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P L A N T P R O F I L E

PRODUCTION OF DOUBLE FIRED
CERAMIC WALL TILES

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1. Definition of Product

The term ceramic applies to any product fired from clays. The clay is simply defined as hydrous alumo-silicate that forms a paste when mixed with water and that hardens when dried and heated. (Decisive mineral is kaolinite).

According to ANSI /American National Standard Institute/

"Tile - ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay and other ceramic materials, called the body of the tile, having either a glazed or unglazed face and fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics".

"Wall tile - a glazed tile with a body that is suitable for interior use and that is usually non-vitreous, and is not required nor expected to withstand excessive impact or be subject to freezing and thawing conditions".

The definition does not distinguish wall tiles from mosaics so that it is to be added that usually tiles of larger facial area than 25 sq.cm are regarded as wall tiles.

2. Market

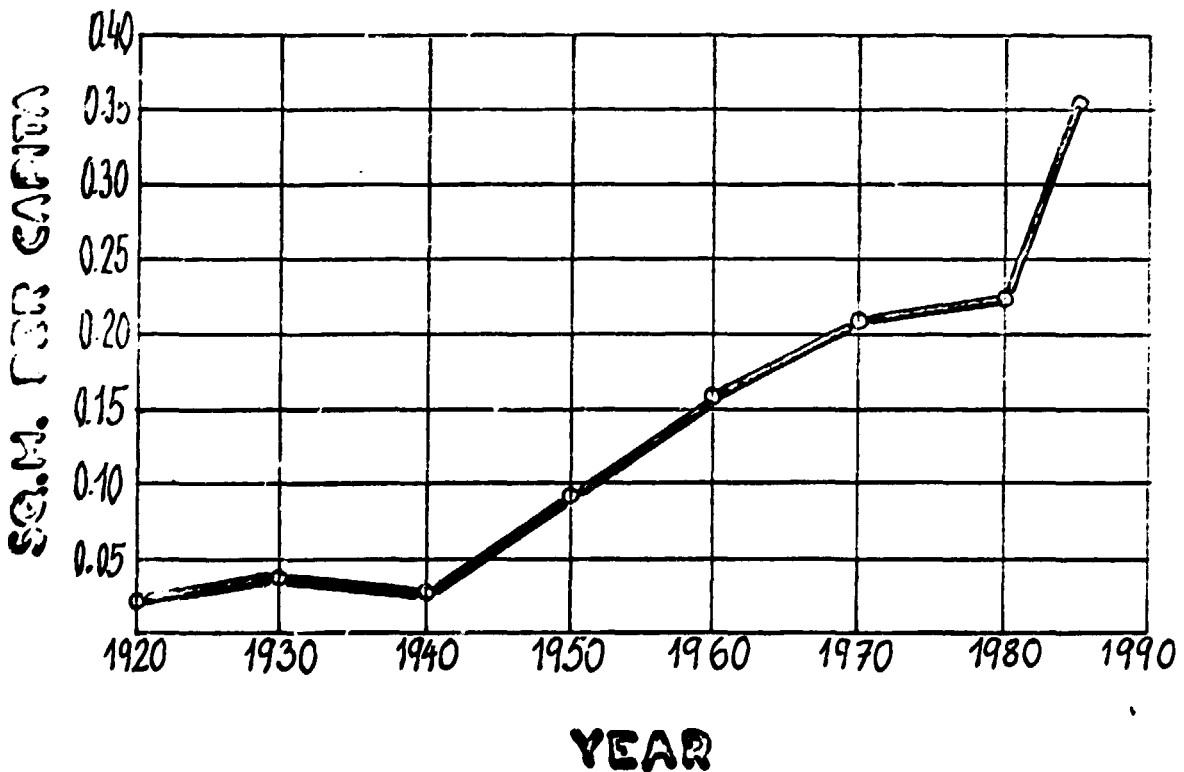
The tile may appear to be an expensive material initially but it is highly competitive with alternative surfacing materials when the life span is considered. The long service life is due to its mechanical strength, chemical resistance at any concentration and temperature as glazed on the surface the tile shows hard, impervious and wear resistant surface and jointly it contributes to decoration and can easily be maintained.

There is an apparent trend in the trade for the ceramic tile to substitute for textile, wood, stone, paper and plastic

coverings. The tile is no longer confined to kitchen and bathroom but it invades halls and corridors and public buildings, schools, hospitals, restaurants, supermarkets and underground stations. The validity of this fact is demonstrated by statistics ^{+/}. In spite of the slowdown in the construction sector consumers increasingly desired to use ceramic tiles in place of other coverings especially in the last decade.

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TILE CONSUMPTION IN A DEVELOPED COUNTRY



3. Plant Capacity, Processing, Equipment

Referring to the enclosed flow sheet the technique to produce wall tiles is comparatively simple as it is the equipment. No considerable training of manpower is necessary and the setting-up of a plant does not require excessive capital outlay. The wall tiles are made from low-cost non-metallic materials according to various formulae; principal raw materials are quartz, feldspar, limestone, talc, kaolin, clay.

Economic Capacity

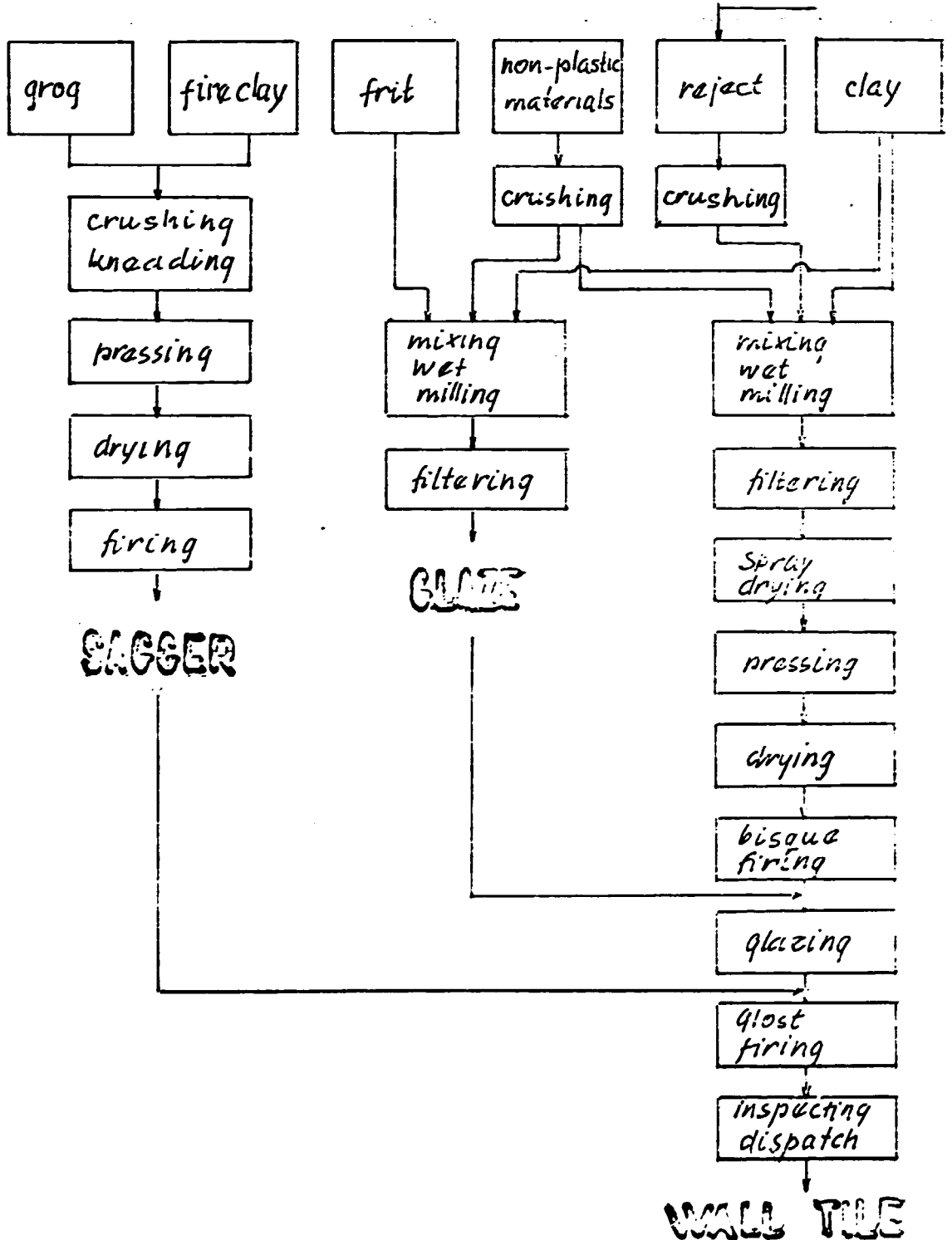
The decision on the production capacity depends first of all on the market and other local economic factor considerations. However, if a modern industrial production is discussed there is certainly a minimum capacity which is derived from the output of some key equipment, especially kilns. The wall tiles are fired in continuous kilns the smallest units of which, produced and delivered by renown firms, have output around 150 - 200 thousand sq.m per annum. Glazed floor and wall tiles can interchangeably be produced in the wall tile plant which enables to produce economically less wall tiles and complement the production programme with floor tiles.

It is claimed that economical capacity of a specialized wall tile plant is somewhere between 0.2 - 1.0 mil. sq.m per year. The decisive factor of the economical minimum is the amount of fixed assets so that even smaller units operated manually can be economical.

Processing

There are two different technologies to produce wall tiles which are most distinctive - single firing process and double firing process. The advantages of single firing consist in a lower per-kg-energy consumption, lower need for

flow sheet - double firing process



manpower and possibility of full automation. On the other hand there is a need for skilled manpower to operate more sophisticated equipment, higher consumption of electric power, strict requirements for raw materials of uniform and defined properties and costlier equipment. Further, usually thicker tiles are to be produced so that the specific energy consumption per 1 sq.m (which is the selling unit) does not differ so considerably from per-sq.m.-energy consumption on the double fired wall tiles. The higher cost in raw materials (more and good quality) may more than counterbalance the energy savings.

Equipment

There is a tendency in the countries with cheap and abundant unskilled manpower to install as few as possible machinery and use that manpower to handle materials. Such a policy has certain limits since each contact of an unskilled worker with green tile bears a hazard of mechanical damage and the portion of reject is high. Therefore, it is recommendable to consider a reasonable mechanization of handling operations, especially sagging.

4. Wall Tile Plant - 200 000 sq.m

a/ Required Equipment (main)

| Section | Description |
|--|--|
| Crushing and weighing | Mechanical pay-loader, hopper, vibrating feeder, jaw crusher, rubber belt conveyor, electric hoist, platform balance, trucks and skips Installed power - 12 kW |
| Body slip preparation | Ball mills, vibrating sieves, stirrers, diaphragme pump, cement and metallic tanks Installed power - 62 kW |
| Spray drying | Spray drier, rubber belt conveyor, vibrating sieves, bucket elevator, metallic silos, dischargers, V-type belt conveyors Installed power - 30 kW |
| Pressing | Sheet hoppers, level indicators, hydraulic presses, collecting and piling machine Installed power - 96 kW |
| Glaze preparation | Balance, electric hoist, ball mills, skips, diaphragme pump, metallic tanks, stirrers, sieve, metallic containers Installed power - 23 kW |
| Drying, bisque firing and glost firing | Tunnel drier incl. accessories, tunnel bisque kiln incl. accessories, tunnel glost kiln incl. accessories Installed power - 19 kW |
| Glazing | Special glazing line provided with fettling and brushing equipment, moisture cabin, bell glazing cabin, screen printers, dropping cabins (60 m long), automated sagger load machine Installed power - 10 kW |

| Section | Description |
|---------------------------------|---|
| Inspection Expedition | Semi-automated unsagging machine, manual inspection line, packaging equipment Installed power - 14 kW |
| <u>Auxiliary Plants</u> | |
| Sagger production | Edge runner mill, pug mill, friction press, bucket elevator, hopper |
| Physical laboratory | Breakage resistance indicator, balance moisture measuring, grain size analyzer, steel sieves, stirrer, drier, jar mill, dilatometer, atomizing mill, viscosimeter |
| Screening laboratory | Pneumatic press, floor driers, kiln, degreasing and development tank, decorative machine |
| Maintenance and auxiliary shops | installed power - 232 kW |

F.O.B. price /approx./ 2 000 000 US \$

Installed power 520 kW

b/ Required Raw Materials and Utilities

| <u>Component</u> | <u>Annual Input</u> |
|----------------------|---------------------|
| <u>Raw Materials</u> | |
| raw kaolin | 800 tonnes |
| plastic clay | 400 tonnes |
| limestone | 600 tonnes |
| silica sand | 800 tonnes |
| frits | 140 tonnes |
| stains | 30 tonnes |
| <u>Utilities</u> | |
| water | 1 100 tonnes |
| electric power | 900 Mwh |
| fuel oil or | 550 tonnes |
| natural gas or | 600 000 cu.m |
| town gas | 1 400 000 cu.m |

There will be consumed auxiliary materials, lubricants, plaster of Paris, spare parts which usually accounts for about 2 - 3% of the price of equipment.

The above raw material composition is based on the common-type lime-siliceous body formula which is popular for low firing temperatures and almost zero-shrinkage.

c/ Required Manpower +/

| | No. |
|---|-----|
| Technical + administration staff, supervisors | 15 |
| Workers in production plant | |
| unskilled and semi-skilled | 35 |
| skilled | 5 |
| Workers in auxiliary plants | |
| unskilled and semi-skilled | 2 |
| skilled | 8 |
| <hr/> | |
| Total staff | 65 |

+/ Note: Depending on automation level.

d/ Location and Site

The plant should be located close to the place of key raw materials and not far from the places of demand. In case of smaller capacities the decisive criterion is the access to established infrastructure, esp. roads, water, grid system, banks, communication, human residences.

Plant Site Area

| | | |
|-----------------|---------|-------------|
| built-up area | approx. | 4 000 sq.m |
| plant site area | | 10 000 sq.m |