The future development of the iron and steel industry in South Africa

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SYNOPSIS

There is an ample supply of all the raw materials required for the future development of the industry, with the possible exception of coking coal. Improved methods of coke production are being developed. It is anticipated that steel production will reach eight million tons per annum by 1980. New techniques and equipment for refining steel will be installed, together with new processing equipment. The most serious problem now facing the industry is the acute shortage of labour.

I must confess that, when approached to present this paper, I was honoured; but, when the topic *The Future Development of the Iron and Steel Industry in South Africa* appeared in cold print before my eyes, I was somewhat at a loss. The iron and steel industry embraces such a vast field that one really does not know where to start or where to end. After all, the raw materials required for the production of iron and steel are just as important to the industry as the final products and, because your Institute is the mouthpiece for mining as well as for metallurgy, your members are interested in both aspects.

We have it on the good authority of the Chamber of Mines of South Africa that, although the Republic of South Africa constitutes only 0.8 per cent of the earth's dry surface, it contains the world's largest known deposits of gold, platinum, chrome, antimony, and probably manganese. With South West Africa, it has the largest deposits of gem diamonds, and uranium is found in quantities unrivalled by the non-Communist world, except in the expanses of the United States and Canada. Nature also provided our country with some of the largest known deposits of asbestos, fluorspar, vanadium, vermiculite and, last but not least, high-grade iron ore which, of course, is indispensable for any integrated iron and steel works.

Coal mining, and I am thinking of coal mining in general, is one of the country's most important basic mining activities. By providing the major source of fuel and power it has permitted the rapid development of mining, manufacturing, and other enterprises, and it makes a vital contribution to practically all our industrial undertakings. Coal is also the basis of coke production as we have known it up to now, and it is the keystone for undertakings like Sasol and other chemical industries, which play a vital part in sustaining and developing our general economy.

In South Africa, coal is usually found at shallow depths and in thick seams; as a result, the current pit-head price is among the lowest in the world. Extensive prospecting has revealed in situ coal reserves of more than 12 000 million tons. However, we are handicapped by the fact that coal from most of our known coal reserves does not give good yields when it is beneficiated for the production of reasonably low-ash coal. Resources of coking coal in South Africa are limited both in quantity and quality. From the outset it has been necessary for the South African Iron and Steel Industrial Corporation Limited (Iscor) to blend coal having feeble coking properties (obtained from the Witbank area) with better-quality coking coals from the limited sources in Natal. Even these better-quality coals do not compare favourably with the coking coals used in other steel-producing countries, on account of their high ash and high volatile content.

Iscor has, therefore, started work on three plants for the drying and preheating of the coal charged into the coke ovens at its Pretoria Works. It is expected that all three plants will be operating during this year and, if they prove successful, similar plants will be erected at the Vanderbijlpark Works.

These production units will be unique in combining the drying and preheating of coal for the purpose of improving the quality of the coke. Investigations that started here some ten years ago and further development in the United Kingdom by the British Coke Research Association have shown that hot dry-charging will produce a stronger coke having improved shatter-impact and abrasive-resistance qualities, even when lower percentages of the better-quality coking coals are used in the blend.

At present, straight coking coal from Natal constitutes about 37 per cent of the coal charged into the coke ovens at the Pretoria Works. It is expected that this will be reduced to approximately 25 per cent, and it is anticipated that an increase in oven throughput will be achieved. It is envisaged that the Pretoria Works will not need to draw coke from the Vanderbijlpark Works.

Coal received from the washing plants at the collieries contains approximately 7.5 per cent moisture. Air drying can reduce this to about 2.0 per cent. In the new plants the coal will be completely dried, heated to a temperature of 150 degrees Centigrade, stored in hot coal-storage bins, and charged by new smokeless charging cars, which feed the coal into the ovens with a minimum loss of heat. Coal will be taken by conveyor from the wet-coal bunker to the drying stage of a unit, and will then be fed into a drier duct, through which passes a forced draught heated by the combustion of coke oven-gas and air. The coal will be dried as it is forced up the duct. At the end of the duct it will be graded by a classifier, the oversize material being returned to the intake of the drier duct via a hammer mill. The graded coal will pass to the preheating stage, where it will be fed into a duct heated by the hot exhaust gas from the combustion chamber. The waste gases from the preheating stage will be used in the drying stage. Primary and secondary cyclones will separate the heated coal from the gas and extra fines and the coal will then be fed to the hot coal-storage bunkers for storage in an inert-gas atmosphere.

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Closely related to the drying and preheating of coal is another venture by Iscor, viz., the production of form-coke. There is evidence that this research at Iscor is in line with, or even ahead of, the most advanced achievements overseas, and the form-coke produced can be claimed as the first to be made from high-volatile briquettes in a conventional oven. The progress achieved thus far holds prospects for the conservation of the dwindling resources of metallurgical coking coal and for the use of coal hitherto considered unsuitable for coking purposes. Form-coke has the additional advantages of low ash and sulphur contents.

The present consumption of coal for coking at the Pretoria Works is about 117 000 tons a month. About 63 per cent of this is blend coal from the Witbank area, and approximately 37 per cent is straight coking coal from northern Natal. Consumption at the Vanderbijlpark Works is 182 000 tons a month, in a proportion of about 60 per cent blend coal to approximately 40 per cent Natal coal. At this stage the Newcastle Works is using approximately 1 600 tons a month, of which 30 per cent is blend coking coal.

A much higher consumption rate is expected as the Newcastle Works comes into full production and as the Vanderbijlpark Works increases its production capacity.

One of the coals used for form-coke experiments originates from Iscor-controlled prospecting operations in the vast Waterberg coalfields. In the production of form-coke, the coal is milled and mixed with other ingredients, and is pressed into oval-shaped briquettes of about 50 cubic centimetres in volume. It will be appreciated that no more information can be disclosed at this stage.

Physical tests carried out on form-coke produced in this way have shown that it is at least equal to our best coke produced by the conventional method, and that its resistance to crushing is superior, while the contents of both ash and sulphur are lower. In the first experiments, briquettes in stainless-steel containers were coked by being heated in a furnace. Tests on the coke were encouraging, and the next step was the building of a moving-grate furnace. In this type of furnace the charge moves continuously through the oven and is exposed to temperatures that rise gradually to 950 degrees Centigrade.

The good results achieved with Iscor's experimental moving-grate furnace resulted in box tests in a conventional oven, followed by tests in an experimental conventional type of oven at the Fuel Research Institute of South Africa and, eventually, in the coke ovens of the Pretoria Works.

The briquettes should be of such a nature that sufficient fusion is obtained for an oven to be "pushed" successfully without causing complete fusion of the mass.

By the middle of this year, a briquetting plant having a capacity of 100 tons per hour will be taken into production, and full-scale blast-furnace tests will be conducted on this coke. Only then will it be established with certainty whether this method of form-coke production has met with the anticipated success. Experiments will also be conducted to coke the briquettes produced by means other than the conventional oven.

Mention has already been made of the vast reserves of high-grade iron ore in the Republic. Iscor has more than 4 000 million tons in the Sishen area alone, quite apart from other deposits or reserves belonging to other South African organizations. Because of the abundance of iron ore, Iscor some time ago started giving serious thought to the feasibility of exporting some of this high-grade iron ore to overseas countries. With this aim in view, Government approval was sought, and given, for the construction of a deep-sea harbour at Saldanha Bay, where ore-carriers of 250 000 tons and larger could be loaded. Should the iron ore contracts become reality, this scheme would also entail the building of a railway line from the Sishen iron ore mine in the Northern Cape to Saldanha Bay.

The Corporation's largest reserves of high-grade iron ore, which are also the largest known in the Republic, are to be found in a portion of the Gamagara formation which extends over a distance of 40 miles north-south between Postmasburg and Sishen in the Northern Cape. The horizon bearing the iron ore outcrops intermittently along a range of low hills, known as the Gamagara Ridge, and dips gently under cover to the west to depths of more than 3 000 feet. The basal conglomerate and shale beds of the Gamagara formation are ferruginized extensively into high-grade hematite. The conglomerate ore attains a thickness of up to 50 feet, while the overlying laminated iron ore of ferruginized shale may reach a maximum thickness of 190 feet, with an average of 60 to 90 feet. The floor on which the ore rests is usually banded ironstone, minor portions of which are also sometimes enriched into a high-grade iron ore. In one area the combined thickness of all high-grade layers is some 300 ft.

The open-cast mine at Sishen, where operations commenced in 1953, is the main source of supply for the Corporation's works at Vanderbijlpark, and certain tonnages are also despatched to the other works. During the past financial year, 2 600 000 metric tons of iron ore were despatched from Sishen. Of this quantity, more than 1 600 000 tons went to the Vanderbijlpark Works and 635 000 tons to the Pretoria Works, and 311 000 tons were exported to Japan.

During the same period Iscor's iron ore mine at Thabazimbi produced 1 750 000 metric tons, of which 1 111 000 tons went to the Pretoria Works and 639 000 tons to the Vanderbijlpark Works. Since July, 1970, the Lylyveld iron ore mine, which previously belonged to Amcor, has been operating for Iscor. It is still delivering the ore for No. 4 blast furnace at Newcastle which produces the pig iron for export to Japan.

In an effort to ensure better burdens and higher productivity, a great deal of attention is being given to the supply of the most suitable ore fractions to the works and to the levelling out of fluctuations in the chemical composition of the ore.

If the proposed scheme to export an initial minimum of 10 million tons of iron ore annually, through Saldanha Bay, comes to fruition, it is envisaged that the capacity of the Sishen mine will have to be increased to about 18 to 20 million tons per annum, which would meet both the export requirements and Iscor's own growing needs.

Iscor, which at present meets about 80 per cent of the domestic demand for steel, has no undue worries about the other raw materials like dolomite, zinc, and tin, which are supplied by its dolomite quarries at Mooiplaas and Glen Douglas, its tin mine at Uis in South West Africa, and the zinc mine at Rosh Pinah, also in South West Africa.

In the field of metallurgy the Corporation finds itself on the threshold of many new developments that augur well for the future and which should enable it to attain a total production capacity of over eight million ingot

tons by the turn of this decade. The present extension programme, which actually started at the beginning of the sixties, is progressing satisfactorily. During the past financial year the whole programme was revised in the light of the latest technical developments and market trends. It is estimated that, based on the present cost of equipment, an amount of approximately R1 300 million will have to be spent to increase the annual production capacity of its works from its present 3.9 million ingot tons to about eight million ingot tons by 1980. Extensions to the seven mining centres are included in this estimate.

Should the experiments on the drying and preheating of coal and on the production of form-coke be successful, the burdens of the existing ten blast furnaces at the three works will be improved and they will attain higher productivity.

A contract for the building of a fourth blast furnace at the Vanderbijlpark Works has been awarded, and the civil engineering work has actually started. A similar furnace may later be erected at the Newcastle Works or even at Saldanha Bay or Sishen.

Up to now the refining of hot metal to steel at the Vanderbijlpark and Pretoria Works was done in open-hearth furnaces, rotor furnaces, arc furnaces, and a tandem furnace. At the Pretoria Works, Bessemer converters are used in conjunction with open-hearth furnaces in the duplex process. In the course of last year Iscor decided to abandon the open-hearth, duplex, and rotor processes.

In the refining of iron to steel, new avenues are being explored and additional production units will have to be ordered in the near future to replace those that have become redundant, because of the latest technological developments. The two rotor furnaces, which have given excellent service, have been in operation for more than ten years and will operate for a few more years before they are replaced. Open-hearth furnaces, whether oxygen-blown or not, are outmoded and can no longer meet the requirements of modern steel technology.

As for the outdated Bessemer converters, Iscor had already decided to scrap them, but it is claimed that a new breakthrough, achieved in steel technology overseas, may mean that basic-lined Bessemer converters can be used in the most modern techniques. Should this practice prove to be of greater economic value than the latest L.D. oxygen converters, this method of refining may well become the main process to be used by Iscor.

Two electric-arc furnaces, which are among the most modern in the world, recently came into operation at the Vanderbijlpark Works. Built at a cost of about R14 million, the new plant will ultimately increase Vanderbijl's production by more than 700 000 metric ingot tons per annum. In addition, a D.H.-type vacuum degassing plant, which is nearing completion, will assist in the production of steels having reduced gas contents, which are required for some uses. The use of this plant will also reduce furnace refining time.

Each of the two electric furnaces, which, when ordered, were claimed to be the second-largest in the world, has a capacity of 135 metric tons. The furnace transformer is rated at 60/72 MVA, giving a maximum power input available for melting the charge of 49 MW. During the melting operation the temperature of the arc from the electrode to the scrap is about 12 000 degrees Centigrade. Power input and maximum demand are controlled by a computer, which forms part of the installation.

In a country like South Africa, where the costs of electric power are relatively low and the price of scrap is favourable, the advent of the ultra-high-power steel-making arc furnace has led to a situation where the economics of this method of steelmaking is inherently more attractive than that of steelmaking from hot metal. The main reason is that the capitalization per ton of finished steel capacity is only about half that needed when steel is made from ore via hot metal.

Iscor's decision to install the two large arc furnaces at Vanderbijlpark aims partly at sharing in the economic advantages of this process and partly at restoring the imbalance between scrap usage and hot-metal usage that has been developing within Iscor itself since the advent of oxygen steelmaking in the form of the rotor and tandem furnaces.

An analogous cycle of events has been taking place elsewhere in the world over the past 15 years.

Since the mid-fifties, open-hearth furnaces throughout the world have been replaced increasingly by oxygen steel processes with their more favourable processing costs. Because less scrap can be melted in these processes than in the open-hearths, there was a surplus of scrap, which tended to reduce scrap prices. Whereas electric steel furnaces based on scrap still concentrated in the 'twenties and 'thirties only on the small-scale manufacture of special steels, they began, particularly during the late 'forties and early 'fifties, on an ever-increasing scale and at very favourable processing costs to melt ordinary mass production steels by use of an ultra-high power supply.

These two tendencies together led to the risk that the nonintegrated steel manufacturers, whose process was based on purchased scrap, would increasingly encroach on the markets of the large integrated steelworks, unless the latter also processed scrap in electric furnaces to an increasing extent. Under these circumstances the large integrated works are, as Iscor is doing now, installing large electric-arc furnaces so that they can also take advantage of the more-favourable economics of this method.

As an alternative to the installation of large arc furnaces, various special techniques are being developed to enable the oxygen-steelmaking processes to absorb a higher proportion of scrap.

In a freely competitive economy these trends would cause scrap prices to rise to levels where the two effects would more or less offset each other, and this has in fact occurred in the United States. There the price of heavy melting scrap dropped from about $50 per gross ton in the mid-fifties to around $25 to $35 per gross ton in the mid-sixties; and has recently climbed back to about $50 to $55 and sometimes even to $70 per gross ton. In South Africa, where there is a common scrap-purchasing agency, such self-adjusting effects are not possible, and it has thus become a delicate matter for the scrap users to find a formula for the equitable allocation of the available purchasable scrap, which in general amounts to only about 24 to 25 per cent of the country's steel consumption at a given time.

Because of this low availability of purchasable scrap, Iscor, if it has to keep pace with its responsibility and hence with the country's consumption of steel, will in the future as in the past have to base its steel production mainly on the reduction of ore. This is in fact our intention, but it is, nevertheless, essential in the interests of Iscor's economics that it should also participate equitably in the usage of locally purchasable scrap; and the installation of the two arc furnaces at Vanderbijlpark must be viewed in this light.

While on this subject it would be as well to mention the trend elsewhere in the world towards the use of metal-

lized pellets in electric-arc steelmaking. This process has been hailed as a breakthrough. It has been claimed that an ore-based integrated steelmaking plant can be established on a relatively moderate scale, and that it will be economically competitive with the large integrated works based on blast furnaces. Present indications are that this method is not going to offer a magic solution to the problem, and that the capitalization and cost per finished ton of steel produced by this route is not going to be very different from that using the blast furnace. Whether this method is going to be a breakthrough for the small integrated plant is expected to be proved, one way or other, within the next five to ten years.

Because of the Government's interest in the decentralization of our industry, Iscor is also watching this development with very active interest.

It is not only on the raw material and refining side that big improvements are in the offing, but also as far as the rolling mills are concerned.

Rounding-off work at the Vanderbijlpark Works to increase its annual capacity to 3 700 000 metric tons is continuing. The slabbing/plate mill, built at a cost of more than R60 million, started rolling its first slabs at the end of June last year. This mill has been designed to roll 1 400 000 metric tons of ingots into slabs a year, of which about 200 000 metric tons can be re-rolled into plate, but a number of other product combinations is possible.

A heat-treatment plant is being installed for the quenching and tempering as well as for the normalising of steel plate. A batch furnace will be built for rolling off-size and very heavy slabs to plate, and an automatic four-side hot scarfing machine will be installed in the course of this year. It is expected that the production of these and existing facilities will be able in the not too distant future to meet the local demand for as-rolled and heat-treated plate.

A third galvanizing line is now in full production that will raise the production capacity of the three lines to approximately 28 000 metric tons per month. Tenders have been called for a semi-continuous hot-strip mill for the rolling of slabs into strip, having a finished width of up to 1.83 metres. The initial capacity of this mill complex, which is expected to come into production during 1973, will be about 1 150 000 metric tons per annum, but it can subsequently be increased to more than 2 250 000 metric tons. The initial cost, including the necessary wide cold-rolling facilities, will be in the neighbourhood of R100 million. Once in full production, it should be able to supply the needs of the local motor vehicle industry for wider sheet widths.

A continuous strip-annealing line and a roll-form corrugating line have been ordered to permit the production of corrugated sheets of up to 12.19 metres in length, and negotiations for the installation of an organic coating line to pre-coat coils of steel strip have reached an advanced stage.

At the Pretoria Works a modernization scheme is under way, providing for extra capacity at the steel melting plant, mills, and wire plant. This requires only slight changes in the modernization programme begun in the early 'sixties. Some of the production units — now 36 years old — have become technically outdated. Plans are under consideration for the introduction of vacuum degassing and continuous casting. Also part of the new developments is the proposed transfer of the wire plant to a new site at Kwaggasrand on the western outskirts of Pretoria. The Pretoria Works is scheduled to produce a total of 135 000 metric tons of wire per annum by 1979/80.

An agreement has been reached with Australian Wire Industries for the exclusive use in the Republic of its patented process for the production, at about three times the speed of the conventional processes, of heavily galvanized wire.

Iscor's Newcastle Works should start steel production during the second half of 1973. The first production units to be installed will be a steel-melting plant and a bar mill. The steel-melting plant will consist of two top-blown basic oxygen furnaces and a continuous casting plant, where the steel will be cast into blooms, which will then be rolled into light sections, such as angles, fencing standards, droppers, window sections, and rounds with diameters ranging from 10 to 60 millimetres. The expected capacities of the production units, which should be operating towards the end of 1973, are as follows: steel-melting plant, 1 300 000 metric tons; continuous casting plant, 900 000 metric tons; billet mill, 1 400 000 metric tons; and a bar mill, 400 000 metric tons.

It has been decided to produce wire at Newcastle, starting with a capacity of about 50 000 metric tons per annum by 1974/75 and reaching 68 000 metric tons by 1979/80.

Like Iscor, the other major South African steel producers are in the throes of big expansion programmes in an effort to satisfy the country's rising demand for steel. Healthy competition between the various steel producers is to be commended and can ultimately only serve the interests of the Republic of South Africa as a whole by making it possible for the country to attain the growth targets set by the authorities.

However, a note of caution should be sounded. In common with other sectors of the economy of the country, the South African steel industry is faced with an acute shortage of skilled labour. To obtain factual information on the current position of immediate and short-term labour shortages, a survey of labour requirements was conducted by Seifsa during June of last year. This survey revealed that the immediate shortage at that time was 26 000 workers of all races or about $7\frac{1}{2}$ per cent of the total labour force (350 000) of the metal and engineering industries. The shortage of white workers was 15 400, or 12 per cent of the total number of Whites employed, with journeymen recording a vacancy ratio of not less than 17 per cent (7 200 vacancies) and operators 15 per cent (4 300), but managerial, administrative and clerical staff showing a shortage of only four per cent. Immediate vacancies existed for 1 000 apprentices (12 per cent). The overall shortage of Coloureds and Asiatics was nine per cent, and the total immediate shortage of Bantu workers amounted to 9 300 or five per cent. From these figures it is obvious that a concerted effort should be made by all concerned to draw and train as many men as possible to fill these vacancies, because, if that is not done, all the expensive production units cannot be properly manned to produce the maximum output. This will mean a tremendous loss to the industries but, graver still, to the country as a whole, which must go all out to export as much as possible in our effort to curb the inflationary tendencies besetting our country. It seems to me that individual efforts by the metal and engineering industries are not enough; we shall have to put our heads together to solve this really acute problem. But this is not the time and place to go into details; a conference table, and the right atmosphere and approach by all involved are necessary for that.

In conclusion, without donning the mantle of a prophet, I want to state categorically that I am convinced of a rosy future for the South African iron and steel industry. There are many problems, but they *can* be solved, and *will* be solved by mature-thinking men.