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TRADE STATISTICS IN REFRACTORIES[1/]

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I. THE ROLE OF REFRACTORIES IN INDUSTRY AND INTERNATIONAL TRADE

A. World's production of main refractories

Refractories are not only an indispensable material for lining a very wide range of industrial furnaces but constitute also an interesting article of the international trade, playing thus an important role in foreign exchange economy of a large number of countries. Their growing significance for modern industries in the future is quite obvious.

Iron and steel industries have as yet been the main consumersof all refractories and even in the future these industries will decisively influence the further development of the refractories industry and the future trends of refractories trade.

The table below shows approximate consumption of refractories in the individual sectors as % of the total consumption in Japan, USA and USSR :

	Japan :	USA :	USSR :
Iron and steel	72.0	63.0	73.9
Non-ferrous industry	1.6	8.0	5.8
Steam and power plants	0.6	7.0	10.6
Glass and cement, potteries	8.7	14.0	8.1
Chemicals industry	3.6	4.0	0.7
Other	13.5	4.0	0.9
	100.0	100.0	100.0

Since - as shown above - the requirements for refractori-

es depend mainly on the development of the steel industry, special attention will be given to this industry's future trends when estimating the future consumption of refractories in the respective countries. Naturally, the obtained figures will be corrected by additional quantities foreseen for other industries, such as cement and glass industries.

Refractories are usually subdivided in three main groups - fire-clay, silica and basic products. From the point of view of this grouping the percentage consumption in the decade 1960 - 1970 was approximately :

	Fire-clay	silica	basic
	products		
in USA	58	27	15
in Japan	68	18	13
in Germany Fed.	58	4.5	31

In the course of the decade 1960 - 1970 the percentage consumption of fire-clay refractories remained roughly at the same level, while that of basic products was growing and that of silica went down rapidly, making in West Germany in 1963 1.15 kilos per 1 ton steel produced and only 0.39 kilos in 1972.

In accordance with the development of new technologies of steel making, noticeable changes occured also among refractories both in their production and trading. Whilst basic /magnesite/ products played rather an insignificant part before the World War II in steel making technologies in comparison with fire-clay and silica products, their importance increased very substantially during the post-war period. First of all it was the switch to all-basic open-hearth furnaces replacing silica roofs by chrome-magnesite or magnesite-chrome roofs, then replacing of dolomite wall linings of electric arc furna-

ces by magnesite linings as well as replacing of a part of checkers in regenerators of industrial furnaces and finally replacing dolomitic fettling material by masses prepared from magnesite.

The picture of international trading with refractories during the post-war era varies very distinctly from that of the pre-war period because in the course of time the majority of countries consuming refractories erected own plants producing refractories making use of own raw materials. Only few countries remained dependent completely on import of such refractories as fire-clay which is the most common refractory product.

It is extremely difficult now for all manufacturers and exporters of fire-clay bricks to compete with these building materials on foreign markets because of their relatively low prices and increasing transport rates.

New steel making technologies brought about - as said above - a sensible decline the production of silica bricks which were used until recently as main construction material for roofs of electric arc and open-hearth furnaces. While high alumina bricks took over nearly completely their part in electric arc furnaces, their substitute for roofs of open-hearth furnaces became bricks made from magnesite with addition of chrome ore. This development led to the liquidation of many silica plants in the producing countries because the demand for coke oven and glass works silica could not compensate the consumption decrease in the steel industry.

The following tables review the world production of the most important refractory materials and should give also a general information about the channels of international trade with refractories.

It is absolutely impossible to specify the production of fire-clay and silica bricks in detail as these common refractory products are manufactured in many countries of the world and reliable summarizing statistics do not exist. Nevertheless, total world production of fire-clay bricks in the last years amount, according to experts, to 15 - 20 million tons yearly and that of silica bricks to 1.5 million tons.

Relatively exact data about magnesite and magnesite products are available due to the fact that magnesite deposits suitable for production of basic refractories have been discovered in some countries only and the production of synthetic magnesite from sea water or other sources is being registered and published.

For better information about importation and exportation of fire-clay and silica refractories it is necessary to apply to trade statistics of every country in question in case such statistics ever register particular groups of refractories, what seems to be rather an exceptional case as far as countries disposing of small consuming industries are concerned.

Table 1. The growth of production of raw magnesite in the decade 1960-1970
/From "Statistical Yearbook", 1972 and "Mining Annual Review" - June 1972/

	1960 /'000 tons/	1970 /'000 tons/
World	7.500	11.000
Australia	63	22
Austria	1.625	1.610
Brazil	63	236
China	800	800
Czechoslovakia	1.145	2.000
Greece	187	704
India	156	344
Iran	3	4
Korea D.P.R.	50	1.200
South Africa	61	84
Spain	48	222
Turkey	-	270
USA	300	320
USSR	2.400	3.000
Yugoslavia	252	500

Table 2. The growth of production of dead burnt magnesite from natural magnesite in the decade 1960-1970

	1960 /000 tons/	1970 /000 tons/
World	2.430	5.300
Austria	500	600
Brazil	30	100
China	300	300
Czechoslovakia	330	631
Greece	-	220
India	60	150
Korea D.P.R.	100	600
Spain	20	120
Turkey	10	110
USA	155	150
USSR	1.000	1.700
Yugoslavia	90	200

Table 3. The growth of production of synthetic magnesia in the decade 1960-1970

	1960 /000 tons/	1970 /000 tons/	
World	610	1.900	
Canada	-	30	
Great Britain	250	250	
Ireland	-	70	
Italy	-	110	
Japan	-	685	
Mexico	-	70	
USA	360	650	
Israel	-	200	1/

1/ under construction

Table 4. The growth of production of basic /magnesite/ bricks in the decade 1960 - 1970

	1960 /000 tons/	1965 /000 tons/	1970 /000 tons/
World	2.560	3.530	4.400
Austria	260	280	400
Brazil	?		
Czechoslovakia	115	165	210
Germany Fed.	110	150	310
India	40	60	60
Japan	180	330	400
Poland	60	70	90
USA	480	560	750
USSR	900	1.370	1.500
Yugoslavia	-	-	150

Table 5. Export and Import of raw and burnt magnesite in 1970

	Export: tons		Import: tons	
Argentina			raw and burnt	21.425
Austria	burnt	211.000	raw	34.200
			burnt	75.500
Australia			burnt	12.830
Belgium			burnt	8.710
Czechoslovakia	burnt	251.000		
Denmark			raw	8.570
Canada			burnt	61.680
France			burnt	56.585
Germany Fed.			burnt	309.765
Great Britain			burnt	118.000
Greece	burnt	297.000		
Holland			burnt	39.625
Hungary			burnt	84.375
India	raw and burnt	34.525		
Italy	raw	11.365		
	burnt	44.135		
Japan			burnt	59.065
Korea D.P.R.		500.000		
Mexico			burnt	31.955
Poland			burnt	206.163
South Africa			raw	104.785
Spain	raw and burnt	73.000	raw and burnt	35.875
Sweden			burnt	12.770
Turkey	raw	34.200		
	burnt	75.500		
USA	burnt	89.000	burnt	96.300
USSR	burnt	207.000		
Yugoslavia	burnt	107.000		

B. The role of refractories in international trade

Table 6. Export of basic /magnesite/ bricks in 1971 effectuated by the biggest exporting countries /tons/

From Austria:	totally	400.000
to	Germany Fed.	101.395
	France	67.395
	Romania	42.714
	Benelux	21.189
	Spain	22.273
	Hungary	18.024
	Sweden	17.375
	Turkey	17.176
	Italy	16.816
	Great Britain	14.860
	Algeria	5.243
From Czechoslovakia:	totally	79.807
to	Romania	20.452
	Poland	20.000
	Germany Fed.	10.781
	Germany D.R.	10.268
	Bulgaria	6.380
	Benelux	4.366
	U.A.R. Egypt	1.809
	Great Britain	1.460
	France	1.078
	Cuba	802

From	Germany Fed.:	totally	116.200
to	Benelux		24.310
	France		15.270
	Sweden		12.975
	Italy		9.190
	Great Britain		6.810
	Denmark		5.890
	Finland		5.075
	South Africa		2.873
	Iran		2.038
	Ceylon		1.040
	Peru		562
	Nigeria		334
	Argentina		734
From	Great Britain :	totally	33,100
to	Holland		6.115
	Sweden		4.100
	India		2.820
	Australia		2.400
	Ireland		1.410
	Zambia		1.050
	Argentina		390
	Nigeria		343
	Thailand		310
	Ghana		3

From	Yougoslavia :	totally	65.760
to	Germany Fed.		35.015
	Bulgaria		13.480
	Romania		11.625
	Poland		4.277
	France		3.149
	Italy		2.730
	Sweden		2.349
	Great Britain		1.038

C. Comments on relation steel production to refractories production or consumption

When relating the estimated total world production of fire-clay, silica and basic refractories as well as burnt magnesite to the world's steel output, the following approximate figures result for 1970 :

consumption per one ton of steel

(35 kilograms of fire-clay products
(2.5 kilograms of silica products
(7.5 kilograms of basic /magnesite/ products
(11.5 kilograms of burnt magnesite

Of course, the steel industry is merely the main but not the only branch of industry which consumes refractories and especially fire-clay products are encountered in many other fields of application.

Among other refractory materials the production of burnt magnesite /both natural and synthetic/ increased conspicuously

in the last decade. While 8,9 kilograms of burned magnesite correspond to one ton of steel produced in 1960, ten years later the same relation represents already 12 kilograms.

Table 7. Relation between the growth of steel production and the growth of production of raw magnesite and basic refractories in the decade 1960 - 1970

	1960 /million tons/	1970 /million tons/	increase /%/
steel production	341	595	74.5
production of raw magnesite	7.5	11	47
production of burnt magnesite	2.4	5.3	119
production of synthetic magnesite	0.6	1.8	194
production of basic bricks	2.6	4.4	72

The rapid growth of the production of burnt magnesite /natural as well as synthetic/ in the decade 1960-1970 can be explained not only by the increasing demand for basic bricks for the linings of all-basic open-hearth and electric furnaces, oxygen vessels, cement kilns etc., but also by adopting magnesite as a better ramming, fettling and gunning material in place of dolomite.

The consumption figures of dead burnt magnesite and dolomite as ramming and fettling materials recorded in West

Germany at the beginning and towards the end of the last decade give an objective example of this phenomenon :

Germany Fed.	1963	1968
steel production	31.6 million tons	41.2 million tons
consumption of burnt magnesite in the steel industry	9.000 tons	126.000 tons
consumption of dolomite in the steel industry	438.000 tons	106.000 tons
consumption of burnt magnesite per 1 ton steel	0.28 kilos	3.05 kilos
consumption of dolomite per 1 ton steel	13.8 kilos	2.57 kilos
consumption of both material together per 1 ton steel	14.08 kilos	5.62 kilos

The switch from dolomite to magnesite for fettling enabled in some cases to reduce the consumption of fettling material to one-third of the quantity used so far, not mentioning an important reduction of the necessary fettling times and other advantages, such as lower stocking and handling expenses.

Very typical for the decade 1960-1970 is the rapidly growing production of synthetic magnesia which was nearly doubled in the course of only few years.

While only natural magnesite was available on the world markets before World War II, supplied by a very restricted number of producing countries, the post-war period with its new technologies created a new situation. The traditional producers and exporters of natural magnesite were no more

in a position to meet all requirements imposed by the rapidly developing steel industries with their modern processes necessitating mainly magnesite linings and repair materials. Furthermore, frequently occurring lacks of refractories made from natural magnesite awoke the desire of the refractories industry to control its own sources of magnesite and this desire led to heavy investments in plants manufacturing synthetic magnesia by the extraction from sea water or brines on the basis of a process developed as early as 1930's. The first sea water magnesia plant was erected in England. About 22 synthetic magnesia plants are operating nowadays in the world, among them 10 in USA and 4 in Japan. USA and Japan are the most significant producers of synthetic magnesia and mainly the Japanese sea water magnesia is being introduced in interesting lots to foreign markets.

It is an astonishing fact that the capacity of all synthetic magnesia plants represents already one-third of the whole world's production of burned magnesite.

Also the claim that low iron magnesite refractories are more suitable for pneumatic steel making than those with a higher iron content, helped synthetic magnesia to come through the competition with traditional qualities of magnesites.

The demand for dead burned magnesite of this type resulted also in an expansion of magnesite mining in those countries in which deposits had been discovered. The major development occurred in Greece from 1963 onwards. Similarly, new mining and calcining operations were initiated in Turkey and Rhodesia.

By expanding or initiating magnesite mining operations, the majority of countries possessing deposits of magnesite tried to create a suitable basis for basic refractories industry which would be able to supply their developing steel indus-

tries with a sufficient quantity and range of basic products. Only surplus quantities were intended for export. Nevertheless, some other countries started the exploitation of their magnesite deposits with the idea of placing the majority of the refractories production on the foreign markets. Austria can be named as a representative in this respect, but also the exported tonnages from Greece, Turkey and Korea D.P.R. are much bigger than the home consumption of these countries.

An important role in the international trade with basic refractories has ever been played by Germany Fed. - a country which owns neither natural nor synthetic resources of magnesia and nothwithstanding belongs to the greatest exporters of basic refractories. In 1971 116.200 tons of basic bricks were exported from this country, although, on the other hand, nearly the same quantity /98.813 tons/ had to be imported. The highly developed ceramic industry of Germany, dependent totally on imported magnesite, is making a good business by exporting specialities and importing a relatively simple assortment.

D. Price observations

Because of the wide range of sorts and qualities that are available both for fire-clay, silica and basic refractories and because of the constant fluctuation of prices, we deliberately gave up accompanying our figures in the presented tables by values of the production or import and export. It will be mentioned only that the price relations among the main groups of refractories towards the end of the decade 1960-1970 were approximately as follows :

Fire-clay squares	100
Silica squares	100
Basic squares	175
Crude magnesite	100
Dead burned magnesite for brickmaking	350
Dead burned magnesite for maintenance	250
High quality magnesite for specialised applications	625

Between the years 1960 and 1970 the prices of refractory products in Europe increased approx. by 16 %. The growing tendency was much more accentuated in the second half of the decade than in the first one and the upwards trend is still keeping up today.

II. PERSPECTIVES OF FUTURE REQUIREMENTS FOR REFRACTORIES

A. General considerations

It is not a simple task to forecast the future trends of consumption of the particular groups of refractories since there are very many factors that may influence the expected consumption of refractories as a whole or least of some kinds among them. Nothwithstanding, there is no doubt that the decisive factor influencing any further development of refractories industry anywhere will remain the iron and steel industry. Consequently, the growth of this industry, differentiated according to the individual steel making processes intended for every country, can provide a solid basis for reasonable speculations about the future requirements for refractories.

Another important factor which must necessarilly be taken into consideration in connection with expected consumption of refractories is the cement industry.

The consumption of cement is, as a matterof fact, so inter - related with that of steel that in a fully developed economy the growth of one determines broadly the pace of development of the other.

The cement-to-steel ratio is a convenient tool in planning development programmes for these idustries.

In USA the ratio is approx. 50 : 100. However, in a developing economy it would not be accurate to forecast requirements of cement solely on the basic of expansion programmes for steel production.
In the case of India for example, the cement-to-steel ratio of approx. 250 : 100 of the decade 1960-1970 changed to approx. 220 : 100 by 1970 and will change to 100 : 100 by 1975.

Non-ferrous metals industry, glass industry and others must equally be considered as important consumers of refractories and - mainly as far as fire-clay products are concerned - it has been ascertained that other industries consume together approximatly the same quantities of fire-clay products as the steel industry itself.

Average consumptions of refractories per one ton steel produced by different methods in three prominent steel producing countries - Germany Fed., Great Britain and Soviet Union have been taken into account for evaluating future trends of world's consumption of refractories for steel making, i.e. :

<u>O. H. process</u> :

fire-clay products	21 kilograms
silica products	1 kilogram
basic products	8 kilograms

Electric furnace :

fire-clay products	20 kilograms
basic products	7 kilograms

Oxygen vessels :

fire-clay products	17 kilograms
basic products	3 kilograms

Dead burned magnesite and dolomite have not been estimated in view of the fact that it would be utterly difficult, if not impossible, to speculate about the magnesite and dolomite quotas which would be involved in the steel making process in the future, as very of both materials influences the real consumption in a very different way and quantity.

It cannot be excluded that the above enumerated consumption figures would be influenced by positive and negative factors in the course of time e.g. by introduction of better qualities of refractories, or, on the other hand, by intensification of furnace working conditions etc. However, the calculated figures will grosso modo remain unchanged at least until 1980.

As far as cement kilns are concerned, a consumption of 0.7 kilograms of fire-clay products per one ton cement klinker and 0.8 kilograms of basic bricks are considered, according to experts, a reasonable basis for calculation.

The future consumption of other sectors of industry is very difficult to estimate so that the supposed figures cannot be considered to be very exact.

B. Perspectives of world's consumption of refractories

Table 8.

1. Steel industry

	1975 /million tons/	1980 /million tons/	2000 /million tons/
Total steel output-world 1/	700	952	2 000
Open-hearth process	180	100	80
Oxygen vessels	342	500	1 400
Electric furnaces	170	310	500
Other processes	8	42	20
Estimated consumption of fire-clay products t o t a l	13.1	17.6	35.9
for open-hearth process	3.8	2.1	1.7
for oxygen vessels	5.8	8.5	23.8
for electric furnaces	3.4	6.2	10
for other processes	0.I	0.8	0.4
Estimated consumption of silica products t o t a l	0.7	0.7	1
Estimated consumption of basic products t o t a l	3.2	4.8	8.1
for open-hearth process	1.4	0.8	0.6
for oxygen vessels	0.5	1.5	3.8
for electric furnaces	1.2	2.2	3.5
for other processes	0.07	0.3	0.2

1/ According to "International Iron and Steel Institute"

2. Cement industry

	1975 /million tons/	1980 /million tons/	2000 /million tons/
Cement output - world	763 2/	1.015 3/	2 000 4/
Estimated consumption of fire-clay products	0.5	0.7	1.4
Estimated consumption of basic products	0.6	0.8	1.6

3. Other industries

	1975 /million tons/	1980 /million tons/	2000 /million tons/
Estimated consumption of fire-clay products	7.5	9.1	12
Estimated consumption of silica products	0.7	0.9	1
Estimated consumption of basic products	0.4	0.8	1.1

2/ According to periodical "Zement-Kalk-Gips" N° 8/August 1972

3/ and 4/ The author's estimations

Summarization :

1. Fire-clay products

	1975 /million tons/	1980 /million tons/	2000 /million tons/
Steel industry	13.1	17.6	35.9
Cement industry	0.5	0.7	1.4
Other industries	7.5	9.1	12
t o t a l	21.1	27.4	49.3

2. Silica products

	1975 /million tons/	1980 /million tons/	2000 /million tons/
Steel industry	0.7	0.7	1
Cement industry	-	-	-
Other industries	0.7	0.9	1
t o t a l	1.4	1.6	2

3. Basic products

	1975 /million tons/	1980 /million tons/	2000 /million tons/
Steel industry	3.2	4.8	8.1
Cement industry	0.6	0.8	1.6
Other industries	0.4	0.8	1.1
t o t a l	4.2	6.4	10.8

C. Future presumable trends in refractories trading

Though the obtained results make it evident that the fire-clay and basic refractories production must be more than doubled by 2 000, there is no doubt that the refractories industries will be able to keep pace with the growing demands. There are practically unlimited resources of necessary raw materials and moreover there are only few countries without reserves for this kind of refractories. Consequently, it can be assumed that because of relatively low prices of fire-clay refractories /with the exception of high alumina products/ the majority of consuming countries will try to make these products at home. Bulk imports will be encountered solely in case the inland requirements should prove to be too small to justify erection of new plants.

According to the conclusions of United Nations Economic Commission for Asia and Far East from December 1965 /Bangkog/, units to be economical should have the following capacities :

Fire-clay refractories : 30 000 tons / year based on a continuous tunnel kiln with a capacity of 70 tons / day

Silica refractories : 12 000 tons based on a continuous tunnel kiln or chamber kiln

Basic refractories : 20 000 tons based on continous tunnel kiln or chamber kiln

However, common refractories such as fire-clay products should all be made by consuming countries, provided the annual demand exceeds 10,000 tons and suitable grades of fire-clay are available.

For developing countries where current demand is above 10,000 tons/year, plants of 30 - 100 tons/day capacity should prove to be economical. Countries with a demand less than 3 000 tons/annum might find it more economical to import rather than to produce refractories at the production level by less than 10 tons per day.

Fire-clay refractories, therefore, hardly will play a very important part in the future international trade ; only high alumina raw materials and products for specialised applications will be of paramount interest. Similarly, the trade with silica products will be confined to short distances and relatively small quantities only.

Basic refractories, on the contrary, will be traded in still bigger lots in view of the fact that even in the future many steel making countries will be dependent on import of both dead burned magnesite and magnesite products. Even those countries that possess sufficient reserves of natural magnesite may not decide to start refractories manufacture on behalf of the necessary heavy investments and also on behalf of the existence of a well established and experienced competition. It is, as a matter of fact, extremely difficult to introduce new products to the foreign markets and take away a share from well known suppliers. A favourable price policy need not mean a certain success for new manufacturers and exporters since the price is certainly not the decisive factor in the refractories trade.

Within the range of magnesite refractories preference will very probably be given to low iron magnesia and bricks made from it, which fact will still more encourage the existing and projected plants producing synthetic magnesia that already today can produce nearly two million tons yearly.

III. COMMENTS ON STATISTIC CONCERNING REFRACTORY PRODUCTS SEPARATELY FOR EACH OF SELECTED COUNTRIES

A. Introduction

The aim of this part of paper was to gather the maximum of statistical data concerning refractories imported by selected countries in the decade 1960-1970, further requirements for main groups of refractories in these countries and finally to make some recommendations about how to meet the foreseen requirements. Unfortunatelly, it was not possible in spite of sincere efforts to present complete and exhausting statistics concerning refractories covering the wholedecade and the individual groups of refractories separately because of the fact that such detailed data are simply not available or are not reliable enough. Therefore it was necessary to pick them up laboriously from many different sources and even then it was impossible to get a clear picture. For the foreign trade of the majority of selected countries refractories do not play a very important part and therefore are not specified separately in many cases.
Nothwithstanding it is believed that a certain orientation has been provided.

The estimations of future consumption have been based on expected production of steel /respecting different technologies/ and cement, published by renowned international experts or institutions, e.g.

B. Selected countries

A L G E R I A

Algeria has been a substantial iron ore producer for many years and there are plentiful supplies of dolomite as well as considerable reserves of silica in the country. All these facts justify the projected considerable increase of steel output which should reach 200,000 tons by 1975, 500,000 tons by 1980 and one million tons by 2000.

The country used to import in the decade 1960-1970 up to 1 000 tons basic bricks mainly from Austria and Czechoslovakia, silica bricks from France and Czechoslovakia and high alumina fire-clay bricks from Morocco. The requirements of the only steel works /open-hearth/ were hitherto correspondingly small.

Estimated future requirements for refractories depending on the following projected increase of steel and cement production as well as other industries are :

	1975 /000 tons/	1980 /000 tons/	2000 /000 tons/
Steel production			
OH	20	-	-
LD	180	500	1 000
t o t a l	200	500	1 000
Cement	1 500	2 000	4 000

	1975 /000 tons/	1980 /000 tons/	2000 /000 tons/
Fire-clay products			
for steel	3.5	8.5	17
for cement	1.1.	1.4	3
other	0.4	1.6	5
t o t a l	5	11.5	25
Silica products			
for steel	0.1	-	-
other	0.2	0.3	0.5
t o t a l	0.3	0.3	0.5
Basic products			
for steel	0.7	1.5	3
for cement	1.2	1.6	3.2
t o t a l	1.9	3.1	6.2

In view of the above mentioned conclusions of U.N.E.C. it would be recommendable to provide basic products, mainly specialities for oxygen vessels, from abroad while fire-clay products could be made in the country and specialities imported from Morocco.

E T H I O P I A

No statistics are available. There was no steel production in the country during the last decade. Production of cement was represented by approx. 30,000 tons at the beginning of the decade and reached 175,000 tons by 1970.

According to the prognosis the following production of steel and cement is expected, bringing about the following requirements for refractories :

	1975 /000 tons/	1980 /000 tons/	2000 /000 tons/
Steel /probably electric furnaces/	100	200	400
Cement	275	675	1 500
	tons	tons	tons
Fire-clay products			
for steel	2 000	4 000	8 000
for cement	200	500	1 000
other	400	1 000	4 000
t o t a l	2 600	5 500	13 000
	tons	tons	tons
Basic products			
for steel	700	1 400	2 800
for cement	220	550	1 200
other	-	-	-
t o t a l	920	1 950	4 000

In view of the foreseen low consumption, import from abroad should satisfy all necessities of this country's industry.

G H A N A

Statistics for the first half of the decade are not available. From 1967 onwards the country imported :

	1967 tons	1968 tons	1969 tons	1970 tons
Refractory bricks				
total	2 331	1 650	6 367	5 940
total value /000 US $ /	/378.000,-/	/232.000,-/	/705.000,-/	/1.109.000/
from USA	1 396	251	3 712	4 850
from U. Kingdom	913	1011	1 236	1 090

The main consumer was the cement industry that produced approx. 450,000 tons in 1970 and is expected to produce 700,000 tons by 1975, one million tons by 1980 and 1,600,000 tons by 2000. No steel industry is being planned at present. The estimated future demands for refractories are :

	1975 tons	1980 tons	2000 tons
Fire-clay products	7 000	9 000	13 000
Basic products	600	800	1 300

The necessities of the industry should be satisfied by import.

K E N Y A

Only very sporadic statistical data are available indicating import of about 300 tons of refractory bricks in a year /from Austria and Great Britain/ during the last decade, destined probably for the cement industry which produced 340,000 tons of cement by 1960 and 790,000 tons by 1970.
There has been no steel industry in the country hitherto but steel will be produced in the future.

For the following steel and cement industries and other sectors following requirements for refractories should result :

	1975 /000 tons/	1980 /000 tons/	2000 /000 tons/
Steel production	100	200	400
Cement production	1 000	1 500	3 000

	1975 /tons/	1980 /tons/	2000 /tons/
Fire-clay products			
for steel	2 000	4 000	8 000
for cement	700	1 100	2 100
other	500	1 000	2 000
t o t a l	3 200	6 100	13 150
Basic products			
for steel	700	1 400	2 800
for cement	800	1 200	2 400
t o t a l	1 500	2 600	5 200

In spite of the fact that magnesite veins occur in several localities and have been worked sporadically /100 to 500 tons yearly/ it would be advisable to import all necessary refractories from abroad.

N I G E R I A

Extremely difficult to find reliable statistical data refering to refractories. Nevertheless it has been ascertained that in 1967 the country imported 9 124 tons of refractory bricks /including some hundreds of tons of basic bricks/. The main suppliers were :

Great Britain	-	3 164 tons
Sweden	-	1 798 tons
USA	-	1 184 tons
Germany Fed.	-	952 tons

No steel making facilities have been available so far but the Federal Government is planning an integrated iron and steel plant to utilize local raw material. The country produced approx. 170,000 tons of cement in 1960 and approx. 600,000 tons in 1970.

Expected future production of steel and cement :

	1975 /000 tons/	1980 /000 tons/	2000 /000 tons/
Steel	300	400	800
Cement	850	1 500	3 500

Expected future consumption :

	1975 / tons /	1980 / tons /	2000 / tons /
Fire-clay production			
for steel	6 000	8 000	16 000
for cement	800	1 100	2 500
other	10 000	13 000	20 000
t o t a l	16 800	22 100	38 500

	1975 /tons/	1980 /tons/	2000 /tons/
Basic products			
for steel	2 100	2 800	5 700
for cement	700	1 200	2 800
other	-	-	-
t o t a l	2 800	4 000	8 500

Erection of a plant producing fire-clay products should be considered.

E G Y P T

Reliable statistics including export and import of refractories are available only for the second half of the decade, unfortunatelly without a more detailed specification :

I m p o r t
/metric tons/

	1967	1968	1969
Refractory bricks - total			
	6 483	8 888	11 806
/US$/	/2.406.000.-/	/2.911.000.-/	/4.331.000.-/
from: Czechoslovakia	1 403	2 099	1 280
France	1 004	358	858
Germany Fed.	1 045	1 365	2 041
Great Britain	280	436	633
India	-	-	2 174
Italy	430	368	929
Morocco	-	982	985
USA	178	591	650
Yugoslavia	1 121	1 064	1 234

/about 2 000 tons yearly are basic bricks/

	1967	1968	1969
Refractory materials - total			
	8 216	7 327	6 289
/US $/	/537.000.-/	/418.000.-/	/500.000.-/
/clay, dolomite, magnesite and similar refractory materials/			
from: Czechoslovakia	4 789	1 761	2 353
Germany D.R.	2 537	-	-
URRS	-	-	1 191
/mostly dead burned magnesite/			

Estimated future requirements for refractories based on the following expected steel and cement production including requirements of other industries are :

	1975	1980	2000
		/million tons/	
Steel : OH	1.3	0.4	-
Electric furnaces	0.6	0.6	0.8
LD	1.6	4	6.2
t o t a l	3.5	5	7
Cement	4	6	12

	1975	1980 / 000 tons /	2000
Fire-clay products :			
for steel	10.3	54	71
for cement	2.8	4.2	8.4
other	4	10	30
t o t a l	17.1	68.2	109.4
Silica products :			
for steel	0.5	0.9	1
other	0.7	1	2
t o t a l	1.2	1.9	3
Basic products :			
for steel	3.8	12.9	16
for cement	3.2	4.8	9.6
other	-	-	-
t o t a l	7	17.7	25.6

Egypt has erected modern plants producing fire-clay, silica and basic refractories and practically only magnesite deposits are absent in the country. The existing capacities could and should be extended to meet the country's growing requirements. Only dead burned magnesite and basic bricks and masses for specialised applications should be imported in the future.

A R G E N T I N A

The country made a great progress during the decade 1960-1970, increasing the steel output from approx. 280,000 tons in 1960 to 1,860,000 tons in 1970 and the production of cement from approx. 2.6 million tons in 1960 to 5.5. million tons in 1970.

The future trends of both industries are also very promising :

		1975	1980 /million tons/	2000
Steel production :	OH	1.3	0.4	-
	El.furn.	0.6	0.5	0.8
	LD	1.6	4	6.2
	t o t a l	3.5	5	7
Cement production :		6.5	9	15

Statistical data refering to the first half of the decade 1960-1970 do not cover total import of refractories. Notwithstanding they show that important quantities of basic and dead burned magnesite were regularly imported.

From 1967 onwards the country's imports are :

	1967	1968	1969	1970
		/000 tons/		
Refractory bricks :				
t o t a l	16.8	11.4	13.1	18.7
value/000 US $/	/3.155/	/2.613/	/3.159/	/4.346/
From: U S A	6.8	2.9	3.6	3.2
Brazil	2	3.7	4.3	4.8
Germany Fed.	1.6	0.8	1	5.9
Great Britain	3	1.2	2	0.5
Austria	1.1	1.8	1	2.6
Refractory materials :				
/other than bricks/				
t o t a l	32.8	31.5	54.6	82.2
value/000 US $/	/1.591/	/1.695/	/2.946/	/4.094/
From: Austria	-	-	5.1	5.6
Brazil	-	2.4	5.8	5.3
Great Britain	1.8	2.6	3	-
Greece	-	-	5.1	5.6
Italy	-	-	1.6	4.6
Uruguay	16.6	16.1	21.4	40.2
U S A	10.8	11.4	13.3	11.5

Estimation of future consumption :

	1975	1980	2000
		/000 tons/	
Fire-clay products :			
for steel	66.5	88.5	121
for cement	4.5	6.5	11
other	40	60	90
t o t a l	111	155	222
Silica products :			
for steel	1.9	1	0.8
Basic products :			
for steel	19.4	19.4	24
for cement	5.3	7.2	12
other	0.3	0.4	1
t o t a l	25	27	37

The existing refractories industry covering also the manufacture of basic products could meet all requirements for refractories - in the future by expanding and completing new plants.

Only specialities should be brought in from abroad and - naturally - dead burned magnesite or other materials indispensable for the refractories industry.

B O L I V I A

No complete statistics are available. Basic bricks were imported mainly from Austria and Great Britain in the decade 1960 - 1970. The country has no steel production. The cement industry made 40,000 tons of cement in 1960 and 115,000 tons in 1970.
No steel plants are planned as yet for the future. The cement industry is expected to be expanded to 200,000 tons in 1975, 300,000 tons in 1980 and one million tons by 2000.

The refractories requirements would be probably very small, such as approx. 250 tons of fire-clay products by 1975, 600 tons by 1980 and 2 000 tons by 2000, as well as approx. 200 tons of basic bricks by 1975, 300 tons by 1980 and 800 tons by 2000.

In spite of these small figures it is reported that La Corporación Boliviana de Fomento is studying the possibility of production of basic refractories, thinking probably of some export possibilieties.

C O L O M B I A

Statistics concerning the first half of the last decade reveal mainly import of basic bricks of approx. 1 000 tons yearly /from Austria, Germany Fed. and USA/.

Further imports :

	1967	1968	1969	1970
		/tons/		
Refractory bricks:				
t o t a l	2 688	3 367	1 346	3 756
value /000 US $/	/807/	/772/	/454/	/959/
From : Austria	675	241	652	493
Canada	564	-	52	1 007
Czechoslovakia	-	519	-	533
U S A	789	2 426	542	1 623

Expected steel and cement production :

	1975	1980	2000
		/000 tons/	
Steel /mainly electr.furn./	500	800	1 200
Cement	3 500	4 700	8 000

Resulting consumption figures :

	1975	1980	2000
		/tons/	
Fire-clay products :			
for steel	6 000	12 000	22 400
for cement	2 500	3 300	5 600
other	1 000	3 000	10 000
t o t a l	9 500	18 300	38 000
Basic products :			
for steel	2 100	4 200	6 000
for cement	2 800	3 800	6 400
t o t a l	4 900	8 000	12 400

Fire-clay products should be made at home, basic refractories, although a production of 100 to 300 tons of magnesite is reported in the decade 1960 - 1970.

C U B A :

Statistical data are only sporadicly available and reveal imports of fire-clay, silica and basic bricks as well as of dead burned magnesite. The main suppliers are USSR and Czechoslovakia.

A small production of steel /approx. 100 000 tons to 150 000 tons/ was reported towards the end of the decade 1960-1970, while 810 000 tons of cement were produced in 1960 and 750 000 tons in 1970.

No estimations about the future development are available.

N I C A R A G U A :

No steel is being made in Nicaragua nor is any steel production plamed for the future.
Cement production reached only 32 000 tons in 1960 and grew up to 130 000 tons in 1970.

The country imported 588 tons of refractory bricks /from USA/ for US $ 114.000.- in 1969 and 3129 tons for US $ 302.000.- in 1970.

Cement production will probably grow up to 200 000 tons by 1975, 600 000 tons by 1980 and 1 200 tons by 2000 and the country's demand for refractories can be estimated as follows :

	1975	1980 /tons/	2000
Fire-clay products	650	1 500	3 000
Basic products	200	500	1 000

These small quantities should be brought in from abroad.

P E R U :

Imports of refractories are difficult to be traced. However, about 700 tons of basic bricks and 3 000 tons of dead burned magnesite were yearly imported in the decade 1960-1970, the usual suppliers being Austria, Germany Fed., Great Britain and USA.

The steel production fluctuated between 60 000 and 75 000 tons/ year during the decade, while the cement output was nearly doubled, making 600 000 tons in 1960 and 1 135 000 tons in 1970.

Further estimated development of steel and cement industries :

	1975	1980 /000 tons/	2000
Steel : LD	400	900	1 500
Electric furnaces	100	100	-
t o t a l	500	1 000	1 500
Cement	1 400	2 000	4 000

would be accompanied by following approximate requirements for refractories :

	1975	1980 /tons/	2000
Fire-clay products :			
for steel	8 800	18 000	25 000
for cement	1 000	1 500	3 000
other	4 000	8 000	15 000
t o t a l	13 800	27 500	43 000
Basic products :			
for steel	2 000	3 400	4 500
for cement	1 100	1 600	3 200
t o t a l	3 100	5 000	7 700

Expected fire-clay consumption it high enough to justify a study about a fire-clay plant provided is has not yet been considered.

I N D I A :

India is both importer and exporter of refractories. The country has a developed steel as well cement industries and is planning further expansion of these and many other industries.

The refractory industries dispose of an total annual capacity of 1 300 000 tons of all refractory products.

The steel production was doubled during the last decade, being 3.3 million tons in 1960 and 6.3 million tons in 1970. The same development registered the cement production /7.8 million tons of cement in 1960 and 14 million tons in 1970/.

India imported :

	in 1967	1968	1969	1970
refractory bricks for 000-US $	428	497	640	4.526
refractory materials /other than bricks/ for 000-US $	702	448	639	509

and exported :

	in 1967	1968	1969	1970
refractory materials for 000-US $	3.767	3.331	3.885	5.777

Future trends of the steel and cement production :

	1975	1980	2000
	/million tons/		
Steel : O.H.	5.4	4.5	-
oxygen vessels	4.3	13.5	20
electric furnaces	0.3	1	1
t o t a l	10	19	21
Cement	19.5	25	40

Estimated future consumption of refractories :

	1975	1980	2000
		/000 tons/	
Fire-clay products			
for steel : O.H.	113.4	1115.5	-
oxygen vess.	73.1	229.5	340
electr.furn.	6	20	20
t o t a l	192.5	365	360
for cement	13.5	17.5	28
other	150	250	330
t o t a l	356	632.5	718
Silica products	7.7	10.5	7
Basic products			
for steel : O.H.	43	44	-
oxygen vessels	13	40.5	60
electric.fur.	2	7	7
t o t a l	58	91.5	67
for cement	15.6	20	32
t o t a l	73.6	111.5	99

India has a very good chance to expand the existing facilities for manufacturing refractories to make the country practically self-supporting as far as all kinds of refractories are concerned.

I N D O N E S I A :

There is no iron and steel plant of any significance in Indonesia today. On the other hand the cement production increased 13 times 1960 between 1970, when 532 000 tons of cement were manufactured.

Statistical data before 1968 are very scarce :

in 1968 Indonesia imported 2 380 tons of refractory bricks for US $ 487.000.-

in 1969 " " 1 701 tons of refractory bricks for US $ 315.000.-

in 1970 " " 3 253 tons of refractory bricks for US $ 758.000.-

The majority of these bricks came from Japan, Holland and Germany Fed.

Estimation of future steel and cement production :

	1975	1980 /000 tons/	2000
Steel /probably electric furn./	50	100	300
Cement	2 000	2 500	7 000

Estimation of future refractories consumption :

	1975	1980 /tons/	2000
Fire-clay products :			
for steel	1 000	2 000	6 000
for cement	1 400	1 800	5 900
other	2 500	5 000	10 000
t o t a l	4 900	8 800	21 000

	1975	1980 /tons/	2000
Basic products :			
for steel	400	700	2 100
for cement	1 600	2 000	5 600
t o t a l	2 000	2 700	7 700

Consuming industries should resort to import to satisfy their necessities.

I R A N :

Iran has substantial deposits of iron and chrome ores, coal and magnesite. Therefore, a plan to establish an integrated steel plant /300 000 tons annually/ has been the subject of studies by the Government.

The production of crude magnesite reached 8 000 tons/year and the production of chrome are 220 000 tons/year towards the end of the last decade.

The country imported :

	in 1967	1969 /tons/	1970
Refractory bricks			
t o t a l	8 121	14 307	23 390
/value 000-US $/	/ 1 768 /	/ 15 317 /	/17 831/
mainly from : Benelux	-	-	1 279
Germany Fed.	2 174	1 640	3 099
Japar	-	-	2 573
U S A	1 783	-	1 293
USSR	-	9 868	12 539

	1967	1969 /tons/	1970
Refractory materials /other than bricks/			
t o t a l	13 513	6 785	11 197
/value 000-US $/	/ 1 416/	/ 705 /	/ 2 558 /
mainly from : Canada	-	-	5 929
Germany Fed.	983	1 128	-
Great Britain	-	1 335	-
Italy	9 263	2 203	-
South Africa	-	-	4 135

Estimated future steel and cement production :

	1975	1980 /000 tons/	2000
Steel /LD/	700	2 000	3 000
Cement	6 350	8 000	10 000

Estimated future refractories consumption :

	1975	1980 /000 tons/	2000
Fire-clay products			
for steel	12.9	34	51
for cement	4.5	5.6	7
other	22	30	50
t o t a l	39.4	69.6	108
Silica products /mainly for glass works/	1.5	2	3

	1975	1980 /000 tons/	2000
Basic products			
for steel	2.1	6	9
for cement	5.1	6.4	8
t o t a l	7.2	12.4	17

The country has all possibilities to become self-supporting to a very great extent as far as all main groups of refractories are concerned and should be confined to import some specialities only.

P A K I S T A N :

There is no integrated iron and steel industry in Pakistan. There are several electric arc furnaces which produce, together with open-hearth units, about 100 000 tons of steel per year.

The production of cement ist more developed and reached 2 700 000 tons in 1970.

Import statistics give only total value of imported refractories, such as :

	in 1967	1968	1969	1970
000 US $	2 139	1 897	2 263	2 189

The main suppliers were Japan, Great Britain, Austria, Germany Fed. and Czechoslovakia. The import of basic bricks usually did not exceed 2 000 tons/year.

Estimation of future steel and cement production :

		1975	1980 /000 tons/	2000
Steel	: O. H.	100	100	-
	E L	400	900	1.500
	t o t a l	500	1 000	1.500
Cement		3 500	5 000	10 000

Resulting estimation of refractories consumption :

	1975	1980 /000 tons/	2000
Fire-clay products			
for steel	10.1	20.1	30
for cement	2.5	3.5	7
other	4	10	20
t o t a l	16.6	33.6	57
Silica products	0.5	1	1.5
Basic products			
for steel	3.6	7.1	10.5
for cement	2.8	4	8
t o t a l	6.4	11.1	18.5

The country should try to be self-sufficient in fire-clay products and study the possibility of own production of simple assortment of basic refractories in view of the fact that the country is mining magnesite and chrome ore.

S R I L A N K A :

The country has no steel production. The cement industry produced 86 000 tons of cement in 1960 and already 326 000 tons by 1970.

Sporadic statistical data from the first half of the decade 1960-1970 registrered yearly about 300 tons of basic bricks imported from Austria and Great Britain.

In 1967 Sri Lanka imported 1 698 tons of refractory material for US $ 193.000.-

in 1969 " " " 1 909 tons for US $ 114.000.-, equally from West Europe.

952 tons of basic bricks had been imported in the value of US $ 257.000.- in 1969 also from West Europe /Great Britain and Austria/.

Expexted future steel and cement production :

	1975	1980 /000 tons/	2000
Steel /probably electric furn./	100	150	250
Cement	700	1 000	2 000
will be followed by requirements for :			
fire-clay products			
for steel	2	3	5
for cement	0.5	0.7	1.4
other	0.7	1.5	3
t o t a l	3.2	5.2	9.4
basic products			
for steel	0.7	1.1	1.8
for cement	0.6	0.8	1.6
t o t a l	1.3	1.9	3.4

These quantities can easilly be imported from abroad.

T H A I L A N D :

Steel production in Thailand is still very small /6 000 tons in 1970/.

Cement production had grown up five times in the course of the decade 1960-1970, being 540 000 tons in 1960 and 2 630 000 tons in 1970.

Early statistics mention imports of approx. 1 000 tons basic bricks yearly. More complete statistics are available from 1967 onwards.

	1967	1968	1969	1970
		/tons/		
Refractory bricks				
t o t a l	7 328	8 504	7 942	8 783
/value - 000 US $/	/1.333/	/1.234/	/1.585/	/1.745/
Main supplies :				
China	-	1 396	-	-
West Europa /Britain, Germ.Fed./	1 049	1 551	1 180	2 767
Japan	3 986	4 669	5 445	5 600
Refractory materials /Other than bricks/				
t o t a l	7 110	10 884	9 557	8 855
/value - 000 US $/	/502/	/806/	/628/	/780/

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Estimated steel and cement production :

	1975	1980 /000 tons/	2000
Steel /mainly electr.furn./	300	500	1 000
Cement	4 200	5 500	10 000

Resulting estimation of refractories consumption :

	1975	1980 /000 tons/	2000
Fire-clay products			
for steel	6	10	18.5
for cement	3	4	7
other	6	9	15
t o t a l	15	23	40.5
Basic products			
for steel	2.1	3.5	5
for cement	3.4	4.4	8
t o t a l	5.5	7.9	13

The country should give the possibility of own production of fire-clay products a serious consideration while basic products should be imported.

T U R K E Y :

Turkey steel industry made approx. 280.000 tons in 1960 and more than 1.500.000 tons in 1970. Two million tons of cement were produced in 1960 and 6.4 million tons in 1970.

I m p o r t :

	1967	1968 /tons/	1969	1970
Refractory bricks				
t o t a l	21.995	24.072	21.435	16.341
/value - 000-US $/	/ 3.430	/ 3.724/	/ 3.972/	/ 3.354/
from : Austria	2.412	4.873	5.824	4.381
Germany Fed.	11.964	7.066	6.030	3.310
Italy	4.092	3.017	3.337	2.909
U S A	1.096	3.406	3.261	1.925
Refractory materials				
t o t a l	1.970	2.938	2.018	5.274
/value - 000-US $/	/186/	/190/	/164/	/419/
/mainly from West Europe/				

E x p o r t :

	1967	1968 /tons/	1969	1970
Refractory materials				
t o t a l	36.848	55.489	59.900	95.928
/value - 000 US $/	/1.597/	/2.868/	/3.371/	/4.295/

/Mainly magnesite to Austria, Belgium, Holland, Germany Fed. and Czechoslovakia./

Besides that Turkey exports big quantities of chrome ore for refractory purposes.

Future trends of steel and cement production :

	1975	1980 /000 tons/	2000
Steel : O. H.	200	-	-
oxygen vessels	2 000	3 200	4 000
t o t a l	2 200	3 200	4 000
Cement	7 000	9 000	15 000

Estimated future consumption of refractories :

	1975	1980 /000 tons/	2000
Fire-clay products			
for steel	38.2	54.4	68
for cement	5	6.3	10.5
other	12	20	40
t o t a l	55.2	80.7	118.5
Basic products			
for steel	7.6	9.6	12
for cement	5.6	7.2	-
t o t a l	13.2	16.8	24

Turkey has already refractories industry manufacturing also basic products. Owing to the large deposits of raw materials, among them magnesite and chrome ore, the country has every chance to become self - supporting in refractories.

IV. CONCLUSIONS

The purpose of the paper was to to review the world's production of main groups of refractories and show the significance of refractories as an article of foreign trade of a number of selected countries.

On the basis of expected trends of steel and cement industries of the selected countries an attempt was made to forecast future requirements for refractories in the respective countries together with recommendations how to provide them.

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ESTADISTICAS SOBRE COMERCIO DE PRODUCTOS REFRACTARIOS[1/]

O. Bursák*

RESUMEN

La extensa aplicación de los productos refractarios en la industria hace de ellos un capítulo importante del comercio internacional. Sin embargo, a partir de la segunda guerra mundial se han modificado las corrientes comerciales, por haber construido la mayoría de los países consumidores sus propias plantas de fabricación de productos refractarios.

Si bien no se pueden obtener cifras concretas sobre la producción y el comercio mundial de productos a base de sílice y de arcilla refractaria, se dan unos cuadros con información detallada sobre los refractarios básicos, de forma que se advierte claramente el rápido incremento que viene tomando este grupo de productos.

Dado que la industria siderúrgica consume alrededor de un 70% de la producción mundial total de refractarios, se consagra un capítulo especial a la relación entre la producción de acero y el consumo de refractarios.

Se recogen en cierto número de cuadros las tendencias que se prevén para el futuro consumo de productos refractarios en la industria siderúrgica, en la del cemento y en otras ramas industriales, y se subrayan las tendencias presumibles del comercio internacional de refractarios. Se llega a la conclusión de que en el futuro sólo tendrá importancia el comercio de productos refractarios hiperaluminosos, especiales y, sobre todo, básicos, mientras que el comercio de productos refractarios a base de sílice y de arcilla refractaria se efectuará tan sólo en pequeñas cantidades y a corta distancia.

1/ Las opiniones que el autor expresa en este documento no reflejan necesariamente las de la Secretaría de la ONUDI. La presente versión española es traducción de un texto no revisado.

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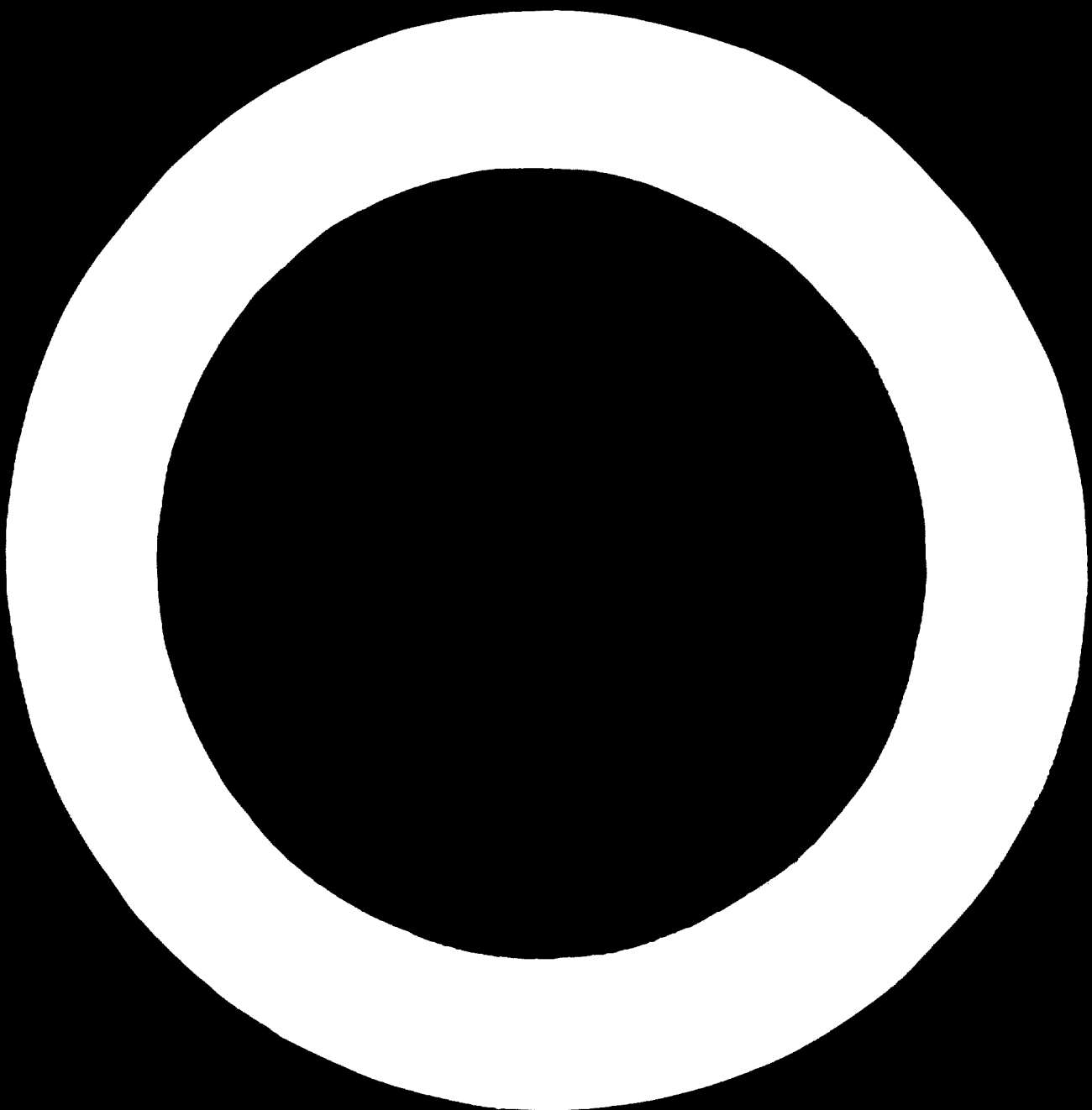
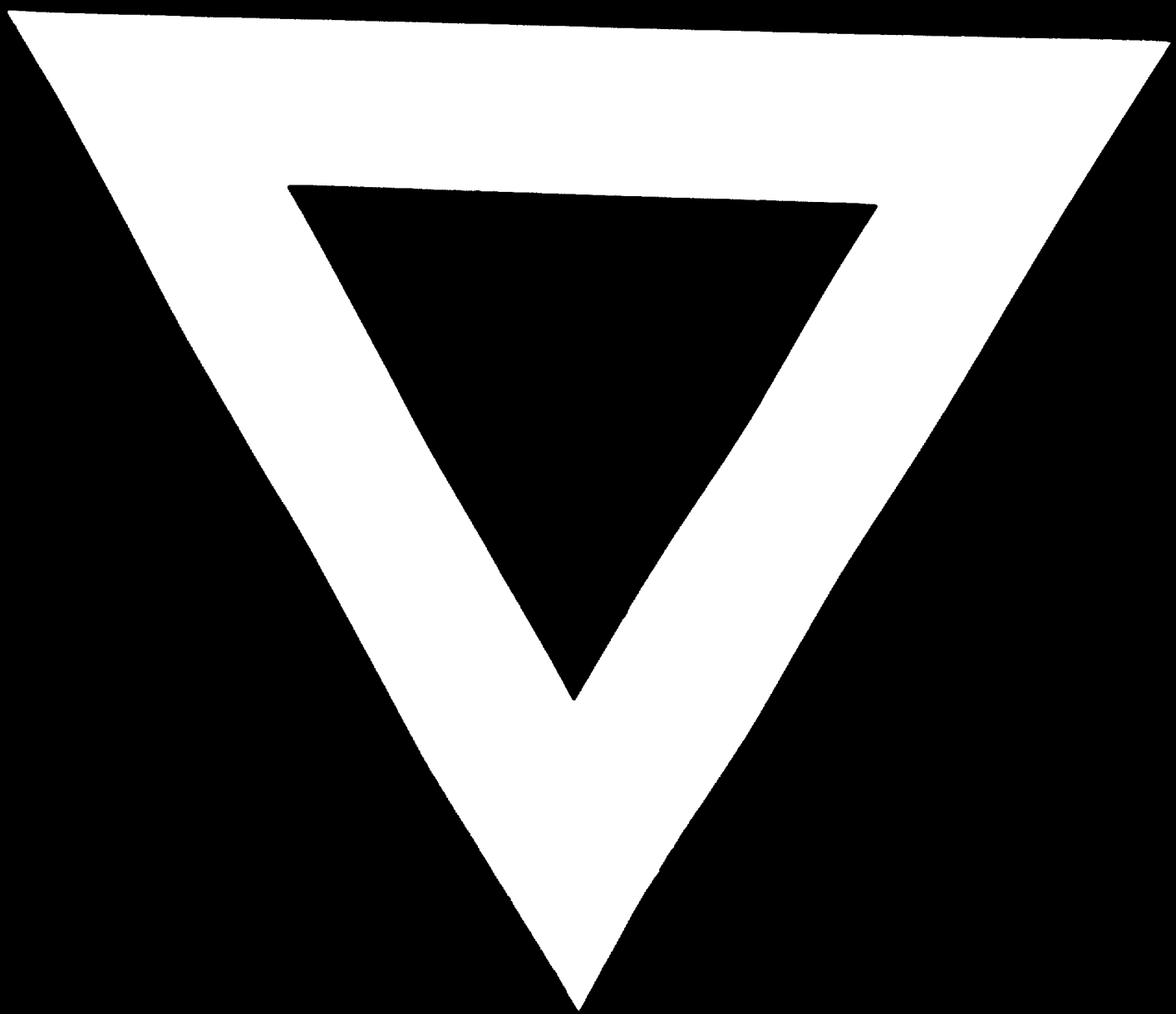


La segunda mitad de la monografía está dedicada a la presentación de estadísticas comerciales y de pronósticos sobre las futuras necesidades de productos refractarios en determinados países, calculadas sobre la base de las previsiones de la industria siderúrgica y del cemento en cada país.



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