Trends in the Ferrochromium Market of the Western World

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SYNOPSIS

Reference is made to the world production of chromite ore (as being the raw material of the world ferrochromium industry), with breakdown to some countries for the year 1971.

A detailed study of the U.S. Bureau of Mines' annual statistics on ferrochromium consumption and International Nickel's statistics of Western World stainless-steel production show that there is a close correlation between them. This has been used to estimate the Western World's ferrochromium consumption from 1950 to 1972 with breakdown to types of high-carbon and low-carbon ferrochromium and ferrochromium—silicon. The trends obtained have been used as a basis to attempt a forecast of the Western World's ferrochromium demand to 1985. The complementary nature of high- and low-carbon ferrochromium demand has permitted the forecast also of the demand for these types.

The London prices for various grades of ferrochromium since 1956 are summarized; their differences, movements, and relation to Western World consumption are commented on.

Reference is made to the ferrochromium industry of Southern Africa and its importance, with supporting statistics of exports and estimated production for South Africa.

INTRODUCTION

Ferrochromium, or more familiarly ferrochrome, is the alloy, containing the metal chromium, that is the international form in which chromium is marketed. There are considerable variations in ferrochromium depending on the end use for which it is required. The U.S. Bureau of Mines lists 15 varieties under the heading of high-carbon (including charge chromium), medium-carbon, ferrosilicon—chromium, and low-carbon ferrochromium—silicon [1-10]. The forms that make up the greatest portion of world trade are high-carbon including charge chromium, low-carbon, and ferrochromium —silicon: the last is also known as silicochromium and chromium silicide. The use of these terms differs from country to country.

Ferrochromium is manufactured by various metallurgical processes from chromite ore. The U.S. Bureau of Mines' statistics for 1971 show that, in the U.S.A., 65,9 per cent of the chromite ore consumed went to the metallurgical industry, 17,7 per cent to the refractory industry, and 16,5 per cent to the chemical industry. Furthermore, of high- and low-carbon ferrochromium consumed, 65 per cent went to the manufacture of stainless steel, the remaining 35 per cent going into carbon steels, cast irons, tool steels, and other alloys, such as welding and hard-facing rods and materials.

The ferrochromium and stainless-steel industries in the Western World are therefore intimately related, and this relationship has been used in estimating some of the trends to be discussed in this paper.

CHROMITE ORE

Chromite ore is the raw material for the world's ferrochromium industry. It is still classified into metallurgical (high), refractory (middle), and chemical (low) grades according to its chemical composition. Its physical condition (that is, whether it is fine or lumpy) is important. This terminology is fast losing its significance owing to new processes, which enable low-grade ores to be used for metallurgical processes, and the fact that some of them have been proved suitable for refractory purposes.

High-grade ore in a lumpy condition with a minimum chromium oxide (Cr_2O_3) content of 48 per cent and a chromium/iron ratio of 2,8 to 1 minimum is preferred for the manufacture of high-carbon ferrochromium and charge chromium by conventional processes.

Table 1 gives the world chromite production in 1971 in units of 1000 tonnes.

Table 1

World production of chromite by countries (U. S. Bureau of Mines) (units: 1000 t)

	1971	%	Acc. %	Type
U.S.S.R.	1 796	28,5	28,5	All grades
South Africa	1 644	26,1	54,6	Dominantly low-grade
Turkey	603	9,6	64,2	High-grade
Albania	535	8,5	72,7	Middle-grade
Philippines	432	6,9	79,6	Some high-grade
Rhodesia	363	5,8	85,4	High-grade
India	261	4,1	89,5	Some high-grade
Iran	200	3,2	92,7	High-grade
Others	459	7,3	100,0	
	6 292	100,0		

The chief producers of high-grade ore are the U.S.S.R., Turkey, the Philippines, and Rhodesia. Russian ores are expensive, at present quoted at U.S. $40-44 c.i.f. per tonne, and are the main cause of the U.S.A. breaking United Nations sanctions to obtain more reasonably priced Rhodesian ore. Supplies from Turkey, the Philippines, India, Iran, and other small producers are not sufficient to meet world demand. South Africa produces a small quantity of high-grade ore from the Consolidated Chrome Corporation's mine near Rustenburg, western Transvaal; concentrates with Cr_2O_3 contents of up to 49 per cent are also produced by the upgrading of ore from Amcor's mine in the northern Transvaal, and this amounted to 48 000 tonnes in 1972, about half of which is

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consumed locally, and was only 3,3 per cent of total production.

Owing to the fact that world production and reserves of high-grade chromite are limited, whereas South Africa possesses probably the largest reserves in the world of easily available low-grade ore with a Cr_2O_3 content of 44 per cent and a chromium/iron ratio about 1,5 to 1, mostly in a fine physical condition, much research has been directed to the beneficiation of this ore on the following lines:

(1) the raising of its chromium content and thereby also its chromium/iron ratio,
(2) the agglomeration of fines by sintering or pelletization, and
(3) the search for a metallurgical process that would be capable of utilizing the Transvaal ore as it exists in nature, or after very simple beneficiation by the removal of gangue minerals in the run-of-mine ore[12].

SPECIFICATION AND PRICES OF FERROCHROMIUM

Table 2 gives a brief specification of the types and prices currently quoted on a delivered basis in *London Metal Bulletin*, except that for charge chromium, which is from another source.

Table 2

Specifications and prices for ferrochromium, according to London Metal Bulletin

	Cr	Si	C	New pence per kilogram contained Cr		£ per ton gross
	%	%	%	Range	Average	Average
Charge chromium	55	+3	4-8	–	17,3	95
High-carbon	60	–	4-6	18,0-19,0	18,5	111
Low-carbon	68-70	–	0,1	27,8-29,0	28,4	196
Low-carbon	68-70	–	0,03	30,8-31,8	31,3	216
Low-carbon	68-70	–	0,015	34,0-34,5	34,3	237
Silico-chromium	37-39	40-47	0,05	36,8-40,8	38,8	147

It is appropriate to mention that much low-carbon ferrochromium is marketed with a lower chromium content than 68 to 70 per cent — in fact, about 55 per cent. The reason is that the 68 to 70 per cent variety has a high melting-point and is therefore not suitable for melting in the induction furnace, whereas the 55 per cent variety is. The price differential between these grades is apparently very small for the reason given.

The price differential of the carbon grades, however, is quite considerable. Low-carbon ferrochromium at 0,03 per cent carbon averaging 31,3 pence per kilogram contained is just under twice that of the cheapest variety – charge chromium at 17,3 pence. On a gross ton basis the ratio is just about 2¼, but, with a chromium content of 55 per cent, the ratio would also be just under two.

FERROCHROMIUM CAPACITY AND PRODUCTION IN THE WESTERN WORLD

Reliable statistics on these items are elusive, but it has been possible to draw up a summary of estimates (Table 3) based on information from various sources[6,9].

Table 3

Ferrochromium capacity and production (unit: 1000 t)

	Capacity	Per cent	Production	Per cent capacity utilized
Japan	780	33,8	420	53,8
U.S.A.	390	16,9	324	83,1
South Africa	290	12,6	160	55,2
W. Germany	220	9,5	190	86,4
France	150	6,5	110	73,3
Rhodesia	150	6,5	130	86,7
Sweden	95	4,1	64	67,4
Italy	55	2,4	30	54,5
Norway	45	1,9	40	88,9
Others	135	5,8	91	–
	2 310	100,0	1 524	66

Figures are, of course, changing all the time, as old plants are scrapped and new ones built. These figures reflect the approximate position to about the end of 1972. It will be observed that the Western World's ferrochromium industry is working at about 66 per cent capacity at 2¼ million tonnes and production about 1½ million tonnes. Japan has the largest capacity in the Western World, but is using only about 54 per cent, owing to the cut-back in production over the last 18 months to meet the decline in Western World demand. It would appear that South Africa, with about 290 000 tonnes capacity, is only using about 55 per cent; this probably is because the extra capacity was not quite finished or ready in 1972. Reports of projected plants in various countries, in particular Italy and South Africa, indicate that Western World capacity will probably increase to 2 400 000 tonnes in 1972 and 2 650 000 tonnes in 1975.

TREND IN FERROCHROMIUM CONSUMPTION BY THE WESTERN WORLD

Figures of Western World consumption are not generally available, except for certain countries, one of which is the U.S.A. Figures of stainless-steel production, however, are available for the major producing countries[8]. In 1971, they were as shown in Table 4, and illustrate how Japan has established herself in a commanding position.

Table 4

Consumption of ferrochromium by the Western World, 1971

(units: 1000 t)

		Per cent
Japan	1 404	32,5
U.S.A.	1 141	26,4
France	394	9,1
W. Germany	370	8,6
Sweden	340	7,9
Italy	216	5,0
United Kingdom	166	3,8
Others	289	6,7
TOTAL	4 320	100,0

It will be observed that these countries are almost the same as those listed in the previous producers of ferrochromium, but with the absence of South Africa and Rhodesia and the addition of the United Kingdom, which imports ferrochromium for her stainless-steel industry.

It is estimated that, of capacity and production, 47 per cent was for high-carbon and 55 per cent for low-carbon ferrochromium. Of the latter, however, some was definitely ferrochromium—silicon, and therefore the ratio of high- to low-carbon ferrochromium is roughly 1:1 at the moment.

FERROCHROMIUM CONSUMPTION AND ITS RELATION TO STAINLESS-STEEL PRODUCTION

It has already been mentioned that, in 1971, 65 per cent of the ferrochromium consumption in the U.S.A. went into the manufacture of stainless steel. A systematic study of the U.S. figures over the period 1950 to 1972 has shown that this ratio varies within narrow limits, ranging from 63,2 per cent to 31,2 per cent, and averaging 66,5 per cent. It is not surprising, therefore, that time graphs of

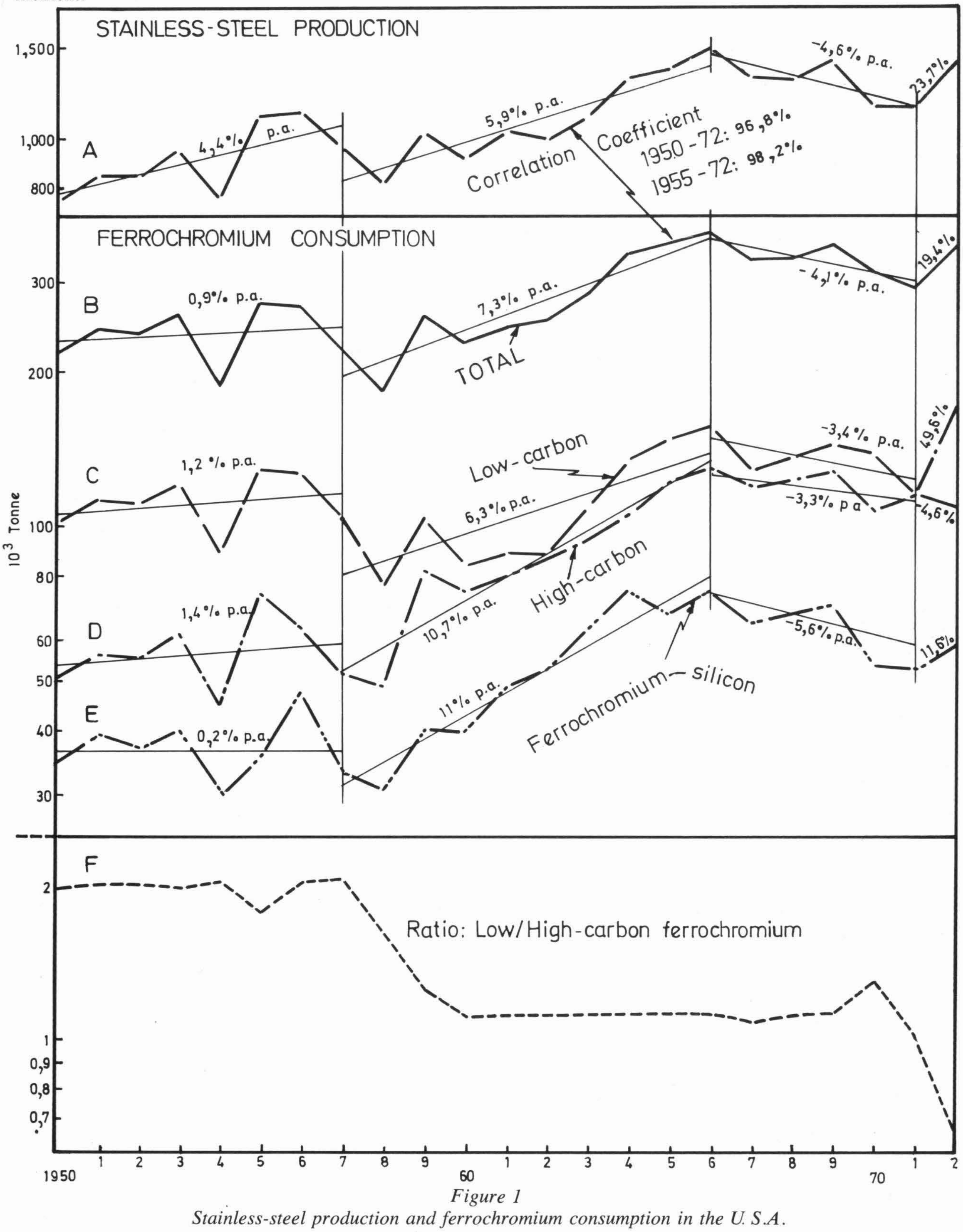

Figure 1
Stainless-steel production and ferrochromium consumption in the U.S.A.

U.S. consumption of ferrochromium and production of stainless steel show a strong correlation (see graphs A and B of Figure 1). The correlation coefficient has been calculated at 96,8 per cent from 1950 to 1972 and 98,2 per cent from 1955 to 1972.

From the very complete statistics, including breakdown to types, of ferrochromium consumption kept by the U.S. Bureau of Mines, it is possible to determine the ratios of the types consumed in stainless-steel production (on an annual basis). It can be assumed that these ratios also hold good for the other major stainless-steel-producing countries, and, therefore, estimates of ferrochromium consumption with breakdown to type can be based on their individual stainless-steel production[8]. The summation of their individual consumptions gives a total for the Western World. This has been done for the years 1950 to 1972 (see Table 5). Checks are possible from figures of ferrochromium consumption of the United Kingdom and Japan, which indicate that the estimated figures correspond closely with the factual in these two cases.

Table 5

Stainless-steel production and estimated ferrochromium consumption[1,2,8] in the Western World (with breakdown to low-carbon, high-carbon ferrochromium, and ferrochromium—silicon 1950 to '72 with forecast of demand to 1985. Unit 1000 t)

	Production of stainless steel	Ferrochromium capacity	Ferrochromium consumption Low-carbon	Ferrochromium consumption High-carbon	Total low- & high-carbon	Consumption of ferrochromium—silicon*	Total all types
1950	1 000		137	69	206	47	253
1951	1 150		153	76	229	52	281
1952	1 190		155	77	232	51	283
1953	1 290		164	83	247	54	301
1954	1 185		140	69	209	47	256
1955	1 640		184	105	289	66	355
1956	1 735		199	98	297	69	366
1957	1 600		178	87	265	57	322
1958	1 480		143	89	232	57	289
1959	1 920		192	153	345	75	420
1960	2 150		198	176	374	94	468
1961	2 346		202	182	384	110	494
1962	2 146		192	189	381	114	495
1963	2 506		248	214	462	143	605
1964	3 126		323	273	596	180	776
1965	3 262		356	294	650	164	814
1966	3 611		374	313	687	179	866
1967	3 760		367	342	709	186	895
1968	4 050		429	383	812	212	1 024
1969	4 630		471	417	888	229	1 117
1970	4 950	2 000	591	455	1 046	226	1 272
1971	4 320		436	432	868	197	1 065
1972	4 600†	2 300	358†	557†	915†	192†	1 107†
			FORECAST				
1973	5 020	2 400	291-321	699-729	1 020	210	1 230
1974	5 490		255-297	833-875	1 130	230	1 360
1975	5 990	2 650	235-284	976-1025	1 260	250	1 510
1976	6 610		225-281	1139-1195	1 420	270	1 690
1977	7 300		221-282	1318-1379	1 600	300	1 900
1978	8 060		220-286	1514-1580	1 800	330	2 130
1979	8 900		222-291	1729-1798	2 020	360	2 380
1980	9 820	3 000-3 250	226-301	1969-2044	2 270	400	2 670
1981	10 800		254-338	2212-2296	2 550	440	3 000
1982	11 970		286-380	2490-2584	2 870	480	3 360
1983	13 220		321-428	2802-2909	3 230	530	3 770
1984	14 590		362-482	3158-3278	3 640	580	4 220
1985	16 110		407-542	3548-3683	4 090	630	4 730
Growth rate p.a.							
1973-75	9,2%			20,4-22,3	11,3%		10,9%
1975-80	10,4%			14,8-15,0	12,5%		12,1%
1980-85	10,4%		12,5%	12,5%	12,5%		12,1%

* Also known as chromium silicide and silicochromium.

† Figures preliminary and subject to amendment.

The U.S. figures have been plotted in Figure 1, and the estimated Western World figures in Figure 2. The total U.S. ferrochromium consumption, graph B, gives an average growth rate of 7,3 per cent per annum for 1957 to 1966 and a fall from 1966 to 1971. The years 1971 to 1972 exhibit a recovery of 19 per cent. The graphs C (low-carbon) and D (high-carbon) show the same rise and fall as B: they parallel each other, with low-carbon being above high-carbon from 1967 to 1970, after which they approach each other in 1971 and cross between 1971 and 1972, showing how the consumption of low-carbon ferrochromium rose above high-carbon in 1972. Graph F, giving the ratio of low- to high-carbon, shows a fall from 1957 to 1962 and then a slow recovery to 1970, and thereafter a steep fall to 65 per cent in 1972. Thus, although a warning was sounded about 1962 that, owing to the introduction of oxygen blowing, etc., the swing would be towards high-carbon as distinct from low-carbon ferrochromium, it has taken a decade for this trend to become apparent. Obviously, it has taken as long to perfect the new metallurgical processes to the extent of their becoming eventually economic. Another factor is that such large amounts of capital have to be invested in these plants that, once erected, it is quite impossible to change them until such time as they have become amortized and/or have become inefficient in operation. This is even more so in the case of stainless steel and its rolled products than in the case of ferrochromium.

The estimated Western World consumption figures of the major consumers for the years 1950 , 1955, 1960, and 1971 are given in Table 6.

Table 6

Major consumers of ferrochromium in the Western World (units: 1000 t)

	1950	1955	1960	1971	Per cent
U.S.A.	188	190	158	229	26,4
Japan	2	6	41	282	32,5
W. Germany	10	22	45	74	8,5
France	7	13	32	79	9,1
Sweden	14	14	31	68	7,8
Italy	2	3	10	43	5,0
U.K.	20	24	39	34	3,9
Others	10	9	18	59	6,8
TOTAL	253	281	374	868	100,0

Japan is now the principal consumer, followed by the U.S.A., France, W. Germany, Sweden, Italy, and U.K. Figures for the estimated total consumption of the Western World for the years 1950 to 1972 are given in Table 5.

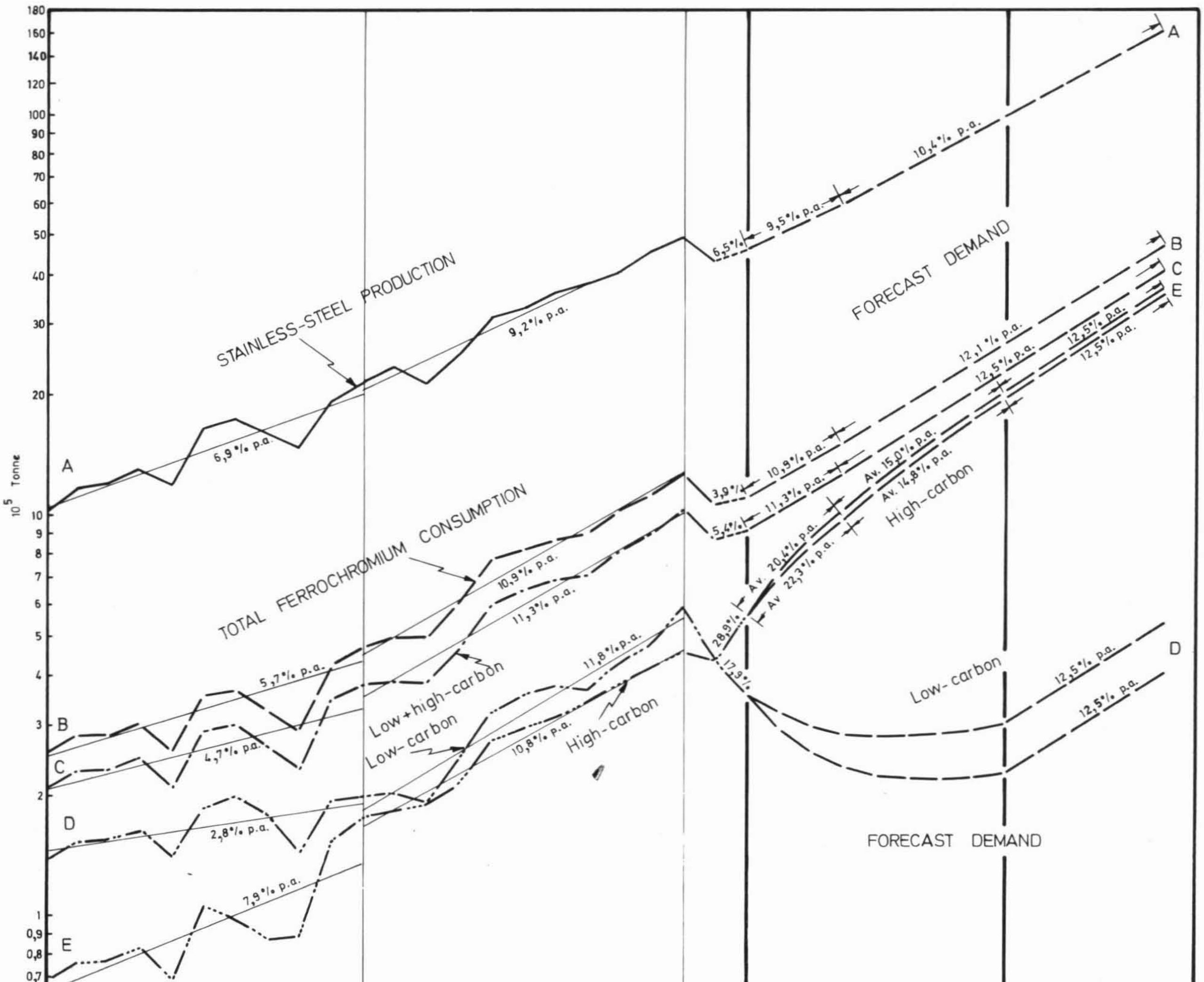

Figure 2

Stainless-steel production and estimated ferrochromium consumption in the Western World

FORECAST OF FERROCHROMIUM CONSUMPTION IN THE WESTERN WORLD

An analysis of the trends from the historical graphs of ferrochromium consumption and stainless-steel production for the Western World in Figure 2 is made in Table 7 for the period 1960 to 1970.

Table 7

Trends in ferrochromium consumption

	Growth rate per annum, %	Increase 1971 to 1972, %
Stainless-steel production	9,2	6,5
Total consumption of ferrochromium	10,9	3,9
Consumption of low- and high-carbon ferrochromium	11,3	5,4
Consumption of low-carbon ferrochromium	11,8	−17,9
Consumption of high-carbon ferrochromium	10,8	28,9

One can conclude from these figures that (1) the overall differential in the compound growth rates of stainless-steel production and total ferrochromium consumption is due to a gradually decreasing chromium grade or content of the ferrochromium utilized over the period, and (2) the small differential of 0,4 per cent between the growth rate of total ferrochromium and low- plus high-carbon ferrochromium is due to an increase of low and high at the expense of ferrochromium—silicon.

The break in these growth rates in 1970 to 1972 due to the world recession has been followed by recoveries from 1971 to 1972, also given above. These recoveries are sufficient to suggest that the historical rates of 9,2, 10,9, and 11,3 per cent per annum for stainless steel, ferrochromium consumption, and low- and high-carbon ferrochromium consumption respectively can be used in projections to 1975. U.S. authorities are already estimating a growth rate for ferrochromium consumption beyond 1975 at 15 per cent per annum. This may well be realized – depending on the tempo of recovery and on the increasing uses of stainless steel, particularly high-chromium stainless (without nickel) in catalytic-converter housing for cars. But it is thought prudent in these estimates of forecasts to use a growth rate from 12,1 to 12,5 per cent per annum for total and low- plus high-carbon ferrochromium consumptions respectively, whereby the probable growth rate for stainless steel to correspond with these would be 10,4 per cent per annum.

The quantitative consumptions of low- and high-carbon ferrochromium types (including charge chromium) are complementary to each other, in that the sum of the two must give the trend of low- plus high-carbon (graph C of the forecast portion of Figure 2). The way in which the trend of low-carbon ferrochromium behaves will be influenced very largely by the trend in metallurgical techniques for the manufacture of stainless steel and their economics, and also by the quantity of scrap utilized. This varies from over 50 per cent in the older countries, such as U.S.A. and the United Kingdom, to about 25 per cent for newer countries such as Japan – it tends to be cyclical, increasing with industrial turnover, for with increased utilization of scrap is likely to go increased consumption of low-carbon ferrochromium.

The forecast demand for low-carbon ferrochromium will ultimately depend on the trend of the high-carbon to low-carbon ratio. The consumption figures for 1970 to 1972 for these two types (Table 5) in units of 1000 tonnes (see also graphs D and E of Figure 2) are as follows:

	Low-carbon	High-carbon	Ratio of high-carbon to low-carbon
1970	591	455	0,77
1971	436	432	Nearly 1
1972	358	557	1,56

The increase in the ratio for 1971 to 1972 is 56 per cent. A Japanese authority has given his opinion that the ratio of high-carbon to low-carbon ferrochromium (in Japan) will tend towards 10:1. Assuming it will reach this level in 1980, this represents an increase of 67,6 per cent per annum (linear) from 1,56 in 1972. The graphs in Figure 3 give the calculated low-carbon-ferrochromium demand for varying rates of increase (of ratio) from 10 per cent per annum (linear) up to the above 67,6 per cent per annum to 1980, and for the period 1980 to 1985 assuming that the achieved ratio in 1980 will remain constant. The figures are as listed in Table 8.

Table 8

Ferrochromium demand for various rates of increase (unit: 1000 t)

Ratio increase per annum linear	1980 ratio	1980 low-carbon demand	1985 low-carbon demand
%			
10	2,8	596	1 073
20	4,1	449	808
30	5,3	360	649
40	6,6	301	542
50	7,8	258	465
60	9,1	226	407
67,6	10,0	206	372

The graphs for 1980 to 1985 will, of course, be straight lines parallel to the 12,5 per cent per annum compound trend of the total low-carbon and high-carbon curve of Figure 2. In Figure 3 are also plotted the high-carbon-ferrochromium demand trend lines at 10, 40, and 67,6 per cent rate of ratio increase, corresponding to these estimated low-carbon figures.

Although it is quite possible that the ratio of high-carbon to low-carbon ferrochromium will increase to 10 : 1 in Japan by 1980, it seems unlikely that a Western World figure would be so high. A range between 6,6 and 9,1 has been selected, with ratio increases of 40 and 60 per cent respectively to 1985; these have been plotted in Figure 2.

On the basis of the assumptions made, conclusions from the graphs of Figure 3 are that, even with linear annual increases in the high-carbon to low-carbon ratio of up to 50 to 68 per cent per annum, the initial fall in demand of low-carbon ferrochromium will tend to recover towards the end of the 1980s and then increase thereafter. The latter increase will, of course, depend on the total demand of all ferrochromium types, which has been assumed to be in the region of 12,5 per cent per annum compound. If this should prove greater, then demand for low-carbon ferrochromium after 1980 will also

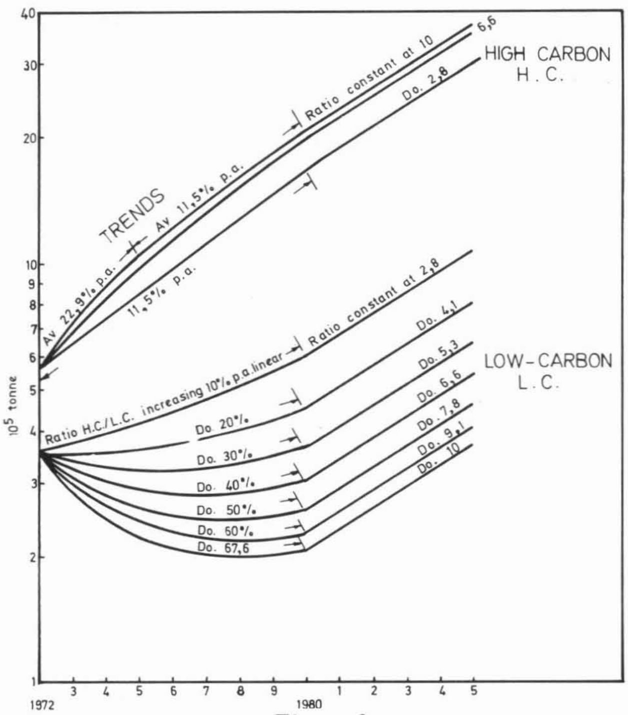

Figure 3

Forecast demand for high- and low-carbon ferrochromium in the Western World (on the basis of an increasing ratio of high-carbon to low-carbon ferrochromium to 1980, and a constant ratio from 1980 to 1985)

be greater. As a corollary, the demand for high-carbon ferrochromium and charge chromium will be trending at between 20,4 and 22,3 per cent per annum to 1975 and between 14,8 and 15 per cent per annum to 1980, and thereafter at 12,5 per cent per annum (all compound).

It can be concluded that the use of low-carbon ferrochromium will not die out entirely, although it is probable that the downward trend will continue for some years before a recovery materializes, as indicated above.

TRENDS IN FERROCHROMIUM PRICES

Average London prices for grades of ferrochromium (reduced to new pence per kilogram) are plotted on an annual basis from 1956 to 1971 and monthly thereafter in Figure 4; the grades are low-carbon 0,03 per cent, 0,06 per cent, 0,1 per cent, and high-carbon 6 to 4 per cent. At some point, quotations for 0,25 per cent carbon were discontinued and replaced by 0,1 per cent carbon, showing a shift in demand for types.

The salient figures are given in Table 9 in new pence per kilogram of contained chromium.

There was a general fall in prices from 1956 to the period between 1964 and 1967, and then a considerable recovery to a peak in 1971, after which the prices slackened to the end of 1972, with a recovery in April 1973. A considerable proportion of this rise was due to the effective devaluation of the floating pound sterling, and the remainder to increased demand. The price ratio of low- to

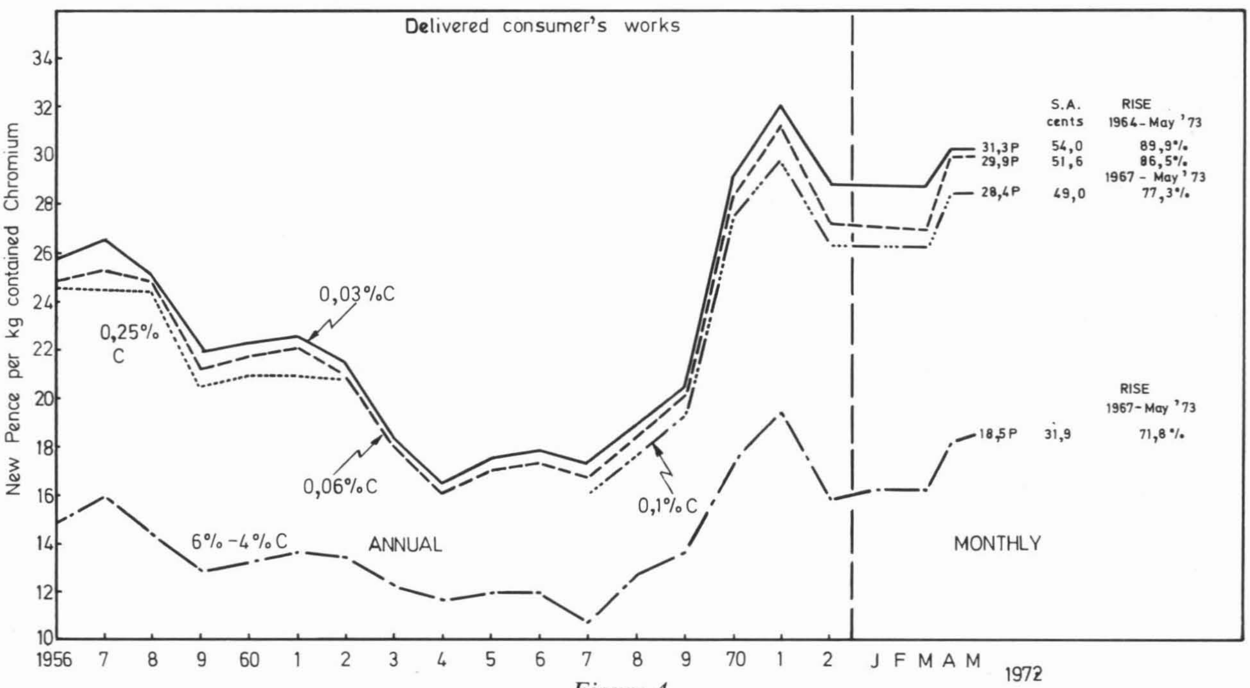

Figure 4

Average London prices for three grades of low-carbon (68 to 78 per cent Cr) and one grade of high-carbon (60 per cent Cr) ferrochromium

Table 9

Trends in ferrochromium prices

Grade	1956	1964	1967	1971	1972	May '73	Rise	Period
Low-carbon 0,03%	25,72	16,48	17,28	32,08	28,78	31,30	89,9	1964—May '73
High-carbon 6 to 4%	14,75	11,77	10,77	19,42	15,90	18,50	71,8	1967—May '73
Ratio of low-carbon to high-carbon	1,74	1,40	1,60	1,65	1,81	1,69		

high-carbon is at present about the same as it was in 1956 – and indicates that the low-carbon price is about 69 per cent above the high-carbon. The price ratio of low-carbon to charge chromium at present at 17,3 new pence per kilogram is 1,81, or low-carbon is 81 per cent above charge chromium. The rise from the lowest to the present value is 89,9 per cent in the case of low-carbon (0,03 per cent) and 71,8 per cent in the case of high-carbon.

These trends and figures indicate quite clearly that, in spite of the swing towards high-carbon ferrochromium shown in Figures 1 and 2, the demand for low-carbon ferrochromium remains brisk; so far there has been no fall that is not also reflected in the high-carbon price graph. The price differential of low-carbon compared with high-carbon and charge chromium is 69 per cent and 12,8 pence, and 81 per cent and 14 pence, respectively. This indicates that, if it were possible to produce low-carbon ferrochromium at prices lower than those ruling in London, considerable profits should be realized.

FORECAST OF FERROCHROMIUM CAPACITY AND DEMAND IN THE WESTERN WORLD.

The forecast picture to 1980 built up from the figures of Table 5 is given in Figure 5. A summary of the figures of this diagram is given in Table 10.

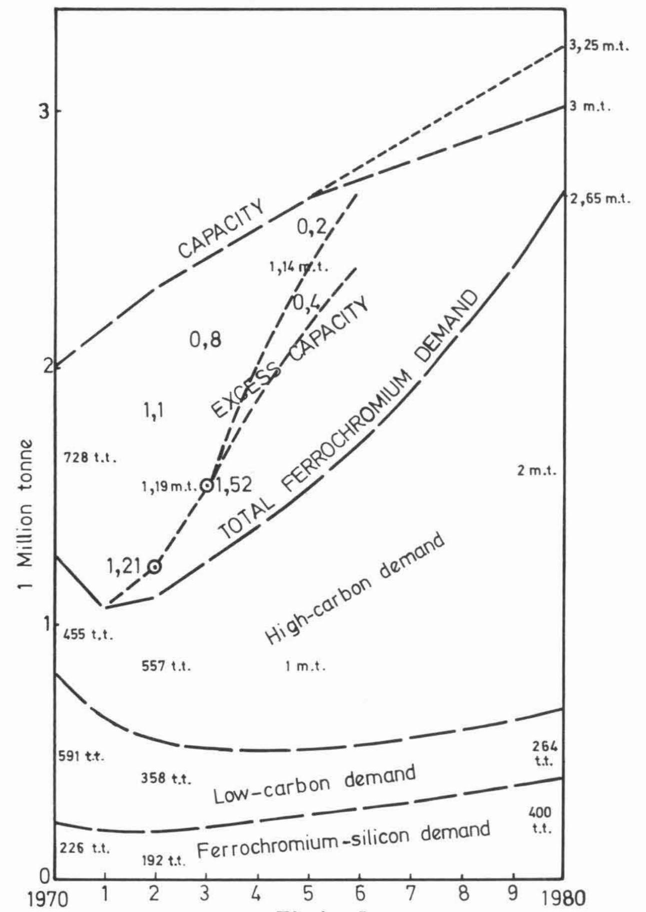

Figure 5

Ferrochromium capacity and demand in the Western World (m.t. = million tonnes, t.t. = thousand tonnes)

Capacity in 1970 was 2 million tonnes and is expected to increase to 2,65 million tonnes in 1975 and to between 3 and 3,25 million tonnes in 1980. It is conceivable that the graph is somewhat on the high side, because news is being received of numerous closures of American plants owing to their inability to work economically under the

Table 10

Ferrochromium capacity and demand in the Western World

(unit: 1000 t)

	1970	1972	1975	1980
Capacity	2 000	2 300	2 650	3 000-3 250
Consumption – demand	1 272	1 107	1 510	2 670
Excess capacity	728	1 193	1 140	330-580
Per cent utilized	63,6	51,9	57,0	82-89
Breakdown				
High-carbon	455	557	1 000	2 000
Low-carbon	591	358	260	264
FeCrSi	226	192	250	400

enforcement of pollution laws. It is very difficult, however, to attempt an evaluation of the amount of capacity so involved until more details are available. The difference between the demand graph and the capacity gives excess capacity. This was estimated at about 36 per cent in 1970, since when it increased to 52 per cent in 1972. The ideal movement of capacity from 1975 to 1980 would be from 2,65 million tonnes to 3 million tonnes, which would tend to close the gap between demand and capacity. The ferrochromium industry is, however, an extremely competitive one with little cooperation between producers (cooperation that would be needed to keep the capacity at a reasonable growth); it is therefore highly probable that capacity will tend to increase at the high rate shown (or even more so) because producers will tend to overreach themselves in their anxiety to participate in the forecast boom period.

The ferrochromium industry of the Western World is therefore at the moment in a rather dangerous condition, with a large excess capacity, estimated at about 50 per cent of the total. The signs of a recovery are irrefutable, with the result that all producers will be poised to take advantage of the situation, particularly after 1975. The danger is that, instead of allowing the estimated gap between capacity and demand to close, producers will increase their capacity to such an extent as to keep the gap open or even make it wider.

FERROCHROMIUM INDUSTRY OF SOUTHERN AFRICA

The companies involved in ferrochromium production are Amcor, Anglo-Transvaal (with Associated Ore and Metal), Barlow—Rand, and Anglo American; in Rhodesia they are Union Carbide and Anglo American.

It is sometimes difficult to interpret figures of capacity or production of ferrochromium—silicon, because, in some cases, although produced, it is not sold but is utilized directly for the manufacture of low-carbon ferrochromium. One cannot, however, ignore or omit it in statistical summaries, because this would also introduce anomalies into them.

A brief estimated summary for Southern Africa is given in Table 11.

In South Africa at the moment there is an estimated balance in favour of low-carbon ferrochromium – 124 600 tonnes as against high-carbon's 109 000 tonnes. This is probably due to the fact that Anglo-Transvaal's plant at Machadodorp, which started up in 1972 with a capacity of 50 000 tonnes, is designed to produce low-

Table 11

Production of ferrochromium in Southern Africa (unit:t)

	High-carbon and charge chromium	Low-carbon	Ferro-chromium—silicon	Total 1972	Total 1973
South Africa	109 000	124 600	57 500	291 100	341 100
Rhodesia	66 000	20 000	64 000	150 000	150 000
	175 000	144 600	121 500	441 100	491 100

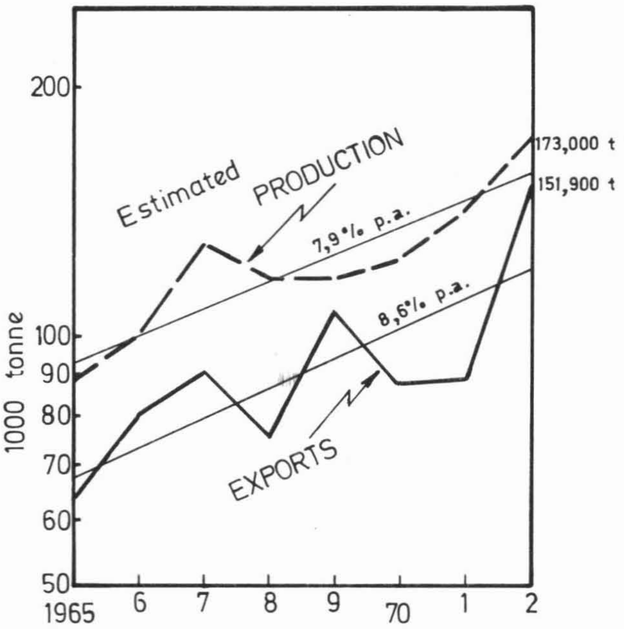

Figure 6

South African production and exports of ferrochromium.

carbon ferrochromium. There is, however, likely to be a change this year when Amcor's charge-chromium capacity at Witbank is brought up to 100 000 tonnes.

South Africa's exports and estimated production are tabulated in Table 12 and plotted in Figure 6.

Exports have increased at the average growth rate of 8,6 per cent per annum, and estimated production at 7,9 per cent per annum. Preliminary figures for 1972 indicate that exports at 151 870 tonnes valued at R18,8 million have increased by 71 per cent over the 1971 figures. The value, however, has increased only by 41 per cent, indicating a higher content of the cheaper high-carbon ferrochromium or charge chromium.

Table 13 gives a breakdown to destination of ferrochromium exports for 1971 in order of importance, which illustrates the fact that exports are world-wide.

Table 13

Destination of South Africa's exports of ferrochromium

	Tonne	%	Accum. %
1. U.S.A.	32 316	36,4	36,4
2. Canada	16 551	18,6	55,0
3. W. Germany	8 614	9,7	64,7
4. U.K.	7 935	8,9	73,6
5. Sweden	6 757	7,6	81,2
6. Australia	4 993	5,6	86,8
7. Japan	4 808	5,4	92,2
8. Italy	3 314	3,7	95,9
9. Switzerland	3 042	3,4	99,3
10. Austria	254	0,3	99,6
11. Brazil	163	0,2	99,8
Others	165	0,2	100,0
TOTAL	88 912	100,0	

Of the exports, 96 per cent was taken by U.S.A., Canada, W. Germany, United Kingdom, Sweden, Australia, Japan, and Italy.

South African ferrochromium consumed in the production of stainless steel at Southern Cross, Middelburg, can

Table 12

South Africa's exports, and estimated production and capacity, of ferrochromium[7,9] (with estimated breakdown to types)

	Exports		Estimated production		Estimated capacity, t			
	Tonnes	R1 000	Tonnes	R1 000	Low-carbon	High-carbon	FeCrSi	Total
1964	28 560	3 415	37 350	4 460				
1965	62 930	9 286	88 060	12 990				
1966	79 860	13 703	99 670	17 110				
1967	90 340	13 140	130 800	19 020				
1968	75 960	10 941	118 100	17 020				
1969	107 473	14 306	117 000	15 560				
1970	87 829	13 154	124 300	18 410	74 600	59 300	57 000	190 900
1971	88 912	13 326	142 300	21 350	39,1%	31,1%	29,9%	
1972	151 870*	18 852*	173 300	21 500	124 600	109 000	57 000	290 600
					42,9%	37,5%	19,6%	
1973	–	–	–	–	124 600	159 000	57 000	340 600
					36,6%	46,7%	16,7%	
Growth rate per annum 1969/1972	8,6%		7,9%					

*Preliminary figures, subject to amendment.

be estimated at about 20 000 tonnes – the difference between estimated production and exports for 1972. South Africa's preliminary export figures at 151 870 tonnes in 1972 were just about 14 per cent of Western World consumption at 1 107 000 tonnes in that year. Since world consumption is estimated to grow at from 10,9 to 12,1 per cent per annum, it can be anticipated that the average export growth will increase from 8,6 per cent per annum to a higher figure; this is indicated by the 71 per cent increase of exports in 1972 over 1971 just mentioned.

CONCLUSIONS

Owing to the fact that about 65 per cent of the ferrochromium produced in the Western World is consumed by the stainless-steel industry, ferrochromium production is very much dependent on that industry. The stainless-steel industry has been characterized by a high average growth rate – 9,2 per cent for the period from 1960 to 1970 with a production of 5 million tonnes in 1970 (see Figure 2) and with a break between 1970 and 1971 owing to the world recession, particularly in the U.S.A. and Japan. Japan usurped the position of prime producer from the U.S.A. in 1970 after a phenomenal growth of 21,5 per cent per annum between 1960 and 1970 to a production of 1,6 million tonnes in 1970, and therefore felt the impact of the recession to a much greater extent than the U.S.A., whose expansion over the same period was only 5,1 per cent per annum.

The Western World consumption of ferrochromium has been estimated on the basis of the ratio of ferrochromium consumed to stainless steel produced, derived from the U.S.A. statistics and applied to all the other major producing countries. This shows a similar trend to stainless steel, but at a slightly higher growth rate of 10 per cent per annum for 1960 to 1970 (see Figure 7).

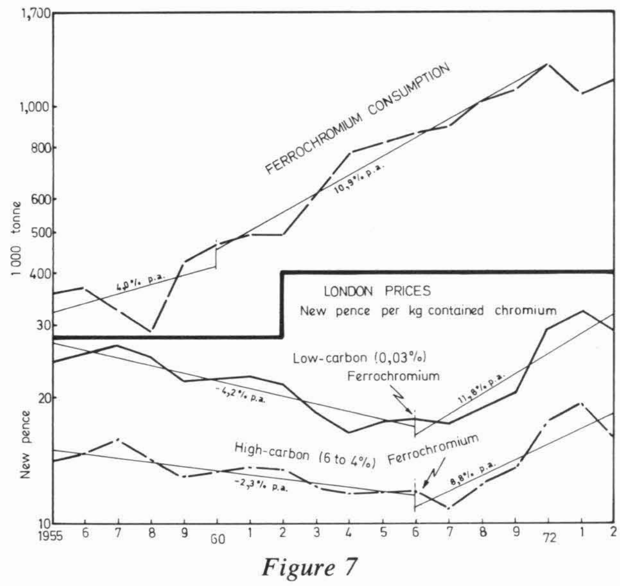

Figure 7

Ferrochromium consumption and prices in the Western World.

Ferrochromium prices have not followed the consumption trend (see also Figure 7), but for high- (4 to 6 per cent) and low-carbon (0,03 per cent) ferrochromium they show a decline from 1955 to between 1964 and 1967, no doubt owing to overproduction; the boom period between 1966 and 1970 shows a very sharp rise in prices with a peak in 1971, followed by a fall to their levels of 28,70 new pence for low-carbon and 16,3 new pence for high-carbon ferrochromium in 1972; in 1973 there was a recovery to the present prices of 18,5 new pence for high- and 31,3 new pence for low-carbon ferrochromium. This recovery was due in part to financial adjustments necessary on currency variations, and in part to increased demands.

The world's ferrochromium industry is at the moment in a state of overproduction. It is estimated that, in 1970, the capacity was about 2 million tonnes and consumption about 1,27 million tonnes – a ratio of about 64 per cent utilized. Owing to the recession and cut-back, particularly in Japan, the situation worsened in 1972, with capacity increasing to 2,3 million tonnes and consumption falling to 1,1 million tonnes – a ratio of only 48 per cent utilized. If one assumes a pre-slump growth rate of 10,9 per cent per annum to 1975 increasing to 12,1 per cent per annum from then to 1980, which seems justified in view of the following indicators, then the demand for ferrochromium will increase to 1,5 million tonnes in 1975 and 2,65 million tonnes in 1980. These indications are as follows.

(i) U.S. consumption of ferrochromium shows a recovery of 19,4 per cent from 292 700 tonnes in 1971 to 349 500 in 1972.
(ii) South African exports of ferrochromium have increased from 88 900 tonnes in 1971 to 151 900 tonnes in 1972 – a 71 per cent increase.
(iii) U.S. imports of ferrochromium for consumption have increased 66 per cent from 85 200 tonnes in 1971 to 141 300 tonnes in 1972.
(iv) Japanese demand for their fiscal year ending March 1972 has been estimated at 470 000 tonnes as against 430 000 for 1971, an increase of 9,3 per cent.

Provided that the growth of capacity is not excessive, the gap of excess capacity should tend to close to 1,2 million tonnes (capacity of 2,65 million tonnes less demand of 1,45 million tonnes) in 1975 and 350 000 to 600 000 tonnes in 1980.

However, the rate at which demand overhauls excess capacity will depend on the speed of recovery of the stainless-steel market. The gap is so large at the moment that it does not appear likely that it will show much of a decrease until 1975.

The demand for high-carbon ferrochromium and charge chromium will be greater in the future than for low-carbon, but the former is the cheapest form of ferrochromium and commands a price of only 17,3 to 18,5 new pence per kilogram of chromium contained c.i.f. Europe, which is only 55 to 59 per cent of that of 0,03 per cent low-carbon ferrochromium, and it is probable that the profit margin of production will be somewhat low. The question of low-carbon ferrochromium should not be entirely overlooked since, although the growth of demand is not likely to be as great as that for high-carbon ferrochromium and charge chromium, there will remain a selective market, with possibly higher profits, owing to its higher price. Furthermore, it seems inherent in the process of stainless-steel manufacture from charge chromium that a certain quantity of low-carbon ferrochromium will be required. An attempt has been made to estimate the trend of demand for low-carbon ferrochromium in the near future, and it has been estimated that the fall in demand will bottom about 1978 and thereafter recover (Figure 2).

It is interesting to note that at the moment (June 1973) a shortage of ferrochromium, including low-carbon (0,05 per cent carbon grade), is reported in the U.S.A., where prices have increased sharply in the face of strong demand. This is apparently due to the fact that the change to argon—oxygen decarburization in the manufacture of stainless steel is not taking place as rapidly as anticipated.

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In presenting his paper, **Dr Way** said: As my paper was written some twelve months ago, I could not include data later than 1972. Here is some later information to update Figure 1 of my paper: for 1973, the stainless-steel production increased to about 1850, the consumption of total, low-carbon, and high-carbon ferrochromium, and ferrochromium—silicon increased by 26, 17, 34, and 23 per cent respectively, and the ratio of low-carbon to high-carbon ferrochromium dropped to 0,56.

These increases have taken place in spite of the energy crisis and oil embargo, and have resulted in just on 100 per cent utilization of U.S. ferrochromium capacity. Japan has also been affected by the energy crisis. The latest news is that power supplies have returned to 90 per cent of normal, but that ferrochromium production has recovered to only 75 to 85 per cent of that planned, with the result that the demand for foreign material is high.

The following (Table 14) are the prices of ferrochromium on the London market.

The real price increases January 1973 to March 1974 for other metals are shown in Table 15.

Since Table 14 was drawn up, the price fixings for the new quarter year have been published in the *London Metal Bulletin,* and they indicate that there has been a small explosion in prices and demand. The average prices are: for high-carbon, 35 pence; for 0,1 per cent C, 39 pence; for 0,06 per cent C, 42 pence; for 0,03 per cent C, 43 pence; and for 0,015 per cent C, 47 pence. These figures give correspondingly real increases since January 1973 of 100, 38, 44, 40, and 41 per cent respectively. The difference between high-carbon and low-carbon ferrochromium has decreased considerably, and, on average, amounts to only 4 pence.

These price increases, coupled with the remarks made on the latest U.S. and Japanese ferrochromium demand, indicate that the speed of recovery on the stainless-steel market has been much greater and quicker than expected.

If the trend shown in Figure 5 of my paper is sustained, the gap of excess capacity over demand will close much sooner than was previously estimated. Whether this trend is sustained or not will depend on how much the chief stainless-steel-producing countries (U.S.A., Japan, West Germany, France, Sweden, Italy, and the United Kingdom) manage to withstand the impact of the energy crisis

Table 14

Average prices for ferrochromium on the London market (in pence per kilogram of contained chromium delivered)

	High-carbon	Low-carbon			
	60% Cr	68 to 78% Cr			
	4 to 6% C	0,1% C	0,06% C	0,03% C	0,015% C
1973 January	16,3	26,2	26,9	28,7	31,2
December	22,5	31,5	33,0	34,5	37,3
Sterling increase	38,0%	20,2%	22,7%	20,2%	19,6%
Real increase, based on weighted sterling depreciation of 7,4%	27,8%	11,3%	13,6%	11,3%	10,7%
1974 March end	25,9	34,0	36,5	37,3	39,5
Sterling increase	58,9%	29,8%	35,7%	30,0%	26,6%
Real increase, based on weighted sterling depreciation of 8,4%	45,6%	18,9%	24,3%	19,1%	16,0%
1974, April 9th	35,0	38,8	41,5	45	47
Real increase, based on sterling depreciation of 6,7% since Jan. 1973	100%	38%	44%	40%	41%

Table 15

Real price increases January 1973 to March 1974

Copper	Tin	Lead	Zinc	Antimony
173%	107%	115%	313%	76%

Table 16
South Africa's exports of ferrochromium

	January-August 1972		January-August 1973		Increase in tonnage
	Tonnes	Value, R	Tonnes	Value, R	%
Ferromanganese	175 300	17 900 000	176 800	20 000 000	0,9
Ferrosilicon	13 800	2 140 000	22 700	2 970 000	64,5
Ferrochromium	85 200	10 880 000	111 500	17 540 000	31,0
Others	6 180	820 000	16 770	3 040 000	171,3
					Increase in value
TOTALS		31 740 000		43 550 000	37,2

and high oil prices on their economies. So far they seem to be weathering the storm well; the demand for ferrochromium is not only being maintained but increasing at considerably above historical rates. It seems inevitable that increasing fuel and power costs will cause ferrochromium prices to rise even higher on the world market. The advantage that South Africa has in relatively cheaper power will be obvious to future ferrochromium producers here; that must be coupled with its large reserves of chromium ore, which, at 16 000 million tonnes, are 96 per cent of the world's reserves.

Table 16 shows the latest South African exports of ferrochromium.

In Table 16, 'others' include ferrovanadium and ferronickel. Extrapolation of the total value for the whole of 1973 gives a figure of R65 million, clearly illustrating the importance of ferro-alloys as an exchange earner for South Africa.

All those responsible for keeping statistics on ferroalloys, particularly ferrochromium, should publish them in a form similar to those of the U.S.A., thereby making things easier for people like me. The publication of such data will not necessarily entail breaking the confidentiality, in individual productions, that is required by most producers.

DISCUSSION

Mr P. Wessels:*

After so many addresses of such excellent quality all this week, my comments, you will be pleased to hear, will be very brief. It is encouraging to see the high growth rates predicted in Dr Way's paper for high-carbon ferrochromium. If the market does indeed develop the way that this forecast predicts, then all of us in this field are going to have an extremely busy time.

The new production capacity required to cater for the expected increase in demand will need an enormous amount of capital investment, and one would like to think that decisions on such investments are based on information and facts of a high degree of accuracy. In this regard, one cannot over-emphasize the fact that a forecast of trends such as that compiled by Dr Way is of necessity always subject to a greater or lesser margin of error. The more reliable the basic information used in arriving at these conclusions, generally the lower the margin of error can be expected to be.

Dr Way makes mention in his paper of the excellent statistics kept by the United States Bureau of Mines, and these are indeed good as far as actual production and consumption are concerned. The same can, unfortunately, not be said of the statistical information available from certain other markets. To quote one example, there would appear to be, even today, unused capacity for ferrochromium production in certain countries. Now, we all know that there is currently an acute shortage of charge chromium all over the world, and, this being the case, one would have thought that, if such apparent unused capacity could in fact be used for the production of high-carbon ferrochromium, it would have been utilized at present. The reason for this apparent anomaly appears to be a certain amount of double counting of furnaces, and also that some of the equipment is probably obsolete. This is but one of several examples that can be quoted of apparent inconsistencies and anomalies existing in the information available at present.

In view of the large sums of capital that will be required to create the increase in capacity that will undoubtedly be required in the future, one wonders whether the industry as a whole should not create the necessary machinery to assemble and disseminate market information regularly and more formally. In this regard it is interesting to note that the lead and zinc producers have had, for some years, a study group headquartered in Switzerland for this very purpose. If there is indeed a need for more accurate information, then it would seem that the alloy industry should create a similar organization or committee to provide this service.

Dr Way:

I would like to thank Mr Wessels for his contribution. My original suggestion, that production figures of ferrochromium and other ferro-alloys should be published, referred to the local production here in South Africa.

I heartily endorse his suggestion, however, that statistics for ferro-alloys should be collected, collated, and summarized by some central body on an international basis. The need for this is obvious in view of the large sums involved in financing future projects, and might result in international cooperation to prevent an oversupply position to develop in the future, which would be disastrous to the ferro-alloy industry in the Western World.

Dr P.R. Jochens:*

Will Dr Way enlarge on how he determined the smelting capacity of the Western World and of South Africa, because the figures for capacity appear to be somewhat high.

Dr Way:

The figures of Free-World capacity were obtained from the publications of the Metal Bulletin, amended and updated as far as it was possible to obtain later figures. They are by no means infallible. It is not easy to keep pace with developments unless one is backed by a large organization to collect information and statistics.

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