REPORT R52/2006

SOUTH AFRICAN FERROALLOY PRODUCTION TRENDS 1995 - 2004

DIRECTORATE: MINERAL ECONOMICS

mineral resources

Department:
Mineral Resources
REPUBLIC OF SOUTH AFRICA

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PRODUCTION TRENDS

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by
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Issued by and obtainable from
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THIS IS THE FIRST EDITION

ISBN: 1-919927-29-8

ABSTRACT

This report represents an analysis of South African production over the 10 year period (1995 – 2004). The ferroalloys focused on include chromium, silicon, vanadium and manganese.

The data used in this report are extracted from the official regulatory monthly returns of operating ferrous plants submitted to the Mineral Economics Directorate, of the Department of Minerals and Energy.

The production trends shown graphically are accompanied by short explanations on the performance of each of the commodities over the ten year period.

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1. CHROME ALLOYS (FERROCHROME)

Chromium alloys - the collective name for the various categories of ferrochrome - are processed from chromite ore, and their main application is in metallurgy where they are an essential ingredient in stainless steel manufacturing. Stainless steel production accounts for 90 percent of ferrochrome consumption. There are three main categories of ferrochrome, namely, high, medium and low carbon ferrochrome.

High carbon ferrochrome or charge chrome (3 to 8 percent carbon), is used to produce steels in which both chromium and carbon must be present. It is made by reducing chromite with coke in a submerged arc furnace with the charge being introduced from an open top. The latest trend in charge chrome production entails the adoption of plasma furnace technology, which involves the injection of pulverized chrome ore into a shaft furnace containing generators that produce high temperature ionized gases. Plasma furnaces allow friable chromite fines to be used as the raw materials, which result in lower material loss thereby increasing the ferroalloy recovery rate.

Ferrochrome containing less than 3 percent medium; carbon ferrochrome, is produced by adding chromite, lime, silicon and fluorspar to molten high carbon ferrochrome in a two-stage process. Ferrochrome with an even lower content of carbon (maximum of 0,1 percent) is produced by heating high carbon ferrochrome with ground quartzite in a high vacuum with the removal of carbon as carbon monoxide. Low carbon ferrochrome is used for producing chromium steels in which the presence of carbon is detrimental.

Fig 1.1

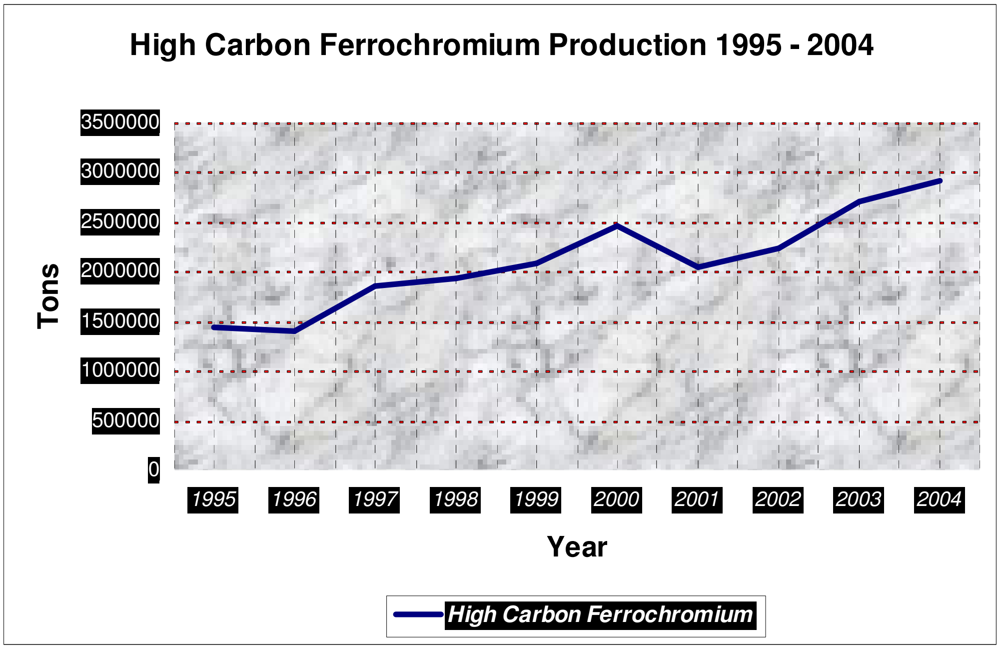
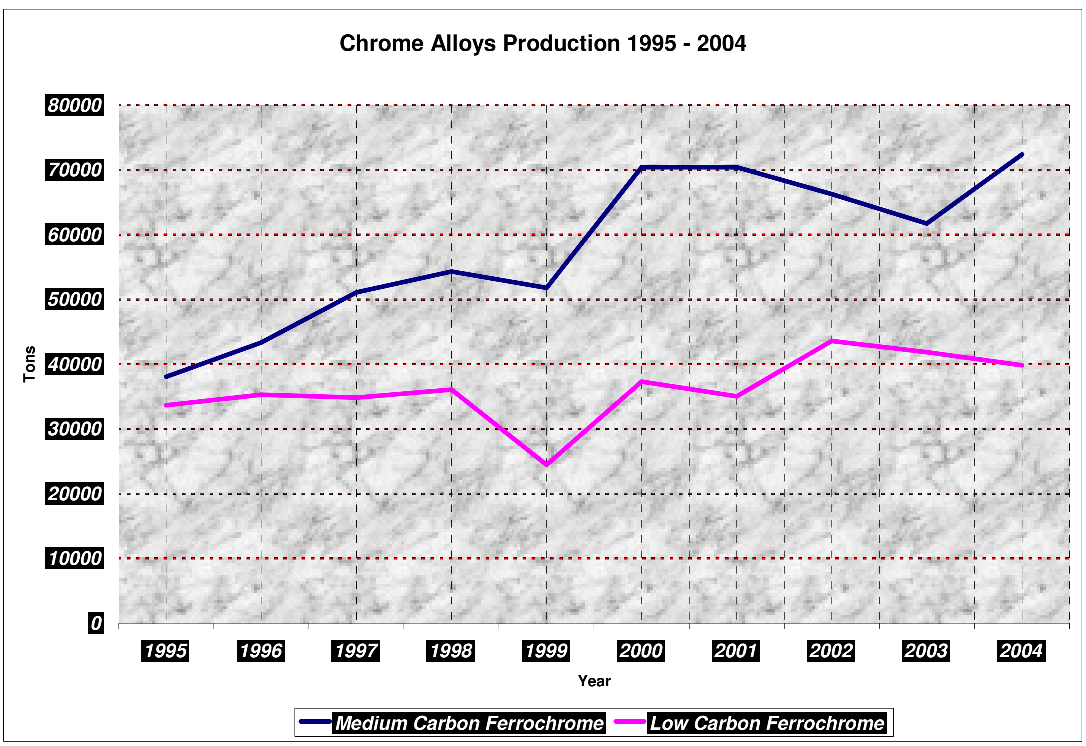

High Carbon Ferrochromium Production 1995 - 2004
Tons
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
High Carbon Ferrochromium

Fig 1.2

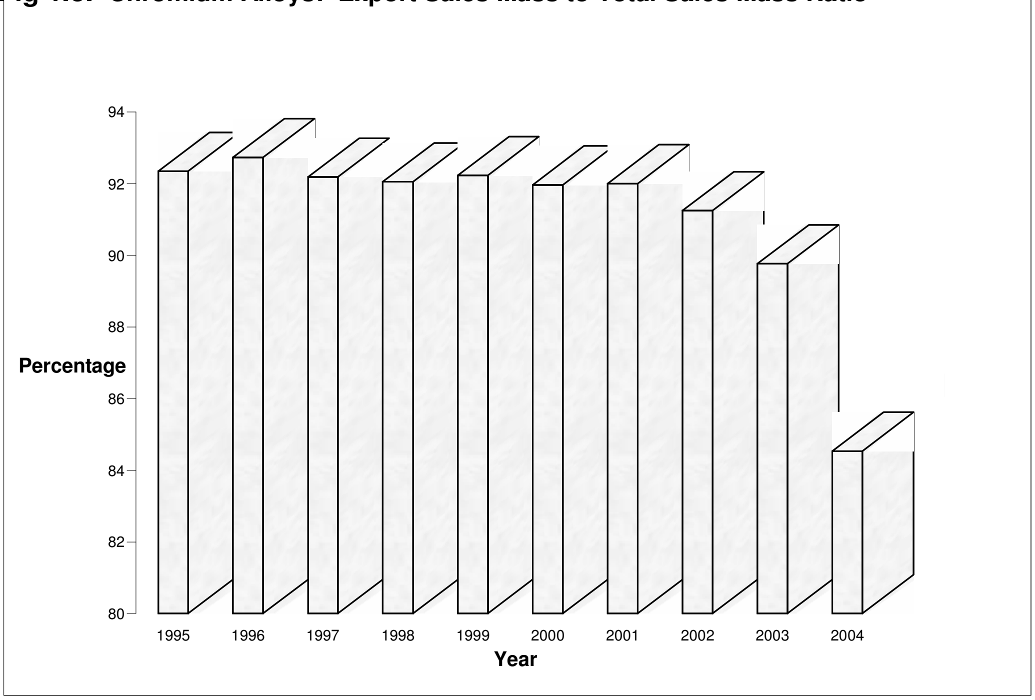

Chrome Alloys Production 1995 - 2004
Tons
80000
70000
60000
50000
40000
30000
20000
10000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Medium Carbon Ferrochrome
Low Carbon Ferrochrome

High carbon ferrochrome production has grown at a rate of 7,3 percent per annum in the ten-year period under review from 1,4 million tons in 1995 to about 2,9 million tons in 2004 (Fig 1.1). Growth was strongly positive from 1996 approaching 2,4 million tons in 2000. This increased output was consistent with stainless steel manufacturing growth, which averaged 4 percent per annum during the same period. By 2000 however, overproduction of charge chrome had depressed stainless steel prices, which led to a significant cutback in output between 2000 and 2001, as ferrochrome plants shut down in response to the prevailing weak demand conditions.

By 2002, however, successive all-time high stainless steel production figures had once again boosted the output of high carbon ferrochrome until the end of the review period in 2004. The highest rate of annual growth was achieved during the first half of the study period when an annual growth of 10,5 percent was attained in comparison with 6,2 percent annual growth being recorded in the second half of the review period.

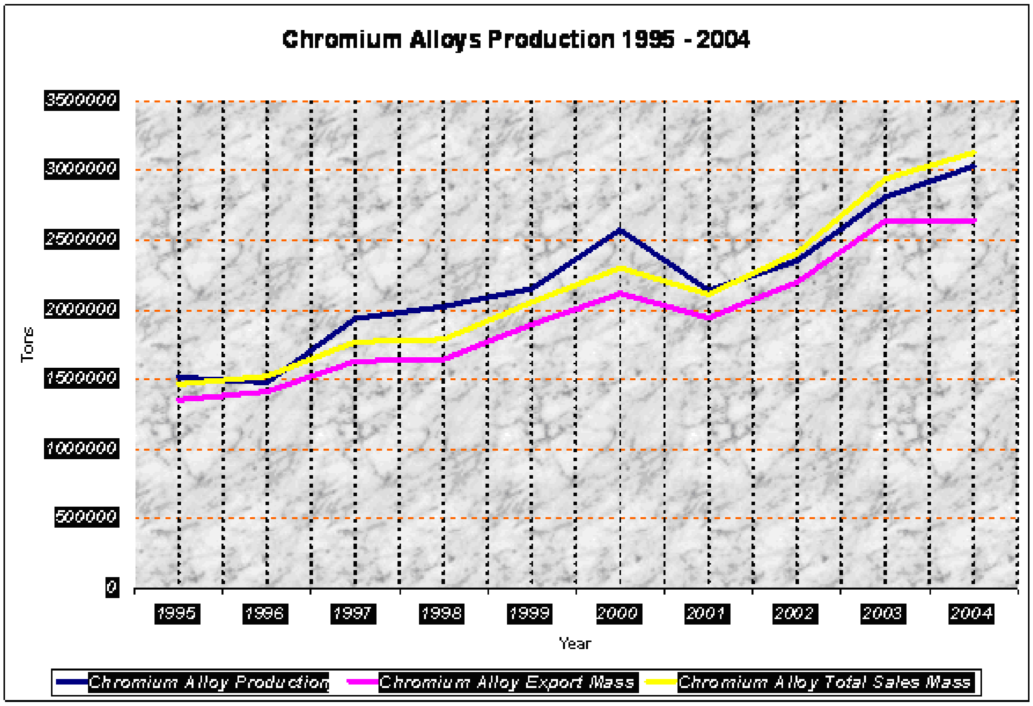
Medium carbon ferrochrome production increased at a rate of 6,4 percent per annum reaching 72 Kt in 2004 from 38 Kt in 1995 (Fig 1.2). This ferroalloy also achieved its highest rate of growth in production during the first half of the study period, expanding at an annual rate of 8,4 percent while in contrast output actually declined at a rate of 0,7 percent per annum during the second half of the study period (2000 – 2004). Low carbon ferrochrome experienced an annual growth rate of 2,5 percent throughout the 10 year period, rising from 33 Kt in 1994 to 39 Kt in 2004. However, this overall growth consisted of declining production, a rate of 6,1 percent per annum during the first half of the period under review, while a recovery was evident in the second half as a modest expansion rate of 3,1 percent per annum was realised.

Fig 1.3. Chromium Alloys: Export Sales Mass to Total Sales Mass Ratio



The ratio of export mass to total sales mass of chromium alloys (all categories) averaged 91 percent from 1995-2004 (Fig 1.3). However, the last two years of the study has revealed a decreasing trend from 89 to 84 percent, which is a noticeable departure from the average. Given the higher output values of the latter period, increasingly high local usage of ferrochrome output for downstream uses appears to have been responsible for the decreasing export ratio. This is borne out by strong and growing domestic consumption in stainless steel manufacturing in addition to an increased output from Acerinox, the largest stainless steel producer in Africa, in 2003 and 2004.

Fig 1.4



Growth in total chrome alloy production (all categories) has been robust, with the main contribution coming from high carbon ferrochrome. Total production grew at a rate of 7,3 percent per annum, while export sales mass rose by 7,5 percent per annum during the 10 year period under consideration (Fig 1.4). Total output of chrome alloys rose from 1,5 Mt in 1995 to 3 Mt in 2004.

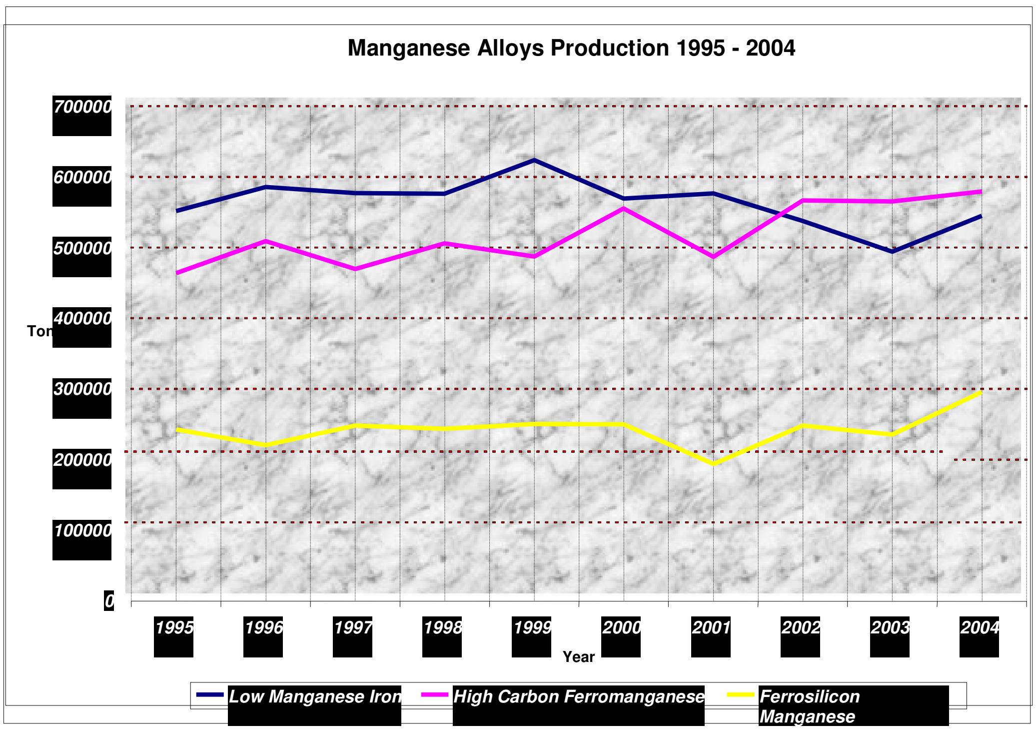
2. MANGANESE ALLOY (FERROMANGANESE)

Manganese can be suitably alloyed with iron, if it has first been converted into ferromanganese. Ferromanganese also performs a very useful function when alloyed with aluminium and other non-ferrous metals. A high percentage of the ferromanganese produced is consumed in steel making, where it is used to produce a strong metal that is easy to machine, form and weld. Manganese imparts the following three important properties to steel: (1) Sulfur fixing, (2) Deoxidising and (3) Alloying. Manganese is also processed into chemical forms such as manganese dioxide for the manufacture of dry cell batteries, manganese oxide, and manganese sulphate used in animal feed and as a fertiliser, respectively.

Manganese is used across a wide spectrum of applications including glass decolourisation, paint manufacturing and agricultural applications (e.g. disinfectant production). A hydro metallurgical extraction process is used to produce electrolytic manganese, which is alloyed with aluminium in the production of beverage cans.

Six main types of manganese alloys are covered in this analysis, namely high and medium-carbon ferromanganese, ferrosilicon manganese, electrolytically produced manganese metal (ElMn), electrolytic manganese dioxide (EMD) and low manganese pig iron.

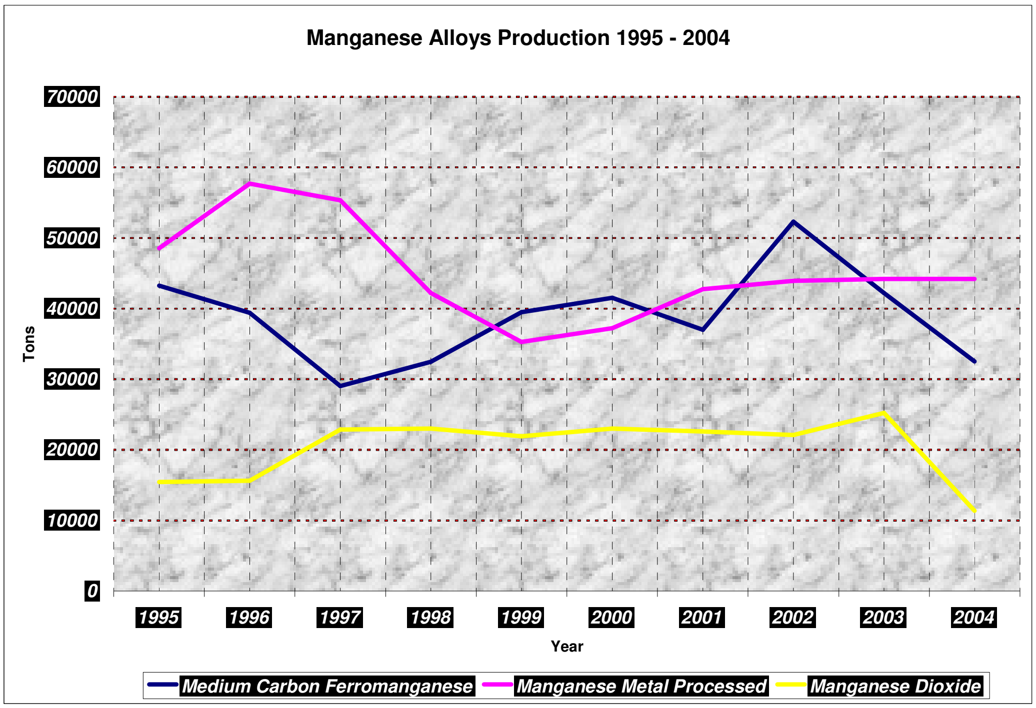
Fig 2.1



Low manganese pig iron production peaked at just above 600 Kt in 1999 before declining to its lowest level of 490 Kt in 2003, with a modest recovery evident in 2004 as the half a million ton mark was achieved (Fig 2.1). Although production declined at an annual rate of 1,5 percent over the full period in question, the rate of decrease was average highest at 2,4 percent per annum during the last 5 years.

From 1995, both high carbon ferromanganese and ferrosilicon manganese recorded stable but rising output levels, reaching 555 Kt and 250 Kt, respectively, in 2000. After a slight downturn in 2001, these commodities continued with the upward trend attaining their highest levels during the period under consideration of 579 Kt for high carbon ferromanganese and 300 Kt for ferrosilicon manganese in 2004. Annual growth rates for high carbon ferromanganese and ferrosilicon manganese for the second half of the period in question were 2,3 percent and 5,3 percent, respectively. These levels were supported by strong performances of domestic and global steel production during the period.

Fig 2.2

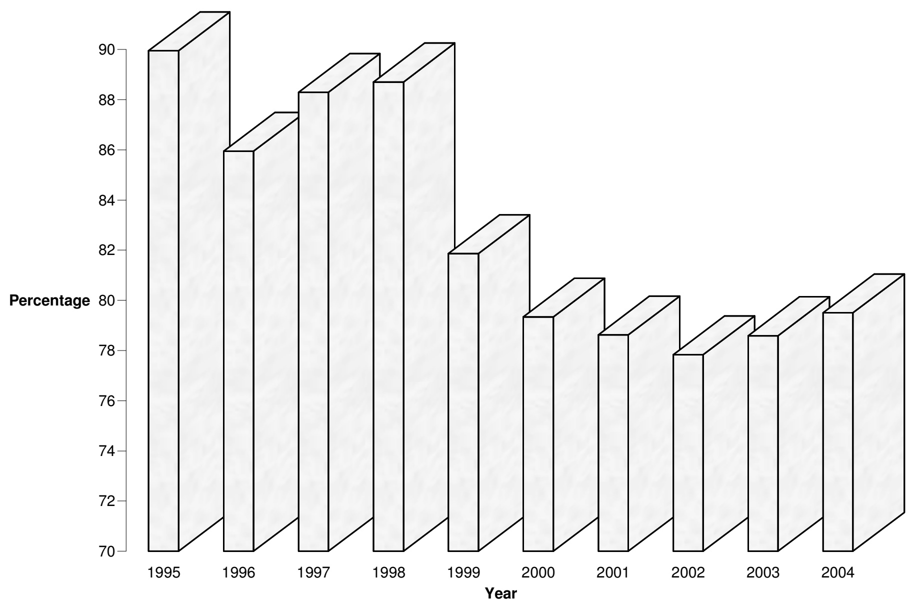


Electrolytic manganese metal output peaked in 1996 at a level of 57 Kt, thereupon a sharp decline in production ensued with output falling to below 45 Kt after 1998 (Fig 2.2). The annual growth rate for the first 5 years was 0,6 percent.

Medium carbon ferromanganese output recorded an annual growth rate of 0,8 percent during the study period, production peaked at 52 Kt in 2002 which was consistent with steel's record breaking output for that year. From 2002 onwards, in reaction to the oversupplied market conditions prevailing since the advent of the new millennium, output dropped to 34 Kt in 2004 as annual production declined at 3,5 percent per annum.

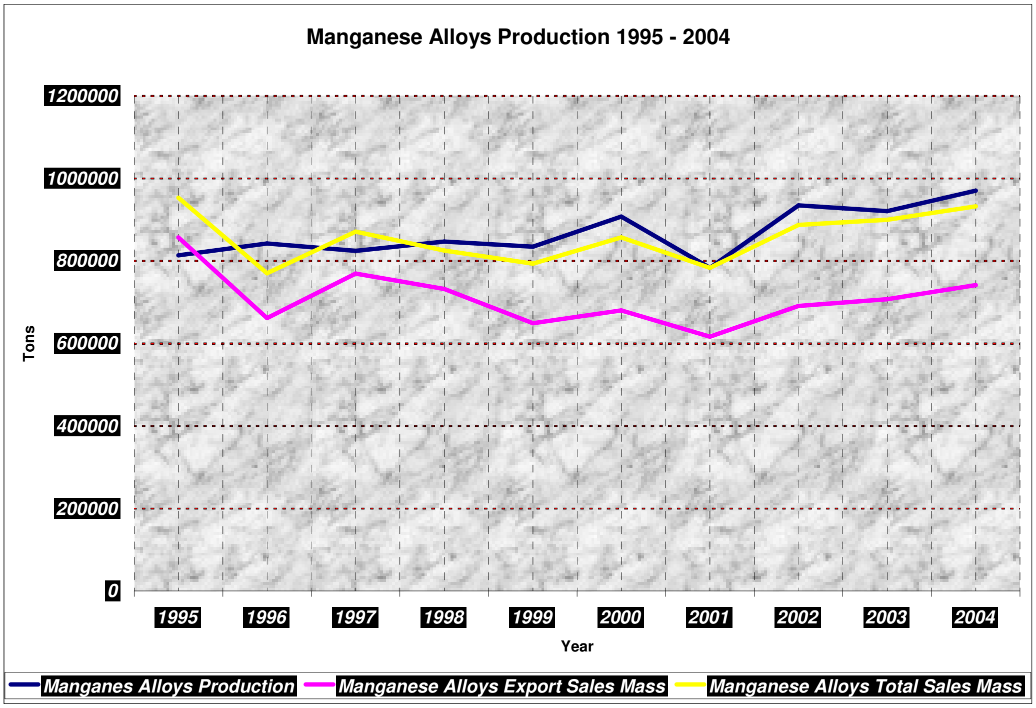
Production mass of electrolytic manganese dioxide was mostly stable during the review period, ranging between 15 and 25 Kt. A growth rate of 0,2 percent per annum was recorded. The highest level of output growth however was recorded during the first few years of the study period when a healthy annual growth rate of 10,8 percent was realised. Production dropped very sharply between 2003 and 2004. Fig 2.2.

Fig 2.3 Manganese: Export Sales Mass to Total Sales Mass Ratio



The average manganese alloy export mass to total sale mass ratio achieved during the ten-year review period was 82 percent (Fig 2.3). However, during the second half of the study period a declining trend in the ratio can be observed as output reacted to persistent oversupply and lower prices in the market. Global market conditions nevertheless started to improve in 2003 reviving export sales of the alloys.

Fig 2.4



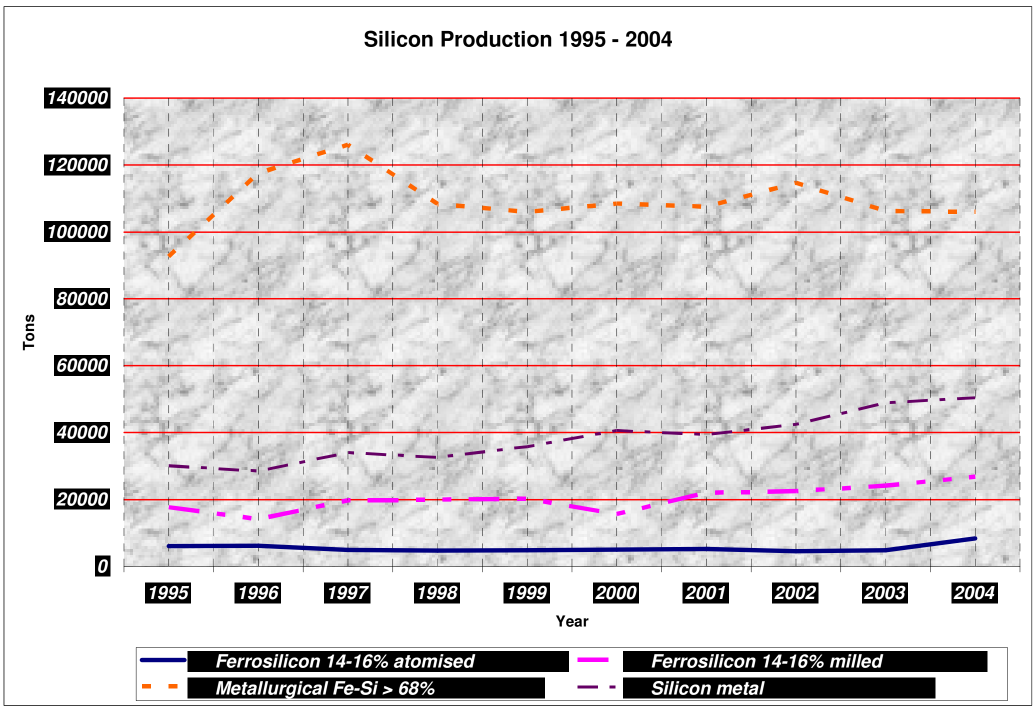
Total manganese alloy output expanded minimally from 800 Kt in 1995 to 970 Kt in 2004 (Fig 2.4), with a growth rate of 1,6 percent per annum. Furthermore, export sales mass declined at an annual rate of 1,2 percent. Another feature worth noting is that total sales mass has tended to track total alloy production and has for most of the time remained consistently below it, which suggests a propensity towards overproduction in the market for manganese alloys.

3. SILICON

Silicon is a chemical element with both metallic and non-metallic properties. Silicon combines with oxygen and other elements to form silica (quartz) and silicates. Silicon has to be derived from silica, as it does not occur naturally. Silica is the feedstock needed to produce silicon ferroalloys for the iron and steel industry and silicon metal for the aluminium and chemical industry. Silicon is also used widely in the construction of computer chips, lubricants, concrete and bricks. Medical applications of silicon entail the manufacturing of silicon implants.

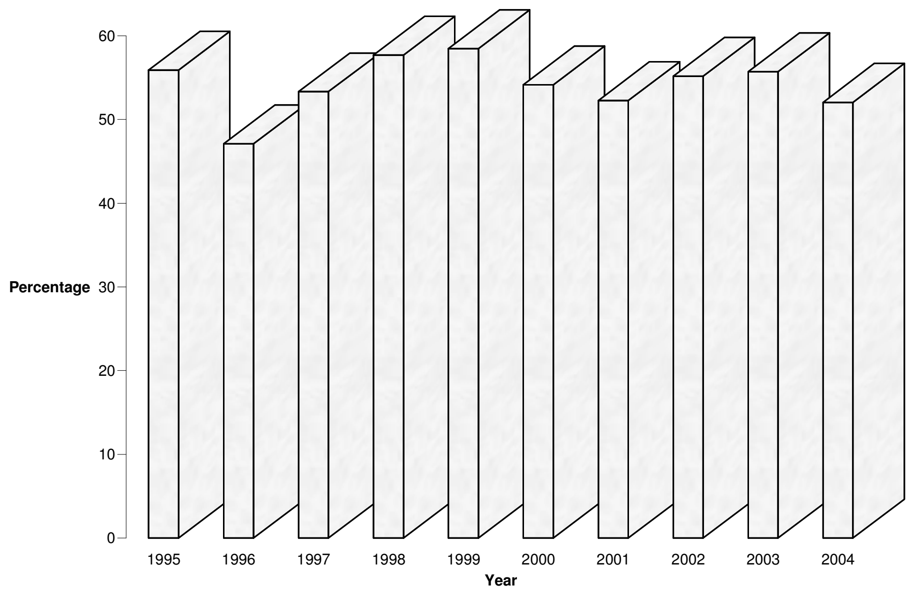
With the exception of 1997, when metallurgical ferrosilicon output reached an all time high of 126 Kt, production of the alloy has largely (seeing that it was below this range in 1995) ranged between 100 and 120 Kt throughout the period under study, with an overall growth rate of 0,02 percent per annum (Fig 3.1). Silicon metal and ferrosilicon (14 – 16% milled) grew at 6,2 and 4,9 percent, respectively. Ferrosilicon (14 –16% atomised) output has varied within a range of 6 to 8 Kt during the study period, with an overall annual growth rate of 0,7 percent.

Fig 3.1



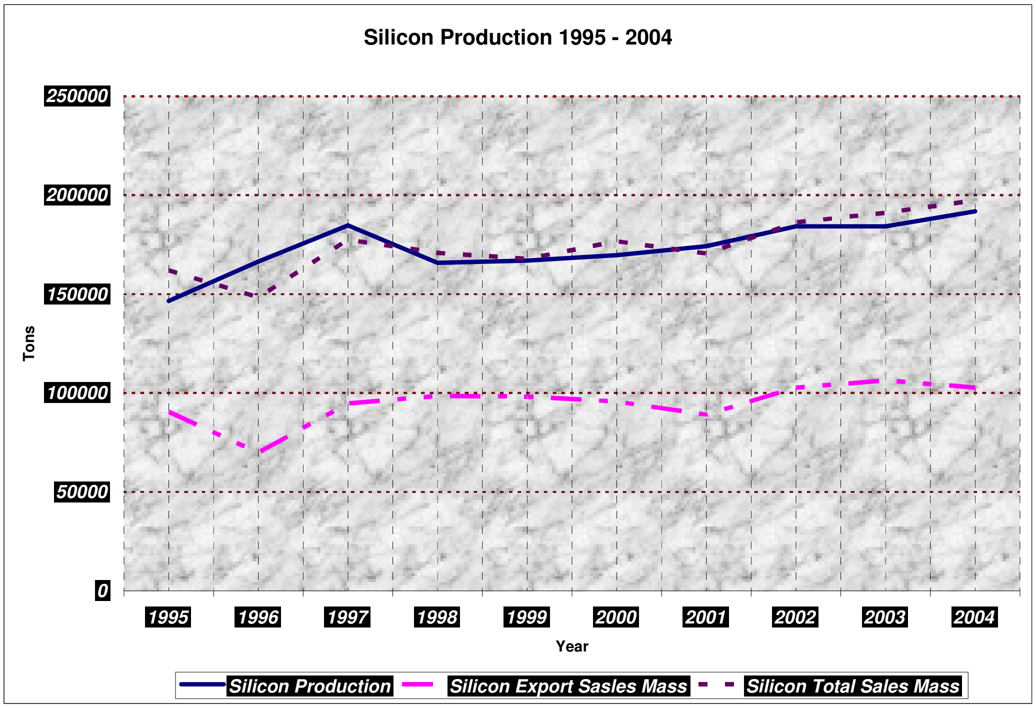
The export mass to total sale mass ratio for silicon alloys has consistently varied around the average of 52 percent, with a low point in 1996, when only 47 percent of total output was exported (Fig 3.2). The consistency shown is due to proportionately smaller volumes of output being destined for the export market in comparison with other ferroalloys, thus reducing the sensitivity of these alloys to fluctuating international market conditions.

Fig 3.2 Silicon: Export Sales Mass to Total Sales Mass Ratio



Total silicon output ranged between 146 Kt and 191 Kt from 1995 to 2004, recording a modest annual growth rate of 1,9 percent, while export sales mass grew by 2,5 percent (Fig 3.3). Exports have remained stable at around 100 Kt for the most part of the period under review.

Fig 3.3



4. VANADIUM

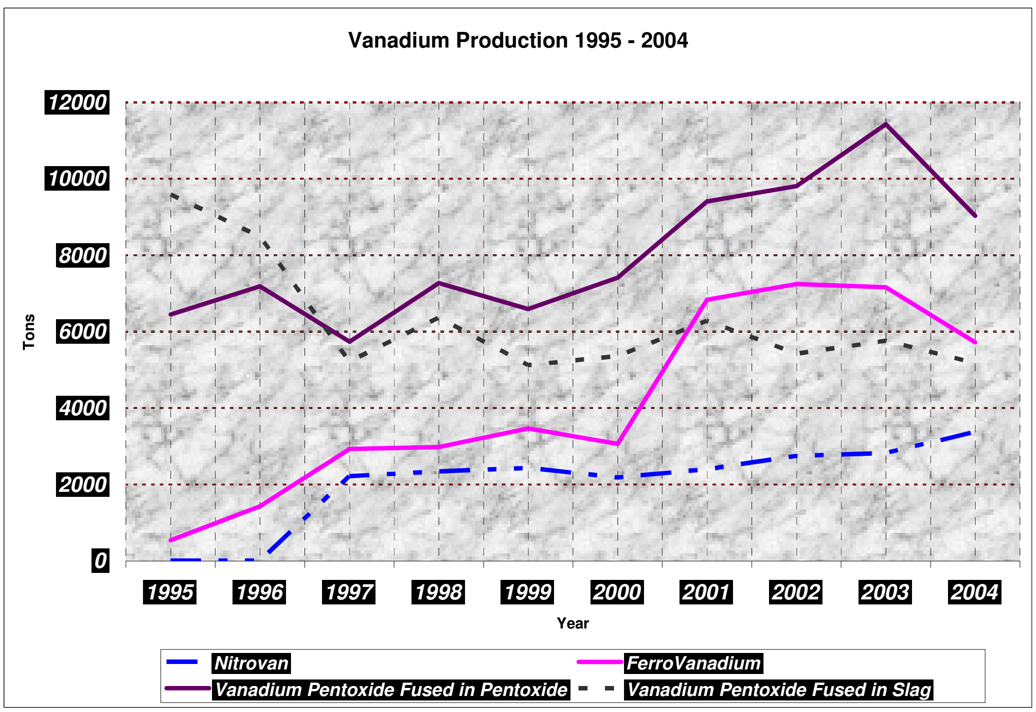
Vanadium is applied in the metallurgical and chemical industries mainly in the form of ferrovanadium and vanadium pentoxide, respectively. Ferrovanadium is used for introducing vanadium into steel. When alloyed with steel, vanadium imparts strength and toughness to the steel, which is used to make tools, especially construction steels. Low alloy steels contain less than 0,15 percent by volume of vanadium while high alloy products have a higher vanadium content.

Vanadium pentoxide is used in glass production, ceramics and as a chemical catalyst. Ferrovanadium is produced by the aluminothermic reduction of vanadium pentoxide in an electric arc furnace. The silicon reduction process is used to produce 45 to 50 percent grade ferrovanadium from slag and other vanadium containing materials. Ferrovanadium improves grain refinement and hardenability in steels. South Africa is a top producer of vanadium supplying 52 percent of vanadium output to the world market.

Vanadium pentoxide (fused in pentoxide) production experienced steep growth of 5,9 percent per annum during the study period (Fig 4.1). Growth, in particular, accelerated after 1999 with output increasing from 6,9 Kt in 2000 and peaking at 11,4 Kt in 2003. A combination of higher world steel output and more stringent regulations in China requiring higher levels of vanadium usage in construction projects in that country contributed to the surge. A dip in production was evident in 2004 as output fell from its high in 2003. This was due to high prices for vanadium products in 2002 and 2003 which encouraged uneconomic producers to flood the market and resulted in lower, unstable prices during 2004 which in turn forced South African producers, the largest in the world, to cut back on their output levels.

As vanadium pentoxide (fused in slag) production decreased from about 9Kt in 1995 to 4,5 Kt in 2005 and ferrovanadium increased in output.

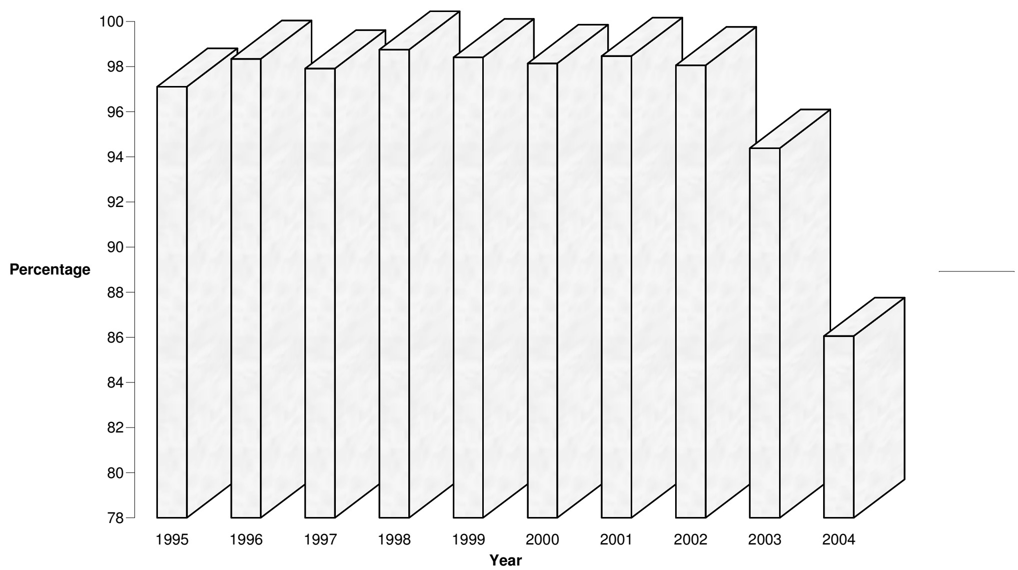
Fig 4.1



Production of nitrovan was relatively stable from 1997, with virtually nil production before that year. Output has ranged between 2 and 3,5 Kt over most of the review period, and an overall annual growth rate of 5 percent was recorded.

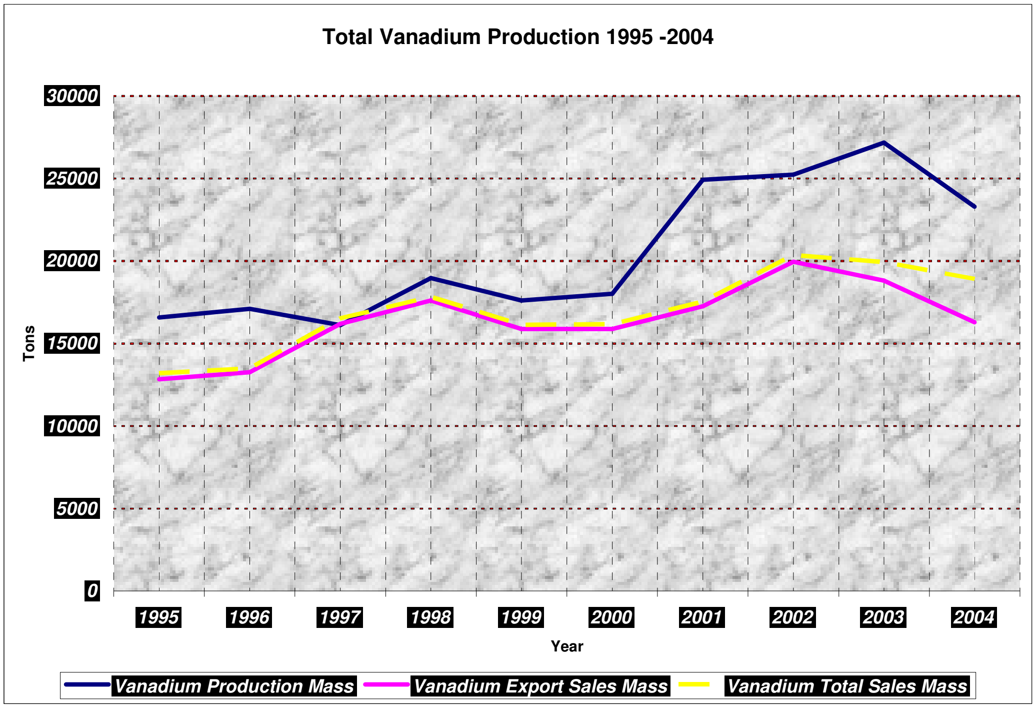
Ferrovanadium output rose from 0,5 Kt in 1995 and reached a peak of 11.4 Kt in 2003 before stabilising around 9 Kt in 2004. An exceptionally high overall annual growth of 23,8 percent was registered for the total period under review. The second half of the study recorded an annual growth of 13 percent with the steepest rise occurring between 2000 and 2001 as output rose to 6,8 Kt in 2001 from 3 Kt in the previous year.

Fig 4.2 Vanadium: Export Sales Mass to Total Sales Mass Ratio



On average some 96 percent of vanadium alloys (all products) has been exported, however, towards the end of the period under review, the export to total sales mass ratio had started to decline, falling to 86 percent in 2004, from 98 percent in 2002 (Fig 4.2). Two main factors contributed to this trend: while strong vanadium demand from local chemical industries had the effect of reducing the quantity of vanadium available for overseas markets, unstable world markets also reduced global demand.

Fig 4.3

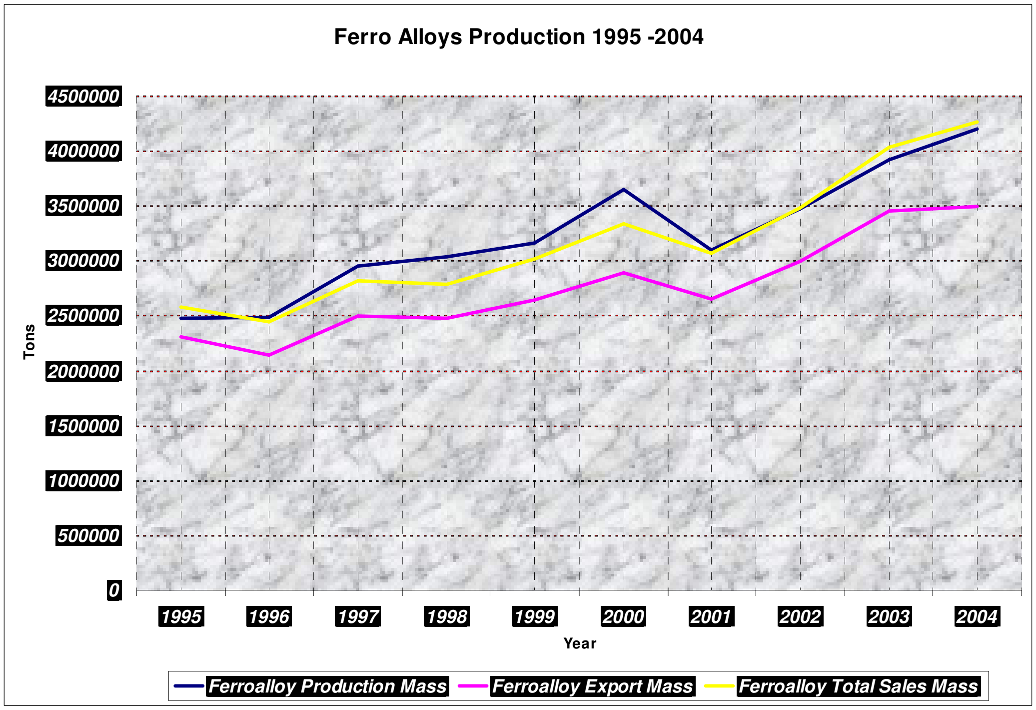


Overall output of vanadium (all product categories) has displayed a healthy growth rate during the study period as total vanadium production advanced by 5,6 percent per annum form 16 Kt in 1995 to 23 Kt in 2004 (Fig 4.3). Export sales mass had an annual improvement of 3,3 percent, peaking at 20kt in 2002

5 CONCLUSION

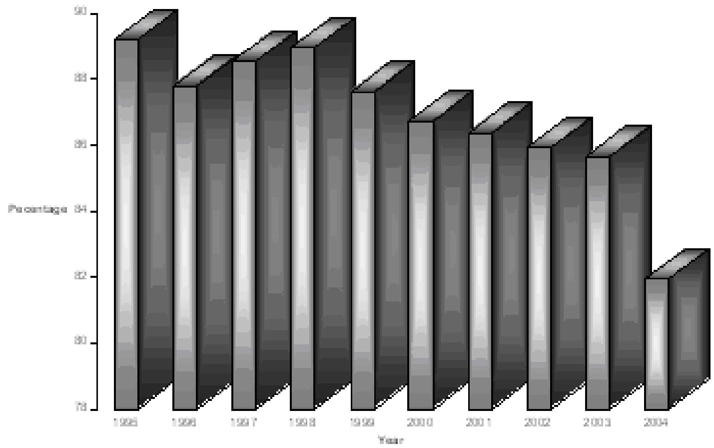
The total overall production and export mass performance of ferroalloys was exceptionally strong during the decade 1995 to 2004, growing at rates of 5,4 percent per annum from 2,4 Mt in 1995 to 4,1 Mt in 2004 (Fig 5.1). Chrome and vanadium alloys were the main drivers of the growth with realised growth rates of 7,3 and 5,6 percent respectively, while the performances of manganese and silicon were in general lacklustre, ranging from marginal to negative growth. Healthy demand for ferroalloys in Asia and Europe, especially in the second half of the study period, was the main factor responsible for the high growth recorded. A higher proportion of export sales were evident for most alloys with the exception of the silicon alloys.

Fig 5.1



The ferroalloy export mass to total sales mass ratio (Fig 5.2) has averaged 82 percent. However, a slight decrease in the export trend is evident towards the end of the study period. This trend can be ascribed to an increasing domestic consumption of ferroalloys for downstream purposes.

Fig 5.2 Ferro Alloys: Export Sales Mass to Total Sales Mass Ratio



Overall, South African ferroalloy producers have adapted well to the strong unexpected upturn in the market during the review period. This flexibility will be decisive in retaining market share as the Chinese and Indian economies continue to unfold. The benefits of having excess capacity, however, should be weighed against costs of maintaining equipment during slack periods, as care and maintenance can be costly. The increasing local use of ferroalloys by local downstream manufacturers observed during the study period is encouraging as it implies an increasing trend towards adding value to South Africa's mineral production prior to export.