

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 equivalent temperatures are determined. Differences between a cone touching the shelf and a cone at the 4 o'clock position are small, usually a few °C or °F.

Temperatures shown on the inside charts were determined under controlled firing conditions in electric kilns and air atmospheres.

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.

Temperatures are shown for specific heating rates. These heating rates are for the last 90 to 120 minutes of the firing. If the heating rate is different, so will be the equivalent temperature. The temperature will be higher for faster heating rates and lower for slower heating rates.

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 Orton does not provide such data for its cones. However, as a general rule, a 1 to 2 hour soak will be sufficient to deform the next higher cones. A soak of 4 to 6 hours will be required to deform two higher (hotter) cones.

for more information on the use and behavior of pyrometric cones, permission to reprint the temperature equivalent chart or to purchase cones, contact:



THE EDWARD ORTON JR. CERAMIC FOUNDATION
PO BOX 2760 • WESTERVILLE OH 43086
614-895-2663 • 614-895-5610 (fax)

102896

USING ORTON PYROMETRIC CONES

CONE NUMBERS
022-12



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 - less than 40°F). The final bending position is an indication of how much heat was absorbed.

Temperatures are given for three series of cones. The soft series covers Cone 022 to 011. The low temperature series covers Cone 010 to 01 and the intermediate temperature series starts at Cone 1 up to 12. Cones are made to Cone 42.

Temperature equivalent charts are periodically updated. The temperatures shown inside represent the most accurate data available for cones shipped today. It will be noted that the temperature spacing between cone numbers varies. As a result, some cone numbers deform closer to their neighbors than others. In some cases, Orton produces a half cone.

Cones located on a kiln shelf near the ware are referred to as witness or shelf cones. Small (junior) cones/bars are used in a Kiln-Sitter™. Small cones are sometimes used as witness cones, but this must be done with care because they bend at substantially higher temperatures. Cones bend when sufficient glass forms and the cone becomes soft. The composition of the cone and the amount of heat determine when the cone bends.

Kiln-Sitter™ cones/bars bend due to the weight of the sensing rod. Witness cones bend due to gravity pulling the cone over. Mounting height and angle affect the bending. If the cone is mounted higher than recommended or if it leans over more than 8°, it will bend earlier.

Orton developed Self-Supporting witness cones to fix mounting height and angle. These provide for more repeatable performance. Temperatures are given for different cone types and mounting heights, all mounted 8° from the vertical.

**TEMPERATURE EQUIVALENTS °C
FOR ORTON PYROMETRIC CONES**

**TEMPERATURE EQUIVALENTS °F
FOR ORTON PYROMETRIC CONES**

These tables provide a guide for the selection of cones. The actual bending temperature depends on firing conditions. Once the appropriate bending cones are selected, excellent, reproducible results can be expected.

Cone	Self Supporting Cones			Large Cones			Small				
	Cone Type and Composition										
	Regular			Iron Free			Regular				
	15	60	150	15	60	150	60	150	60	150	300
Heating Rate °C/hour (last 90-120 minutes of firing)											
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
05 1/2	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
5 1/2	1167	1203	1225				1201	1223			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

Cone	Self Supporting Cones			Large Cones			Small				
	Cone Type and Composition										
	Regular			Iron Free			Regular				
	27	108	270	27	108	270	108	270	108	270	540
Heating Rate °F/hour (last 90-120 minutes of firing)											
022		1087	1094				N/A	N/A			1166
021		1112	1143				N/A	N/A			1189
020		1159	1180				N/A	N/A			1231
019	1213	1252	1283				1249	1279			1333
018	1267	1319	1353				1314	1350			1386
017	1301	1360	1405				1357	1402			1443
016	1368	1422	1465				1416	1461			1517
015	1362	1456	1504				1450	1501			1549
014	1395	1485	1540				1485	1537			1598
013	1485	1539	1582				1539	1578			1616
012	1549	1582	1620				1576	1616			1652
011	1575	1607	1641				1603	1638			1679
010	1636	1657	1679	1600	1627	1639	1648	1675	1623	1636	1686
09	1665	1688	1706	1650	1686	1702	1683	1702	1683	1699	1751
08	1692	1728	1753	1695	1735	1755	1728	1749	1733	1751	1801
07	1764	1789	1809	1747	1780	1800	1783	1805	1778	1796	1846
06	1798	1828	1855	1776	1816	1828	1823	1852	1816	1825	1873
05 1/2	1839	1859	1877	1814	1854	1870	1854	1873	1852	1868	1909
05	1870	1888	1911	1855	1899	1915	1886	1915	1890	1911	1944
04	1915	1945	1971	1909	1942	1956	1940	1958	1940	1953	2008
03	1960	1987	2019	1951	1990	1999	1987	2014	1989	1996	2068
02	1972	2016	2052	1983	2021	2039	2014	2048	2016	2035	2098
01	1999	2046	2080	2014	2053	2073	2043	2079	2052	2070	2152
1	2028	2079	2109	2046	2082	2098	2077	2109	2079	2095	2163
2	2034	2088	2127				2088	2124			2174
3	2039	2106	2138	2066	2109	2124	2106	2134	2104	2120	2185
4	2086	2124	2161				2120	2158			2208
5	2118	2167	2205				2163	2201			2230
5 1/2	2133	2197	2237				2194	2233			N/A
6	2165	2232	2269				2228	2266			2291
7	2194	2262	2295				2259	2291			2307
8	2212	2280	2320				2277	2316			2372
9	2235	2300	2336				2295	2332			2403
10	2284	2345	2381				2340	2377			2426
11	2322	2361	2399				2359	2394			2437
12	2345	2383	2419				2379	2415			2471

SOFT SERIES

LOW TEMP SERIES

INTERMEDIATE TEMP SERIES

Temperatures shown are for specific mounted height above base. For Self-Supporting - 1 3/4". For Large - 2". For Small Cones, 15/16". For Large Cones mounted at 1 3/4" height, use Self-Supporting temperatures.