4.6 THERMAL PROPERTIES

Since the ceramic materials contain relatively few electrons, their thermal properties differ from that of metals. The most important thermal properties of ceramic materials are.

(i) Thermal capacity

(ii) Thermal conductivity

(iii) Thermal shock resistance

(i) Thermal capacity

- The specific heats of fine clay bricks are 0.25 at 1000°C and 0.297 1400°C.
- Carbon bricks possess specific heats of about 0.812 at 200°C and 0.412 at 1000°C.

(ii) Thermal conductivity

- The ceramic materials possess a very low thermal conductivity since they do not have enough free electrons.
- The impurity content, porosity and temperature decrease the thermal conductivity.
- The ceramic materials possess low thermal conductivity due to its low density.

(iii) Thermal Shock

"***Thermal shock resistance***" is the ability of a material to resist cracking or disintegration of the material under sudden changes in temperature.

- *Lithium compounds* are in many ceramic compounds to *reduce thermal expansion* and *provide excellent thermal shock resistance*.

MECHANICAL PROPERTIES OF CERAMICS

The mechanical behaviour of ceramic phases is determined in a number of ways depending upon how the force is applied: compressive, tensile, transverse, torsional shear or impact.

- **Compressive strength.** Compressive strength in ceramics in general is many times greater than tensile strength. Therefore, ceramics like brick, cement, and glass are always used in the compression and not in tension.
- **Shear strength.** High shear strengths and low fracture strengths are generally characteristics of ceramics. Therefore, they commonly fail nonductilely, *i.e.* in a brittle manner by fracture.
- **Tensile strength.** Tensile strength in ceramics are theoretically high, but in practice are usually quite low. Failures are often due to stress concentrations at the pores, grain corner or microcrack.
- **Transverse strength or modulus of rupture.** Transverse strength is difficult to ascertain in ceramic materials. Ceramics are, therefore not used in places where transverse strength of materials is an important criterion.
- **Torsional strength.** Torsional strength is seldom considered as a critical property of ceramics since tensile and cantilever requirements will show the torsional strength of material.
- **Modulus of elasticity.** Ceramic materials have high modulus of elasticity ranging from 7×10^{10} to 42×10^{10} N/m^2 which indicates the strength of the bond.
- **Plastic deformation.** Due to the restricted slip, most of materials does not permit plastic deformation. The ceramic materials have greater resistance to slip than do metals.

Toughness of Ceramic Materials

Due to presence of covalent-ionic bonding, ceramics have low toughness.

ELECTRICAL PROPERTIES

Electrical properties depends upon composition, texture, size and density of material and also on temperature and time. These factors greatly influence the electrical behavior of a ceramic material.

Ceramic materials are used as insulators, conductors, semiconductor and dielectrics. Ceramics are also used as ferroelectric and piezoelectric materials.

- Ceramics are generally poor conductors of electricity because the electrons associated with the atoms ceramics are shared covalent or ionic bonds. The electrical properties of ceramics mainly depend on the following factors.

(i) volume resistivity, (ii) dielectric strength,

(iii) dielectric constant, and (iv) dissipation factor (or loss factor).

Ceramic insulator

Ceramic materials are used in an electrical circuit both as the electrical insulators and as its functional parts.

Porcelains are very commonly used as electrical insulators and resistors.

Dielectric ceramics

Ceramic materials have good dielectric capacity.

Porcelain and high grade fire clays have high dielectric strength. The dielectric varies with temperature.

Ceramic semiconductor

Although ceramic compounds are normally insulators, they become semiconductors if they contain multivalent transition elements.

CHEMICAL PROPERTIES

Chemical resistance

- The great majority of ceramic products, are highly resistant to all chemicals except hydrofluoric acid and to some extent, hot caustic solutions.
- Organic solvents do not affect the ceramics.
- Oxidic ceramics are completely resistant to oxidation, even at very high temperatures.
- Magnesia, zirconia, porcelain, graphite, alumina, etc., are resistant to certain molten metals. They are used for making crucibles and furnace linings.
- Ceramics like glass are employed where resistance to attack from acids, bases and salt solutions is required.