POTENTIALITY OF MANUFACTURING FRIT AND GLAZE IN GUJARAT

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FOREWORD

Liberalisation of the Indian economy has ushered in an era of increasing foreign investment in various industries and the Ceramics Industry of Gujarat is no exception to this. Between August '91 and March '97, the ceramics industry in Gujarat has been successful in attracting Foreign Direct Investment in as many as 111 projects with investment amounting to Rs.587 crores. The major suppliers of technology and machinery in these projects have been companies from Germany and Italy. Gujarat plays host to names such as Madhusudan, Somani and Bell Ceramics.

Gujarat has been successful in attaining a pre-eminent position in the ceramics industry not only in India but in the international market as well. The availability of good quality raw materials like fire-clay, china-clay, plastic-clay, red clay, natural gas etc. has helped Gujarat to attain a prominent place in the ceramics market.

The State produces a wide variety of ceramics products like tiles, sanitaryware, insulators, table crockery, refractory etc., the production of which is to the tune of 90,000 tpd. The requirement of frit is around 10 percent by weight, which results in a demand of frits and glaze to the tune of 9,000 tpd. At present, most of this demand is being met by producers from other states, although a few SSI units in Morbi, Ankleshwar and Vadodara have started producing frits and glazes as a part of their backward integration strategy.

This report incorporates different types of frits formula, raw material requirements, manufacturing processes, the machinery required, list of the major suppliers of this machinery, and different areas of application of frits and glaze. Flow charts of the manufacturing processes have also been provided so as to facilitate better comprehension of the processes. The report also includes profiles of existing units, price tariff and a profile of different end-users.

This report will be helpful to SSI units in expanding their business by way of manufacturing frits and glazes either exclusively or as a backward integration strategy and by exploiting the market opportunities provided by the report in terms of the profile of various end-users of frits and glaze.

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Gandhinagar

Ashok Chawla, IAS
Industries Commissioner &
Chairman, iNDEXTb

ACKNOWLEDGEMENT

Gujarat has a prominent place in the ceramics industry owing to the availability of good quality raw materials like fire-clay, china-clay, ball-clay etc. A comprehensive data regarding the availability of raw material with physico-chemical analysis was published by iNDEXTb in its publication Potentiality of Ceramic Projects. A seminar on Ceramic Industry Raw Material & Essential Input was also organised by iNDEXTb in March 1993. Seminar volume alongwith the special report on Investment Opportunities in High-tech Ceramics was also released at the occasion. The organisation co-sponsored the 61st Annual Session of Indian Ceramic Society and participated in the Mega Exhibition on 18th & 19th December, 1997 at Gajjar Hall, Ahmedabad.

This publication on "Potentiality of Manufacturing Frit & Glaze in Gujarat" is in continuation of the previous publications includes data on different types of glazes and frits, raw material requirements, manufacturing processes etc. The report also covers details of the end-users and existing players. I hope that this report will be helpful to the various SSI units in the ceramics industry in starting a new venture to exploit the market potential.

Shri JV Bhatt, GM (Tech.)II and his team members Shri MM Parmar and Smt. Mary Joseph have put up a comendable work in compiling the necessary information from various ceramics units.

Last but not the least, I would also like to acknowledge the contribution of Shri KN Maiti, Scientist Incharge, C.G.C.R.I (Naroda Chapter) for sparing the flow sheet of the manufacturing process.

We solicit suggestions from the readers for improvement of the report.

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SUMMARY

- Gujarat produces 90,000 tpd of ceramic products covering tiles, sanitary ware, insulators, crockery and refractory. State needs 9,000 tonnes frits considering 0.10 tonne frit per tonne of product. No organised frit manufacturing unit exist in the State. Requirements are mostly fulfilled by outside specialised companies. The raw material for frits e.g. quartz, felspar, fluorspar, hydrated borax, soda ash, cobalt oxide, nickel oxide are required for the formulation. Fluorite, soda ash and china- clay are available in the State. Potash felspar, zircon, quartz are available in Rajasthan and Kerala states.

- Inhouse frit and glaze manufacturing SSI units located at Ankleshwar, Morbi and Baroda have scope towards the production of matt glazes. Frit and glaze unit with 500 tonnes capacity, can be established involving expenditure of Rs.35 lakhs while ceramic colours envisage cost of Rs.2,205 crores investment.

- In the State sanitary units, tiles units, crockery units are in production. These units requirements for quality product is not fulfilled by the (9) existing SSI units. Looking to the requirements of 9,000 tonnes frit threre exists scope for eighteen units (18) with 500 tonnes capacity, creating opportunity for atracting Rs.630 lakhs invesmtent in SSI in the State.

- Alkaline glaze, felspathic glaze, lead glaze, coloured glaze, matt glaze can be formulated with different ingredients in consideration of firing temperature with the help of state mineral.

- The consumption of frits and glazes in sanitary ware, tiles, crockery sectors increasing day by day with the establishment of new tiles project in the South Gujarat. The formulation and flowchart of manufacturing different glazes will include guidelines to new entrepreneurs to go for frit units in the State.

INTRODUCTION

Ceramic term has originated from the greek word "Keramic" which refers to an art of pottery. "Keramic" is also derived from the ancient greek word "Keramous" that indicates a burnt stuff. As such pottery implies an art of pottery and burnt stuff.

In "Mohanjodero" and "Hadapa" archeological sites pottery samples indicated tht clay base articles with different glazes and colours were manufactured by potters serving the needs of household and kitchen articles. "Salarjung Museum" at Hyderabad and "Bhuj Palace Museum" tablewares and crockery utilisation by princes families, sophistication in design and appearance were equal or even better than foreign products. Pots and crockery remnents recovered at "Lothal" site in Dhandhuka taluka of Ahmedabad district shows that ceramic industry in the State was developed in the olden days.

Ceramic industry is an age old industry and technology for making certain day-to-day consumer products have been mastered long back but over the years the design of the product and end-use applications and also raw materials composition changed. These changes have gradually increased the requirement of modern technology. At present, indigenous technology is available for almost all the products. However, sophistication in design and appearance, new innovations in raw material consumption are seen in foreign technology which produces more marketable products. Government of India is now open for allowing any unit to import technology. "SPITI" of Italy, Germany are the biggest suppliers of technologies in the field.

Ceramics covers wide range of metallic and inorganic products which are mainly related to high temperature treatment. They are mainly divided into major groups like refractoris, sanitary ware, glaze tiles, crockery, high tension insulators, low tension insulators, ceramic capacitors, stone ware jars, stone are pipes, enamelled wedges and frits. Indian Ceramic Industry received a boost after de-licensing. Joint sector companies enterd foreign collaboration. At present, 6,99,330 tonnes installed capacity exists in the country. Gujarat State Ceramic industry is also on a developing trend. In all 6% growth is observed in the country. Ceramic tiles has observed 15% growth. Industrial houses are planning to go for above product due to its increasig demand in construction sector. Residential and office buildings have started using ceramic tiles in flooring bathrooms, kitchens. Organised sector units like Bell, Somani, Decora, Madhusudan are inthe prouction in the state, while "Mittal Group" and "Modi Rubber" are planning new units in Bharuch district.

Application of frit is done in two parts: Initially covering the surface with frit/finally by heating the surface to required temperature to get a uniform tough coating as per requirement. Existing and new units need glazes and frits.

In the ceramic industry the term "glaze" is intended to convey a vitreous coating fixed by heat on the underlying pottery body.

Pottery bodies made from clay, which when fired give a hard mass, but, except in the case of clays which of themselves give, when fired, a perfectly vitreous surface, remain of a porous nature and unsuited to domestic requirements. It becomes necessary, therfore, after the first fire, when the ware is in what is termed the "biscuit state", to affix to it a coating which, on being again subjectd to heat, will render it impermeable to moisture and impart a smooth and glossy surface.

The term "glaze", howver, while being understood to refer to this vitreous coating, is also applied to the mixture of ground materials used in the compounding of such glaze, and which mixture may be either in the form of a dry power or an emulsion of these materials suspended in water. The terms used for these two varieties are "dry glaze" and "slop glaze" and these are often supplied to pottera by "millers" specially equipped for their manufacture. The pottera thus avoid the trouble of making small quantity in their own works.

Ceramic crockeryware items include dinner set, tea set, cups, saucers, rice bowls, soup bowls, mugs and plates. These popular and hygenic items are produced with a variety of coloured glazes and decorations on them which make their appearance pleasing and elegant. Crockery are manufactured both by organised and unorganised sector. Production in organic sector is 16,000 MT and unorganised sector it is 72,000 MT with an average growth of 10%. All the crockery units are utilising glaze and frits either by inhouse manufacture or by outside purchase from the reputed firms. Sanitary ware are made up of variety of raw materials having certain advantages over the others. They are used for sanitation purposes in the products ranges from wash basin, closett, urinal sinks, sinks and bath tubs which bears good resistance to contact by most chemicals, weather, high stregnth and hard glazy surfaces and pleasing appearance. There are about 120 small scale units in the Thangadh in the state. Some of the SSI units like "Sunrise Pottery" are exporting products to South Asian countries. Due to demand in the construction sector, an annual growth rate of around 15% is envisaged. All small scale and organised sector sanitary ware units requirements of frits and glazes are fulfilled by "Sahaj Cerchem (P) Ltd" and Ferrous Coatings & Colours Ltd. Kerakrome are the leading companies engaged in the manufacture of the products.

Gujarat produces 90,000 tons/day ceramic product covering glaze tiles, sanitary ware, insulator and crockery. State needs 9,000 tons of frits considering 0.10 ton frit/ton of the product. The raw material for frits is available in the state. Inhouse processed technology is developed by the individual units.

Skilled and trained manpower exist in the ceramic clusters of the state. During last decade there is a phenomenal growth in the field of industrial ceramics in the developed countries to meet the specific demands of user industry and these materials include high alumina ceramics, cutting tiles, piezo electric, ferrites, gas humidity and other heat and rear structural ceramics.

Considering the growing demand of frit and glaze products by the ceramic units in the state, an attempt is made to compile a report covering demand-supply gap, market potential, process of manufacturing, raw materials, the formulation of different glazes and profiles.

DEFINITION OF GLAZES & FRITS

Glazes :

Glazes and frits are important in whitewares and particularly so far tableware. Glaze contains ingredients of two distinct types in different proportions of refractory material ssuch as feldspar, silica and chinaclays and fluxes such as soda potash florspar and borax. Different combinations of these materials and different temperatures at which they are fired give a wide range texture and quality. The glaze must bond with the ware and its co-efficient of expansion must be sufficiently close to that of the ware to avoid defects such as "Crazing" and "Peeling". Earthenware should be glazed between 1050 to 1100C stoneware between 1250 and 1300C.

Glazes broadly may be divided into three classes viz. transparent, opaque and coloured, but all must fulfill certain conditions viz :

1. Must be sufficiently hard to resist abrasion.
2. For domestic use should be resistant to the action of ordinary acid.
3. Must be sufficiently fusible to adhere firmly to the body without supporting this to any undue risk of warping during fire, but sufficiently infusible to prevent running of the biscuit ware during the firing of this glaze.
4. Must have approximately the same co-efficient of expansion to the body, to prvent the risk of either of the two main faults of glaze,s viz. crazing and pooling.
5. Must hold dissolved, without unsightly separations, metallic oxides that have been added to impart colour.
6. Must not exert too strong a solvent action on the colours used in painting and decoration of the ware.

Hard glazes which are applied on porcelain stonewares generally melt above 1200C. They contain much alumina and silica with alkalies, lime or magnesia as bases.

Medium glazes are used on fine earthware melt between 1050C and 1150C. These glazes contain less alumina and silica, some portion of the letter being replaced by boric oxide, lead oxide is used to power down the melting point.

Soft glazes are used on low temperatures majolica wares and melt at above 900C. These glazes, generally contain the alkalies and leadoxide with small amount of alumina and silica to form and easily melting transparent glaze.

The method of preparation and application of glazes is one of their determining factors. The constituents are finely ground in aqeous suspension which is then applied to dry raw or biscuited body. It is therfore necessary that the raw materials put in mill are water insoluble and this may entail their previous treatment by fritting.

The glazed body is next dried when the glaze must adhere regularly otherwise crawling may occur. It is then fired, when the glaze mixture must fuse and becomes homogenous without becoming so fluid that is begins to flow off the vertical portion of the article.

The finished glaze must be hard, smooth and glossy (except matt etc. glazes). This is not only for the visual effect, a smooth surface is more resistant to chemical and physical attack it is less likely to fracture. By applying a glaze of slightly lower co-efficient than that of the body and cooled glaze is brought into slight compression and the mechanical strength of piece is improved.

A good glazes have following desired properties:

1. Feasibility must be such that maximum liquid glaze is formed at the desired maturing temperature.
2. Viscosity should be moderate at peak firing temperature so that surfaces even out but no overall flow occurs down inclined or vertical surfaces.
3. Surface tension should be low to avoid crawlings.
4. Volatisation of glaze components during firing should be minimised.
5. Reaction with the body should be moderate to give good fit without too much change in composition of either glaze or body.
6. Absorption into the body of glaze constituents or entecties formed during firing should not occur.
7. Devitrification should not occur in transparent glazes.
8. Expansion co-efficient and young's modules of elasticity should relate to those of body in such a way that maximum strength is achieved.
9. Homogeneity, smoothness and hardness to resist abrasion scratching etc.
10. Chemical durability
11. Colour for aesthetic or thermal reasons.
12. Electrical properties e.g. low power factor.

The general conventional form of expressing a glaze composition is RO, R2O3, RO2 called the molecular formula. here RO stands for the oxides alkaline earths and the divalent metal such as lead sinc etc. R2O3 represents alumina and some time of ferric oxide. RO2 stands for silica and often boric oxide. The total oxides under RO is made unity and the other oxides are modified accordingly. This method of representing the composition of glaze helps to a great extent in comparing and controllig their properties.

Frits & Fritting :

When the glaze materials contain soluble salts like alkali carbonates or nitrates, borax etc. these salts are liable to get dissolved in water and separate out from main mixture. In order to obviate this difficulty, these soluble salts are made insoluble by fussion them together with silica lime or lead oxide according to the composition of the glaze. This fused glass like mass is termed in pottery as frit, and the process of fusing is termed as fritting. The remaining insoluble portion of the glaze mixture is added to the frit and ground together with water.

There are several other advantages of fritting the glaze mixture and these can be stated as follows:

1. It minimises the difference in densities of the various constituents of the glaze and so reduces the chance of their setting down separately.
2. It drives out the Co2 and other gases and overcomes some of the heat work to be done by glost firing which is so essential in modern electric fired tunnel kiln.
3. It dismismies the solubility of the glaze in acids minimises lead poisoning certain forms of lead salts such white lead and lead sulphate are more and soluble in human gastric juice than other lead compounds. In order to minimise the solubility in weak acid all lead glazes are required to be fritted before use.
4. It renders soluble materials insoluble.

If soluble materials are left alone, the biscuit ware will absorb some of them and on subsequent firing dense patches may form on these places where soluble salts get deposited most. Some in glaze colour are also attacked by presence of soluble salts in the glaze.

Fritted glazes are commonly used for whitewares and the tendency now is to use larger proportion of frit than formerly. In fact the all fritted glaze is now used for some type of wares. The greater cost is balanced by the case of application and firing.

Boric acid frits: As basic oxide and most borates are soluble in water, boron must be introduced as frit. A typical lead frit is shown below:

0.69 CaO		2.17 SiO_2
0.19 Na_2O	0.37Al_2O_3	1.16 BO_2O_3
0.12 K_2O		

Lead containing frits: For reasons of health, lead is usually introduced into commercial glaze as frit. The simplest frit is the lead by silicate PbO $2SiO_2$ which is reltively insoluble in water. A more complete frit may also contain alkalies and alumina as:

0.94 PbO		1.23 SiO_2
0.03 Na_2O	0.07 Al_2O_3	1.23 SiO_2
0.03 K_2O		

Frit with both lead and boric oxide: These frits are often used in low temperature glaze. Typical composition is:

0.53 PbO		2.70 SiO_2
0.10 Na_2O	0.12 Al_2O_3	2.70 SiO_2
0.07 K_2O		0.69 B_2O_3
0.30 CaO		

Certain rules should be observed in fritting:

1. The ratio between acides and bases in the frit should be within the range of easy fusion i.e. the acid molecules should not fall below molecules nor exceed them three times. The low limit is exemplified by the formula:

0.3 Na_2O		0.7 SiO_2
0.3 K_2O	0.1 Al_2O_3	0.3 B_2O_3
0.4 CaO		

and the high limit by :

0.3 Na_2O		2.45 SiO_2
0.3 K_2O	0.1 Al_2O_3	0.6 B_2O_3
0.4 CaO		

2. The two substances most commonly requiring fritting are the alkalies, nearly all salts of which are soluble, and boric acid which is itself soluble and also forms some soluble salts.

   The alkalis are remarkable in that they form soluble silicates; therefore it is not enough to fuse a soluble alkali compound with silica, as this would not produce an insoluble silicate. For instance, $K_2O{:}2SiO_2$ when fritted is soluble, but 0.5 $K_2O{:}0.5CaO{:}2.OSiO_2$ is insoluble, base which forms an insoluble silicate, e.g. lime, lead, zinc, alumina etc. may reduce or inhibit the solubility of the alkaline silicates. Boric acid also requires crossing to make its produts safe for use. A common practice years ago among some potters was to frit boric acid and flint together without any basic matter. Such a frit, however, is not insoluble.

   A good rule to follow is to use atleast two bases other than the alkalis, one of which shall be Al_2O3 if the glaze formula allows of this.

3. The ratio between the alkalis and boric acid in the first formula should be the same as in the completed glaze, otherwise some other source of alkali or B_2O_3 will need to be introduced in the glaze, and to avoid this is the object of fritting.

4. The ratio between the alkalis and the other elements of the frit must not fall below that existing in the glaze for the same reason as in (3). It may exceed this ratio, as additions of the insoluble bases are readily made in the glaze.

MANUFACTURING PROCESS

The basic coating material is known as FRIT which is a special type of glass in granular form. This frit, water, clay, colour pigments and other auxiliary materials are known as "SLIP".

The raw materials for frits e.g. quarts - 30-35%, felspar - 15- 20%, fluorspar - 5-10%, hydrated borax - 25-30%, soda ash (dry) - 10-15%, cobalt oxide - 0.3-0.5%, nickel oxide - 0.5-1.0% are weighed as per the formulation and a physical mixture is made manually, the mixture is taken in a crucible and then fused in a furnace at a temperature of around 1600^{o}C with continuous agitation for uniform mixing of the molten mass, the temperature is checked with pyrometer and the molten sample is drawn from time to time to check the uniformity of the mix. After attaining the univormity the molten mass is taken out from the furnace and discharged in a cold water bath when the material cools down to room temperature and disintegrated to very small particles. the mass is separated from water and dried. At this stage, it is known as "FRIT". The frit is converted to "SLIP" before application by mixing, grinding and dispersing in a ball mill with water, clay, clourants and other auxiliary materials.

Flow Chart

Raw materials > Primary Mixing (filled in crucible) > Fusion in Furnace > droping molten mass in water > removal of water by filtration and dir drying - Ready FRIT and other R/M > Ball Mill Discharge > application FRIT.

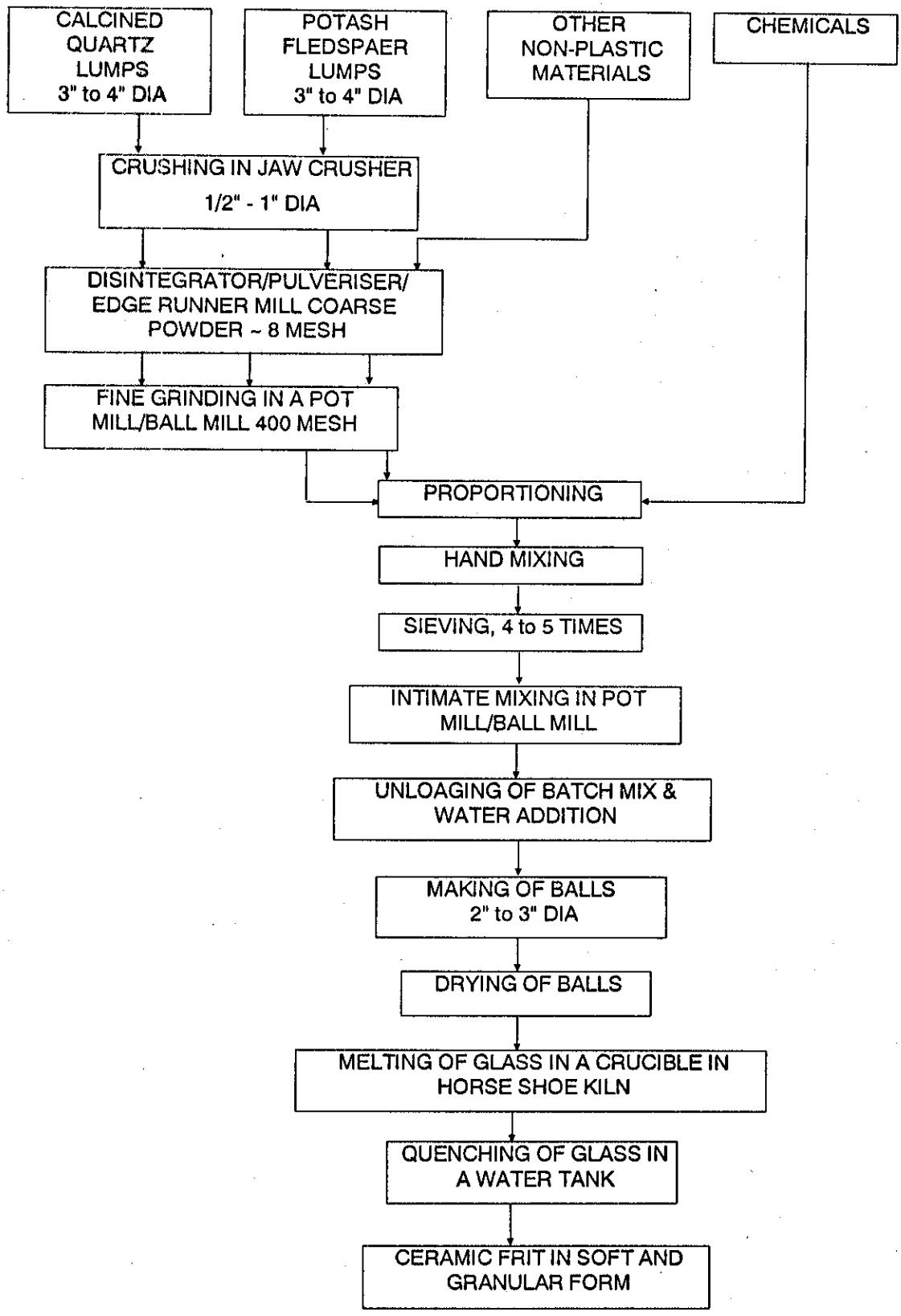


FIG. I **FLOW SHEET FOR MANUFACTURE OF CERAMIC FRIT**

Source: CGCRI, Naroda Centre, Ahmedabad

DIFFERENT TYPES OF GLAZES

1. Alkaline Glazes:

The simplest example of the first type of glaze i.e. the alkaline, is the wellknown salt glaze used extensively on stoneware, but also formely applied to eathenwae which fied, is essentially an alkali alumina silicate. It is produced in practice by the introduction of common salt into the kiln when the ware is near its vitrifying point. The vapour of the salt into sodium oxide and hydrochloric acid, the former entering into combination with the silica, alumina and basic compounds of the clay to form and sodium alumina glass very rich in silica. A very good salt glaze, after firing approximate to the formula:

$RO:05\ Al_2O_3,\ 4.0\ to\ 8.0\ SiO_2$

As the salt gives only the one constituent viz: Na_2O to the RO content, it is evident that the remainder of the formula must be taken up from the body.

It is also essential that the body shall possess the alumina and silica in such a ratio as to give the most stable glaze. The body also must contain sufficient fluxing material to become vitreous at a reasonable heat, for if the body be still porons when the alkali fumes are introduced in the kiln, these will be absorbed by the clayware without glazing the surface.

Much research work has been done with a view to finding the best relations between the constitution of a clay and its ability to form a good salt glaze. I.E. Barringer (Trans. Amer. Ceram. Soc. 1902, 4,211) proves that, contrary to some expressed opinions, it is essential that the clay shall have a certain alumina-silica ratio to be capable of giving a good salt glaze. He gives the analysis of the clay used, and also of the glaze, taken from fired specimens of what is known as a first class salt-glaze product.

Clay analysis

SiO_2	63.11
Al_2O_3	23.30
Fe_2O_3	2.235
CaO	0.725
MgO	0.970
Na_2O	0.490
K_2O	0.930
SO_3	0.240
H_2O	7.810
	99.810

Corresponding to the formula:

$$0.056\ CaO,\ 0.105\ MgO,\ 0.034\ Na_2O,\ 0.042\ K_2O\ +\ 1.95\ H_2O\ \ 1.00\ Al_2O_3,\ 0.06\ Fe_2O_3\ \ 4.605\ SiO_3$$

and the glaze gave

SiO_2	55.475
Al_2O_3	21.340
Fe_2O_3	2.640
CaO	3.500
MgO	0.040
Na_2O	17.210
K_2O	0.080
	100.285

Corresponding to the formula:

0.812 Na_2O		
0.002 K_2O	0.612 Al_2O_3	
0.182 CaO	0.048 Fe_2O_3	2.704 SiO2
0.002 MgO		

RO=0.998

It will be noticed that for the clay, Al_2O_3 is taken as unity, while in the glaze the sum of the base RO is taken as unity, following the practice usually adopted in ceramic calculations. This particular clay is thus seen to have an Al_2O_3:SiO_2 ratio of 1:4:6.

From further experiments recorded in the same work worker still got a good salt glaze, by the adition of free silica to the original clay upto the ratio Al_2O_3 to SiO_2 1:10.

Knell (Tonid Ztg. 1806, 20, 495) assumed that the salt vapour attacked a double silicate of aluminium and iron in the body: the sodium of the salt displaced the iron of the double silicate; and the salt glaze remained behind as a double silicate of aluminium and sodium. The iron was supposed to be liberated as ferric chloride which, in contact with water vapour in the oven, was transformed into ferric oxide and hydrogen chloride. He gives the reactions occuring as:

$(AlFe)_2O_3 + SiO_2 + 6NaCl = (AlNa_3)_2O_3 + SiO_2 + Fe_2Cl_6$

$Fe_2Cl_6 + 3H_2O = Fe_2O_3 + 6HCl$

But this view meets with little approval, as the quantity of iron present in the clay body exposed to the action of the salt fumes is too small to account for the amount of glaze formed.

It is quite evident, however, that the salt vapour, in attacking the silica and alumina of the body, will have its effect on the iron content of the clay according to the amount of iron present, and also to the nature of the fire just prior to salting, as in the event of this being "reducing", the iron will be reduced to the ferrous state and give to the finished glaze a much darker colour than if an oxidising atmosphere had been maintained throughout the firing and glazing. While salt glaze is mainly used in the stoneware of a good white colour was glazed by this process, but it was entirely abandoned with the advent of lead glazes.

The chief advantage of salt glaze is its high resistance to the action of acids and this property has led to its extensive use in the manufacture of articles for the chemical industry.

In applying the salt glaze the ware is placed in the kiln with the surfaces to be glazed exposed to the kiln atmosphere. When the temperature corresponding to the vitrifying stage of the clay ware is reached and a clear fire maintained, a quantity of salt is thrown in the fire holes; this decomposes in the kiln with a lowering of the temperature inside the kiln of about 100°C. The fires are then fed to restore the temperature to the desired level and a further batch of salt introduced; the same procedure may be repeated three or four times according to the quantity of salt used in each application and the composition of the body. After the last salt application, the reheating is repeated until the maximum temperature is reached, approximately 1,250 °C, when the kiln is allowed to cool.

It has been suggested (Everhart, J.Amer, Ceram, Soc. 1930, 13, 401) that the salt instead of being applied by the foregoin method, can be utilised as a glaze when embodied in a slip and dipped on the ware in the usual way. A clay slip made from the same material as the body offers the ideal medium for introducing the salt. A mixture of 75 clay to 25 salt ground together and applied either by dipping or spraying and fired to about 1,150°C gives a nice smooth surface. This method does not seem to have passed the experimental stage, but the results so far obtained are quite satisfactory. Coloured slips may also be used with good effect.

2. Felspathic Glazes:

This type covers the range usually termed Bristol Glazes which are of a felspathic type and maturing at a high temperature, 1,250 - 1,300 °C. They are of two varieties - transparent and opaque - and mainly used on stoneware and glazed bricks. In this type a representative formula for a transparent glaze would be (N.D. Wood, Trans. Coram. Soc. 1935, 34, 279)

$$\left.\begin{matrix} 0.18\ K_2O \\ 0.38\ CaO \\ 0.44\ ZnO \end{matrix}\right\} \quad 0.21\ Al_2O_3\ ,\ 1.95\ SiO_2$$

The raw materials usually adopted being felspar, whitting, zinc oxide, chinaclay and flint, whereas the opaque variety is produced by varying the proportions of the same raw materials and adding an opacifying agent such as tin oxide, zirconia, arsenious oxide, bone ash, etc. Such glazes approximate to the formula:

$$\left.\begin{matrix} 0.50\ K_2O \\ 0.40\ ZnO \\ 0.10\ CaO \end{matrix}\right\} \quad 0.50\ Al_2O_3,\ 3.50\ SiO_3$$

These glazes possess the advantage of cheapness, no fritting being required, but they do not give a very brilliant surface, so that for the better classes of stoneware (domestic and art ware) a fritted leadless glaze is usually adopted with the approximate formula as follows:

Frit

0.14 K_2O		
0.14 Na_2O	0.41 Al_2O_3	2.61 SiO_2
0.09 CaO		0.13 B_2O_3
0.67 ZnO		0.006 SnO_2

Glaze containing 3% of above frit

0.157 K_2O		
0.090 Na_2O	0.567 Al_2O_3	4.025 SiO_2
0.537 CaO		0.037 B_2O_3
0.133 BaO		0.053 SnO_2
0.082 ZnO		

A felspathic glaze, as used in the production of hard porcelain, both Continental and English, with which the body is first fired at a low temperature, about 800°C and then glazed and fired at a very high temperature (1400 - 1500°C) would approximate to the formula:

0.62 K_2O	1.33 Al_2O_3	, 15.60 SiO_2
0.38 CaO		

The third group glazes comprises those consisting mainly of silicates and boro-silicates with some alumina and softened by the addition of lead oxide; such include all ordinary English earthenware transparent glaze and also most of the English porcelains.

The best glazes in this group approximate to the formula:

0.30 KNaO		
0.40 CaO	0.25 Al_2O_3	2.50-3.00 SiO_2
0.30 PbO		0.40 B_2O_3

and give a good clear transparent glaze when fired to about 1150 °C.

These glazes are usually compounded from a frit consisting of borax, whiting, flint, felspar and china clay, to which is added on grinding white lead, felspar or cornish stone, china clay and flint.

A typical example of such a glaze is

Frit	
Borax	37.7
Whiting	18.8
Cornish stone	18.8
Flint	18.8
China clay	5.6
	99.7
Glaze	
Frit	36.8
Cornish stone	31.8
Flint	10.2
White lead	21.2
	100.0

giving formula :

Frit

0.370 KNaO		1.90 SiO_2
0.40 CaO	0.30 Al_2O_3	0.04 B_2O_3

Glaze

0.30 KNaO		3.10 SiO_2
0.40 CaO	0.30 Al_2O_3	0.36 B_2O_3
0.30 PbO		

3. Lead Glazes:

The great variety of pottery bodies made from such different clays and admixtures necessitates such a range of glazes, that to act a standard to suit all requirements would be impossible. The numerous published receipes, however, when calculated out to the suggested formula, can be reduced to a few main types which may be classified according to their lead content.

Redware - This is the simplest and cheapest type of glazed pottery formed often from natural clay alone, such as is used for common bricks, but washed before use. Such clays are fired at relatively low temperature, approximately 900°C. The products in this grade consist of such articles as milk crocks, common bowls, teapots etc. The glaze for such bodies is of the basic type and is often applied on the clay ware; it sometimes consists solely of a wash of litharge or galona, and depends on the adsoption of sufficient alumina and silica from the body during firing to form the glaze. An approximate formula of such glaze after firing is :

PbO	0.09 Al_2O_3	1.4 SiO_2
	0.03 Fe_2O_3	

Naturally, such a basic glaze is very liable to the action of acids and not to be recommended for use on vessels intended for domestic purposes.

A higher grade of Redware is that known as red clays and often mixed with a proportion of ball clay or china clay and flint, the desired tone of colour being given by the addition of ochre. This class of body is usually given a biscuit fire at approximately 1100°C. Before being glazed, although at the present time considerable quantities are being completed in one fire only. The glaze for this class is usually of the raw lead type consisting of white lead, cornish stone, china clay and flint, to which is added manganese dioxide.

Commercial bisilicate

An approximate formula is :

0.80 PbO		
0.20 KNaO	0.20 Al_2O_3,	2.0 SiO_2

with approximately 10% MnO2 added.

Closely allied to the Rockingham grade is the one known as "Jet Glaze". This is applied to the same red body as used for Rockingham, but to give the jet black coloured glaze, cobalt oxide is substituted for the manganese dioxide used in the Rockingham glaze. During the last few years considerable progress has been made with a view to substituting glazes of a low solubility nature for this grade of ware in order to be free from the restrictions imposed on users of raw lead glazes. One such low solubility glaze approximates to the formula:

0.20	KNaO		
0.30	CaO	0.160 Al_2O_3	2.20 SiO_2
0.50	PbO		0.30 B_2O_3

with the addition of 10% MnO_2 and compounded from borax frit, lead frit, cornish stone, china clay and manganese dioxide.

Another type of high lead glaze, formerly extensively used, is that termed "Majolica Glaze". This grade of earthenware was in great demand years ago in the manufacture of ornamental goods such as flower pots, umbrella stands, pedestals, etc. the body being made from a cheap earthenware recipe, fired biscuit at a relatively low temperature and covered with a soft glaze often made up by the addition of colouring oxides to a standard white glaze.

A typical glaze of this type would correspond to the formula :

0.25	Na_2O		
0.25	CaO	0.20 Al_2O_3	2.5 SiO_2
0.50	Pb		0.5 B_2O_3

prepared from a frit of the formula :

0.50	Na_2O	2.0 SiO_2
0.50	CaO	1.0 B_2O_3

with the addition of white lead, china clay and flint. The colouring agent would then be added in the desired proportion during the grinding of the glaze.

As will be seen from the formula, the foregoing four types of glazes are all of high lead content, approximating to between 40 and 50% PbO, but are used on common clay bodies of uncertain colour. Lead glazes are also used for what are termed "whiteware bodies" and these cover a wide range from the common earthenware to the highest class semi-porcelain and china.

While the material used in the various bodies are practically the same for all types, the proportions and qualities vary widely; a few typical examples will furnish a fair idea of the general range.

Common earthenware, formerly designated by the term C.C. or cream colour. Here the body is usually composed of the cheaper varieties of china and ball clays with the addition of cornish stone and flint. The clay content is usually higher than in better class wares, to ensure easy working properties and the fineness of texture, etc, required do not demand so much preparation of the clay body. The percentage

composition of a typical cream colour body in ball clay 34, china clay 26, flint 25 and cornish stone 14, but the glaze used in practically the same in both cases. A simple glaze largely used for this type before the introduction of the low solubility variety had the recipe, white lead 59.0, cornish stone 31.7 and flint 9.3 parts, corresponding to the formula:

0.10	KNaO		
0.05	CaO	0.20 Al_2O_3,	2.2 SiO_2
0.85	PbO		

but since the introduction of fritted glazes a more general formula has been :

0.33	KnaO		
0.33	CaO	0.25 Al_2O_3	2.50 SiO_2
0.33	PbO		0.33 B_2O_3

made up from a borax frit with cornish stone, china clay and white lead added.

The bodies for the higher grade of earthenware and semi-porcelain and the type formerly known as "Granite" are usually compounded from better class clays and cornish stone; the clay content is lower and the flint and stone content higher, thus giving a better colour and increased vitrocousucess. A body of this type will approximate to the recipe, ball clay 30, china clay 20, flint 33 and cornish stone 17% and to give extra whiteness a small proportion of cobalt oxide stain is added, approximately 1 in 12,000 parts. The working clay is prepared with extreme care to ensure as clean a body as possible.

The body of chia in distinguish from earthenware by reason of its transluence, and is compounded from calcined bone, cornish stone and china clay with the addition of a small quantity of ball clay to increase plasticity, although this detracts somewhat from the perfect colour.

A typical bone-china body has the following percentage composition: bone 46, cornish stone 29, china clay 23 and ball clay 2, varying slightly according to quality required.

The glaze usually adopted for both the better class earthenware and the china is now the low solubility type composed of borax frit, lead frit and mill mixture, being mainly cornish stone, flint and china clay.

A typical formula would be :

0.066	K_2O		
0.260	Na_2O		
0.383	CaO	0.29 Al_2O_3	2.80 SiO_2
0.288	PbO		0.50 B_2O_3

Such glazes represent a lead content of approximately 18% PbO.

Other white ware glazes in which lead is used are those for white tiles, in which the body contains a very high proportion of flint, sometimes as high as 45% owing to

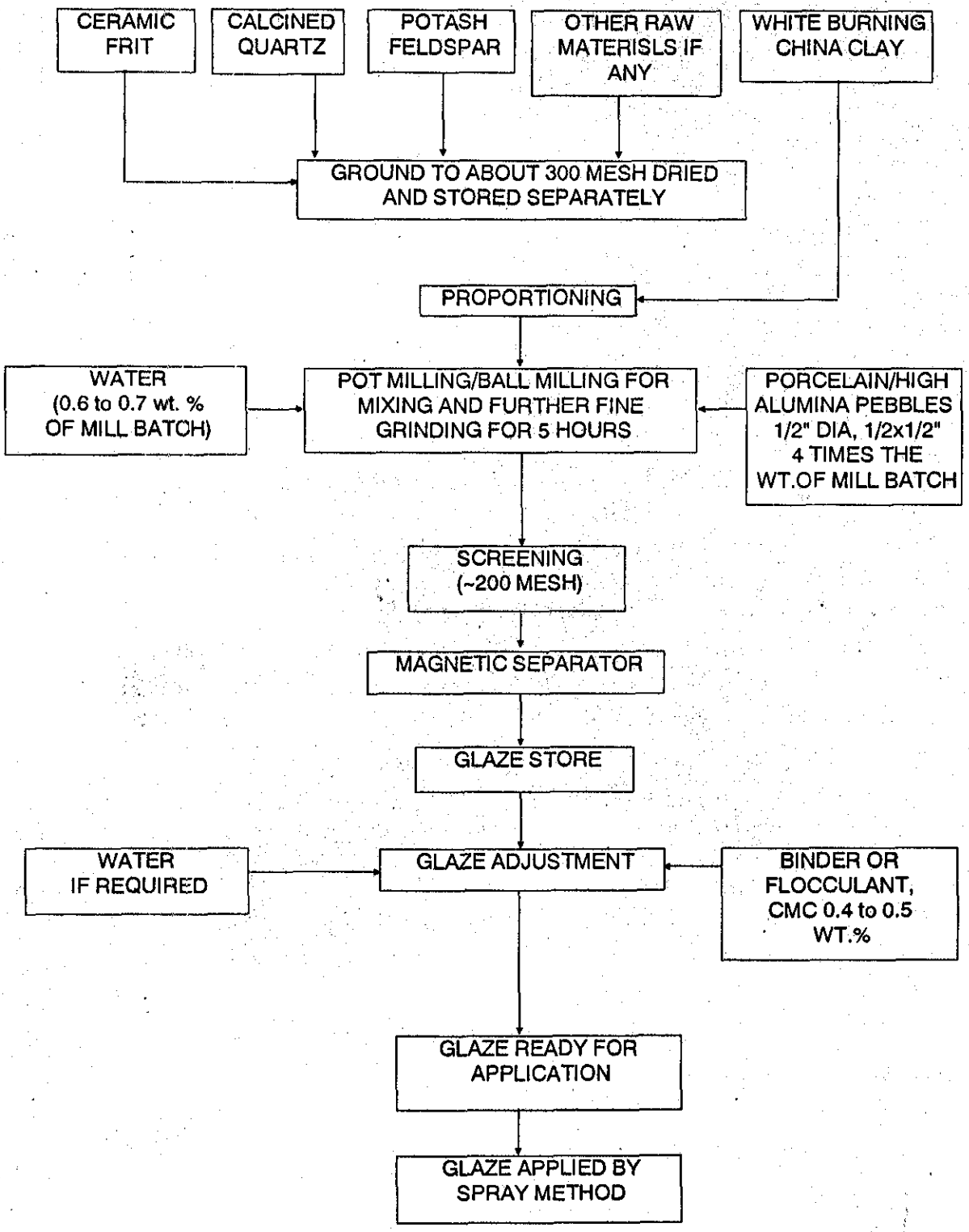


FIG. II **FLOW SHEET FOR MANUFACTURE OF GLAZES FOR ROOFING AND DECORATIVE TILES**

Source: CGCRI, Naroda Centre, Ahmedabad

the necessity of freedom from warping during firing. The glaze for such bodies is usually much higher in lead content than the other white ware bodies, varying from 25 to 40% PbO.

A typical formula is:

0.28	KNaO		
0.29	CaO	0.24 Al_2O_3	2.70 SiO_2
0.43	PbO		0.38 B_2O_3

maturing a temperature of 970°C, compounded from borax frit, cornish stone, china clay and white lead.

4. Coloured Glazes:

This term is mainly used to describe those bodies covered entirely with a glaze in which is incorporated a certain proportion of a colouring oxide and does not refer to the colouring obtained by the use of a printed or painted decoration on the biscuit ware.

Such glazes are usually confined to majolica ware and to tiles, but sometimes they are also used in stoneware. In the case of majolica and tiles, it is essential that the firing temperature be relatively low, approximately 960°C, consequently the lead content is high. To give the necessary colour, it is usual to grind a percentage of colouring oxide with a portion of the glaze and then mix well with the whole batch. A more satisfactory method, however, is to use (1) a batch of transparent glaze, (2) a batch of coloured glaze too high in colouring oxide for the purpose required. By using suitable proportions of each, any desired blend can be obtained. Much time is saved by adopting this method and the inconvenience of storing a large number of blends is avoided. A simple example will illustrate the procedure:

Transparent glaze No.1, formula 1.00 PbO: 0.15 Al_2O_3, 1.75 SiO_2, and with this as base a series of majolica glazes are to be made with cobalt oxide as colouring agent.

For this purpose a glaze No.2 is made up, having the formula :

0.80	PbO		
0.20	CaO	0.15 Al_2O_3,	1.75 SiO_2

This glaze will be black in colour and can be used with No.1 in any desired proportion.

If glaze No.3 is required to contain 0.02 mol. parts of CaO, the difference between the CaO content of glaze No.2 and the required CaO content of glaze No.3 is 0.18 mol. parts. Dividing the difference in the CaO content of the desired glaze and the extreme by the total difference between the two extremes gives a fraction expressing the proportion of the opposite extreme to be used in the miexuture, thus:

$$\frac{\text{Desired difference}}{\text{Total difference}} = \frac{0.18}{0.20} = 0.9$$

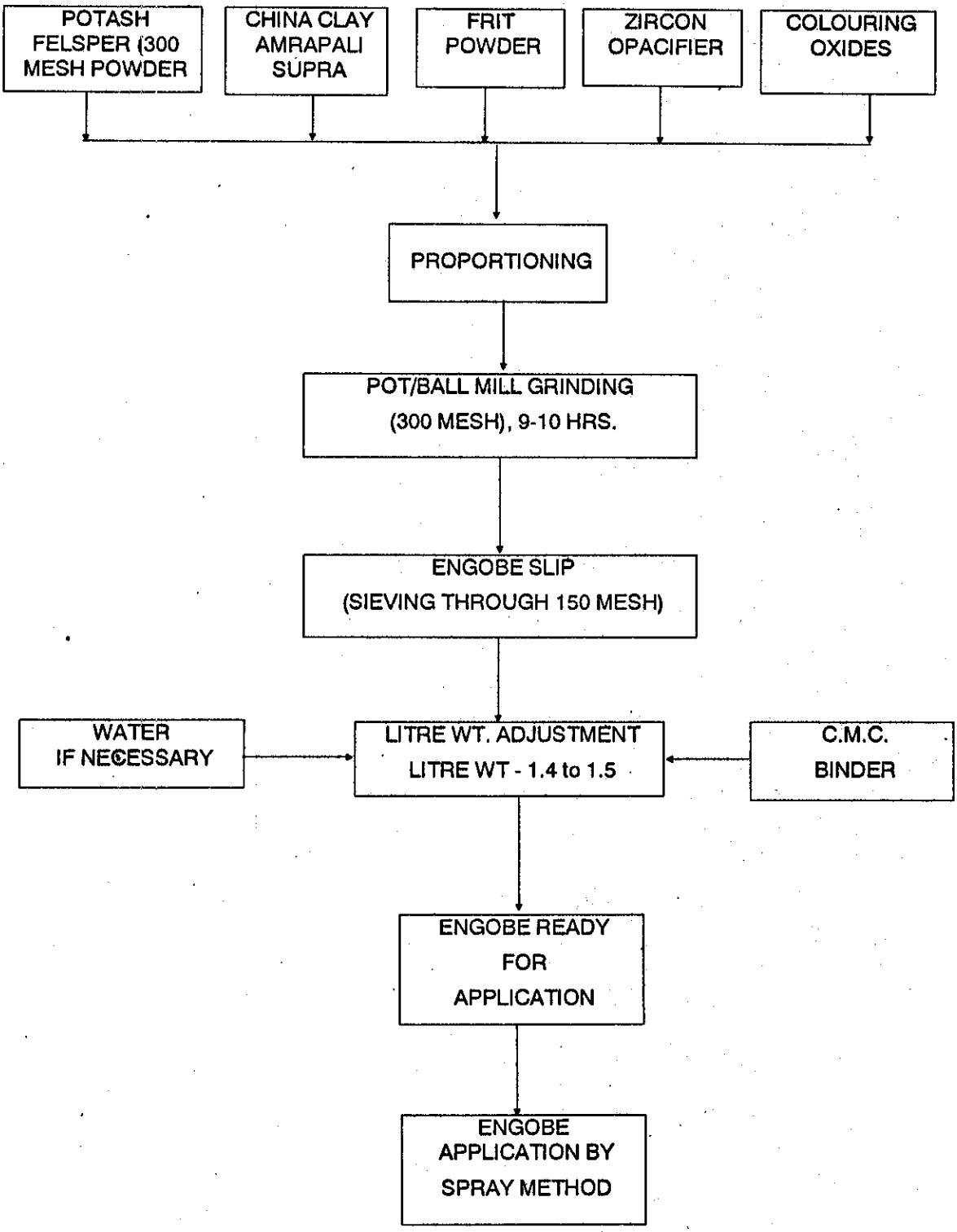


FIG. III **FLOW SHEET FOR MANUFACTURE OF ENGOBE ON ROOFING TILES**

Source: CGCRI, Naroda Centre, Ahmedabad

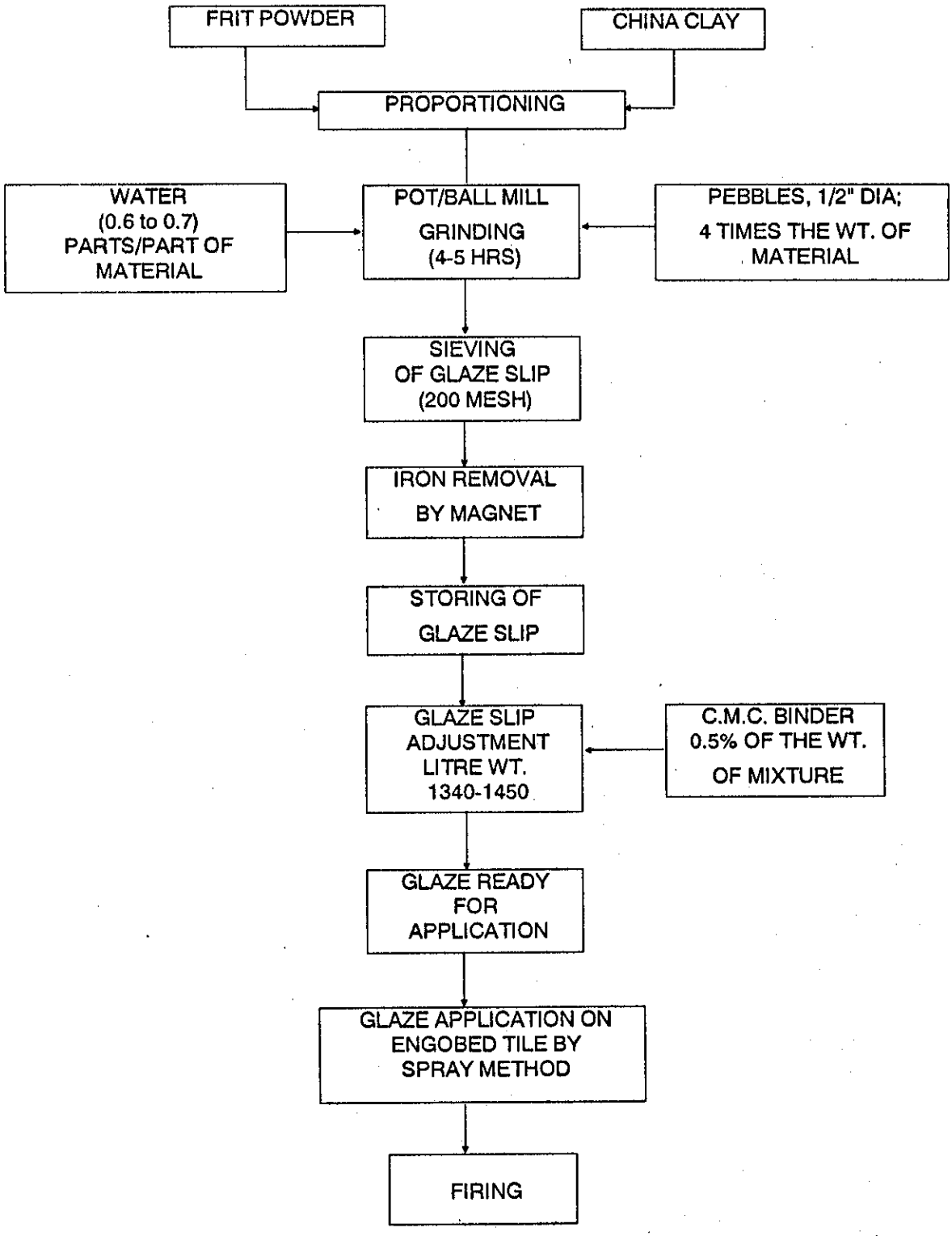


FIG. IV **FLOW SHEET FOR THE MANUFACTURE OF GLOSSY GLAZE FOR ROOFING TILES**

Source: CGCRI, Naroda Centre, Ahmedabad

Therefore glaze No.3 requires :

0.9 molecular parts glaze No.1
0.1 molecular parts glaze No.2

This method has the advantage that the glazes Nos. 1 and 2 can be kept in the slop state and thus readily mixed without the necessity of drying; the only precaution being that the dry content per unit volume of the slop glazes be known.

A more perfect mixture is, however, obtained if the colouring oxide in glaze No.2 is embodied in a fritted form.

5. Matt Glazes:

Of recent years, such glazes have rceived much atention owing to their decorative possibilities and are largely used in the tile and ornamental trades. Many of these glazes are compounded by the addition to a transparent glaze of a so-called matt mixture, depending for its composition on the type and colour of the surface required. The matt effect is produced by the addition of either alumina, lime or magnesia, with the addition of zinc oxide to give the desired sheen. These glazes may also be made direct as raw glazes. A typical raw matt-glaze has the composition: red lead 42.0, whiting 6.4, felspar 16.0, chia clay 21.5, flint 10.6 and zinc oxide 3.5%, corresponding to the formula:

0.10 KNaO
0.20 CaO
0.57 PbO $\quad 0.35\ Al_2O_3,\quad 1.60\ SiO_2$
0.135 ZnO

and matures at 1080°C.

Many examples of such glazes are quoted by C.F. Binns (Trans. Amer. Ceram. Soc. 1903, 5, 50).

A type of lime matt-glaze is produced by the addition of approximately 25% whiting to an ordinary low solubility transparent glaze. Coloured matt-glazes may be produced by using any of the usual coloured glazes with the addition of a matt mixture, this being either added to the transparent glaze or sometimes dipped on the top of the glazed piece before firing. One such matt mixture used in practice has the percentage composition: SiO_2 36.97, Al_2O_3 9.36, TiO_2 9.90, MgO 19.27 and CO_2 23.47 corresponding to the formula :

MgO: $0.2\ Al_2O_3$ $\quad 1.28\ SiO_2$
$\quad 0.26\ TiO_2$

Care must be taken in the selection of a suitable matt mixture as this will exercise considerable influence on the final colour. As an instance, if the above matt mixture be super imposed on a blue glaze, the resultant colour instead of being a matt blue will be of a dark plum colour, owing to the action of the magnesia on the cobalt oxide in the base glaze.

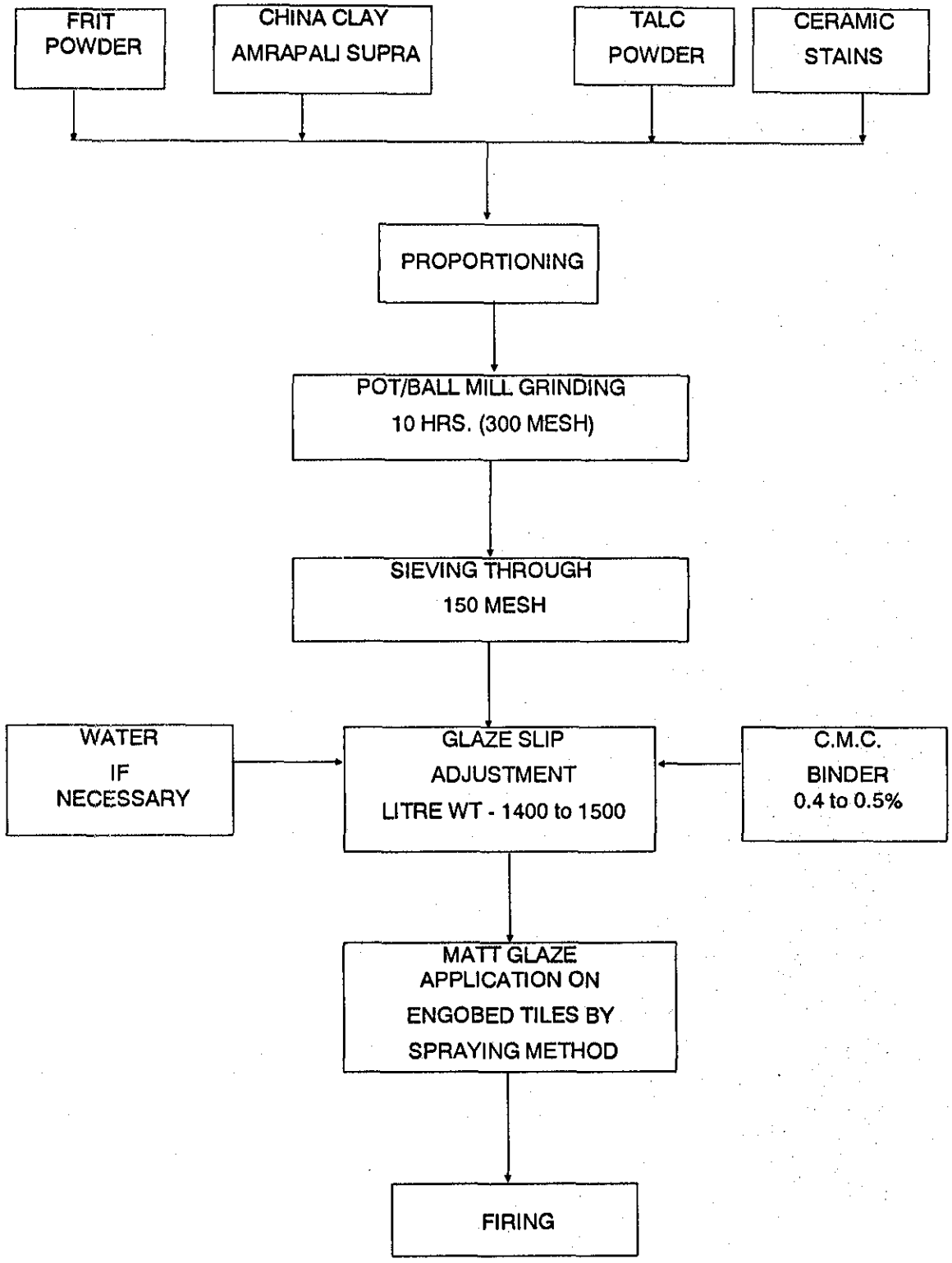


FIG. V **FLOW SHEET FOR MANUFACTURE OF MAT GLAZE FOR ROOFING TILES**

Source: CGCRI, Naroda Centre, Ahmedabad

FIELD OF APPLICATION

Ceramic coatings are known for kitchen wares and hospital wares. But the scope of its use in other fields are tremendous, which are as follows:

Electrical application: It is such a wonderful system that electrical insulation at high temperature or a coating with good insulating property can easily be attained just by adjusting a few ingredients in a composition. It can be used in flash bars audio, automotive sensors, controllers, power devices, TV sets, PCB, Solar energy panels (and almost every place where even the most hitech organic coatings do not witstand). The coating can withstand 3200 V for 1000 to 1200 hrs. at 100-150^{o} C. It has a resistivity of 10^{14} ohms/cen.

High temperature application: Ceramic coatings can successfully be applied on surface where it is required to put a barrier in between the metal ubstrate and high temperature environment of a high temperature fluids. Example of some areas are:

1. Jet Aero Engine Components
2. Waste Gas Burning Tubes
3. Mettalic Spark Plub
4. Radiant Tubes of Heat Treating furnacers
5. Metallic Muffles
6. Chlorinating Tubes used in Aluminium production

Acid resistance coatings: If there is any requirements of a special coating material to protect a metallic substance from hot acidic condition for a prolonged period, then ceramic coating is the only an ideal solution.

Chemical resistance coatings: Industrial construction equipment structures are always exposed to a corrosive atmosphere due to close contact of chemical reaction or due to various corrosive gases and temperature evolved. Ceramic coatings can stand as a barrier to protect the virgin metal from decay in industries like Petrochemical, Fertilizer, Cement, Sugar, Pharmaceutical, Oil Field involving Nitration, Sulphonation, chlorination and polymerisation.

Application:

Application of Frit is done in two parts: initially covering the surface with frit/slip, finally by heating the surface, to required temperature to get a uniform tough coating as per requirement. The initial application technique can be varied as per the requirement.

1) **Dry application:** Dry fine Frit powder is either sprayed on a preheated substrate or the pre-heated substrate is rolled over a bed of powdered frit which is followed

by final heating to get the firt melt for an uniform coating, this process is mainly applicable for cast iron wares.

2) **Wet application:** Here the frit is converted to slip which is then applied by spraying or dipping. The rheological property of the slip is very important apart from sp.gr, particle size distribution and flowability to obtain best result.

3) **Electrostatic application:** Dry ground frit of particles size 30 um and 0.5% organic encapsulant, e.g. silane is sprayed from an electrostatic spray gun under a potential difference equivalent to 100 KVA such high PD is requried because of high density of frit.

4) **Electrophoratic deposition:** It is a system similar to electroplating. The substrate is made anode in a vat containing the frit dispersed in water and suspended form. A current is applied for a high P.D., frit is allowed to deposit on the substrate, which is dried in a hot air stream and passed to high temp. oven for curing. Very thin coating can be achieved by this process of application.

RAW MATERIALS

The raw materials neededfor the product is divided into two parts:

1. Glass forming oxides

2. Auxiliary Mateials

Glass forming oxides are (a) Acidic oxide, (b) Basic oxide, (c) Amphoteric oxide, (d) Simultaneously acidic & basic oxide introducing materials.

Acidic Oxides: Acidic oxides are silica, quartz, boric acid etc. Silica is available in two forms, crystalline and amorphous, trydymite and crustofalite comes under crystallines and diatomite, opal and tripoli are example of amorphous forms.

Out of all the above oxides, quartz is used widely, many qualities of quartz are available, vein grade quartz is available in most purest form. Contamination in forms of soda potash alumina and magnesite are not harmful but presence of Iron, Chromium or Vanadium Oxides can impair the desired enamel properties.

Boric oxide or/acids are mainly used to make products with low alkali content.

Another acidic oxide, phosphorous pentoxide, its ammonium salts or alkali phosphate is used.

Basic Oxide: This includes oxides of alkali and alkaline earth metals, alongwith zinc and lead oxides, sodium can be used as soda ash, potassium as potash and lithium as there ores e.g. lepidolite, spodumene, etc. Alkaline earth oxides can be used as carbonates, e.g. limestone or marble for calcium oxide. Magnesite or dolomite as a source of magnesium. The source for Barium Oxide and strontium oxide is barytes and strontiamite respectively.

Amphoteric Oxide: Oxie and hydroxide of Aluminium is an example of amphoteric oxide.

Materials for simultaneous introduction of Acid and Basic Oxides:

1) Felspar is a common source for silica, alumina and alkali oxide, alongwith a small amount of alkaline earth metals. Potash felspar is mostly used.

2) Pegmatite is a mixture of felspar and quartz.

3) Borax is a source of Sodium Oxide and Boric Acid.

4) Ortho - meta and pyrophosphate of sodium is the oxide source of sodium and phosphorous.

5) Kaolin is mainly aluminium silicate in composition which is a main source of alumina besides this for simultaneous introduction of alumina and silica, bentonite can be suggested.

Auxiliary Materials: are those which may or may not take part in enamel glass formation, their usage is very small but they play a key role during manufacturing as well as application of enamels. They are classified as: (1) Oxidising Agent (2) Bonding Oxides, (3) Opacifiers (4) Nucleating Agents (5) Coourants and Pigments.

(1) Oxidising Agents: The examples in this series are Alkali nitrates, Nitrites and Manganese Dioxide (Pyrolusite).

(2) Bonding Oxides: The term bonding is heard in paint industry as adhesion. The materials import bonding of vitreous enamel with the surface of the substrate, particularly steel surface. The main bonding agents are cobalt oxide (mixture of 'us' and 'lc' type) Nickel oxide, Molybdenum oxide, alkali molybdates, besides the oxides of arsenic, antimony and manganese.

(3) Opacifier: These are the materials which confer an opacity or opaque colour, mostly milky white to the finished vitreous enamel coatings.

(a) Fluorides - Cryolite, fluorspar are the two fluoride based opacifier, cryolite contains soda, silica, sodium fluoride and hydrated alumina, fluorspar on the other hand contributes calcium fluoride.

(b) SnO_2 (Stanic Oxide) - It is also a opacifier, but compared to its cost, it is not that good, CeO2 is also an opacifier but its high cost makes its use very limited and restricted.

(c) Arsenic and Antimony Compounds - Though they are good opacifiers but very limited use due to its toxicity.

(d) Zircon or ZrO_2 - are very good Opacifiers and used widely, they impart other properties to the coating apart from opacifying property. However, due to its refractory nature, there are some restrictions in using these. It is obtained in nature as Zircon or baddeleyite, it is nontoxic its common contaminants are iron oxide, titania and silicates.

(e) Titanium Dioxide - The best opacifier ever known. It is available in three forms, Rutile, Anatase and Brookite. Anatase gives best opacity. It is nontoxic and economical.

Nucleating Agent:

These agents are particularly important for glass ceramic coatings. These materials on suitable heat treatment yields nucleating sites or nucleas for further growth of crystals. Desired size and distribution of crystals can be formed with suitable nucleation, several nucleating agents can be used, but most common is the phosphorous pentoxide and Titanium Dioxide.

Colourants and Pigments: Both these materials are used to get coloured coatings, but colourants imparts a transparent colour whereas pigments give colour with opacity.

The colourants consists mainly oxides and other salts of transition element, i.e. Cobalt, Nickel, Copper, Manganese, Chromium, etc. and Compounds of gold and copper in colloidal state.

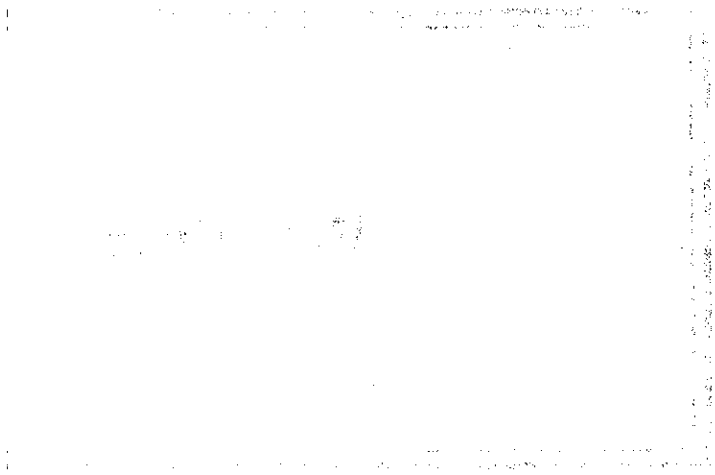
CoO is introduced normally as oxide, grey cobalt oxide contains chiefly CoO and black oxide consists of a mixture of CoO and Co_2O_3 or pure Co_2O_3, it gives distinct blue colour to the coatings.

Nickel Oxide: It is generally used as Ni_2O_3 and NiO the former is black, whereas NiO is greyish green in colour. Also $Ni(OH)_2$ and $NiCo_3$ are sometimes used. NiO imparts a red violet or brownish violet colour to an enamel coating.

Copper Oxide: Generally used in the form of Cu_2O and CuO in addition to that metallic copper is also used, CuO gives a green and Cu_2O gives a red hue.

Chromium Oxide: It is a colourant as well as pigment, CrO_3 gives a yellow shade while Cr_2O_3 imparts a green colour.

PROFILES



FRITS & GLAZES

Introduction

"Ceramic Glaze Frits and Stains" are used by Ceramic and Glass Industries only. A Frit may be defined as mixture of inorganic substances fused together in a furnace and guenched rapidly by either a water bath or water-cooled metal rolls. Frit is a complex combination of materials. Its purpose is to render solubles and toxic components insoluble by combining them with silica and other oxides.

The fritting is done either on a continuous basis by introducing raw batch into a properly heated furnace or on a batch basis in crucibles or a rotary furnace or on a batch basis in cruciables or a rotary furnace. Frit then is used in combination with clay and possibly other suspending agents to produce a coating material for whiteware, which is applied, dried and fired to produce the glassy deposit called a glaze. Fritted glazes are commonly used in glazed wall tiles and other whitewares. The greater cost is balanced by ease of application and firing.

Stains

One of the great asset of ceramic pieces is the fact that they may be decorated with a wide range of colours. The ceramic industry generally buys its colours for decoration from a ceramic colour manufacturer. Ceramic stains are crystals coloured by a transition element except for a few cases in which coloured glasses are employed. The stains in fine powder form is used in the glaze body. For overglaze decoration, a flux (60 to 95%) is added to cause it to fuse on to the glaze at the low decorating temperature. For underglaze application a small amount of flux and a little amount of clay are added. Bulk quantity of stains used in whiteware industry go to the wall tile and sanitaryware industries. About 50% of stains that go into these products consist of the

Market Potential

In Gujarat six hundred and fifty small scale, ten medium scale and seven large scale organised sector units are manufacturing ceramic products like crockery, sanitary ware, insulator, refractory, stoneware pipes, tiles, etc. All units are purchasing Frits and Glazes from "Ferro Coating Company", Calcutta. No reputed organised unit exist in the State. In the States 30 MT frits is produced by the units. "Gibrator Ceramics" at Padra produces 10 MT, the rest nine of the eight units in Ankleshwar, Morbi and Baroda produces 3 to 6 MT frits in tiny sector.

From the production of ceramic products, it is inferred that one tonne ceramic products needs 0.10 tonne frits for the coating. In country all the ceramic items goods manufactured will require 55,510 tonnes frits with country installed capacity 5,55,110 tonnes for ceramic products.

There are number of small, medium and large ceramic and glass factories in the country. Decoration in the wares are being a common practice to all, over and above a large number of glass bangle makers also use this collars and frits in their production of colourful bangles. This item has a great demand in our country till today and there is a good scope for the quality colours both high temperature and low temperature quality.

Ceramic frits and stains are essential items for glazed wall tiles and low-fired potteryware units. Major tile industries can afford to have fritting kilns for their captive consumption. However, small scale wall tile manufacturers depends on outside sources for their requirement of frits and stains. Enamelware manufacturers do also require glaze frits for application on tin enameled wares. Similarly, colour stains also demanded by variety of small scale pottery units. With a large number of manufacturing units for wall tiles and pottery wares and only a few frit manufacturers in India, marketing of this product is expected to be easier.

Basis & Presumptions

The unit is envisaged to produce 500 MTs of frits and 50 MTs glaze stains.

The unit will be operated throughout the year. The project is envisaged to work at 75% of its rated capacity.

Project Implementation Schedule

The major series of activities in the implementation of the project are as follows:

1. Site selection and registration as the small scale unit.
2. Collection of quotation and selection of machinery
3. Preparation of project report
4. Obtaining loan from financial organisations, if required
5. Acquisition and development of land
6. Placing orders for plant and machinery
7. Construction of factory sheds & kilns
8. Installation of power fittings
9. Procurement of raw materials
10. Trial production
11. Commercial production

For completion of the above schedule it is considered that it would take 6 to 8 months. Delay in any of the above activities would directly result in the delay of implementation of the project.

Financial Aspects

Fixed Capital

Land 2000 sq.mtrs @ Rs.100/sq.mtr	Rs. 2,00,000.00
Building Office Stores etc. 100 sq.mtrs @ Rs. 2000/-	Rs. 2,00,000,00
Work shed 250 sq.mtrs @ Rs. 1000/-	Rs. 2,50,000.00
Total	Rs. 6,50,000.00

Machinery & Equipment

		Qty.	Amount (Rs.)
1)	2'x4' rotary melter with oil fired equipments and other accessories including IS 8 & siliminite brick lining with 3 H.P. Motor	1 No.	1,50,000/-
2)	2'x2' Ball mill with porcelain lining electronic motor of 3 H.P.	1 No.	10,000/-
3)	High density grinding balls	500 Kg.	10,000/-
4)	Mixer machine with 3 HP motor	1 No.	15,000/-
5)	Vibrating screen (5 HP motor) 2500x1000 mm	1 No.	35,000/-
6)	Electric furnace upto 1000 ^{o}C with temperature indicator & accessories	1 No.	1,00,000/-
7)	Frit furnace (cylindrical) 18' length & 4' θ Capacity 2 MT/Charge with siliminite brick lining & other accessories.	1 No.	2,25,000/-
8)	Laboratory testing equipment	L.S.	1,50,000/-
9)	Water pump & fittings	1 No.	50,000/-
	Total cost of m/c & equipment		7,10,000/-
	Cost of office equipment & working tables		1,00,000/-
	Pre-Operative expenses		50,000/-
			8,60,000/-

Total fixed capital : Rs.15,10,000/-
or Say :: Rs.15,00,000/-

Working Capital (PM)

i) Personnel

Sr. No.	Designation	No.	Salary(Rs.)	Total (Rs.)
1	Plant Manager	1	4000/-	4000/-
2	Supervisor	2	2000/-	4000/-
3	Skilled Labour	4	1500/-	6000/-
4	Unskilled labour	6	1000/-	6000/-
5	Clerk/Accountant	1	1250/-	1250/-
6	Peon/Watchman	1	1250/-	1250/-
	Total			22500/-
	Perquisites @ 15% of salaries			3375/-
				25875/-
		or Say ::	Rs.	25000/-

ii) Raw materials including packaging requirements per month

Sr.No.	Particulars	Qty	Rate/Unit	Value(Rs.)
1	Frit making raw materials	40 MT	Ave.4000/MT	1,60,000/-
2	Metallic oxide	5 MT	Ave.60000/MT	3,00,000/-
3	Ceramic raw	5 MT	Ave. 1000/MT	5,000/-
4	Packaging requirement Gunny bags & Boxes	Lumpsum		5,000/-
	Total cost of raw materials :			4,70,000/-

ii) Utilities (Per Month)

1)	Power 5000 KWH units @ Rs. 3.25/ unit			1,625/-
2)	Fuel (I.D.C) 25,000 H.S. @ Rs.6.00/lt			1,50,000/-
3)	Water (L.S)			3,000/-
	Total cost of utilities			1,54,625/-
		or say ::	Rs.	1,55,000/-

iv) Other contingent expenses (P.M)

a)	Repairs & maintenance	1,000/-
b)	Transportation	1,000/-
c)	Sales expenses	750/-
d)	Office expenses	750/-
e)	Postage & stationery	500/-
f)	Telephone	1,000/-
g)	Insurance	1,000/-
h)	Misc. expenditure	1,000/-
	Total	7,000/-

v)	Total recurring expenditure (P.M.)	Rs. 6,57,000/-
vi)	Total working capital (on 3 months basis)	Rs.19,71,000/-
	or Say :: Rs. 20.00 lakhs	

Total Capital Investment

i)	Fixed Capital	Rs.15,00,000/-
ii)	Working Capital	Rs.20,00,000/-
	Total	Rs.35,00,000/-

Financial Analysis

1.	Cost of production (per year)	80,00,000/-
2.	Depreciation on building @5%	22,500/-
3.	Depreciation on machinery & equipment @ 10%	33,500/-
4.	Depreciation on furnaces @ 20%	65,000/-
5.	Depreciation on Office equipment @20%	20,000/-
6.	Interest on total investment	
	@ 21% on working capital	4,20,000/-
	@ 17.5% for fixed capital	2,62,500/-
	Total cost of production	88,23,500/-

Turnover (Per Year)

Item	Qty	Rate (Rs)	Value (Rs)
Ceramic Glaze Frit	500 MT	11,000/MT	55,00,000/-
Ceramic Stain	50 MT	1,00,000/MT	50,00,000/-
			1,05,00,000/-
Net Profit per year (H_2-H_1)	or Say ::	Rs.16,76,500/- Rs.16.5 lakhs	

Net Profit Ratio

$$\frac{\text{Net Profit per year} \times 100}{\text{Turnover per year}} = \frac{16,50,000 \times 100}{1,05,000} = 15.7\%$$

Ratio of Return

$$\frac{\text{Net profit per year} \times 100}{\text{Total investment}} = \frac{16,50,000 \times 100}{35,00,000} = 47\%$$

Break-even Point (% of total production envisaged)

a)	Depreciation on Building	Rs. 22,500/-
b)	Depreciation on M/c & Equipment	Rs. 33,500/-
c)	Depreciation on office equipment	Rs. 20,000/-
d)	Interest on total investment	Rs. 6,82,500/-
e)	Insurance	Rs. 12,000/-
f)	40% of Salary & Wages	Rs. 10,000/-
g)	40% of other contingent expenses	Rs. 33,000/-
	Total fixed cost	Rs.8,14,100/-

B.E.P

$$\frac{8,14,000 \times 100}{8,14,000 + 16,50,000} = \frac{8,14,00,000}{24,64,000} = 33\%$$

Suppliers of Raw Materials

1. M/s. Associated Electro Ceramic
   B-104, IInd Cross Road
   Peenya Industrial Estate, Bangalore 560 056

2. M/s. Wolkem Pvt Ltd
   Mewar Industrial Area
   Post Box No. 21, Udaipur 303 001

3. M/s.ACE Chemicals Enterprises
   Vijay Industrial Estate
   Padra Road, Baroda

4. M/s. The Golden Chemicals Pvt Ltd
   Chromium House, SV Road, Dahisar
   Bombay 400 068

5. M/s. Ramik Rasayan Udyog
   Prabhav Nivas, Panchvati, Ellisbridge
   Ahmedabad

6. M/s. Rajendra Mineral Grinding Industries
   58, Subhash Market
   Beewar (Rajasthan)

Suppliers of Machinery & Equipment

1. M/s. Keshab Machinery Pvt Ltd
   Bose Park, Sukchar
   Dist. 24-Parganas (WB)

2. M/s. Benwalt India Ltd
   507 Kakad Chambers
   Dr. Annie Besant Road, Worli
   Mumbai 18

3. M/s. Ami Industries Pvt Ltd
   10 BT Road, Calcutta 700 056

4. M/s. Rational India Engg
   7/10 Horniman Circle
   Fort, Mumbai 1

5. M/s. DK Engg. Works
   8 Panchaantale Balgheria
   Calcutta 700 056

6. M/s. Shree Lokmanya Engg. Works
   20, Bharatkhand Cotton Mills Compound
   Near Amdupur Bus Stand, Naroda Road
   Ahmedabad

7. M/s. NM Ceramic Kilns
   P B No. 30
   B-8 Ram Balaram Apartment, Kalol
   Dist. Mehsana 382 721

8. M/s. Unifire
   16B Shakesphere Sarani
   Calcutta 700 007

9. M/s. Firegas & Kiln India Pvt Ltd
   156, Jodhpur Park
   Calcutta 700 068

10. M/s.Lloyds Engg. Company
    86/4 A-Surendra Nath Banerjee Road
    Calcutta 14

11. M/s. Durgapur Engg. Co. Ltd
    Box No.2385 GPO
    Calcutta 1

CERAMIC COLOURS

Introduction

The use of ceramic products has been on the increase in India. Owing to the change in lifestyles, increasing disposable income, higher growth of construction activity and liberal govt. policies demand for ceramic products such as tiles, crockery, sanitaryware has been increasing substantially. As a result, several new units are in the pipeline and the existing capacity to manufacture ceramic products would be doubled in the next 3-4 years. Correspondingly, the demand for ceramic colours would also increase in the future.

Ceramic colours or stains find wide applications for decorative purpose in glazed (wall & floor) tiles, sanitaryware and artware ceramics. These may be on-glaze, over-glaze or under-glaze colours depending upon the way it is applied to the type of surface.

Market Potential

The present demand for ceramic colours is about 1000 tonnes. The break down is:

Used sector	Demand (in tonnes)
Ceramic Tiles	800
Sanitaryware	115
Crockery	60
Other Sectors	25

Ferro Coatings and Colours Ltd., Calcutta is the only manufacturer of ceramic colours in the organised sector in India. Its maximum production has not exceeded 120 TPA during the last decade. There are few manufacturers in the unorganised sector also. But, their annual production is meager.

About 71% of the present demand is met through imports. The major imports are from Degussa of Germany, Blythe & Cooksons of UK and Colorobbia of Italy.

The proposed project is for 500 TPA of ceramic colours and frits with project capacity utilization of 70%, 80% and 90% in the 1st, 2nd and 3rd years respectively.

The average selling price of ceramic colour is taken to be Rs. 500 per kg. However, the actual price varies from Rs.200-600 depending upon the type of raw materials used.

The total project cost is estimated at Rs.2205 lakhs. Promoters equity would be Rs.138 lakhs and a working capital loan of Rs.56 lakhs would be required in the first year.

A total manpower of 88 persons are required which include skilled, semi-skilled and unskilled personnel. A total built-up area of 12,000 sq.m is required. The unit expected to be profitable from the very first year of its operation. A BEP of 26.14% is estimated.

The proposed project would not have any problem in getting raw materials as most of them are indigenously available in India. The availability of skilled/unskilled manpower, utilities also don not pose any problem as well. It is suggested that the project be set up in some centrally or state declared backward areas as several types of incentives and subsidies are available for the project in these locations.

NRI investments in India are being highly encouraged and NRI project proposals are given top priority by Central Govt. departments, State Governments, Financial Institutions, etc. Various incentives include remittances of interest/dividends, repatriation of capital, transfer of investments, EOU benefits, special subsidies on land, capital investment, liberal financial assistance terms. The foreign equity holding in projects being promoted in India has been increased to 51% by the Indian Govt. which would provide NRIs with greater control on the Indian company's operations.

There is an urgent need for building confidence in the users mind about the quality of the indigenously manufactured ceramic colours.

As far as technology requirements is concerned, it would be advisable to seek know-how from abroad for production of high- grade ceramic colours.

Manufacturing Process

The manufacturing process consists of dosing, mixing, washing, crushing, wet drying, final grinding and grading. The raw materials feed can be mixed to get a continuing gradation of colour from one end member to another. The critical factor would be adherence to quality standards.

Capacity	: 500 tonnes per annum (3 shifts/day, 300 working days).
Ex-factory Prices	: Rs. 5,00,000/- per tonne
Turnover	: Rs. 25.00 Crores (at 100% capacity)

Plant & Machinery

Name	No
Mixer	1
Grinder	1
Stirrer	-
Storing Tank	1
Dryer	1
Dryer	1
Packing Machine	1
Electric Motors, Water Tanks	

Utility:

Water : Potable water
Power : 50 KW

Project Cost :

		(Rs. in lakhs)
Land and site development (12,000 sq.m)		20.30
Building (1100 sq.m)		22.50
Plant & Machinery	:Imported	1388.50
	:Indigenous	211.50
Misc. Fixed Assets		132.00
Technical know-how fee		37.80
Indian Consultants fee		8.00
Preliminary Expenses		5.00
Pre-operative expenses		152.00
Provision for contingencies		197.76
Margin Money for working capital		30.37
Total		2205.73

Means of Financing

Equity Capital	
Promoters	Rs. 138.73 lakhs
Public	Rs. 611.00 lakhs
Term Loan	Rs.1456.00 lakhs
Working Capital Loan (1st year)	Rs. 56.00 lakhs

Profitability

	I year	III Year	VI Year
Capacity utilisation	70%	80%	90%
Sales realisation(Rs. in crores)	17.50	22.50	22.50
Cost of Sales (including fin. exp.) (Rs. in lakhs)	830.74	866.65	765.71
Profit before tax (Rs. in lakhs)	919.26	1383.35	1484.29

Manpower

Managers	1
Administrative Staff	3
Foreman	6
Secretarial	2
Clerks	6
Skilled Workers	10
Semi-skilled workers	20
Unskilled workers	35
Others	5
Total	88

Power	.. 200 H.P connected load
Breakeven Point	.. 26.14%
Debt : Equity	.. 2:1
Investment : Turnover	..1:1.020
PBT : Turnover	.. 61.48%
PBT : Investment	.. 62.72%

Locations:

The plant can be located at Morbi, Than, Wankaner, Kadi, Vagra, Jhagadia.

Raw Materials

Zirconium oxide, Zirconium carbonate, Zirconium oxychloride, Cobalt oxide/chloride/sulphate, Nickel oxide, Cerium oxide, Chrom oxide, cadmium carbonate, Barium carbonate, Borax, Antimony oxide, Lithium carbonate/oxide, Borax, etc.

Raw Material Suppliers

1. Allied Minerals & Chemicals
   Munda Khera Road, Khurja 203131
   UP. Ph. (05738) 23945

2. Paras Minerals & Alloys
   M-25 Kirtinagar
   New Delhi 110 015 Ph. 5434766

3. Screen-O-Graphic Arts & Ceramics
   11, Silk House, 2nd floor, 630, Girgaun Road
   Hamalwadi, Bombay 400 002

Machinery Suppliers

1. Saraswati Engineering
   Sarkarpara, PO Sheoraphuly, Dist. Hooghly
   West Bengal Ph. (033) 62-2767

2. Hindustan Engineering Company
   123/7/Gopallal Tagore Road, Banhoogly
   Calcutta 700 035 Ph. 52-3042, 2096, 4461,7140, Fax: (033) 523041

3. Keshab Machineries Pvt Ltd
   Base Park, PO Sakchar
   Dist. 24 Paraganas, WB Ph. 553-3472, 553-2320

EXISTING FRIT & GLAZE UNITS

1. Excel Frits & Colours Ltd
PO Joka 743 512
24, Parganas
Calcutta

2. Ambe Sneyd Oxides Ltd
805 & 806 Central Plaza
26, Sarat Boze Road
Calcutta 700 020

3. Nahar Colours & Coating P. Ltd
Plot No. G-1, 90-93 Udyog Vihar
Sukher, Udaipur 313 001

4. Bright Ceramics
8-A National Highway, Opp: Vishaldeep Mill
Lalpur, Morbi 363 642

5. Fine Ceracote Surfaces Pvt Ltd
454, Makarpura Indl. Estate, GIDC
Baroda 390 010

6. Unique Ceracote Industries
"Anand", Lilapur Road
Morbi 363 641

7. Krishna Ceracoats Industries
C1-B-233/4 GIDC
Pore Raman Gamdi
Baroda

8. Gibrator Ceramics Ltd
Baroda Padra Highway
Nr. Ceramicnagar, Padra 391 440
Dist. Baroda

9. Bhalla Chemical Works Pvt Ltd
Daulatabad Road
Gurgaon 122 001, Haryana

10. Bhanu Cerglaze Pvt Ltd
6-3-652 Kautilya, Somajiguda
Hyderabad 500 0482

11. Ferro Coatings & Colour Ltd
PO Joka 743 512
24 Praganas, West Bengal

12. Sahaj Cerchem (P) Ltd
47, Vijaynagar Colony (Old)
Agra 282 004

13. Auxiliaries & Chemicals Industries
66, Paik Para Row Row
Calcutta 700 037

14. Colour Chem Ltd
Ravindra Annexe,
194, Churchgate Reclamation
Mumbai 400 020

15. Enamelnagar Development Corpn. Ltd
P-22, Bondel Road
Calcutta 700 019

16. Mirachem Industries
111, Yogeshwar, 135/139, Kazi Sayed St.
Mumbai 400 003

17. Navrang Chemical Industries
Opp: Mittal Estate, Andheri-Kurla Road
Marol-Naka, Mumbai 400 059

18. Interchem
77, RR Layout, RS Puram
Coimbature 610 002

19. Kera Krome
G-27, Patel Nagar-III
Ghaziabad 201 011

20. Sakaso Ceracolours Pvt Ltd
1275, Road, 63A, Jubilee Hills
Hyderabad 500 033

TARIFF OF FRITS, FRITTED & RAW GLAZES

(Rate Per kg.)

Particulars	Fusion Range	Frit Dry	Powder glaze
A. FRITTED GLAZES			
Transparent Earthenware loadless glaze	950-1100 °C	24.00	26.00
Leadless & Zincless Opaque Glaze for Terracotte & Wall tiles	-do-	24.00	26.00
Leadless & Zincless Opaque Glaze for Terracotte & Wall tiles	-do-	25.00	27.00
Titanium Opacified Loadless glaze	1100-1150 °C	24.00	25.00
Stoneware Pipe Brown Glaze	900-1200 °C	-	24.00
Leadless transparent Overglass Flux	750-800 °C	100.00	105.00
General purpose Flux	-do-	125.00	-
Flux for Selonium Red	-do-	130.00	-
Flux for Cadmium Yellow	-do-	125.00	-
Flux for Pink	-do-	110.00	-
Flux for Iron Rod	-do-	110.00	-
Flux for Pink with Cd.stabilised	-do-	120.00	-
Flux for Blue	-do-	105.00	-
Flux for Black -do- 105.00 -			
B. RAW GLAZES			
Transparent Glaze for Stoneware	1180-1200	-	12.00
Brown Glaze for stoneware	1200-1260	-	15.00
Black Glaze for stoneware	1260-1300	-	30.00
Opaque white glaze for stoneware	1180-1200	-	16.00
Glaze for Processed Porcelain	1200-1300	-	15.00
Transparent Glaze for Porcelain	1200-1300	-	12.00
Transparent Glaze for Porcelain	1200-1300	-	8.00
H.T. Brown for Insulator	1280-1300	-	15.00
Green Glaze for Porcelain	1260-1300	-	15.00
Turquoise Blue Glaze for Porcelain	1260-1300	-	15.00
C. STAINS & OPACIFIERS (CERAMIC COLOURS)			
Zircon Opacifier (225 mesh)		-	40.00
Zircon Opacifier (350 mesh)		-	50.00
Lemon Yellow (Zr-Fr)		-	450.00
Peach Pink (Zr-Fe)		-	380.00
Turquoise (Zr-V)		-	340.00

Particulars	Fusion Range	Frit Dry	Powder glaze
D. BONDING FRIT			
200-300 Mesh	760-900 °C		80.00
-do-	-do-		65.00
-do-	-do-		70.00
-do-	-do-		50.00
-do-	-do-		36.00
-do-	-do-		45.00
			100.00
			40.00
			45.00
			60.00
			80.00
			70.00

Source: Enamelnagar Development Corporation Ltd., Calcutta, W. Bengal.

CONSUMING CERAMIC UNITS

A. GLAZED TILES

1. Madhusudan Industries Ltd,
9, GIDC Estate, Kadi 382 715,
Dist. Mehsana
Tel: 02769-2271,2329,2619,2638
Fax: 02769-3365

2. Somany Pilkington Ind.Ltd,
GIDC Estate, Kadi 382 715,
Dist. Mehsana
Tel: 3011,2153,2542

3. Siddharth Ceramic,
GIDC Estate, Kadi 382 715,
Dist. Mehsana

4. Bell Ceramics Ltd,
Panorama, 3rd floor, RC dutt Road,
Baroda 390 005
Tel: 323630,330214,329590

5. Decora Ceramics Pvt Ltd,
Orbit Centre, 2nd floor,
Moti Tanki Chowk,
Rajkot 360 001
Tel: 0281-45864,45867,49147

6. Diamond Regina Ceramics Ltd,
Survey No. 212, Irana Road,
Nr. Helious Pharmaceuticals,
Village Budasan, Kadi 382 715,
Dist. Mehsana
Tel: 3743

7. Ajanta Glaze Tiles,
Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87779(O), 30722(R)

8. Yera Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87744(O), 30328(R)

9. Fine Ceramic Pvt Ltd
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87713

10. Moherm Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 22202 (R)

11. Classic Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87776(O), 30942(R)

12. Surya Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87721 (O), 21299(R)

13. Amrut Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87734 (O), 31084(R)

14. Amarnath Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87717(O), 40977

15. Sunsil Ceramics Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87750 (O), 21221 (R)

16. Gangotri Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87774(O), 40351(R)

17. Divine Ceramic Pvt Ltd,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87725(O), 27447(R)

18. Evershine Ceramic Pvt Ltd,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87722(O), 87733(R)

19. Sunshine Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87745(O), 31002(R)

20. Lucky Ceramic Industries,
Village Dhuva363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 87780(O), 40179(R)

21. Apex Ceramic Industries,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 83701

22. Himat Glaze Tiles,
Village Dhuva 363 622, Ta. Wankaner,
Dist. Rajkot
Tel: 83719(O), 22665(R)

23. Opal Ceramic Industries,
Village Dhuva 363 622,
Ta. Wankaner,
Dist. Rajkot
Tel: 83712(O), 30260(R)

24. Astron Ceramics Industries,
8A National Highway,
Nr. Dariyalal Weigh Bridge,
Morbi 363 642, Dist. Rajkot
Tel: 3364,2518, 3316

25. Devson Ceramics Pvt Ltd,
Survey No.250, Plot No.2/7,
Shapar 360 002, Dist. Rajkot
Tel: 47559

26. Bharat Ceramics,
C1-28, GIDC Estate, Kabilpole,
Navsari 396 424, Dist. Valsad

27. Royal Ceramics Pvt Ltd,
5/6 GIDC Estate, Wankaner 363 621,
Dist. Rajkot
Tel: 3783,2474

28. Swam Ceramics Pvt Ltd,
23-27 GIDC Estate, Wankaner 363 621,
Dist. Rajkot

29. Kiran Tiles,
Navagam Road, Thangadh 363 530,
Dist. Surendranagar
Tel: 02751-20833(O), 20650(R)

30. Koras Tiles,
Tarnetar Road, Thangadh 363 530,
Dist. Surendranagar
Tel: 02751-20911(O), 20565(R)

31. Zalawad Tiles Works,
Tarnetar Road, Thangadh 363 530,
Dist. Surendranagar
Tel: 20434(O), 20351(R)

32. Bhavani Ceramics,
Amrapur Road, Thangadh 363 530,
Dist. Surendranagar
Tel: 02751-20337(O), 20156(R)

33. Ankur Tiales Pvt Ltd,
B\h Witco Pottery Works,
Thangadh 363 530,
Dist. Surendranagar

34. Deep Ceramic Industries,
Amrapar Road,
Thangadh 363 530,
Dist. Surendranagar

35. Akar Cera Tiles Pvt Ltd,
Plot No.3106, Phase III,
GIDC Chhatral 382 729,
Ta. Kalol, Dist. Mehsana

36. Italia Ceramic Pvt Ltd,
Plot No.23/D, GIDC Estate,
Kadi 382 715,
Dist. Mehsana

37. Jeevandeep Ceramics,
Tarnetar Road,
Thangadh 363 530,
Dist. Surendranagar

38. Keda Cera Industries,
Near Sadappura Bus Stop,
Himatnagar Highway,
Idar, Dist. Sabarkantha 383 430

39. Lamina Ceramic Pvt Ltd,
Plot No.1069, Chhatral 382 729,
Kadi Road, Dist. Mehsana

40. Marval Ceramic Industries,
Gondal Highway, Veraval Shapar,
Dist. Rajkot 360 002

41. Narayan Pottery Works,
Naroda Road, Saijpur Bogha,
Ahmedabad 380 025

42. National Elegance Ceramic,
Opp: Railway Station, Limbdi,
Dist. Surendranagar

43. Uneed Ceramic Pvt Ltd,
Tamir Plaza, Johapura, Sarkej Road,
Ahmedabad

44. Ravi Tiles Pvt Ltd,
Near Vaaval Patiya, Shapar 360 002,
Dist. Rajkot

45. Varsha Ceramic Industries,
Ghuny Road, Morbi,
Dist. Rajkot 363 642

46. Sigma Ceramic Industries,
Mahendranagar, Morbi,
Dist. Rajkot 363 642
Tel: 40152(O), 20153(R)

47. Kaliyan Glaze Tiles,
Jasmneliya, Ta. Morbi,
Dist. Rajkot
Tel: 40974(O), 30524(R)

48. Sunglass Ceramic Industries,
8A National Highway, Lalpur,
Morbi 363 642, Dist. Rajkot
Tel: 40040

49. Ambuja Cement Pvt Ltd,
Near Custom Check Post,
Bhachau,
Dist. Kutch

50. Alpa Ceramic,
B/h Suyog Farm, Chem, Vadavan Zin,
National Highway, Himatnagar,
Dist. Sabarkantha 383 001

51. Advance Ceramics,
B\h Suyog Farm Chem, VadavanZin,
National Highway, Himatnagar,
Dist. Sabarkantha 383 001

52. Alpine Ceramic Industries Ltd,
Plot No. 100/102 GIDC Estate
Ankleshwar Rajpipla Road,
Dist. Bharuch

53. Amul Ceramics,
Old Rafaleshwar Road, Morbi Bhadiyad,
Dist. Rajkot

54. Caroma Ceramics,
C1/305 GIDC, Pandesara,
Dist. Surat.

55. Diamond Tiles Ltd,
Orbit, 3rd floor, Moti Tanki Chowk,
Rajkot 360 001

56. Jay Ambe Ceramics,
Opp: Railway Station, Limbdi,
Dist. Surendranagar

57. Royal Ceramics Pvt Ltd,
Sanala Road, Morbi 363 641,
Dist. Rajkot

58. Solar Ceramics,
Plot No.610, Phase IV, GIDC Estate,
Naroda, Ahmedabad 382 330

59. Patidar Ceramics Pvt Ltd,
Survey No.262, Village Shapar,
Ta. Kotda Sangani, Dist. Rajkot

60. Marvel Ceramics,
Village Veraval Shapar,
Ta. Kotda Sangani, Dist. Rajkot

61. Oxford Ceramic Pvt Ltd,
Village Shapar, Ta. Kotda Sangani,
Dist. Rajkot

62. Golden Ceramic Pvt Ltd,
Village Shapar, Ta. Kotda Sangani,
Dist. Rajkot

63. Gayatri Ceramic Pvt Ltd,
246/7 GIDC Estate, Waghodia,
Dist. Baroda

64. Amul Ceramics,
Old Rafaleshwar Road, Near Amul Pottery,
At Bhadiyal, Ta. Morbi, Dist. Rajkot

65. Paras Ceramic Pvt Ltd,
8A National Highway, Lalpar,
Morbi 363 642, Dist. Rajkot
Tel: 40751(O), 30006(R)

66. Aakash Ceramic Pvt Ltd,
8A National Highway, Lalpar,
Morbi 363 642, Dist. Rajkot
Tel: 40688(O), 21462(R)

67. Deco Ceramics,
Mahendranagar, Morbi,
Dist. Rajkot 363 642
Tel: 40560(O), 20345(R)

68. Citizen Ceramic Industries,
Amreli Road, Morbi,
Dist. Rajkot 363 642
Tel: 24685(O), 31313)R)

69. Sonsil Ceramics Pvt Ltd,
C/o Morbi Roadways, 7 Lalitplot,
Morbi, Dist. Rajkot
Tel: 22317(O), 22717(R)

70. Jyoti Industries,
8A National Highway, Lalpar,
Morbi 363 642, Dist. Rajkot
Tel: 40703(O), 21066(R)

71. Everest Cera Tiles Pvt Ltd,
8A National Highway, Lalpar,
Morbi 363 642, Dist. Rajkot
Tel: 40225(O), 30813(R)

B. SANITARY WARE

1. Krishna Industries,
Station Road, Opp: Pathikashram,
Thangadh 363 530
Tel: (02751)20413(O), 20813(R)

2. Kailash Pottery Works,
Chotila Road,
Thangadh 363 530
Tel: 20280(O), 20580(R)

3. Kandorana Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20369(O), 20669(R)

4. Kotechar Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20389(O), 20323(R)

5. Kartik Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20478(O), 20784(R)

6. Ketan Pottery Works,
Navagam Road,
Thangadh 363 530
Tel: 20837(O), 20441(R)

7. Koras Tiles,
Tarnetar Road,
Thangadh 363 530
Tel: 20911(O), 20565(R)

8. Kalpana Refractories,
Tarnetar Road,
Thangadh 363 530
Tel: 20641

9. Kartik Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20057

10. Gokul Ceramics Industries,
Amrapar Road,
Thangadh 363 530
Tel: 20031

11. Globe Pottery,
Tarnetar Road,
Thangadh 363 530
Tel: 20260(O), 20427(R)

12. Gajendra Tiles works,
Tarnetar Road,
Thangadh 363 530
Tel: 20367(O), 20735(R)

13. Choice Ceramics Pvt Ltd,
Opp:Dholeshwar,
Thangadh 363 530
Tel: 20046(O), 20727(R)

14. Chamunda Vijay Pottery,
Tarnetar Road,
Thangadh 363 530
Tel: 20251(), 20715(R)

15. Zalawad Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20336(O), 20526(R)

16. Jay Refractories,
Chotila Road,
Thangadh 363 530
Tel: 20171(O), 20266(R)

17. Jagdamba Vijay Carborandum Works,
Opp: Railway Station,
Thangadh 363 530
Tel: 20402(O), 20204(R)

18. Jivandeep Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20056(O), 20755(R)

19. Jagdish Ceramic Industries,
Dholashwar,
Thangadh 363 530
Tel: 20638(O), 20238(R)

20. Tirupati Ceramics,
Vagadia Road,
Thangadh 363 530
Tel: 20834(O), 20174(R)

21. Than Pottery Works,
Tarnetar Road,
Thangadh 363 530
Tel: 20500(O), 20001(R)

22. Than Ceramic Industries,
GIDC Estate,
Thangadh 363 530
Tel: 20508(O), 20808(R)

23. Deep Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20628(O), 20827(R)

24. Dodhiwala Ceramic Works,
GIDC Estate,
Thangadh 363 530
Tel: 20292(O), 20342(R)

25. Dergirja Pottery Pvt Ltd,
Vagodia Road,
Thangadh 363 530
Tel: 20306(O), 20906(R)

26. Divya Ceramic,
Tarnetar Road,
Thangadh 363 530
Tel: 20552(O), 20652(R)

27. Deepak Ceramics,
Vagodia Road,
Thangadh 363 530
Tel: 20862

28. Deel Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20971(O), 20671(R)

29. Dhiren Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20041(O), 20841(R)

30. Dharmendra Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20368(O), 20382(R)

31. Narendra Enterprises,
GIDC Estate,
Thangadh 363 530
Tel: 20090(R)

32. Nilkanth Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20348(O)

33. Nilesh Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20560(O), 20660(R)

34. Navrang Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20774(O), 20776(R)

35. Narendra Chemicals,
Tarnetar Road,
Thangadh 363 530
Tel: 20814(O), 20714(R)

36. Newlight Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20948(O), 20148(R)

37. Pratik Ceramics,
Near FCI Godown,
Thangadh 363 530
Tel: 20691(O), 20751(R)

38. Pragati Ceramics,
Near FCI Godown,
Thangadh 363 530
Tel: 20456(O), 20345(R)

39. Panchali Ceramics,
Chotila Road,
Thangadh 363 530
Tel: 20151(O), 20152(R)

40. Poonam Pottery Works,
Tarnetar Road,
Thangadh 363 530
Tel: 20296(O)

41. Pioneer Ceramics,
GIDC Estate,
Thangadh 363 530
Tel: 20354(O), 20520(R)

42. Prajapati Refractories,
Near Railway Crossing,
Thangadh 363 530
Tel: 20361(O)

43. Prakash Pottery,
Jawhar Society,
Thangadh 363 530
Tel: 20385(O)

44. Parmar Ceramics,
Dholeshwar,
Thangadh 363 530
Tel: 20440(O), 20640(R)

45. Premier Refractories,
Vasuki Plot,
Thangadh 363 530
Tel: 20465(O)

46. Parimal Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20471(O)

47. Parmeshwar Pottery Works,
Opp: Railway Station,
Thangadh 363 530
Tel: 20343(O), 20783(R)

48. Prem Refractories,
Near Railway Crossing,
Thangadh 363 530
Tel: 20514(O)

49. Pankaj Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20709(O), 20320(R)

50. Prakash Ceramics,
Vagadia Road,
Thangadh 363 530
Tel: 20856(O), 20359(R)

51. Yash Ceramics,
GIDC Estate,
Thangadh 363 530
Tel: 20006(O)

52. Bajrang Ceramics Industries,
Sarvoday Society,
Thangadh 363 530
Tel: 20702(O), 20322(R)

53. Bhawani Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20337(O), 20156(R)

54. Miral Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20651(O), 20051(R)

55. Maruti Ceramics,
Sarvoday Society,
Thangadh 363 530
Tel: 20101(O), 20322(R)

56. Mamaiya Pottery Works,
Tarnetar Road,
Thangadh 363 530
Tel: 20224(O)

57. Mayur Ceramic Works,
GIDC Estate,
Thangadh 363 530
Tel: 20303(O), 20429(R)

58. Mahakali Ceramic Works,
Vagadia Road,
Thangadh 363 530
Tel: 20815(O), 20816(R)

59. Modern Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20976(O)

60. Yogiraj Pottery Works,
Tarnetar Road,
Thangadh 363 530
Tel: 20363(O), 20063(R)

61. Reliance Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20111(O)

62. Ravi Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20140(O)

63. Raj Ceramics,
Near Bus Station,
Thangadh 363 530
Tel: 20581(O), 20502(R)

64. Ratnadeep Ceramics,
Ambika Society,
Thangadh 363 530
Tel: 20524(O), 20724(R)

65. Ruby Chemicals,
Amrapar Road,
Thangadh 363 530
Tel: 20483(O)

66. Ranuja Pottery,
Tarnetar Road,
Thangadh 363 530
Tel: 20659(O), 20540(R)

67. Rajdeep Ceramic Industries,
Opp: Bus Stand,
Thangadh 363 530
Tel: 20817(O)

68. Lakhtar Ceramic Industries,
Tarnetar Road,
Thangadh 363 530
Tel: 20179(O), 20779(R)

69. Laxmi Pottery,
Vagadia Road,
Thangadh 363 530
Tel: 20331(O)

70. Lakhtaria Refractories,
Chotila Road,
Thangadh 363 530
Tel: 20616(O)

71. Vimal Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20260(O), 20352/20423(R)

72. Witco Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20529(O)

73. Vasudev Refractories,
Sarvoday Society,
Thangadh 363 530
Tel: 20650(R)

74. Vikas Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20675(O), 20515(R)

75. VB Naramiya & Co.,
Station Road,
Thangadh 363 530
Tel: 20825(O), 20725(R)

76. Swata Pottery Works,
Amrapar Road,
Thangadh 363 530
Tel: 20541(O), 20148(R)

77. Silver Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20160(O)

78. Sunrise Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20194(O), 20192(R)

79. Sompura Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20291(O), 20401(R)

80. Sakariya Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20365(O)

81. Sigma Ceramics,
Chotila Road,
Thangadh 363 530
Tel: 20364(O), 20788(R)

82. Siddharth Ceramics,
Amrapar Road,
Thangadh 363 530
Tel: 20545(O), 20537(R)

83. Somnath Vijay Ceramics,
Chotila Road,
Thangadh 363 530
Tel: 20542(O), 20619(R)

84. Sanjay Ceramic Works,
Navagam Road,
Thangadh 363 530
Tel: 26615(O), 20715(R)

85. Sandeep Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20654(O), 20423(R)

86. Sagar Ceramic Industries,
Amrapar Road,
Thangadh 363 530
Tel: 20802(O), 20801(R)

87. Shah Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20384(O), 20487(R)

88. Shivshakti Calcine,
Tarnetar Road,
Thangadh 363 530
Tel: 20425(O), 20826(R)

89. Shital Pottery Works,
Amrapar Road,
Thangadh 363 530
Tel: 20442(O), 20728(R)

90. Hemang Pottery,
Chotila Road,
Thangadh 363 530
Tel: 20418(O), 20815(R)

91. Haresh Pottery,
Tarnetar Road,
Thangadh 363 530
Tel: 20504(O)

92. Shreeram Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20317(O), 20316(R)

93. Arjun Ceramics,
Vagadia Road,
Thangadh 363 530
Tel: 20002(O), 20451(R)

94. Amrut Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20025(O), 20035(R)

95. Ansuya Ceramics,
Amrapar Road,
Thangadh 363530
Tel: 20209(O)

96. Anand Ceramic Industries,
GIDC Estate,
Thangadh 363 530
Tel: 20234(O), 20039(R)

97. Ashok Ceramics,
Tarnetar Road,
Thangadh 363 530
Tel: 20987(O)

98. Alankar Ceramics,
Vagadia Road,
Thangadh 363 530
Tel: 20405(O), 20707(R)

Sr. No.	Name and address of the unit	Phone No.	Product
15.	Bhagvat Ceramics, National Highway 8, Himatnagar 383 001, Dist. Sabarkantha	22356	Cup saucer
16.	Bharat Ceramics, National Highway 8, Himatnagar-383 001, Dist. Sabarkantha	22449	Cup saucer
17.	Bhavani Ceramics, Motipura, Himatnagar 383 001, Dist. Sabarkantha		Cup saucer
18.	Daylight Ceramics Gujarat Pvt Ltd, Aji Industrial Estate, Nr. Power House Road, Rajkot 360 003	Tlx:016-286	Crockery
19.	Deepak Ceramic Works, GIDC Estate 132/134, Kalol 382 725, Dist. Mehsana	2780	Cup saucer
20.	Delux Ceramic Decorative Industry, Ambawadi Udyognagar, Wadhwan City 363 030, Dist. Surendranagar	20194 22685	Crockery
21.	Dev Ceramic Industry, Opp: Electric Sub-Station, Wankaner 363 622, Dist. Rajkot		Crockery
22.	Dipali Ceramics, 412, GIDC Estate, Phase IV, Naroda, Ahmedabad 382 330	2822916 2825554	Cup saucer
23.	Divya Ceramics, Tarnetar Road, Amrapa, Thangadh 363 530, Dist. Surendranagar		Cup & saucer
24.	Eagle Ceramic Industries, C1-226, GIDC Estate No.2, Dolatpura, Junagadh 364 465	22068 20363	Crockery
25.	Friends Ceramics, Opp: Pathik Ashram, PB No.5, Thangadh 363 530, Dist. Surendranagar		Crockery
26.	Gajanand Ceramics, National Highway, Himatnagar 383 001, Dist. Sabarkantha		Cup & saucer
27.	Ganesh Ceramics, National Highway, Motipura, Himatnagar, Dist. Sabarkantha		Cup & saucer
28.	Gayatri Ceramic Decorators, 1216/33, GIDC Estate, Phase IV, Naroda, Ahmedabad	2811729	Crockery

C. CROCKERY

Sr. No.	Name and address of the unit	Phone No.	Product
1.	Roopal Ceramics, GIDC Estate, Wadhwan City 363 030, Dist.Surendranagar	20194	Crockery
2.	International Ceramics, GIDC Estate, Wadhwan City 363 030, Dist. Surendranagar	20956	Crockery
3.	Roopal Porcelain Industry, GIDC Estate, Wadhwan City 363 030, Dist. Surendranagar	21736	Crockery
4.	Gohil Pottery, High Road, Wadhwan City 363 030, Dist. Surendranagar	22827	Crockery
5.	Bhagyodaya Ceramics Industry, GIDC Estate, Wadhwan City, Dist. Surendranagar	24892	Crockery
6.	Mukesh Pottery works, GIDC Estate, Wadhwan City 363 030, Dist. Surendranagar	20788	Crockery
7.	Bharat Ceramics Industry, Nr. Old Rly.Station, Wadhwan City 363 030, Dist. Surendranagar	21790	Crockery
8.	Abdulkadar Abdulrahim, Kazi Tekra, Thangadh 363 530, Dist. Surendranagar		Crockery
9.	Ambica Ceramic Industries, 11/12, GIDC Estate, Naroda, Ahmedabad 382 330	2823315	Fine crockery
10.	Ambica Porcelain works, 910-A, GIDC Estate Phase IV, Naroda, ahmedabad 382 330	2824566	Cup saucers
11.	Ami Ceramics, Nr. GIDC Estate, Idar 383 430, Dist. Sabarkantha	180	Cup saucer Crockery
12.	Ashok Ceramics, 35 GIDC Estate, Motipura, Himatnagar 383 001, Dist.Sabarkantha		Cup saucer
13.	Ashok Pottery Works, Nr. MEMCO, Naroda Road, Ahmedabad 380 025	370130	Crockery
14.	Avon Ceramics & Insulators Pvt Ltd, Motipura, N.H. 8, Himatnagar 383 001, Dist. Sabarkantha	221088 221087	Cup saucer

Sr. No.	Name and address of the unit	Phone No.	Product
43.	Morbi Ceramics, Kankarol, Himatnagar 383 015, Dist. Sabarkantha		Cup & saucer
44.	Muliya Brothers, Tanetar Road, Thangadh 363 530, Dist.Surendranagar		Crockery
45.	Natraj Ceramic Industries, 296, Naroda GIDC Estate, B\h Calama Pump, Naroda, Ahmedabad 382 330	2811229	Cup & saucer
46.	Nadtraj Ceramics, Phase I GIDC Estate, Naroda, Ahmedabad 382 330		Cup & saucer
47.	Navdeep Ceramics, 42 GIDC Estate Phase I, Naroda, Ahmedabad 382 330	2810180	Cup & saucer
48.	Oswal Industries, Amrapar, Thangadh 363 530, Dist.Surendranagar		Crockery
49.	Paradise Pottery Works, Tarnetar Road, Thangadh 363 530, Dist.Surendranagar		Cup & saucer
50.	Paramshakti Ceramic Industry, B/h Kubeshwar Mahadev, Saijpur Bogha, Ahmedabad 380 025	370041	Crockery
51.	Parijat Enterprises, Ambawadi Udyognagar, Wadhwan City 363 030, Dist.Surendranagar	20194 22585	Crockery
52.	Parimal Ceramic Industry, Tarnetar Road, Thangadh 363 530, Dist.Surendranagar		Cup & saucer
53.	Perfect Ceramics, Decorations Industry, K1-65 GIDC Estate, Himatnagar 383 001, Dist. Sabarkantha		Cup & saucer
54.	Pioneer Pottery Works, Opp. Railway Station, Chotila 363 520, Dist. Surendranagar		Cup & saucer
55.	Prabhat Pottery Works, Nr. Memco, Naroda Road, Ahmedabad 380 025	371337	Crockery
56.	Pragati Ceramics, Tarnetar Road, Thangadh 363 530, Dist. Surendranagar		Crockery

Sr. No.	Name and address of the unit	Phone No.	Product
57.	Rajdeep Ceramic Industry, Post ONGC Colony, Vijapur Road, Mehsana 384 002	21582	Cup & saucer
58.	Rajkamal Pottery Works, B/h Kubeshwar Mahadev, Saijpur Bogha, Naroda Road, Ahmedabad 380 025	374085	Crockery
59.	Roopa Ceramic, 18, GIDC Estate Phase 3, Naroda, Ahmedabad 382 330	2813509 7476463	Cup & saucer
60.	Sabarkantha Ceramics, National Highway, Himatnagar 383 001, Dist. Sabarkantha		Cup & saucer
61.	Sahkar Pottery Works, 163 GIDC Estate Phase 1, Naroda, Ahmedabad 382 330	2813266	Cup & saucer
62.	Saraswati Ceramics, 373, Ambawadi, GD High School Road, Saijpur Bogha, Naroda Road, Ahmedabad 380 025	370130	Crockery
63.	Sarvoday Pottery Co-op.Society Ltd, Pilvai 382 850, Ta. Vijapur, Dist. Mehsana	353	Cup & saucer
64.	Shah Ceramics, Tarnetar Road, Thangadh 363 530, Dist. Surendranagar		Crockery
65.	Shakti Ceramic Industry, Opp: GEB Sub-Station, Kadi Road, Chhatral 382 729, Dist. Mehsana	2255	Cup & saucer
66.	Shiv Ceamics, Plot No. 414 Phase IV, GIDC Estate, Naroda, Ahmedabad 382 330	2813395	Cup & saucer
67.	Shivshakti Ceramics, GIDC Estate, Motipura, Himatnagar 383 001, Dist. Sabarkantha	1674	Crockery
68.	Shivshakti Ceramic Industry, Plot No.610/611, Phase IV, GIDC Estate, Naroda, Ahmedabad 382 330	2810475	Cup & saucer
69.	Shree Gopinath Refractories, Plot No.299, GIDC Estate, Phase I, Naroda, Ahmedabad 382 330	2812013	Cup & saucer
70.	Shree Narayan Pottery Works, Saijpur Bogha, Naroda Road, Ahmedabad 382 025	372527 370037	Crockery

Sr. No.	Name and address of the unit	Phone No.	Product
71.	Shree Nilkanth Ceramic Works, Saijpur Bogha, New GD High School, Naroda Road, Ahmedabad 382 025	334543	Crockery
72.	Shri Shakti Vijay Pottery Works, Opp: Kalyan Mills, New Memco, Saijpur Bogha, Ahmedabad 380 025	372536	Crockery
73.	Shreeji Ceramics, 171 GIDC Estate, Naroda, Ahmedabad 382 330	2811332	Cup & saucer
74.	Shree Laxmi Pottery Works, Opp: New Pordars Chawl, Saijpur Bogha, Naroda Road, Ahmedabad 382 025	373019 371529	Cup & saucer
75.	Sona Ceramics, Plot No.198, Phase II, GIDC Estate Naroda, Opp: Indian Gum Industries, Ahmedabad 382 330	2813039	Cup & saucer
76.	Standard Ceramics, Plot No.109/110 GIDC Estate, Nr. Arts & Commerce College, Dehgam 382 305, Dist. Ahmedabad		Cup & saucer Crockery
77.	Sumitra Ceramic Industries, National Highway No.8, Himatnagar 383 001, Dist. Sabarkantha		Cup & saucer
78.	Sun Electrical Components, C1B/3702 GIDC Estate, Sachin 394 230, Dist. Surat		Cup & saucer
79.	Swan Ceramics, Plot No. 51, GIDC Estate, Phase III Naroda, Ahmedabad 382 330	281392	Cup & saucer
80.	Swastic Ceramics, Plot No.16, New GIDC Estate, Phase III Naroda, Ahmedabad 382 330	2813501	Cup & saucer
81.	Uma Ceramic Industries, Idar 383 430, Dist. Sabarkantha		Cup & saucer
82.	Vahari Ceramic Industry, B/h Rly. Station, Vijapur 382 870, Dist. Mehsana		Cup & saucer
83.	Varia Ceramic Company, National Highway, Hasanpur, Wankaner 363 622, Dist. Rajkot	240	Cup & saucer
84.	Vijay Ceramics, National Highway Road, Himatnagar 383 001, Dist. Sabarkantha		Cup & saucer
85.	Yogeshwar Ceramics, Opp: Sahakari Jin, National Highway, Himatnagar 383 001, Dist. Sabarkantha	22449	Cup & saucer