

TAMIL NADU PUBLIC SERVICE COMMISSION
SYLLABUS FOR CERAMIC TECHNOLOGY
SUBJECT: CERAMICS
DIPLOMA STANDARD

Code No.189

1. INTRODUCTION TO CERAMICS

Definition – History - Domestic and Industrial uses – Subdivision of ceramics.

RAW MATERIALS

PLASTIC MATERIALS

Definition- Occurrence- Purification of clay, Types of clay- Primary clay, Secondary clay, China clay, Ball clay, Fire clay, Brick clay, Stoneware clay, Properties, Clay minerals groups: Kaolin, Montmorillite and Illite – Structure – Characteristics and their function.

NON PLASTIC MATERIALS

Silica, Alumino silicate materials, Feldspar, Nepheline syenite, Calcium, Magnesium, Fluorspar, Barium carbonate, Borax, Boric acid, Red lead, White lead, Pyrophyllite, Wollastonite, Talc, Mica, Opacifier – Properties and function.

SYNTHETIC AND OXIDE MATERIALS

Bayer Alumina, Electro fused alumina, Sea water magnesia, Carbide, Nitride, Borides, Silicides, SIALON, Zirconia, Mullite, Titania, Thoria

OTHER MATERIALS

Bone ash, Colouring oxides, Flocculants, Gypsum- Calcinations, Plaster of Paris, Deflocculants, Binders, plasticizers, Lubricants, Sintering aids.

2. PROCESSING EQUIPMENTS & FABRICATION PROCESS

Mechanism of size reduction, Crushers – primary crusher, Jaw crusher, Gyratory crusher, Secondary crusher - roll crusher, Hammer mill, Pan mill, Grinders – Attrition mill, Rod mill, Pot mill, Conical ball mill, ball mill
Factors affecting the grinding of ball mill, pug mill, pugging – Advantages and disadvantages.

Principle of screening, Type of screening, Magnetic separator, Mixing – Types of mixing, Bungler – Agitator, Types of pumps, Filter press – Spray drier and other driers.

Pressing, Process flow chart. Types of presses – Tools. Uniaxial pressing – Principle, construction and working. Stress distribution, defects and remedies. Other methods - Isostatic Pressing – Cold Pressing, Hot Pressing.

Plastic forming methods – Throwing, Hand moulding, Jiggering and Jollying, Extrusion, Injection moulding – Defects and remedies, Plastic pressing – Cold, hot – principle, working – Advantages and disadvantages.

Preparation of mould – Plaster of Paris – description – modelling, mother mould, case mould and working mould.

Preparation and Characteristics of slip, Additives – Types of casting – hollow, solid, pressure, vacuum casting Process - control of defect and remedies. Other casting techniques – Battery casting, Tape Casting, Water fall casting.

DRYING

Mechanism of drying, Modes of heat transfer, Factors controlling drying, First falling rate, Second falling rate, Critical moisture content, Types of Dryers – Natural dryer, Artificial dryer- Intermittent and Continuous dryer. Drying defects and control.

FIRING

Action of heat on ceramic bodies, firing schedule, firing curve, firing equipments, problems, Vitrification, liquid phase sintering, Microstructure Control.

3. WHITE WARE AND HEAVY CLAY WARE

Terracotta, Majolica, Triaxial bodies –Porcelain, Stoneware, Earthenware, Art ware. Raw materials used in triaxial bodies and their pyrochemical reaction – Physical and chemical characteristics – Field of application – Merits and demerits. Chemical porcelain, dental porcelain, Tableware, dinnerware, Art ware. - Properties - applications.

Raw material–Method of winning, Handling. Classification of building material Common bricks – Engineering bricks – Perforated and hollow bricks – ridge tiles –

Terracing tiles – Floor tiles – Ceiling tiles – red clay products – Manufacturing method
Hand moulding – Machine moulding, Extrusion – Pressing – Drying and Firing .
Stoneware pipes – Extrusion, drying, finishing, glazing and firing. Properties -
applications.

4. GLAZE AND GLAZE MATERIALS

Definition, Types of glazes - Raw glazes- Fritted glazes, Lead glazes, Porcelain
glazes- High temperature glazes, Low temperature glazes ,Salt glazes- Decorative
glazes, Loam or earth glazes- Aventurine glazes – Bristol glazes – Crystalline glazes
Matt glazes – Colored glazes – raw materials-Characteristics and function .

GLAZE BATCH CALCULATION, PREPARATION AND APPLICATIONS

Ceramic glazes – Bodies and enamels-, Empirical formula and its Calculation from
the chemical analysis – Calculation of percentage composition from empirical
formula – Calculation of weight (molecular weight), equivalent weight and formula
batch weights – compounding of raw glazes the calculation of formula to recipe and
recipe to formula – Rational analysis and proximate analysis.

Batch materials composition – mixing – Milling – Dry – Equipment – consistency –
deflocculates – flocculants – Adhesives and suspension agents – Gum.

Painting - brushing and immersion or dipping – spraying – spray guns – spray
patterns – Reservoirs – consistency of spraying.

DECORATION AND GLAZE DEFECTS

a) Decoration, Ceramic transfers - Preparation, application and firing – Screen
Printing, decalcomania, printing, grinding and marbling, stippling and
Miscellaneous.

b) Glaze defects and remedies: Crazeing- Bubbles-Crawling – Pinholes – Blistering
chipping, copper edging, egg shells, fish scale – gloss hair lining – Jumping, Tool
marks, re-boiling , rusting, specking tearing ,waving surfaces.

c) Properties: Thermal, Optical, Physical, mechanical, chemical and electrical
properties.

5. PROPERTIES OF CERAMICS

MECHANICAL PROPERTIES

Stress – Strain – Young's modulus, Critical strain, Strength, effect of Porosity and grain size on strength – brittle fracture – mechanism, hardness and abrasion – relationship with elastic modulus – Creep.

THERMAL PROPERTIES

Specific heat capacity – Thermal expansion – Thermal conductivity – Thermal diffusivity – Thermal shock resistance – low thermal expansion bodies – effect of temperature difference on firing the body – stress in glaze and body due to thermal expansion differences.

OPTICAL PROPERTIES

Basic relationships – Reflection, Transmission, Absorption, loss of intensity - Refractive index- dispersion, Scattering of light by a spherical bubble – boundary reflectance and surface gloss – Specular and diffused reflection – Opacity and translucency – absorption and colour – applications.

ELECTRICAL PROPERTIES

Classification – metal, semi conductors and insulators – resistivity, effect of Composition of bodies – variation of resistivity with temperature – effect of Porosity, moisture permittivity, dielectric strength, conducting glazes dielectric loss.

MAGNETIC PROPERTIES

Susceptibility – Permeability – flux density – types of magnetism and their origin – electronic structure and magnetic moment – spin structure and ferro magnetism – exchange interaction and super exchange interaction – hysteresis loop and magnetic domain – domain structure.

6. REFRACTORIES

CLASSIFICATION AND PROPERTIES

Introduction – General classification – Types of Refractory – Acidic – Basic – Neutral and general properties.

Specific gravity – Bulk density – Porosity – Permeability - Refractoriness – Refractoriness under Load – Volume stability – Slag attack – Resistance to thermal

shock – cold crushing Strength – Abrasion resistance – Hot modulus of rupture – Creep.

ACIDIC REFRACTORIES

Material processing – Manufacture – Properties and uses of Silica, Semi silica, Fireclay, Kyanite, Andalusite, Bauxite. Process and manufacturer of Electro cast Refractories.

BASIC REFRACTORIES

Material processing – Manufacture – Properties and uses of Magnesite – Dolomite Dead burnt magnesite – Stabilized dolomite – chrome magnesite – Mag chrome – Forsterite.

NEUTRAL AND SYNTHETIC REFRACTORIES

Material processing – Manufacture – Properties and uses of Neutral Refractories – Graphite – Chromite – Zirconia .Synthetic Refractories – Silicon carbide – Fused Alumina – Fused Magnesia – Mullite – Magnesite alumino spinal.

INSULATION BRICKS AND APPLICATION OF REFRACTORIES

Material processing – Manufacture – Properties and uses of insulating bricks, Ceramic fibre, Monolithic, Castables, Ramming mass, Fettling mass. Application of Refractories: Refractory in metal industries – Blast furnace – Refractories in non-metal industries – Coke ovens – Pottery and refractory – Chemical industries – Refractory in atomic energy (only principles)

7. CEMENT

Raw material, lime stone, sand, fly ash, gypsum. Types – Natural cement-Portland cement, Special Portland cement, Pozzolona cement, Slag cement, High alumina cement, White and coloured cement, Water proof cement. Manufacturing process: Portland cement- Wet and dry method. Rotary kiln. Setting of cement: Hydration, Hydrolysis, Hardening and crystallization.

8. FUELS

Definition of fuels – Classification – Solid, liquid, gaseous fuel. Solid fuels: Coal - formation, Coal classification – Peat, lignite, Bituminous coal, Anthracite coal and coke. Storage of Coal: Handling – Transportation – Advantages/disadvantages Liquid fuels: Types of oils, Petroleum, Refining of Petroleum. Storage: Handling – Transportation - Advantages/disadvantages. Gaseous fuels: classification of gaseous

fuels, natural gas, producer gas, water gas, Blast furnace gas, LPG- advantages/disadvantages.

PROPERTIES OF FUELS

Combustion, Production of flame, Ignition temperature- Gases and vapours – Limits of combustion- Inflammability and vapours – Velocity of flame propagation – Calorific value – Gross calorific value – Net calorific value - High flash point – low viscosity limited sulphur, presence. Analysis of coal (proximate and ultimate).

9. FURNACES

TYPES OF FURNACE – INTERMITTENT AND CONTINUOUS

Intermittent: Open top kiln or Clamp kiln – Up draught kiln, Horizontal draught kiln – Down draught kiln – Bottle kiln – Muffle kiln.

Continuous kilns: Semi continuous kiln –Muffle type continuous kiln - Hoffmann kiln Tunnel kiln – different zones, operation -Rapid cooling temperature – Heat recovery from hot gases – Advantages over other kilns.

10. TEMPERATURE MEASUREMENTS

Effects of heat – Assessing temperature using colour tint – Eye vision, Wedge wood Cylinder, Pyrometric cones, Holdcrafts bar, Bullers rings.

Principles and description and function - Thermocouple, pyrometer, Radiation pyrometer, Optical pyrometer, Ferry optical pyrometer and wedge optical pyrometer, Advantages and disadvantages of pyrometry and pyroscopes.

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