# Pyrometric cone

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**Pyrometric cones** are pyrometric devices that are used to gauge heatwork during the firing of ceramic materials. The cones, often used in sets of three as shown in the illustration, are positioned in a kiln with the wares to be fired and provide a visual indication of when the wares have reached a required state of maturity, a combination of time and temperature. Thus, pyrometric cones give a *temperature equivalent*, they are not simple temperature-measuring devices.

Self Supporting Cones prior to firing (top) and after (bottom)

The pyrometric cone is described by Dodd and Murfin (1994) as '*A pyramid with a triangular base and of a defined shape and size; the "cone" is shaped from a carefully proportioned and uniformly mixed batch of ceramic materials so that when it is heated under stated conditions, it will bend due to softening, the tip of the cone becoming level with the base at a definitive temperature. Pyrometric cones are made in series, the temperature interval between the successive cones usually being 20 degrees Celsius. The best known series are Seger Cones (Germany), Orton Cones (USA) and Staffordshire Cones (UK)*'.

Seger Cones after use

## Contents



## Usage

For some products, such as porcelain and lead-free glazes, it can be advantageous to fire within a 2-cone range. The 3-cone system can be used to determine temperature uniformity and to check the performance of an electronic controller. The 3-cone system consists of three consecutively numbered cones:

- **Firing Cone** - cone recommended by manufacturer of glaze, slip, etc.
- **Guide Cone** - one cone number cooler than firing cone.
- **Guard Cone** - one cone number hotter than firing cone.

Additionally, most kilns have temperature differences from top to bottom. The amount of difference depends on the design of the kiln, age of the heating elements, load distribution in the kiln, and the cone number to which the kiln is fired. Usually, kilns have a greater temperature difference at cooler cone numbers. Cones should be used on the lower, middle and top shelves to determine how much difference exists during firing. This will aid in the way the kiln is loaded and fired to reduce the difference. Downdraft venting will also even out temperatures variance.

Both temperature and time and sometimes atmosphere affect the final bending position of a cone. Temperature is the predominant variable. We refer to the temperature as an equivalent temperature, since actual firing conditions may vary somewhat from those in which the cones were originally standardized. Observation of cone bending is used to determine when a kiln has reached a desired state. Additionally, small cones or bars can be arranged to mechanically trigger kiln controls when the temperature rises enough for them to deform. Precise, consistent placement of large and small cones must be followed to ensure the proper temperature equivalent is being reached. Every effort needs to be made to always have the cone inclined at 8° from the vertical. Large Cones must be mounted 2 inches above the plaque and Small Cones mounted 15/16 inches. With the cones having their own base "*Self-Supporting Cones*" eliminates errors with their mounting.

Reference tables for the temperature equivalents for a number of different Pyrometric cones can be found through links in the 'External Links' section.

# Control of variability

Pyrometric cones are sensitive measuring devices and it is important to users they should remain consistent in the way that they react to heating. Cone manufacturers operate procedures to control variability (within batches and between batches) to ensure that cones of a given grade remain consistent in their properties over long periods. Whilst there are a number of national standards[1][2] ISO have published ISO 1146:1988-02[3] regarding Pyrometric cones.

Even though cones from different manufacturers can have relatively similar numbering systems they are not necessarily identical in their characteristics. If a change is made to cones from one manufacturer to another than allowances for the differences can sometimes necessary.

# History

Archaeologists working at Northern Song period (960 to 1127 AD) kiln sites in the Chinese provinces of Shaanxi and Shanxi have reported that pyrometric cones about five centimetres tall and made from loess were used to help control the firing of the kilns.[*citation needed*]

In 1782, Josiah Wedgwood created accurately scaled pyrometric beads. This led him to be elected a fellow of the Royal Society.

The modern form of the pyrometric cone was developed by Hermann Seger and first used to control the firing of porcelain wares at the *Königliche Porzellanmanufaktur* (Royal Porcelain Works) in Berlin, in 1886. *Seger cones* are to this day made by a small number of companies and the term is often used in Europe as a synonym for *pyrometric cones*. The *Standard Pyrometric Cone Company* was founded by Dr. Edward J. Orton, Jr. in 1896 to manufacture pyrometric cones. Following the death of Dr Orton in 1932, a charitable trust was established to operate the company.

Commercially produced pyrometric cones replaced glaze cones used by European and American potters in earlier times.[*citation needed*] Glaze cones were made by evaporating water from a liquid glaze until the resulting mass reached the consistency of a plastic clay. The plastic mixture was then formed into cones that were dried and set in a soft pad of clay in a kiln. When observed through the viewing port of a kiln the potter could see when a glaze cone had reached its melting point. Asian potters used *draw rings*, rings of clay dipped in glaze, for a similar purpose.[*citation needed*]The rings were removed from the kiln through special loopholes in the kiln walls using metal rods and examined for signs of melting in the glaze.

# Ceramic Art

A biennial ceramic art exhibition for small work, The Orton Cone Box Show,[4] takes the *Orton Cone* company's pyrometric cone box as the size constraint for submissions.

# References


1. ^ [1] (http://www.webstore.jsa.or.jp/webstore/Com/FlowControl.jsp?bunsyoId=JIS+R+8101%3A1999&dantaiCd=JIS&status=1&pageNo=0&lang=jp)
2. ^ http://www.china-refract.org/cr/standard-pg1.htm
3. ^ [2] (http://www.iso.org/iso/catalogue_detail.htm?csnumber=5688)
4. ^ [3] (http://www.coneboxshow.com)

- Dodd, A. and Murfin, D. (ed.) (1994) *Dictionary Of Ceramics.* 3rd edition. Institute of Materials. Woodhead Publishing Limited, Cambridge. ISBN 0-901716-56-1.
- Hamer, Frank and Hamer, Janet (1991). *The Potter's Dictionary of Materials and Techniques.* Third edition. A & C Black Publishers, Limited, London, England. ISBN 0-8122-3112-0.
- Role of August Hermann Seger in the development of silicate technology. Lange P. Ceram. Forum Int./Ber. DKG 68,No.1/2,1991
- The Seger Cone: 100 years old. Osterr. Keram. Rundsch. 23, (9/10), 9
- 100 years ‘Seger Cone’. Joger A. Silikattechnik 36, (12), 400, 1985


# External links

- Temperature equivalents table (http://www.nimracerglass.com/pc_tempchart.htm) & description of Nimra Cerglass pyrometric cones. (http://www.nimracerglass.com/pyrocones.htm)
- Temperature equivalents table & description of Orton pyrometric cones. (http://www.ortonceramic.com/resources/reference/cone_ref.shtml)
- Temperature equivalents table of Seger pyrometric cones. (http://www.boerkey-keramik.de/Texte/segerkegetabellel.htm)

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