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REFRACTORIES IN EGYPT [1]

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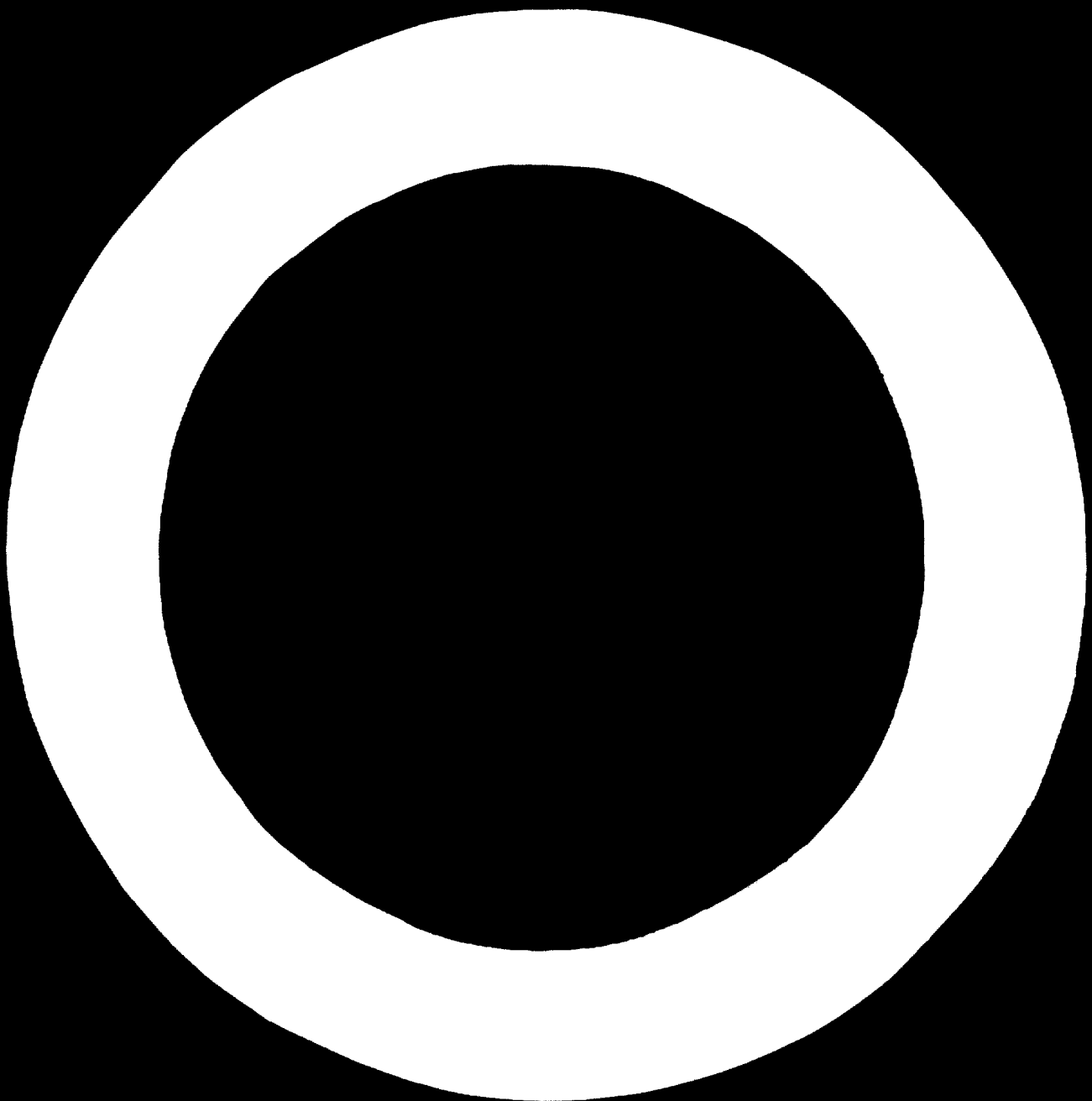


(1) INTRODUCTION

Refractories are that materials which can withstand high temperature without melting. The refractories are available as bricks, pieces of special shapes, mortars, pipes and crucibles.

The refractories are used in different industries such as lining of the furnaces of iron and steel and other metallurgical industries, foundaries, cement, glass, ceramics, and chemical industries and also for boilers.

The industry of refractories in Egypt started from about 60 years ago in SORNAGA factories, 70 kms. at the south of Cairo, these factories are now called EL-NASR Company for refractories and ceramics ex. Sornaga, and belongs to the Government. This industry began by producing fire clays and low aluminus refractories by using local raw materials, and it was progressed afterwards. Now there are two governmental companies, in addition to some private factories :-

1) EL-NASR Company for refractories and ceramis ex. Sornaga
2) The Egyptian Company for refractories. They together produce about 70000 tons of different kinds of refractories per year in addition with some other kinds of products

2) Scope of production :

The Egyptian companies produce the following kinds :-

A) Acidid refractories
B) Neutral "
C) Basic "
D) Insulating "

E) Red bricks and facing bricks

F) Anti-acid blue vitrified bricks

G) Salt glazed pipes

H) Ceramic floor and wall tiles

I) Sanitary ware

J) Decorative ceramic articles

K) Insulators

In this report I shall only discuss the refractories i.e. the products mentioned in items A, B, C and D.

A) **Acidic refractories** :

They include silica, fire clay and zircon refractories

A.1) **Silica refractories**: In this kind of refractories the si O_2 do not less than 92%, and can be subdivided into:-

1- Ordinary silica refractories in which the si O_2 is from 92% to 95% and $Al_2 O_3$ plus $T_i O_2$ plus the other alkalines do not exceed 2.5 %

2- Special silica refractories in which the sb O_2 do not less than 95% and the $Al_2 O_3$ plus $T_i O_2$ plus the other alkalines do not exceed 1%

3- Semi silica refractories in which the si O_2 is not less than 78% but the $Al_2 O_3$ ranges between 8% and 22%

A.2) **Fire clay refractories**: They are the most usable kind of refractories (about 70% of the consumption of all kinds of refractories).

The essential component of this kind of refractories is the aluminium silicates. The percentage of Al_2O_3 do not less than 22% and they can be subdivided into :-

1- Silicates fire clay refractories which contain from 22% to 29% Al_2O_3

2- Ordinary fire clay refractories which contain from 30% to 38% Al_2O_3

3- Special fire clay refractories which contain from 39% to 45% Al_2O_3

B) Neutral refractories :

They include aluminus, chromite and carbon refractories .

B.1) Aluminus refractories: They contain more than 45% Al_2O_3 and they can be used instead of basic refractories in some cases such as the reaction zone in clinker furnaces

B.2) Chromite refractories: In which the Cr_2O_3 must not be less than 40%

C) Basic refractories: They can be divided into :-

C.1) Magnesite refractories: In which the MgO do not less than 80%

C.2) Magnesite chrome refractories: In which the MgO do not less than 60%

C.3) Chrome magnesite refractories: In which the MgO do not less than 25%

C.4) Dolomite refractories: In which the MgO do not less than 30%

D) Insulating refractories: They represent an important section in refractories. The efficiency of running on the kilns in many cases depends on their heat insulation for preventing heat loss by radiation. There are many kinds of insulating refractories such as :-

D.1) Fire clay insulating refractories

D.2) Diatomite insulating refractories

D.3) Vermiculite insulating refractories

D.4) Silica insulating refractories

The insulating refractories are produced by adding some burnable materials to the body composition to be burnt during the firing and thus leaving air gaps which make the insulation.

The specification of refractories produced by EL-NASR Company for refractories and ceramics Ex. SOHNAGA, are shown in Annex A.

3) Raw materials used in refractories industry in Sornaga Factories

a) For aluminus products

The main raw materials are :-

- Fire clays: Such as Aswan clays, Malkata and Beledu clays, these raw materials are presented in Aswan area in big quantities
- Kaolin : We have in Sina a high quality kind of kaolin, but after the delivary of this kaolin was stopped after the 67 Middle East War, our geological men found another source of kaolin in Kalubsha near Aswan.

- **Bauxite** : There is no bauxite in Egypt, so it is imported from Britsh Guiana

b) **For silica products:**

- Quartizite
- Quick lime (unslaked)
- Iron oxide mineroliser
- Mollasse

All these raw materials are supplied locally

c) **For magnesite and other basic and neutral refractories:**

- **Magnesite:** It is imported either from CSSR or from North Korea.
- **Chrome ore:** It is delivered locally .
- Mollasse (locally)
- Commercial sulphuric acid (locally)

The percentages of the raw materials in the different kinds of refractories are considered as a secret of industry and I am not allowed to mention them.

The specification of these raw materials are shown in (Annex B).

4.A) **Manufacture Process of low alumina products:**

These kinds of products are produced in the old plant by the plastic method, and it is done as follows :-

1- The raw materials are stored in opened unroofed suitable stores, some of these raw materials are dressed by washing.

2- The raw materials used in every kind of these products according to their percentages in the body composition are weight and then put together in a four wheels rail car and then transported to the preparation section.

3- The raw materials are then ground in edge runner mills, the grain size is controlled by viberating screens which pass the fine sizes, and retain the coarse sizes back to the mills.

4- The ground materials are then stored in suitable stores, and the required batch is taken to the double shaft mixer to mix it with water and then passed to the pug mill for complete mixing and roughly shaping.

5- The pressing is done by one of the following methods :

a. For standard bricks, there are some units, each unit consists of an edge runner mill, mixer and a mechanical rotary table press coupled with each other. This type of presses inspite it is an old type, but it has some advantages such as a relatively high productivity capacity (1000 pieces per hour i.e. about 4 tons per hour), very easy and simple for maintenance and all its spare parts are manufactured in our workshops without the need of importation .

b. For some big sizes or special shapes, the roughly shaped pieces are taken from the pug mill to mechanical friction presses for pressing and final shaping

c. The big sizes and the special shapes which cannot be made by presses, are pressed by hand moulding. Also hand moulding is used for pressing the pieces which do not need high pressing force or high cold crushing strength, and also when the number of pieces required from a certain shape is low to a degree that it will be expensive to make a mould for it for pressing by presses.

6- After pressing, the pressed pieces are transported to the halls of drying. The drying is done naturally. The time of drying takes from 15 days to 30 days according to the degree of temperature, the atmospheric conditions and the kind of products.

7- After drying the dry products are transported to the firing section. In the old plant we have several types of kilns such as down draft kilns, Hofman kilns, muffle kilns, up draft bottle kilns and electrical kilns. Only the first two types of kilns are used for firing the refractories. These kilns are batch type kilns and they use heavy oil (mazout) as a fuel .

8- After the firing cycle is finished , the products are sorted and the first class products are stored in the products stores and the other classes of products are used as a grog and are transported to the mills.

4.B) **Manufacture process of high alumina products up to 62% alumina**

These kinds of products are produced in the new unit by using the dry method, and it is done as follows :-

1- Each type of raw material is stored after washing if necessary in an individual and suitable store. The raw materials are brought to the factory by lorries and a mobile belt conveyor is used for piling up.

2- The raw materials are trasnported to the mass preparation section by bucket trucks then to the jaw crusher via the belt conveyor. The material is then taken by another belt conveyer to the edge runner mill with perforated bottom. The gound material is then taken by a vertical bucket elevator to the vibrating screen which retains the coarse sizes back to the mill to be remilled, and passes the fine sizes to a horizontal belt conveyor below the vibrating screen. The screen can be changed according to the grain size wanted. The horizontal belt conveyor takes the fine ground material to the corresponding silo. There is one silo or more for each grain size of each raw material.

3- In the floor under the silos there is an automatic weighing machine on rails which is used for taking the constituents of the batch by weight from the corresponding silos using the segment closures.

4- The whole mass is shuted by gravity via belt conveyor to the edge runner mixer. Water is then added so that the mixture will have a moisture percentage of about 6% in case of pressing by presses or about 8% in case of hand moulding. After the mixture is throughly mixed, it is taken to the presses or to the area of manual moulding.

5- The pressing is done by using the following presses :-

a) Hydraulic press 150 tons

b) Hydraulic rotary table press 200 tons

c) Hydraulic press 900 tons

d) Mechanical toggle press 200 tons

e) Hydraulic press 800 tons

f) Hydraulic press 800 tons with two sliding moulds.

Some of these presses are also used for producing silica and magnesite.

The manual forming in moulds is done by using electrical hammers.

6- The green products are dryed in channel dryers using clean hot air drawn from the cooling zones of the tunnel kilns until the moisture content is reduced to about 0.5%. The

dryed products are then loaded on the tunnel kiln cars and are transported to the kiln.

7- The firing is done in the tunnel kilns, we have two tunnel kilns, one of them is used for the high aluminus, products and the other one is used for half the year for silica products and the other half of the year for magnesite and other basic and neutral products. The kiln consists of three zones i.e. the pre-firing zone, the firing zone and the cooling zone. The fuel used is heavy oil (mazout) and we use compressed air to atomise the mazout. The capacity of each kiln is about from 6000 tons to 8000 tons per year according to the rate of moving of the cars inside the kiln which depends on the time required in the firing zone. The temperature required for firing the high alumina refractories ranges from 1300°C to 1450°C according to the percentage of alumina

8- After finishing the firing, the final products are sorted and the first class refractories are taken to the production stores. The other classes of products are considered as agrog and are taken by bucket trucks to the mass preparation section for crushing and used in the body mass again.

4-C) <u>Manufacture process of silica refractories</u>:

The silica refractories are also produced in the new unit. The steps of production are as follows :-

1.a) As previous mentioned in item No. 1 in section 4B

1.b) The quick lime is slaked and the slurry (milk of lime) is screened into daily tanks with stirrer and then is transferred to the mass preparation section by recirculating pumps.

2.a) As previous mentioned in item No. 2 in section 4B.

2.b) We use a closed cycle ball mill for fine milling of the quartzite to powder size.

3- As previously mentioned in item No. 3 in section 4B

4- The whole mass is shuted by gravity via belt conveyor to the edge runner mixer. After dry mixing a binding agent is added i.e. milk of lime in an amount up to 2% Ca O. The adhesive molasse is then added in about 1.5 % and water is then added so that the mixture will have a moisture percent of about 7% in case of semi dry pressing by presses or contains about 8-9% in case of hand moulding. The mixture is again throughly mixed and it is taken to the presses or to area of manual moulding.

5- The pressing is done as previously mentioned in item No. 5 in class 4B.

6- Drying is done as previously mentioned in item No. 6 in class 4B. But it takes longer time and slow rate of drying.

7- The firing of silica is done in the second tunnel kiln. The temperature in the kiln can reach 1450°C. The silica refractories take long time for firing because it need long time for firing because it need long soaking period, so the productivity of the kiln is decreased when we use it for firing the silica. We are now making some trials to fire the silica in direct fired, batch type down draft kiln so that the second tunnel kiln will be used for firing magnesite and other basic refractories for half the year and high alumina refractories for the other half of the year.

8- Sorting and packing are done as previously mentioned in item No. 8 in class 4B

4.D) <u>Manufacture process of magnesite and other basic refractories</u>:

The magnesite and other basic refractories such as magnesite chrome and chrome magnesite are also produced in the new unit.

The steps of productions are as follows :-

1- As previously mentioned in item No. 1 in class 4.B

2.a) As previously mentioned in item No. 2 in class 4.B

2.b) We use also the closed type ball mill for the fine milling.

3- As previously mentioned in item No. 3 in class 4.B

4- The whole mass is shuted by glavity via belt conveyor to the edge runner mixer. After dry mixing we add the adhesive molasse in about 2%, then we add the commercial sulpheric acid in about 1.5% then we add the water till moisture percent is about from 5% to 6%. The mixture is again throughly mixed and it is then taken to the presses or to the hand moulding area.

5- Because the magnesite and its derivatives need high cold crushing strength more than 300 kg/cm^2, we do not use the mechanical toggle press we use only the hydraulic presses which can give us the required pressure

6- Drying is done as previously mentioned in item 6 in class 4B

7- The firing is done in the second tunnel kiln and as previously mentioned in item No. 7 class 4B, but by using high temperature about 1560°C

8- Sorting and backing are done as previously mentioned in item No. 8 class 4B

9- We also produce the chemical bonded magnesite refractories. In this kind of products we use a greater percentage of fine grain size ground material i.e. powder, and we use high pressure hydraulic presses and we increase the time of drying in a hot atmosphere but they do not need firing.

5- **Selection of suitable kind of refractories for different purposes :**

The selection of the suitable kind of refractories for lining the kilns depends on the chemical and physical factors inside the kiln. For example the acidic refractories are preferred for lining the kilns in which the lining is subjected to acidic influences, and the basic refractories are preferred in the cases of basic influences. In the cases that the lining is subjected to high mechanical forces, the lining must be selected from that kinds which have high cold crushing strength and high R.U.L.

In some cases we can replace a certain kind of refractories by another, for example the magnesite refractories are used in cement industries but we are going now in Egypt to use the Forshterite refractories instead of the magnesite refractories because we have the ores of serpantine and talk in Egypt.

6- **Average consumption of refractories in some industries:**

The rate of consumption of refractories depends on some factors such as :-

a) The specifications of the refractories.

b) The design of the kilns and heat distribution inside them.

c) The method of building and lining of the kilns and the skill of the builders.

d) The kind of mortar used and if it is suitable for the kind of refractories used and the circumstances inside the kilns, or not.

e) Methods of utilising the furnace and whether it is subjected to thermal shocks or not.

f) Maintenance in the suitable time and with the suitable method.

But we can consider the following rates of consumption of refractories as average rates :-

a) From 50 kgs to 60 kgs of refractories for each one ton production of iron.

b) One kg. of refractories for each one ton production of cement.

c) From 20 kgs to 25 kgs of refractories for each one ton production of glass.

6- Quality Control:

To be able to make sufficient supervision and accurate control in all production stages in different production lines and testing of raw materials, intermediate and finished products we have the following laboratories :-

a) Chemical laboratory complete with all the chemicals required for chemical analysis and also a photo colour meter apparatus to make optical analysis for the groups RO and R_2O .

b) Physical laboratory complete with the instruments and apparatus required for making the following tests

- Seger cone test
- Cold crushing strength test
- B.U.L. test
- Sieve analysis
- Moisture percentage
- Ignition loss
- Apparent porosity
- Bulk density

c) Technical laboratory complete with a pilot plant for scientific researches, The quality is done in the different stages, and the following analysis and tests are made :-

1) Chemical analysis for some samples of each quantity of raw materials comes to the factory. The analysis is done to determine the percentage of the different elements in the raw material and also the loss by ignition, and comparing these results with the standard specifications

2) Chemical and physical analysis of the body composition before pressing to determine the percentage of each element, the percentage of different grain sizes, and the percentage of moisture.

3) After pressing some tests are made to determine the bulk density, moisture percentage and to check the dimensions.

4) After drying and before firing the moisture percentage test is done.

5) After firing some appaent test are made such as measuring of the dimensions, sureness of no cracks and no strange spots, then some samples are taken to the laboratories to make the following analysis and tests :-

- Determination of the percentage of AL_2O_3 or $Si O_2$ or Cr_2O_3 accoruing to the kind of the refractory.
- Determination of cold crushing strength
- " " R.U.L.
- " " pyrometric cone equivalent
- " " bulk density
- " " apparent porosity
- Other special tests if any according to the demand of the consumer.

6) <u>Future possibilities</u>:

The consumption of refractories in Egypt is more than the present production. The consumption will increase rapidly in the near future because of the increasing of the following industries :-

- Metallurgical industries such as iron and steel, copper, aluminium, ... etc.
- Glass industry
- Cement industry
- Coke industry
- Various chemical and petro-chemical industries
- Boilers
- And other industries

The production of refractories in Egypt in the last year (1973) was about 70000 tons and we import about 7000 tons, thus the total consumption is about

77000 tons of refractories as follows :-

48000 tons for metallurgical industries
8500 tons for boilers
6500 tons for cement industries
4500 tons for glass industries
9500 tons for other industries

77000 tons total consumption

We expect that the consumption of the refractories in Egypt will increase rapidly and will be doubled during five years because the extensions in the Egyptian Iron and Steel Company alone need 40000 tons of refractories per year.

For this reason we began to study the future possibilities of consumption of refractories in Egypt and we are now preparing for the following projects :-

1 - A new unit for producing high aluminus refractories

2 - " " " " " magnesite and other basic refractories

3 - A new unit for producing silica refractories

4 - A new unit for calcination to produce the grog required for the new and existing units.

5 - A unit for obtaining the magnesite ore from the sea water

ANNEX A

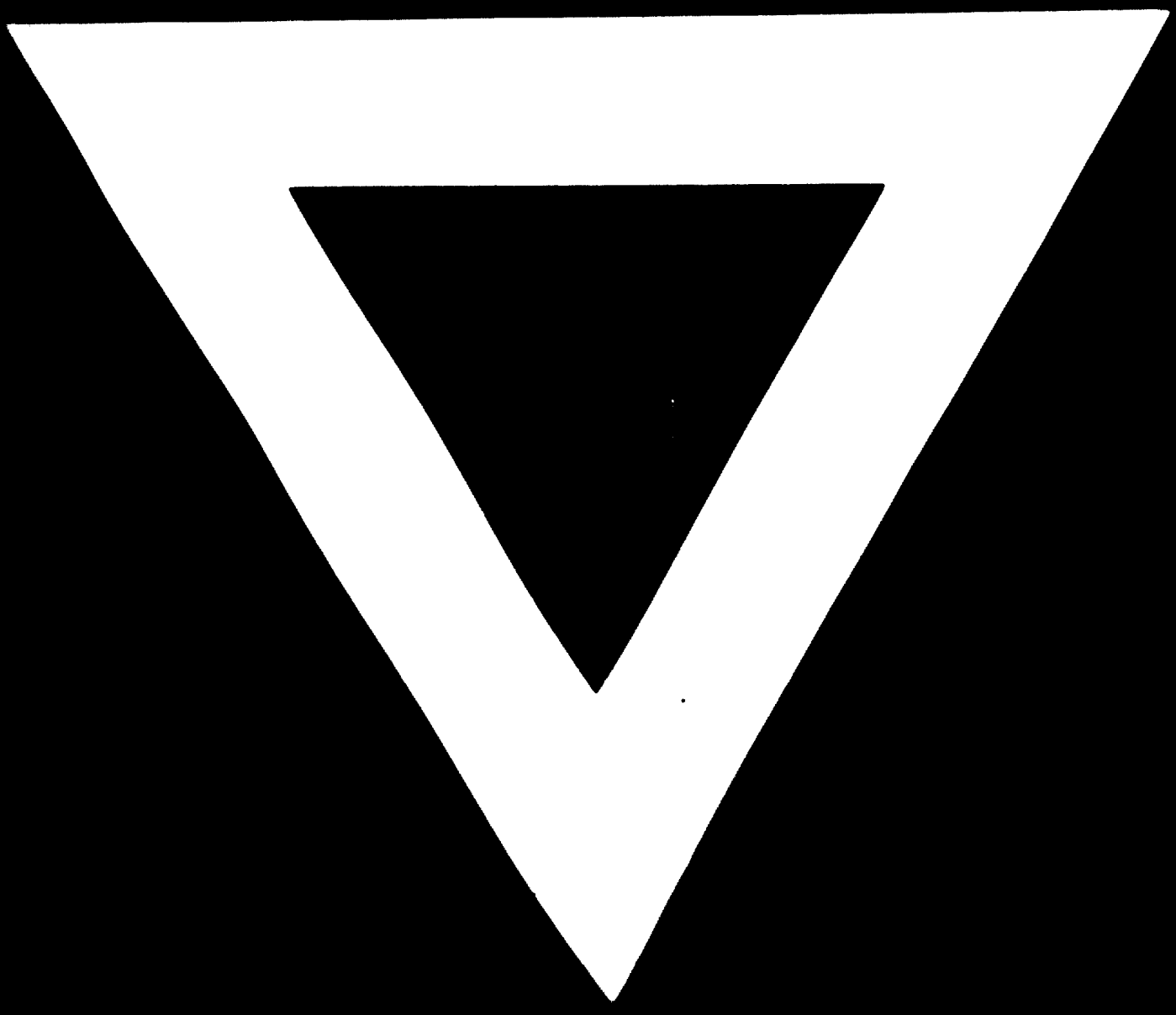
Specification of refractories produced by SORMAGA

Products	Content %	Bulk density gm/cm³	Apparent porosity %	R - U - L Load 2 kg/cm² Ta °C	Pyrometric cone equivalent Temperature °C	Cold crushing strength KG/cm²
Fire Clay Bricks						
MT	20-25 Al_2O_3	1.90	22-26	1300	1650	200-250
MH	26-28 "	1.90	22-26	1300	1670	200-250
M 30	29-31 "	1.90	22-26	1320	1680	200-250
M 35	33-35 "	1.90	22-26	1330	1700	200-250
M 36/39	36-39 "	2.05	20-25	1370	1710	200-300
M 40/42	40-42 "	2.10	20-24	1400	1730	200-300
High Alumina Bricks						
M 45	44-45 "	2.15	18-22	1430	1740	200-300
M 47	46-47 "	2.15	18-22	1450	1750	200-350
M 52	51-53 "	2.20	22-25	1510	1770	250-500
M 62	60-62 "	2.30	22-25	1530	1790	250-500
Silica						
MS	95 SiO_2	1.80	20-24	1640	1700	200-400
M.Magnesite	85-86 MgO	2.80	24	1600	1850	300-350
M.Chrome-Magn.	25Cr_2O_3/45 MgO	2.90	22	1550	1850	250-300
M.Magnesite/chro.	70MgO/10Cr_2O_3	2.80	24	1500	1850	250-400
M.Chromite	40 Cr_2O_3	3.20	20	1400-1500	1850	350-500

ANNEX B

Raw Materials Specifications

Material	Moisture	Loss of Ignition	SiO_2%	$Al_2O_3 + TiO_2$%	Fe_2O_3%	CaO %	Other Oxides
White Aswanly	2-2.2	11.2-11.7	51-51.5	31-31.5	4.2-4.5	Traces	0.5-1
Black Aswan	2 -2.5	10-10.5	51-52.5	27-28.5	7-8.5	"	1-2
Sina kaolin	1 -1.2	12.5-13.8	43-44.5	40.5-41.5	0.6-1	"	0.5-1
Kalabsha kaolin	1.2-1.5	12-14	43-48	38-40	0.7-1.5	"	0.8-1.2
Nolgata clay	0.4-0.5	11.5-12	53-54	31-31.5	2.2-2.5	0.4-0.5	0.5-1
Beleda clay	0.5-0.7	7.5-8	65-66	23.2-23.5	1.2-1.7	Traces	0.7-1
Quartzite	-	0.10-0.12	98-98.5	0.2-05	0.3-0.6	0.2-0.5	0-0.5
Chromite	0.2-0.3	4-4.2	5-6	15.5-16.6	15-16	0.5-0.8	16-17MgO+35-41 Cr_2O_3
Magnesite(CSSR)	burnt	-	0.3-0.5	1.5-2	4-5	2-2.7	89-92 MgO
Magnesite(Korea)	"	-	1.5-3	1.2-3.8	1-1.7	0.4-1.5	88-91 MgO
Bauxite	0.02	0.20	8.7-8.9	86.5-86.7	2.3-2.4	1.1-1.2	0.8-0.9
Lime	-	3-4	5-5.5	0.6-1	0.3-0.5	82-85	1-3



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