Firing Equipment and Techniques

PMC Conference 2004

Torch Firing

Torch Firing Kit from PMC Connection

Advantages:

1. Inexpensive
2. Fast

Disadvantages:

1. Can be difficult to control resulting in melted pieces
2. Pieces are not as strong as properly kiln fired pieces.
3. Limited to 20 Grams maximum

Notes:

Alchohol Fuel Fired Systems

Hot Pot Kit from PMC Connection

Advantages:

1. Inexpensive
2. Fast
3. Cannot overfire and melt

Disadvantages:

1. Limited to 20 Grams maximum
2. Pieces are not as strong as properly kiln fired pieces.

Notes:

Electric Kilns

Brick Kilns

Hot Box Kiln with Pyrometer by Evenheat

Manual Kilns

Advantages:

1. Generally cheaper than Fiber Kilns
2. Readily available in the used kiln market
3. Some have high fire capability for other uses, Doll making etc.

Typical Kiln Control Switches

Disadvantages:

1. Slow heatup and cool down.
2. Imprecise heat control or no control at all
3. Requires pyrometer to accurately gauge temperature

Kilns Equipped with Kiln Sitters

Advantages:

1. Generally cheaper than Fiber Kilns
2. Readily available in the used kiln market
3. Some have high fire capability for other uses, Doll making etc.
4. Kiln Sitter allows control of terminal temperatures with some interpolation
5. Control switches provide some speed control

Electric Kilns Cont'd.

Brick Top Loading kiln
by Evenheat

Disadvantages:

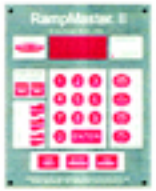
1. Slow heatup and cool down.
2. Imprecise heat control or no control at all
3. Requires pyrometer to accurately gauge temperature

Kilns Equipped with Digital Controllers

12 Button Digital Programmer
by Orton Ceramic Foundation

Advantages:

1. Generally cheaper than Fiber Kilns
2. Some are available in the used kiln market
3. Some have high fire capability for other uses,
   Doll making etc.
4. Controller allows control of ramp rates, temperatures and
   Hold times with a high degree of accuracy and
   repeatability



24 Button Digital Programmer
by Bartlett Instrument

Disadvantages:

1. Slow heatup and cool down.
2. Most brick kilns with controllers are largeer than needed
   and often require 240v power to operate.
3. Many are top loading which makes removing pieces
   while hot difficult if not dangerous

Fiber Kilns

RF-6 High Speed kiln w/ pyrometer
by Evenheat

Manual Kilns

Advantages:

1. Usually only require 120V
2. Fast heat up and cool down, Short Cycle time
3. Most such as Evenheat RF-6 are equipped with pyrometer

Disadvantages:

1. Easy to exceed melting temperature of PMC if distracted.
2. Imprecise heat control or no control at all.

Fiber Kilns Equipped with Digital Controllers

Sierra Model 91

Advantages:

1. Most require only 120V circuit
2. Fast heat up and cool down cycles possible
3. Controller allows control of ramp rates, temperatures and Hold times with a high degree of accuracy and repeatability
4. Most are front loading for easy placement and removal of projects.
5. Lighter than comparably sized brick kilns, more portable.
6. Very economical to operate. Generally half the operating co st of a comparable brick kiln.
7. Most have controller designed specifically for PMC.

VISUAL INDICATIONS OF TEMPERATURE WHEN FIRING PMC

Color	PMC Color	Degrees C	Degrees F
DARK RED		485	900
BLOOD RED		565	1050
DARK CHERRY		580	1075
MEDIUM CHERRY		675	1250
CHERRY RED		750	1375
BRIGHT RED		850	1550
RED-ORANGE		900	1650
ORANGE		940	1725
YELLOW-ORANGE		995	1825
YELLOW		1080	1975
YELLOW-WHITE		1200	2200
BRIGHT WHITE		1290	2350

**this chart is intended as a reference only and actual conditions will vary*

BUTANE TORCH FIRING

NO MUSS, NO FUSS, NO KILN

Smaller PMC+ and PMC3 pieces can be fired quite easily using a butane torch. Pieces that have an overall even thickness work best with this method (e.g. a ring, small pendant, earring, etc.) The advantage of the butane torch firing method is you can fire your piece in just a few minutes and you don't have to heat up a kiln to fir just one item.

Finish the bone-dry clay as normal (sand, file and shape it) and be sure it is completely dry. This is always important but especially when using the torch firing method. Any moisture in the piece will quickly turn to steam when you apply the torch. As the steam expands rapidly it can cause the clay to crack or fragment and possibly fly apart.

MATERIALS:

Butane torch, butane, tweezers, heatproof surface, soldering block

PROCEDURE:

1. Finish your piece in the normal way. Be sure it is completely dry and finish the surface with fine sandpaper or a buffer block.
2. Work in a well ventilated area. Place the soldering block on the heatproof surface and the dry PMC piece on the soldering block.
3. Fill the butane torch as directly by the manufacturer. Ignite the torch, following the manufacturer's directions. Adjust the fuel flow so that the inner blue flame is about 1 ½" (4 cm) long. The outer flame should be about ¾" (2 cm) longer. Aim the inner flame slightly above the PMC+ piece.
4. Move the torch in a circular motion, keeping the flame in continuous motion across the entire piece. Use the outer flame at first to warm the piece, then slowly move the flame closer to increase the heat applied. As the temperature increases, the organic binder will begin to flame and then quickly burn off.
5. Continue to heat the piece, using a continuous circular motion until it reaches the "sintering" temperature. (Sintering means to cause to become a coherent mass by heating without melting.) You have reached a sintering temperature when the piece is faintly glowing with a visible orange color. As soon as the orange color appears begin the firing period of 2 to 3 minutes, depending upon the size of the piece. Be sure to use a timer to insure that the full time period has passed. It is difficult judging the passage of time while working with the torch.
6. Be careful not to overheat the piece because you can actually melt it. If the surface turns from orange to a shimmering "wet look" silver color, immediately move the torch farther away from the piece to reduce the heat. The shimmery look indicates the surface is starting to melt.
7. When you have completed the full firing cycle simply turn off the torch and let the piece cool down to room temperature. This will take a while so be patient or you could risk a serious burn. Once cooled finish the piece in the normal way.

Temperature Equivalent Chart for Orton Pyrometric Cones (°C) Cone Numbers 022-14

	Self Supporting Cones						Large Cones				Small
	Regular			Iron Free			Regular		Iron Free		Regular
	Heating Rate °C/hour (last 100°C of firing)										
Cone	**15**	**60**	**150**	**15**	**60**	**150**	**60**	**150**	**60**	**150**	**300**
022		586	590				N/A	N/A			630
021		600	617				N/A	N/A			643
020		626	638				N/A	N/A			666
019	656	678	695				676	693			723
018	686	715	734				712	732			752
017	705	738	763				736	761			784
016	742	772	796				769	794			825
015	750	791	818				788	816			843
014	757	807	838				807	836			870
013	807	837	861				837	859			880
012	843	861	882				858	880			900
011	857	875	894				873	892			915
010	891	903	915	871	886	893	898	913	884	891	919
09	907	920	930	899	919	928	917	928	917	926	955
08	922	942	956	924	946	957	942	954	945	955	983
07	962	976	987	953	971	982	973	985	970	980	1008
06	981	998	1013	969	991	998	995	1011	991	996	1023
05½	1004	1015	1025	990	1012	1021	1012	1023	1011	1020	1043
05	1021	1031	1044	1013	1037	1046	1030	1046	1032	1044	1062
04	1046	1063	1077	1043	1061	1069	1060	1070	1060	1067	1098
03	1071	1086	1104	1066	1088	1093	1086	1101	1087	1091	1131
02	1078	1102	1122	1084	1105	1115	1101	1120	1102	1113	1148
01	1093	1119	1138	1101	1123	1134	1117	1137	1122	1132	1178
1	1109	1137	1154	1119	1139	1148	1136	1154	1137	1146	1184
2	1112	1142	1164				1142	1162			1190
3	1115	1152	1170	1130	1154	1162	1152	1168	1151	1160	1196
4	1141	1162	1183				1160	1181			1209
5	1159	1186	1207				1184	1205			1221
5½	1167	1203	1225				N/A	N/A			N/A
6	1185	1222	1243				1220	1241			1255
7	1201	1239	1257				1237	1255			1264
8	1211	1249	1271				1247	1269			1300
9	1224	1260	1280				1257	1278			1317
10	1251	1285	1305				1282	1303			1330
11	1272	1294	1315				1293	1312			1336
12	1285	1306	1326				1304	1324			1355
13	1310	1331	1348				1321*	1346*			N/A
14	1351	1365	1384				1388*	1366*			N/A

Pyrometric cones have been used to monitor ceramic firings for more than 100 years. They are useful in determining when a firing is complete, if the kiln provided enough heat, if there was a temperature difference in the kiln or if a problem occurred during the firing.

Cones are made from carefully controlled compositions. They bend in a repeatable manner (over a relatively small temperature range - usually less than 40° F). The final bending position is an indication of how much heat was absorbed.

Behavior of Pyrometric Cones

Typically, it takes 15 to 25 minutes for a cone to bend once it starts. This depends on the cone number. The cone bends slowly at first but once it reaches the half way point (3 o'clock), it bends quickly. When the cone tip reaches a point level with the base, it is considered properly fired. This is the point for which temperature equivalents are determined. Differences between a cone touching the shelf and a cone at the 4 o'clock position are small, usually 1 or 2 degrees.

Temperatures shown on the charts were determined under controlled firing conditions in electric kilns and an air atmosphere. Temperatures are shown for specific heating rates. These heating rates are for the last 100°C or 180°F of the firing. Different heating rates will change the equivalent temperature. The temperature will be higher for faster heating rates and lower for slower heating rates.

Cone bending may also be affected by reducing atmospheres or those containing sulfur oxides. Orton recommends the use of Iron-Free cones for all reduction firings (cones 010-3). If a cone is heated too fast, the cone surface fuses and binders used to make cones form gases that bloat the cone. If cones are to be fired rapidly, they should be calcined (pre-fired) before use. Cones should be calcined to about 850°F (455°C) in an air atmosphere.

If a cone is soaked at a temperature near its equivalent temperature, it will continue to mature, form glass and bend. The time for the cone to bend depends on several factors and as a general rule, a 1 to 2 hour soak is sufficient to deform the next higher cone number. A soak of 4 to 6 hours will be required to deform two higher (hotter) cones.

for more information on pyrometric cones, contact Orton or visit us at www.ortonceramic.com

Orton
The Edward Orton Jr. Ceramic Foundation
P.O. Box 2760 • Westerville, OH 43086-2760
(614) 895-2663 • (614) 895-5610 fax
info@ortonceramic.com
www.ortonceramic.com

These tables provide a guide for the selection of cones. The actual bending temperature depends on firing conditions. Once the appropriate cones are selected, excellent, reproducible results can be expected. Temperatures shown are for specific mounted height above base. For Self Supporting - 1¼"; for Large - 2"; for Small - 5/16". For Large Cones mounted at 1¼" height, use Self Supporting temperatures. * These Large Cones have different compositions and different temperature equivalents.