Fire Clay

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The Present Scenario

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A group of refractory clays which can stand temperatures above Pyrometric Cone Equivalent (PCE) 19 are called fireclay. The clay which fuses below PCE 19 is not included under refractory. Fireclay is essentially of kaolinite group and has a composition similar to that of china-clay. In nature it is usually found to contain 24-32 per cent Al2O3, 50-60% SiO2 and LOI between 9 to 12%. Impurities like oxides of calcium, iron, titanium and magnesium and alkalies are invariably present, making it white, grey and black in colour.

Fireclay is generally of sedimentary origin. Strictly speaking, fireclay is of sedimentary origin and mainly found in the coal measures, as bedded deposits.

Properties and Tests

Refractoriness and plasticity are the two main properties needed in fireclay for its suitability in the manufacture of refractory bricks. A good fireclay, should have a high fusion point and good plasticity. Depending upon their capacity to withstand high temperatures before melting, the fireclays are graded into the following:

- Low duty - withstand temperatures between 1515-1615°C (PCE 19 to 28)
- Intermediate duty - 1650°C (PCE 30)
- High duty - 1700°C (PCE 32)
- Super duty - 1775°C (PCE 35)

The pyrometric cone equivalent (PCE) of a particular fireclay as designed by Edward Orton, Jr., is determined by testing against a series of standardised test pieces, cone shaped and having ceramic composition with different softening points, one withstanding a little higher temperature than the other.

The test pieces are generally made to form triangular pyramids having a height 4 times the base. The softening point is reached depending upon the temperature and the rate of rise of heat. Cones are numbered from 022, 021, 020, 02, 01, 1, 2 to 42. Where the softening range in cones is too close, for example, in 21, 22, 24 and 25, they are omitted from the series and where the temperature range is widely spaced, extra cones like 311/2, 321/2 etc. are added. At the rate of 20ºC rise per hour in temperature the cones numbering 022 to 01 have softening points between 585ºC to 1110ºC and those numbered 1 to 35 have softening points between 1125ºC to 1775ºC. Thus, the predetermined pyrometric cone equivalents of standard test-pieces are placed along with cone made of the samples to be tested in the furnace and the PCE's of the samples are determined by comparison. The softening point is noticed when the tip of the cone starts bending with the rise of the temperature. In practise it has been observed that the higher the alumina content in the fireclay, the higher is the fusion point. All fireclays are not necessarily plastic clays. In such cases, some plastic clay, like ball clay is added to increase platicity to a suitable degree. A good fireclay should have 24-26% plasticity and shrinkage after firing should be within 6-8% maximum. It should also not contain more than 25% Fe_2O_3. It has been observed that some clays lacking plasticity when allowed to 'weather', i.e. left in the open for a few months, become plastic due to the formation of humic acid in the clay. Non-plastic fireclay is also known as flint-clay. It may be called semi-flint and semi-plastic depending

upon the degree of plasticity.

Industrial Applications

Because of the abundant supply of fireclay and its comparative cheapness, the refractory bricks made out of it are the most common and extensively used in all places of heat generation, like:

- in boiler furnaces
- glass melting furnaces
- chimney linings
- pottery kilnsblast furnaces
- reheating furnaces

Fireclay is classified under acid refractories. Acid refractories are those which are not attacked by acid slag. In blast furnaces, the lining is done almost entirely with fireclay bricks. Pouring refractories like sleeves, nozzles, stoppers and tuyers are made of fireclay.

Manufacturing Process

Manufacturing of refractory bricks from fire-clay is an interesting feature. The clay mined is stacked in the factory yard and allowed to weather for about a year. For daily production of different types of refractories, this weathered clay is taken and mixed in different percentages with grog.

The mixture is sent to the grinding mill from where it is transferred to the pug mill. In the pug mill a suitable proportion of water is added so as to give it proper plasticity. The mould is supplied to different machines for making standard bricks or shapes. Intricate shapes are made by hand. The bricks thus made are then dried in hot floor driers and after drying they are loaded in kilns for firing. The firing ranges are, of

course, different for different grades of refractories. After firing, the kilns are allowed to cool; then the bricks are unloaded. By burning fireclay is converted into a stone-like material, highly resistant to acid, water and most other solutions. While manufacturing high aluminous fire-bricks bauxite is added along with grog in suitable proportions.