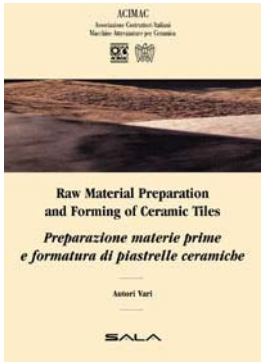

PREPARATION OF RAW MATERIALS AND SHAPING OF CERAMIC TILES

INTRODUCTION: RAW MATERIALS FOR THE PRODUCTION OF CERAMIC TILES

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FIRST PART: RAW MATERIALS PREPARATION

Chapter 1. BODY FORMULATION AND GRINDING: GENERAL PRINCIPLES

1. General
2. Body formulation
3. Grinding: general principles
    - 3.0 General
    - 3.1 Specific surface area
    - 3.2 The reason for grinding
    - 3.3 Determining the threshold dimension
    - 3.4 Principles
        - a) Impact
        - b) Crushing
        - c) Shearing
        - d) Chemical/physical action
    - 3.5 Grinding work

Chapter 2. PRE-GRINDING

1. Raw materials storage
    - 1.1 Variability of raw materials
    - 1.2 Ageing
    - 1.3 First screening
2. First grinding
    - 2.1 Purpose
    - 2.2 Jaw crusher
    - 2.3 Cone crusher
    - 2.4 Roll crusher
    - 2.5 Pan mill
    - 2.6 Blade type lump crusher
3. Mixing

Chapter 3. DRY GRINDING

1. The conventional process
    - 1.1 Pendular mill
    - 1.2 Vertical roller mill
    - 1.3 Rotating pin mill
    - 1.4 Hammer mill
    - 1.5 Peg mill
    - 1.6 Projection mill
    - 1.7 Evaluations of dry grinding mills
2. Screening
3. Further treatments
4. Some dry process developments
    - 4.1 Granulation of dry ground product
    - 4.2 Separate grinding
5. Final points

Chapter 4. WET GRINDING

1. Introduction
2. Discontinuous mills
    - 2.1 Description
    - 2.2 Speed of rotation
    - 2.3 Grinding action
    - 2.4 Grinding media
    - 2.5 Degree of filling
    - 2.6 The internal mill lining
    - 2.7 Slip
3. Continuous processes
    - 3.1 Continuous wet grinding
    - 3.2 Conical mill
4. Developments in wet grinding
    - 4.1 Separate grinding
    - 4.2 Variable speed of rotation
5. Final observations
6. Focus: Microsphere mills for bodies

Chapter 5. SPRAY-DRYING

1. Spray-drying
2. Fluid dynamics
    - 2.1 The movement of the slip
    - 2.2 Formation of granules
    - 2.3 Powder separation
3. Powder
4. Settings
5. Energy recovery

Chapter 6. POWDER FINISHING AND IRON REMOVAL

1. Body colouring
2. Re-granulation
    - 2.1 Principle
        - a) Dry re-granulation
        - b) Dry re-granulation by mechanical action
        - c) Wet re-granulation

2.2 Granulator
3. Iron removal

Chapter 7. DESCRIPTION OF PARTICLES AND SCREENING

1. Shape of particles
2. Screening
    2.1 Sieve screening
    2.2 Air separators
        2.2.1 Static separators
        2.2.2 Dynamic separators
        2.2.3 Cyclones
    2.3 Filters
3. Particle size distribution curves
    3.1 Particle size distribution
    3.2 Cumulative particle size curve
    3.3 Influence of the duration of grinding
    3.4 Ideal cumulative particle size distribution curve
    3.5 Control of particle size distribution

Chapter 8. POWDER STORAGE AND TRANSPORT

1. Storage in silos
2. Extraction from silos / conveyor feeding
3. Feeding
    3.1 Counterweight feeder
    3.2 Blade type feeder
    3.3 Roller feeder
    3.4 Screw feeders
    3.5 Weighing belt feeders
    3.6 Observations
4. Powder transport
    4.1 Powder segregation
    4.2 Flowability
    4.3 Abrasion
5. Belt conveying
    5.1 Conveyor belts
    5.2 Loading devices
    5.3 Unloading devices
6. Pneumatic transport
    6.1 Principles
    6.2 Main applications in the ceramic industry
7. Transport in silos
8. Transport in bags

Chapter 9. BODY DEFECTS

1. Defects in raw materials
2. Preparation defects
    2.1 Insufficient or excessive grinding
    2.2 Incorrect batching
    2.3 Non-uniform powder
    2.4 Inadequate or excessively high moisture content
    2.5 Incorrect particle shapes
    2.6 Presence of lumps
    2.7 Powder contamination

SECOND PART: FORMING

Chapter 1. FORMING

1. General
    1.1 Wet forming
2. Extrusion
        2.1 Extrusion dies
        2.2 Typical defects
3. Forming by extrusion and pressing (moulding)
4. Forming by pressing of wet body (moulding)

Chapter 2. PRESSING

1. Density, apparent density, compactness
2. Press power and specific pressure
3. Main product parameters that depend on pressing
1.1 Effects of specific pressure on density
1.2 Effects of specific pressure on shrinkage
1.3 Influence of moisture content of powders
1.4 Specific pressure: optimal value
4. Powder compression and variability of specific pressure
5. Pressing cycle
6. Stages of pressing action
        6.1 Cavity filling
            6.1.1 Movement of carriage
            6.1.2 Filling
            6.1.3 Punch descent
        6.2 First pressing
        6.3 Air elimination
        6.4 Second pressing
        6.5 Tile demoulding
7. Complementary operations
        7.1 Carriage filling
        7.2 Moulding cleaning
        7.3 Fettling

Chapter 3. MOULDS

1. Re-entering punch mould
        1 – Base plate
        2 – Mould punch or ejector block
        3 – Lower punches
        4 – Die box
        5 – Upper punch
2. Mirror mould
3. Transfer mould
4 Isostatic punches

Chapter 4. UNFIRED PRODUCT CHECKS

1. General
2. Weight check
3. Thickness check
4. Determination of breaking load
5. Determination of permeability
    - 5.1 Determination of pore distribution
6. Durometer
7. Visual checks
8. Checking expansion after pressing
9. Checking moisture content of powder

Chapter 5. MOST COMMON DEFECTS

1. Defects due to preparation errors
2. Defects recognisable on unfired product
    - 2.1 Lamination
    - 2.2 Non-uniform compactness (density)
    - 2.3 Excessive expansion
    - 2.4 Cracks/fractures
    - 2.5 Fettle
3. Defects recognisable on fired product
    - 3.1 Extraction cracks
    - 3.2 Lamination
    - 3.3 Black core
    - 3.4 Dimensional defects
    - 3.5 Stains
4. Problems
    - 4.1 Fall of fettle
    - 4.2 Dirt on mould

Chapter 6. SPECIAL APPLICATIONS

1. Pressing of pieces of non-uniform thickness
    - 1.1 Trim pieces (bullnose, steps, corners, etc.)
2. Relief
3. Double filling
4. Advanced aesthetic effects obtained at the press
    - 4.1 Through-body decoration (entire thickness of tile)
    - 4.2 Surface thickness decoration
    - 4.3 Decal decoration
    - 4.4 Surface decoration / glazing (decoration pressing)
5. Forming by mechanical action
    - 5.1 Shaping of steps

Chapter 7. THE MACHINES

1. The hydraulic press
    - 1.1 Press body or frame
    - 1.2 Pressing unit
    - 1.3 Demoulding unit
    - 1.4 Hydraulic power unit
    - 1.5 Electrical command and control panel