

REFLECTIONS ON THE FUTURE, AND ON THE ROLE OF THE FERRO-ALLOY INDUSTRY IN SOUTH AFRICA AS PART OF THE SOCIAL SYSTEM

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ABSTRACT

The recent political developments in South Africa have created a favourable climate for major industries, including ferro-alloys, to play an increasing role in the various social upliftment programmes such as education, training, occupational health and safety. For this goal to be achieved, the economic viability of the industry must not only be sustained, but also improved. The generation of additional wealth by manufacturing value-added products from ferro-alloys has great potential to assist in addressing South Africa's growing financial needs. The future of the social programmes will no doubt depend on the adoption of appropriate policies and the success of these initiatives, as well as the continuing growth of the ferro-alloy industry itself. Technical and environmental considerations are becoming increasingly important factors.

INTRODUCTION

The ferro-alloy industry in South Africa developed rapidly over the past thirty years as a result of the major investments made mostly by local companies. The availability of abundant raw materials, electrical energy, the development of appropriate technology and the establishment of the necessary infrastructure and manpower resources were critical to its growth. The industry has succeeded in establishing itself as a major global player, despite a long period of economic and political isolation. In 1993, export earnings from ferro-alloys contributed 1.5 per cent of South Africa's gross domestic product, an amount of \$33 per capita.

With the recent noteworthy political developments in South Africa, a more favourable climate for economic and social stability has been created. The ferro-alloy industry has responded to the challenge and opportunities, and is expanding its (already considerable) existing social programmes to assist South Africa's disadvantaged communities to realize

their full potential. Greater international stability in the ferro-alloy markets has also been addressed by the formation of global associations between producers and consumers.

The future prosperity of the ferro-alloy industry depends on responsible production and marketing policies by the major international players, and a forum such as Infacon should continue to play a facilitating role in this regard without detracting from the primary purpose of the technical sessions, namely to encourage innovative technology development in the ferro-alloy industry worldwide.

South Africa is currently a major producer of chromium ore (almost 40 per cent of world production), and it accounts for about 25 per cent of world ferrochromium alloys production. The trend over the past few years has been to export less ore and increase local production of ferrochromium. South Africa produces about 25 per cent of manganese ore exported, and about 20 per cent of world manganese alloys that are exported. Alliances between South African producers and consumers in Europe, and increased demands for manganese alloy production compared to ferrochromium production over the past two to three years, have resulted in a switch of some ferrochromium furnaces to ferromanganese. The recent improvements in the chromium market have now reversed this trend. However, the need to maintain manganese ferro-alloy capacity could result in one or two additional furnace installations over the next few years.

THE ROLE OF TECHNOLOGY

As an emerging producer in the mid-1960s South Africa depended mainly on technical support from Europe, the USA, and Japan. Research to adapt overseas technology and develop a local expertise base to meet the needs of the local ferro-alloy industry was identified as a priority, and by 1970 a Pyrometallurgical Research Group was well established at the University of the Witwatersrand in Johannesburg. The undergraduate projects and postgraduate studies covered topics such as prereduction of ores, smelting reactions, and physico-chemical properties of slags and alloys. Studies into the electrical behaviour of submerged-arc furnaces were undertaken at the University of Cape Town in the early 1970s. This research work, initiated by Mintek and supported by the Ferro Alloy Producers Association (FAPA), was subsequently extended to the universities of Natal, Stellenbosch, and Pretoria.

A substantial technical foundation was in place to support the ferro-alloy industry by the mid-1970s, when the Oil Energy Crisis precipitated a major expansion. The development of the argon oxygen decarburization (AOD) process made it economical to use charge chrome for stainless steel production. Because South African chromite ores were very suitable for producing charge chrome, developments in the industry accelerated. To take advantage of economies of scale, furnace ratings increased from typically 15 MVA to between 48 and 81 MVA. The larger and less forgiving furnaces exposed certain

important differences between the behaviour of local ores and those originating elsewhere. Problems such as excessive ore fines, furnace instability, high electrical reactance, electrode failures, ineffective control and optimization and, generally, poor productivity, were commonplace.

A concerted effort carried out collaboratively between industry and Mintek, with support from several universities, led to the development of a furnace controller based on calculated resistance values and the use of mass and energy balance criteria to improve electrical and metallurgical performance. Controllers have been installed on several ferro-alloy furnaces, with major improvements in productivity.

Although efforts to overcome the problem of raw-material fines by agglomeration or by adapting submerged-arc furnace technology to accommodate substantial amounts of fines in the burden have been successful to some degree, research into alternative furnace technologies that could process fine feed directly was initiated in the late 1970s. The identification of, and need to evaluate, the potential benefits of plasma-arc technology resulted in the construction of a major R&D pilot-plant facility at Mintek. A collaborative R&D effort between Mintek and Middelburg Steel & Alloys culminated in the construction of a 40 MVA dc plasma-arc furnace to smelt ferrochromium at the Palmiet Ferrochrome Plant, now owned by Samancor. This plant has demonstrated that plasma technology can be used successfully to smelt chromite fines to produce high-quality and special grades of ferrochromium at favourable costs. The dc plasma-arc furnace can remelt ferrochromium metal fines, and carry out the selective carbothermic reduction of chromite to produce a low-grade chromium alloy for stainless-steel production and a high-grade slag for producing low-carbon ferrochromium with a high chromium content (>70 per cent,) as well as medium-carbon ferrochromium by refining charge chrome.

Research and development of the carbothermic pre-reduction process for pelletized chromite ore fines by JCI laboratories in the early 1970s culminated in the installation of the CMI plant near Lydenburg, which uses Showa Denko technology. Fluxed pre-reduction testwork in the mid-1980s using chromite fines was carried out initially in association with Krupp in Germany, and resulted in the installation of the CDR (Chromite Direct Reduction) plant at Middelburg Ferrochrome (now also owned by Samancor). High levels of metallization (up to 90 per cent) are achieved, compared with about 60 per cent pre-reduction at CMI. The optimum method of converting this highly metallized product from the CDR process into ferrochromium is still being investigated. However dc plasma-arc technology has been successfully demonstrated on both pilot and full-scale furnaces.

Pyrometallurgical research at the universities of the Witwatersrand, Pretoria, and Cape Town continues, with over ten current postgraduate projects that are relevant to the ferro-alloy and stainless steel industries. Current areas of research and development and anticipated technology implementation at Mintek include the recovery of ferrochromium from liquid and solid slags, environmental problems such as furnace dust emissions and the presence of hexavalent chromium, operator guidance systems for submerged-arc furnaces, and improved ferro-alloy casting and granulation techniques. Ongoing efforts are aimed at reducing, in a cost-effective manner, the use of electrical energy. Preheating of chromite ore fines prior to smelting is being evaluated for possible

commercial implementation on dc plasma-arc furnaces and in conventional submerged-arc furnaces.

The training afforded to the postgraduate students provides industry with an invaluable injection of technical knowledge and manpower. However, South Africa faces a critical shortage of technical personnel, and there is an urgent need to recruit more science and engineering students at the undergraduate level, especially from disadvantaged population groups. This is being addressed by the special educational bridging programmes run by several organizations.

Refining of ferro-alloys to produce products for special market needs has been undertaken commercially using both converter technology and dc plasma-arc technology and these methods are under further development. Methods of direct stainless-steel production are being investigated at a pilot-plant scale.

Industry, research organizations, and universities have benefited from their close interaction. The many significant technical developments that have been implemented have contributed to the initial rapid growth of South Africa's ferro-alloy industry; and its ability to retain, and even improve, its competitive position internationally in difficult times. The wealth generated from the industry and the downstream value-added products that are being increasingly produced have played a major role in the economic and social development in areas associated with the industry.

GENERATION OF WEALTH

Wealth, in the context of this discussion, is defined as the difference between revenue and the cost of materials and services. The wealth thus generated is distributed to employees in the form of wages and salaries, to shareholders as dividends, to new investments, and to the government as taxes.

The South African minerals industry has been a cornerstone of the economy for more than a century. Fabulous wealth was first unlocked by the production of gold and diamonds, which counted for a very significant portion of the country's income. During the past 40-odd years, we have seen the development of a base minerals industry, which included the emergence of, amongst others, the South African ferro-alloy and steel industries.

The ferro-alloy industry is a major creator of wealth and earner of foreign exchange, and employs a substantial labour force, as shown in Table 1. The population in regions in which ferro-alloy plants were installed and in which new plants were commissioned between 1970 and 1991, grew by some 30 per cent compared with 20 per cent for the overall population (Table 2). The ferro-alloy industry has thus created employment opportunities both directly and indirectly.

TABLE 1. South Africa's ferro-alloy industry as a revenue generator and employer, 1993. [1]

Activity	Export earnings \$ million	Employees*
Chromite ore mining	98	4 168
Ferrochromium alloys production	753	4 089
Manganese ore mining	153	4 014
Manganese alloys production	183	3 185
Ferrosilicon and silicon production	91	1 725
Total	1 278	17 181

Export earnings GDP per capita = 1.5%

*Source: FAPA

TABLE 2. Population growth in ferro-alloy producing regions.

Province	Location	Product	Population (1000)		
			1970	1980	1991
Gauteng	Krugersdorp	FeCr	127	167	196
	Meyerton	FeCr	9	11	15
E. Transvaal	Lydenburg Middelburg	FeCr	46	46	37
		FeCr	122	126	140
	Machadodorp	FeCr	2	4	5
	Witbank	FeCr FeMn FeSi	104	152	173
N. Transvaal	Pietersburg	Si	72	88	64
North West	Rustenburg	FeCr	88	101	125
Kwazulu/Natal	Cato Ridge district	FeMn	36	43	36
TOTAL			606	738	791
Growth, %			-	21,8	7,2
Total SA*			21 794	24 885	26 288
SA growth, %			-	14,2	5,6

Source: Central Statistical Service [2]

*Excluding the former 'independent' states (Transkei, Bophuthatswana, Venda, Ciskei)

Although these developments were a welcome departure from the earlier process of digging up the country and selling it overseas, there were many aspects that did not address the needs and expectations of the bulk of the population. Initially, the development of physical assets and financial strength had to take precedence.

However, in more recent years, the ferro-alloy industry has become proactively involved in the advancement of South Africa's historically disadvantaged population groups, and the development of the vast pool of human resources has now to be given the highest priority if the industry is to remain competitive and continue to grow.

One of the five key programmes in the South African Government of National Unity's Reconstruction and Development Programme (RDP) is entitled 'Building the Economy'. This programme recognizes that one of the most important tasks lies in the creation of sustainable employment opportunities and increasing the ability of the economy to absorb new job-seekers.

For the ferro-alloy industry, this means that we must seek not only to convert more of our mineral wealth (ores) into alloys, but also to stimulate the growth of industries using the alloys locally, and thus increase the added value of our exports. This move is supported in principle by the RDP, which clearly states that the Government will encourage forward linkages and further beneficiation of our mineral resources.

For example, the value chain for chromium, using the selling price per ton of contained chromium, as a basis, entails a 160 - fold value addition, i.e.

1 ton of chromium in chromite ore (30% Cr) at \$60 per ton ore = \$200.

1 ton of chromium in ferrochromium (52% Cr) at \$0,45 per pound chromium = \$516

1 ton of chromium in 18% Cr ferritic steel at \$2,73 per kilogram steel = \$15 166

1 ton of chromium in manufactured products = \$32 000.

The further beneficiation of ores into ferro-alloys, stainless steels and alloys, and the manufacture of finished products is thus a major longer term objective that can increase wealth creation on a greater scale in South Africa in the future.

South Africa's dominance in the production of ferrochromium is due to a combination of technical and entrepreneurial skills, favourable market circumstances, and the fact that the country possesses over 70 per cent of the world's known reserves of chromite ore. The ferrochromium industry has grown by more than 700 per cent since 1974, the ferromanganese industry by 100 per cent, and the ferrosilicon industry by 34 per cent (Table 3). Increased capacity to convert ferrochromium into stainless steel is currently nearing completion at the Columbus Joint Venture, a prime example of combining local resources to achieve a common goal. This development could well continue if Iscor's plans to convert its Pretoria Steel Works to stainless-steel production come to fruition. The very significant increase in added value and employment opportunities brought about by this process cannot be underestimated, as shown by the example above[3].

It is quite feasible that South Africa will emerge as a major stainless-steel producer by the year 2000, with a capacity of up to 1 Mt per annum, and this would increase the desirability of moving into the final phase of the chromium chain, i.e. the production of

complex manufactures. This would not only be beneficial to the country in the form of significant growth in export earnings; it would also absorb many new job-seekers, and open up new avenues of advancement for technologists by incorporating new grades of stainless steel and further applications.

TABLE 3. Growth in ferro-alloy production.

Alloy	Year			Maximum	Growth, %
	1974	1986	1993		
Ferrochromium, kt	137	894	884	1149	739
Ferromanganese, kt	365	418	661	731	100
Ferrosilicon, kt	74	89	99	99	34

The case for manganese is different to that for chromium. South Africa, despite its vast manganese ore reserves, is not a dominant manganese alloy producer. Unlike ferrochromium, which enjoyed decades of almost uninterrupted growth, the manganese ferro-alloy industry has been relatively slow-growing, particularly in more recent years. The forward linkage of manganese alloys is also less straightforward than that of chromium, in view of the fact that manganese makes up only a very minor proportion of its main phase 3 product; namely steel. In this connection, it is encouraging that South Africa has embarked upon a modest programme of automobile exports, as is the announcement of Iscor's new Saldanha Bay mill, which will export steel semis.

It is clearly not feasible for South Africa to become as important in steel production as it is in ferro-alloys and will be in stainless steel. In contrast, ample resources exist for further expansion of manganese alloy production, but market volatility is an unpredictable factor. The industry should, however, continue to look at additional opportunities to proceed along the manganese chain.

South Africa already has a small share in the international trade in foundry products. It would be logical for the ferro-alloy industry to become more involved in this activity and seek to expand it. The technology and other resources are available, and again a significant increase in locally added value could be achieved. Castings can be supplied as is, or machined to exact tolerances. Manganese-steel castings for wear parts usually need little machining, but the value of a stainless-steel casting is easily doubled by converting it into a machined component. The incorporation of castings into sub-assemblies also adds very considerable value, with labour forming a significant portion.

Unlike the chromium- and nickel-bearing 300 series stainless steels, the manganese-bearing 200 series is relatively underdeveloped commercially. In these steels, the nickel content is partially replaced with up to 15 per cent manganese. The excellent performance characteristics of these steels are well known. Further development of the 200 series would be an important step along the manganese chain without adversely affecting chromium, and could assist in strengthening the manganese sector significantly.

Ferrovandium is another alloy with growth potential. The extensive deposits of vanadium-bearing ores in South Africa place the country in a favoured position, and

although most exports have been in the form of vanadium pentoxide or vanadium-bearing slag, South Africa's ferrovanadium production has been increasing recently.

Finally, another potentially important sector for growth in the ferro-alloy industry is the recovery of value from waste products. Many works already have plant installed to recover the metallic component from slags. This type of operation, apart from boosting income for a relatively low capital investment, does relatively little to stimulate job creation, although it has a positive effect on wealth. Also, the projected substantial increase in the use of slagment for housing projects is not expected to change the contribution to growth by any significant amount. Perhaps it would be more appropriate for the industry to increase its efforts to produce exportable commodities, such as chemicals from slags. Successful first-world producers are faced with ever increasing environmental demands, which are very costly to meet in old facilities. New plants, incorporating the latest technology, could quickly develop a competitive edge in this regard.

Clearly, in order to secure more sustainable markets, it can be advantageous to enter into alliances with selected customers. In South Africa, Samancor has been spearheading this development through the acquisition of strategic shareholdings in, for example, the French companies SFPO and Ugine, and also by the establishment of the NST joint venture with Nippon Denko of Japan.

Our industry, like other commodity industries, is subject to the vagaries of the market, with its cycles of under- and oversupply having a profound effect on plant utilization and prices. These instabilities have impacted adversely on employment at times. The only realistic counter to this is to ensure that highly competitive production costs are maintained. Competition from producers in the former eastern-bloc countries has made this a critical consideration.

Sustainable production in sustainable markets can be considered the key element in the generation of wealth. Although salaries and wages paid to our employees form part of that wealth, it must not be forgotten that productivity in South African industry is comparatively low. The challenge is to direct our efforts towards expansion into higher-value products while improving our competitiveness at the same time.

During 1992, the local demand for stainless steel in South Africa declined, and Columbus Stainless, in an effort to revive the market, promoted the manufacture of stainless-steel products by small business enterprises targeting African and export markets. Born out of these initiatives was Compots, a 'pots and pans for Africa' project. The products are designed to compete at the lower end of the hollow-ware market, and are produced in a small factory, fitted with simple presses, run by a workforce of about 20. Steel is purchased from Columbus, pressed in the factory or by contractors, and the handles are purchased from another operator. Hundreds of pots and pans are produced in this way. Such projects are being encouraged as small, medium, and micro-enterprises (SMMEs), to increase employment, local sales, and exports of higher-value mineral products.

HUMAN RESOURCE DEVELOPMENT, EDUCATION, AND TRAINING

The ferro-alloy industry in South Africa has been a global player in the base metals and minerals markets for decades. This has meant pricing our ferro-alloys competitively, which we could do initially due to the relatively low input costs of our raw materials, power, and labour. The low wages paid to unskilled and semi-skilled employees in the early years made productivity a relatively unimportant factor. As technology advances, and employees' aspirations result in higher salaries, the industry increasingly needs to develop its human resources. Productivity has become an important issue as far as cost-containment is concerned.

Without development of our people, sustainable economic growth and competitive participation in the global economy are impossible. People development is the key success factor of competitive nations, and South Africa has scored poorly on this criterion over the past few years in the World Competitiveness Report [4]. However, to address this problem effectively and at the same time maintain or improve competitiveness is not an easy task.

Even before the birth of the RDP, our industry began focusing on 'people' issues such as job creation, the development of small businesses, housing, water, electricity, health care, affirmative action, participative management, and in particular education and training. The demands of a new democratic South Africa now require that the industry looks more urgently at the needs of its people, and in particular at the investment needed to improve the capabilities of our black people. A new, more effective strategy is now being followed by all the major industry players. This will take into account not only our unique market situation, for example, the high expectations of the workforce and historical wage disparities, but also the framework of needs outlined by the RDP to position South Africa for economic growth.

Effective repositioning will be achieved only if the following areas are incorporated in our strategy:

- . developing the appropriate organizational structures
- . manning the structures with the right people
- . making changes in a socially sensitive manner
- . addressing employee motivation and productivity levels
- . providing appropriate education, training, and career paths.

These objectives will be met only if the industry remains viable. Business effectiveness can be achieved only by implementing the appropriate organizational structures and ensuring that an adequate pool of trained and motivated staff are available to man these structures. The industry has in place a broad spectrum of training programmes, from basic literacy and numeracy - known as Adult Basic Education - through to technical training for technicians and engineers, as well as management education. Many of these programmes are provided on-site in facilities and with teachers funded directly by the industry.

During 1991 and throughout 1992, the industry faced declining demand for ferro-alloys, and many plants operated at reduced capacity. This resulted in retrenchments and early

retirements, which were instituted in consultation with unions and the workforce. Demand for manganese alloys improved in 1994, and there were indications of improvements in the markets for ferrochromium and other ferro-alloys. Idle capacity was re-commissioned, necessitating the re-employment of many retrenched employees on a basis that was negotiated during consultations prior to the 1992/93 retrenchments.

Given the history of South Africa, it is of fundamental importance that the industry works to create an environment and culture in which the companies and their employees increasingly share common objectives. Each employee needs to feel that the success of the enterprise is important and relevant. Without such commonality, the necessary improvements in motivation, initiative, productivity, and cost control will be ever increasingly more difficult to achieve [5].

An important step is to give employees a direct stake in their organizations. Many of the major mining and industrial companies in South Africa are now extending their share-ownership schemes to include all employees. This initiative forms part of a broader human-resources plan that aims to

- build trust by way of improved communication
- establish a workforce and management structure that will be more representative of South African society, and
- improve the lives of all employees and their dependants.

The industry believes that a harmonious and successful future for the industry's operations can be obtained, provided that a participative and constructive approach is demonstrated by all stakeholders [6].

The industry's social responsibility initiatives complement its human resources strategy using, for example, funds channelled via organizations such as the Samancor Foundation, the Anglo American Chairman's Fund, and the Gencor Development Fund. The ferro-alloy industry has already made considerable progress in family housing for employees, the provision of services such as water to local communities, the building of schools, and the establishment of job-creation projects.

OCCUPATIONAL HEALTH AND SAFETY

The New Environment

Achievement of world standards in the fields of occupational health and safety is a key objective in the development of the industry and its people.

In South Africa, the ferro-alloy industry has not only had to take cognisance of international trends, but also contend with rapidly changing and increasingly stringent legislative requirements. The Occupational Health and Safety Act, which replaced the previous legislation at the beginning of 1994, set new criteria in terms of the technical, labour-relations, and legal aspects of health and safety management.

The compensation laws have been revised to ensure that more occupational diseases are recognised, and increased compensation costs are awarded. As is the case elsewhere,

the South African industry is, in the interests of productivity, experimenting with the concept of multi-skilled and self-directed work teams. By implication, these teams must be equipped to recognise health and safety hazards and to take necessary preventative measures.

Status of Health and Safety Programmes

The industry is certainly not starting from scratch in the field of occupational safety and health. The South African National Occupational Safety Association (NOSA) is well recognised for its safety systems and safety auditing. Industrial hygiene has, however, so far not received first-world levels of attention. There is a need to improve the understanding of the purpose and value of industrial hygiene programmes. (A general concern is that our programmes are mainly reactive and not pro-active). This situation is changing rapidly with the increasing application of risk assessment techniques.

With the almost universal adoption of the ISO9002 quality system, the combining of quality, safety, and health-management systems of a high standard is increasingly under consideration. However, at this stage the development of appropriate procedures is complicated by the high levels of illiteracy and low levels of general schooling amongst the workforce - hence the further importance of the previously-mentioned Adult Basic Education programmes.

The Way Forward

The South African ferro-alloy industry has recognised the need to revise its approach to health and safety in order to ensure that it is able to operate both in the local and the international environment with confidence. Some of the objectives which individual producers have set themselves are to:

- (i) develop and implement techniques to pre-empt health and safety problems;
- (ii) establish consultative frameworks in which employers and employees address health and safety problems co-operatively; and
- (iii) engage in dialogue with communities in the vicinity of plants in order to address their concerns about the quality of water and emissions to the air.

The key challenges in meeting these objectives are the integration of safety, health, and industrial hygiene activities into an explicit and co-ordinated programme with clear objectives and defined roles for service departments, line managers, and operators. The South African ferro-alloy industry is determined to remain competitive in international markets and to be a responsible employer at the same time. Although local plans of action to address our shortcomings have been devised, we believe that it is important that, at an international level, expertise and experiences should be shared in formal and informal ways. Specific concerns such as the cause of explosions in ferromanganese furnaces and in the successful integration of quality, health, and safety-management programmes could well benefit from such international interaction.

ENVIRONMENTAL ISSUES

Environmental issues in South Africa have always enjoyed a high profile, and will continue to do so. However, due to the fragmented nature of the legislative and regulatory process in South Africa, the situation is not ideal. The government departments that currently administer the applicable laws are many and varied. Rationalization of these, or the establishing of an umbrella body, would be beneficial [7]. This may well occur in the general legislative overhaul currently under way in the country.

The ferro-alloy industry in South Africa is a responsible corporate citizen, and individual companies have adopted a pro-active stance towards environmental protection in general, and to the prevention of air, water, and noise pollution in particular.

Numerous research projects have been launched to recycle waste products. For example, the co-generation of electric power from furnace waste gas, agglomeration and recycling of bag filter dust or scrubber sludge, and agglomeration of fines for recycling through pelletizing, briquetting, or sintering. Further investigations have as their aim the use of such waste products for low-cost housing, for example by using crushed, screened, and washed slag as concrete aggregate, and the addition of pozzolanic filter dust to Portland cement. Crushed slags from the high-carbon ferrochrome and ferromanganese furnaces are currently being treated at Transalloys, Metalloys, Middelburg Ferrochrome, Tubatse, and other works for the recovery of metal. The tailings from these operations meet the specifications of the Council for Scientific and Industrial Research (CSIR) for aggregates, and they are sold for road-building and to coal mines for allaying the dust on roads. Rand Carbide, Ferrometals, and Silicon Smelters market the micro-silica from the bag filter collectors for use in the cement industry to enhance the strength and corrosion properties of concrete, as well as to the ceramic industry for the production of, for example, tiles.

The toxicity of some waste products associated with the production of ferro-alloys is a matter of grave concern, and, South Africa is in the vanguard with respect to the detoxification, stabilization, solidification, and recycling of such products. The work on hexavalent chromium that is currently being conducted in South Africa is unique, and will result in a greater understanding of the complex chemistry of this species. The eventual aim is not only to render all wastes containing hexavalent chromium environmentally benign, but also to extract all economically valuable metals from these residues.

SHAPING FUTURE INDUSTRY-RELATED GOVERNMENT POLICIES

During the past two decades, there has been a major shift of the primary manufacturing industries from the developed countries to the developing world, essentially because of increasing costs of power and labour, and increasing environmental pressures.

It makes sound economic and strategic sense to expand the ferro-alloys industries in countries such as South Africa, where the raw materials are close to hand, and power, a major cost factor, is still relatively cheap. These advantages, together with the infrastructural and technological base that has been developed, have allowed South

Africa's ferro-alloys industry to grow at an unprecedented rate, and to become one of the most competitive in the world.

If further growth is to take place, so that the full potential of the industry can be realised, it is essential that the Government should foster a favourable climate that encourages industrial growth and investor confidence. In addition, future government policy should be aimed at increasing its assistance of the industry in the field of technological advancement by sharing the risk of developing new technology.

In the past, the South African government allowed a broadly spread system of export subsidies to be put into place. These subsidies were mainly in the form of rebates on electrical energy, local raw materials, and on other expenditure relating to exported products. In recent years, however, some of these rebates were reviewed with respect to their desirability and affordability. The review process was accelerated significantly in line with South Africa's participation in the recently conducted Uruguayan round of international trade negotiations on GATT. Many subsidies have already been withdrawn, and others are being phased out. In this connection, it was encouraging to note that some - but not all - of the anti-dumping actions against South African ferro-alloy producers were unsuccessful.

Our industry is very energy-intensive. In South Africa, coal provides close to 80 per cent of primary energy requirements, with nearly 50 per cent of the energy generated being consumed by mining and minerals beneficiation.

Minerals, energy, and transport costs constitute 50 to 65 per cent of the free-on-board cost of South African ferro-alloys. The energy and the minerals sectors of South Africa have a very interdependent relationship. They have and contributed between 25 and 30 per cent of the GDP over the past decade. Now that sanctions are no longer in effect, they are likely to contribute even more, as revenue from mineral beneficiation increases.

The ferro-alloy producers are major stakeholders in the minerals and energy sector. Consequently, they are striving to ensure that our new Government takes a balanced view in formulating new policies on mining and mineral rights, and the marketing of minerals and mineral products. Government, industry, and the trade unions are striving to create a more favourable investment climate in South Africa, with the objective of attracting and supporting new investments both from domestic and international investors, so that maximum use is made of South Africa's mineral resources and its highly developed expertise in exploration, mining, and extraction technology.

The RDP calls for an extensive electrification programme to provide all South Africans with electricity. The country is likely to have a national generation and transmission authority, and new tariff structures could develop. A National Electrification Forum (NELF) was constituted in May 1993 with representation from a broad spectrum of stakeholders. The industry through its participation in the Steel and Engineering Industries Federation of South Africa (SEIFSA), has strong representation on NELF, to ensure that reasonable power costs to the ferro-alloy industry are maintained [8].

REFLECTIONS ON THE FUTURE

The ferro-alloy industry is undergoing continuous change in terms of market situation, technology, and its effect on the environment. The relationships already formed between many producers and consumers and those being currently under discussion are having a profound influence on the market. Increased stability and carefully planned growth are objectives that should contribute to the long-term economic viability of the industry. For South Africa, as a major producer of ferro-alloys, it is important that a significant proportion of the benefits that could be derived from such an improved economic climate are passed on to its previously disadvantaged communities. Furthermore, the ongoing programmes in education and training, housing and health care, and overall community upliftment must continue. The viability of the ferro-alloy industry is essential for this to take place. Sound and consistent political, economic, mineral and energy, and environmental policies will, of course, also be of paramount importance to this multifaceted industry.

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REFERENCES

1. South Africa's minerals industry 1993. Johannesburg, Minerals Bureau, 1994
2. Population census 1970, 1980, 1991. Pretoria, Central Statistical Service
3. Hatty, P.R. The potential of the "Chrome Chain" for South Africa. Infacon 6. Proc. of the 1st International Chromium Steel and Alloys Congress, Cape Town, Vol. 2, Johannesburg, The South African Institute of Mining and Metallurgy, 1992. pp 3-5.
4. Human resource development, education and training. South Africa. The Mining Nation. Johannesburg, Ravan Press, 1994. Consultative Business Movement, Nov.1994.
5. Groenewald, D.M. Corporative repositioning in the new SA. Samancor, internal presentation, July 1994.
6. Monitor, v.11, no 8, October 1994.
7. Lloyd, P.J. Environmental protection in South Africa. J. S. Afr.Inst. Min, Metall., Jun. 1994, pp.111-117.
8. Redistributing power. Fin. Mail, 12 Nov.1993, p.103.