crafted Video #4990V

Discover how glass shaping techniques developed thousands of years ago have been put to use by contemporary artists. Observe different stages of the glass melting process. Learn how to turn ordinary glass into beautiful sculpture as well as forming, mold materials, preparation, heating and cooling cycles, and more. Includes example projects ranging from beginner levels to advanced.

