Lecture 07: Ceramic Manufacturing Industry

1. Introduction

The term 'ceramics' is derived from the Greek 'keramos' meaning 'burned earth' and is used to describe materials of the pottery industry.

Ceramics are defined as a class of inorganic, nonmetallic solids that are subjected to high temperature in manufacture and/or use. The most common ceramics are composed of oxides, carbides, and nitrides.

Traditional ceramics refers to ceramic products that are produced from unrefined clay and combinations of refined clay and powdered or granulated non-plastic minerals. Often, traditional ceramics is used to refer to ceramics in which the clay content exceeds 20 percent.

2. Traditional Ceramics classifications

1. **Pottery** is sometimes used as a generic term for ceramics that contain clay and are not used for structural, technical, or refractory purposes.
2. **Whiteware** refers to ceramic ware that is white, ivory, or light gray in color after firing. Whiteware is further classified as earthenware, stoneware, chinaware, porcelain, and technical ceramics.
3. **Stoneware** is vitreous or semivitreous ceramic ware of fine texture, made primarily from nonrefractory fire clay or some combination of clays, fluxes, and silica that, when fired, has properties like stoneware made from fire clay. Applications for stoneware include artware, chemicalware, cookware, drainpipe, kitchenware, tableware, and tile.
4. **Chinaware** is vitreous ceramic ware of zero or low absorption after firing that are used for nontechnical applications. Applications for chinaware include artware, ovenware, sanitaryware, and tableware.
5. **Porcelain** is defined as glazed or unglazed vitreous ceramic ware used primarily for technical purposes. Applications for porcelain include artware, ball mill balls, ball mill liners, chemical ware insulators, and tableware.
6. **Technical ceramics** include vitreous ceramic whiteware used for such products as electrical insulation, or for chemical, mechanical, structural, or thermal applications.

3. Properties of Ceramic Materials

- Density – in general, ceramics are lighter than metals and heavier than polymers.
- Melting temperatures - higher than for most metals
- Electrical and thermal conductivities - lower than for metals; (some ceramics are insulators while others are conductors).
- Brittle and High hardness, electrical and thermal insulating.
- Ceramics are substantially stronger in compression than in tension.

4. Ceramic Manufacturing Process Description

The ceramics sectors can be summarized in two groups:

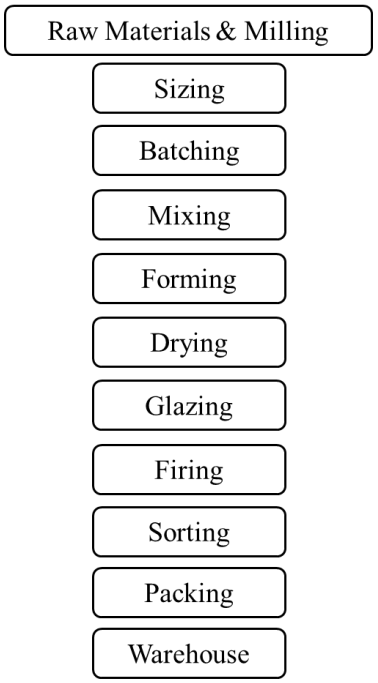
1. 'coarse' or 'construction' ceramics including the bricks and roof tiles, vitrified clay pipes, refractory products and expanded clay aggregates sectors.
2. 'fine' or 'traditional and industrial ceramics', including the wall and floor tiles, table- and ornamental ware, sanitaryware, technical ceramics and inorganic bonded abrasives sectors.

The border between 'fine' or 'traditional and industrial' and 'coarse' or 'construction' ceramics varies between equivalent particle diameters of 0.1 and 0.2 mm. 'Coarse' or 'construction' ceramic products show an inhomogeneity of more than 0.2 mm.

4.1. Ceramic Manufacturing Equipment

1. Pressure vessel
2. Conveyers
3. Jaw Crushers
4. Ball Mill
5. Screens
6. Trommel Screens
7. Tray dryer

4.2.Main steps for ceramic manufacturing



Step #1: Milling & Raw Material Procurement

The raw materials used in the process are milled materials typically found in mining sites that have been reduced from a large size to smaller sizes.

Step #2: Sizing

The milling materials must be sized to separate desirable material by controlling the particle size using Fine mesh vibratory sifting equipment, the result will give you proper bonding and a smooth surface on the finished product.

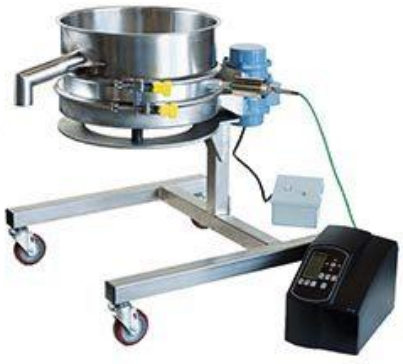


Figure 2: Sizing Machine of Ceramic products

Step #3: Batching

Calculates amounts, weighing and initial blended of the raw materials. For consistent material flow into a pub mill hopper, Vibratory Feeders can be applied in the process.

Step #4: Mixing

To obtain a more homogeneous material prior to forming, the constituents of the ceramic powder are combined using the method of mixing. Pug mills are the preferred piece of machinery used in this step of the process.

Step #5: Forming

The materials such as dry powders, pastes are consolidated and molded. In the case of dry forming, vibratory compaction can be used to achieve the desired shape.

Step #6: Drying

The formed materials hold water and binder in its mix that can in turn cause shrinkage, warping or distortion of the product. Convection drying is the most used method by heated air.

Step #7: Glazing

This step is added to the process prior to firing. Typically, the glaze consists of oxides that give the product the desired finish look. The glaze can be applied using spraying or dipping methods.

Step #8: Firing or sintering or densification.

The ceramics pass through a controlled heat process where the oxides are consolidated into a dense, cohesive body made up of uniform grain. Some general points to remember about different types of firing end products:

- Short Firing Time: gives porous and low-density products.
- Intermediate Firing: gives fine-grained, high-strength products.
- Long Firing Time: gives coarse-grained products and will not distort when under a load for an extended period.

Final Processing

- Following firing, some ceramic products are processed further to enhance their characteristics or to meet dimensional tolerances.
- Ceramics can be machined by abrasive grinding, chemical polishing, electrical discharge machining, or laser machining.
- Annealing at high temperature, followed by gradual cooling can relieve internal stresses within the ceramic and surface stresses due to machining.
- Coatings also may be applied to improve strength, and resistance to corrosion or for decoration.

YouTube: https://youtu.be/SikbHFTiy10