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An Overview of the History and Current Operational Facilities of Samancor Chrome

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Abstract – Samancor Chrome has been, and continues to be, a major player in ferrochromium production. The company has a proud history and possesses benchmark technology and operations. Currently five business units are operating: two sets of mines and three smelter plants. Samancor Chrome produces around one million tons of charge chrome annually. Chrome ore, intermediate-carbon ferrochrome, and low-carbon ferrochrome, form part of the portfolio. Electrode paste is also manufactured through a joint venture with Highveld Steel and Vanadium. Samancor Chrome has a balanced approach towards operational strategy, and has entered into a number of joint venture partnerships. Through its access to quality raw materials, knowledge, and experience of various production technologies, and its strategic abilities, Samancor Chrome is well positioned to reap the benefits from opportunities in the current and future industry context.

INTRODUCTION

Samancor has been a major player in the ferrochromium industry for a number of years. Samancor Chrome has adopted a three-horizon strategy, with Horizon One being safely delivering production, Horizon Two being aimed at value chain optimization, and Horizon Three being the repositioning of Samancor Chrome in a future industry context to be able to reap the benefits from new opportunities. To ensure alignment of tactics, a balanced scorecard approach is used, with the following dimensions:

- SHER (Safety, Health, Environment, and Risk), centring on the principle of zero harm
- Organisational Learning and Development, encompassing both own employees and community projects
- Customers, emphasizing service orientation, and customer solution
- Business Processes, looking at operational stability, continuous improvement, maintenance, procurement, and technology
- Growth, focusing on expansion and delivering on the project pipeline
- Shareholder Value, supported by the other five dimensions, ensuring a value-oriented culture striving for profitability

SAMANCOR CHROME – HISTORY AND OPERATIONS

History

Samancor was formed by the amalgamation of SA Manganese Ltd and African Metals Corporation Ltd (Amcor) in 1975. It was known as SA Manganese Amcor Ltd until 1985, when the name was changed to Samancor.[1]

SA Manganese was formed in 1927, and has expanded to become one of the biggest producers of manganese ores worldwide. Mines were in the Kuruman / Postmasburg area of the northern Cape.

Amcor was founded in 1937, and operated a small blast furnace in Newcastle. With two large ferro-alloy plants, mines, and other centres, Amcor became one of the foremost producers of ferro-alloys in the world. Amcor was also involved in the production of graphite electrodes, chemicals, and fertilizers. The merger was a logical development, as Amcor was the biggest South African consumer of manganese ores, and both companies exported worldwide. Both companies had also worked closely together since 1937.

In 1983, Gencor became the single biggest shareholder in Samancor, with about 40% of the shares, with effective control.

By 1986, Samancor had a number of interests in the production of ferromanganese, chromium-alloys, ferrosilicon, graphite electrodes, and other carbon products, phosphate fertilizers, phosphoric acid, sodium-tripolyphosphate, as well as mineral deposits like chromium ores, dolomite, limestone, vanadium, serpentine, and of course the huge manganese ore deposits.

In 1998, after Gencor's unbundling exercise, Billiton established a joint venture with Anglo American Corporation to purchase and de-list Samancor Ltd. Billiton owned 60% of the shares. Billiton subsequently merged with BHP to form BHP Billiton in 2001.

The Samancor Chrome and Samancor Manganese divisions were split, with the Kermas group acquiring 100% of Samancor Chrome with the effective date of sale on 1 June 2005.

The Kermas group is a producer of and trader in chromium alloys and chemicals, with interests in South Africa, Germany, Turkey, and Russia.

Samancor Chrome currently operates two sets of mines and three alloy-producing plants, in the North West and Mpumalanga provinces of South Africa. The mines are called Eastern Chrome Mines and Western Chrome Mines, and the smelters are called Ferrometals, Middelburg Ferrochrome, and Tubatse Ferrochrome. These operations are located in the northern and north-eastern parts of South Africa (shown in Figure 1).

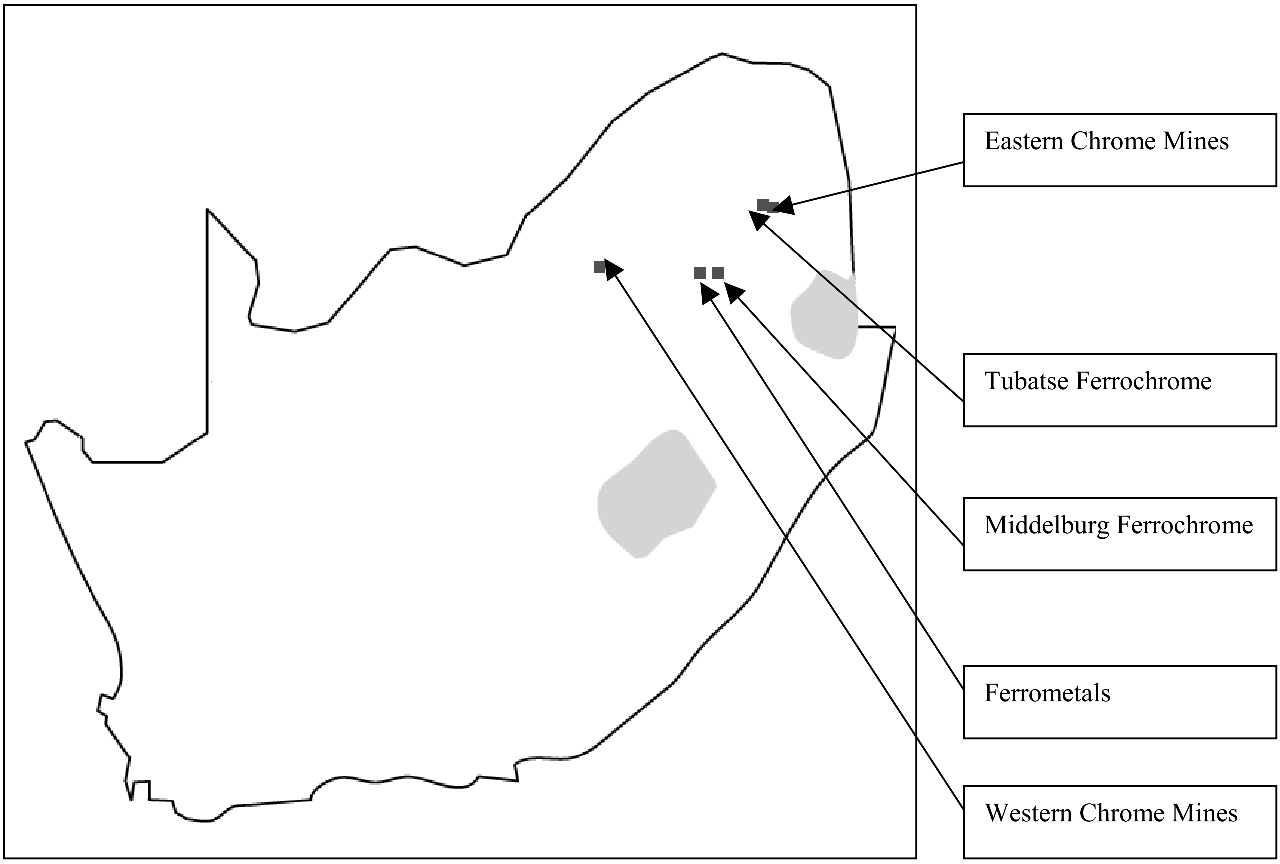

Figure 1: Location of Samancor Chrome operations

Mines

The two sets of mines, known as Eastern Chrome Mines (ECM) and Western Chrome Mines (WCM) respectively, are situated on the eastern and western rims of the Bushveld Igneous Complex, a saucer-shaped deposit in the northern and north-eastern provinces of South Africa. Eastern Chrome Mines stretch over about 100 km in the Steelpoort area, and includes mines like Lannex, Tweefontein, and Winterveld.

Western Chrome Mines stretches over a distance of about 50 km between Rustenburg and Brits in the North West province, and includes Millsell, Elandsdrift, and Mooinooi.

Mining takes place in both open-cast and underground mines, with conventional scraper mining and mechanized trackless mining being used in the underground sections.

Once it reaches the surface, run of mine ore gets crushed down to size and then beneficiated through dense-medium separation technology.

The Samancor Chrome mines produce lump ore and metallurgical concentrate for use in the metallurgical industry for ferrochrome production, chemical grade product for use in the chrome chemical industry (mainly as feedstock for sodium dichromate), foundry grade product used as moulding medium for casting, as well as refractory grade product used in refractory bricks and other products.

Pelletising and sintering

The chromite-containing ores mined by Samancor Chrome are typically quite friable, and contain a fair amount of fine, but mineralogically sought after, material. Samancor Chrome has acquired the technology from Outokumpu to agglomerate and treat this product into sintered pellets. Two pelletising and sintering plants have been erected, one situated at Ferrometals and the other one at Tubatse Ferrochrome.

Chromite fines and fine coke are wet milled together in a ball mill (Figure 2). After milling, the product is filtered, and the filter cake and bentonite are batched and mixed before being sent to the pelletising drum. In the drum, the particles are agglomerated into pellets from where they are screened. The oversized pellets are crushed, and recirculated together with the undersize pellets to the pelletising drum. The on-size pellets go to the sintering furnace. The pellets move through the sintering furnace on a steel belt, covered by a protective layer of previously produced pellets, where the new pellets are sintered. After sintering, the product is cooled and screened again. The undersize product that is screened out is recirculated back to the ball mill, and the on-size product is stockpiled or directly fed to the furnaces (Figure 3).

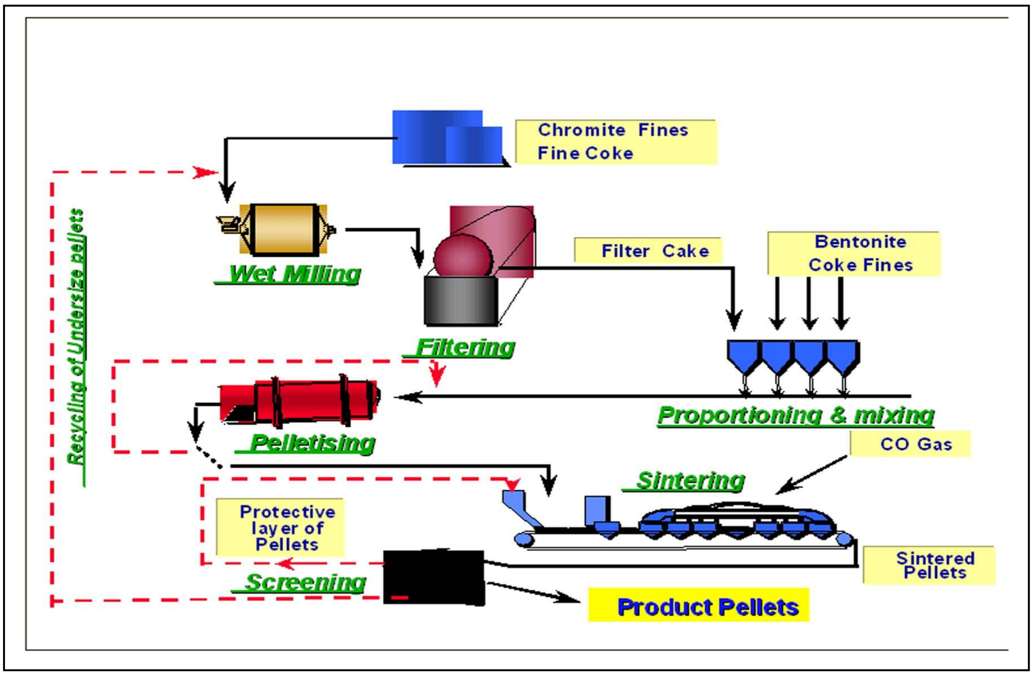

Figure 2: Pelletising and Sintering process flow

Figure 3: Sintered pellets

Chrome alloys
Samancor Chrome currently operates three alloy plants. The alloys produced at these plants are transported by rail (and sometimes by road) to Richards Bay and Durban, for export to customers worldwide. Most of the material is railed and shipped in bulk, although certain grades are also bagged and containerized for specific customers.

Chrome alloys are used in stainless and special steels. In stainless steels, the chromium is chiefly responsible for improved corrosion resistance. In special steels, chromium imparts properties like heat resistance, hardness, and wear resistance.

Charge Chrome
Charge chrome makes up the bulk of the Samancor Cr alloy production. It is an alloy of iron and chromium, containing between 50% and 55% chromium, with carbon at around 7% and silicon at around 4% being the other main constituents. It is produced in both open and closed submerged arc furnaces, as well as in a DC plasma arc furnace. Charge chrome is extensively used in stainless steel production for the manufacturing of a huge range of stainless steels.

In submerged-arc charge-chrome production, the raw materials, consisting of ores, fluxes, and reductants, are batched and mixed before being fed into the furnace. In the furnace, the chromite ore (consisting mainly of iron oxides, chromium oxide, magnesium oxide, and aluminium oxide) are reduced with carbon to form the alloy. The reaction is highly endothermic, and energy is supplied in the form of electrical energy through carbon electrodes.

As MgO and Al_2O_3 are both high liquidus temperature species, fluxes like limestone, dolomite, and quartz are loaded to condition the slag phase so that it can be tapped more easily. Alloy and slag are tapped through the same taphole in a cascade arrangement, with the alloy being trapped in the first ladle, and slag overflowing to the next ladles or into a pit.

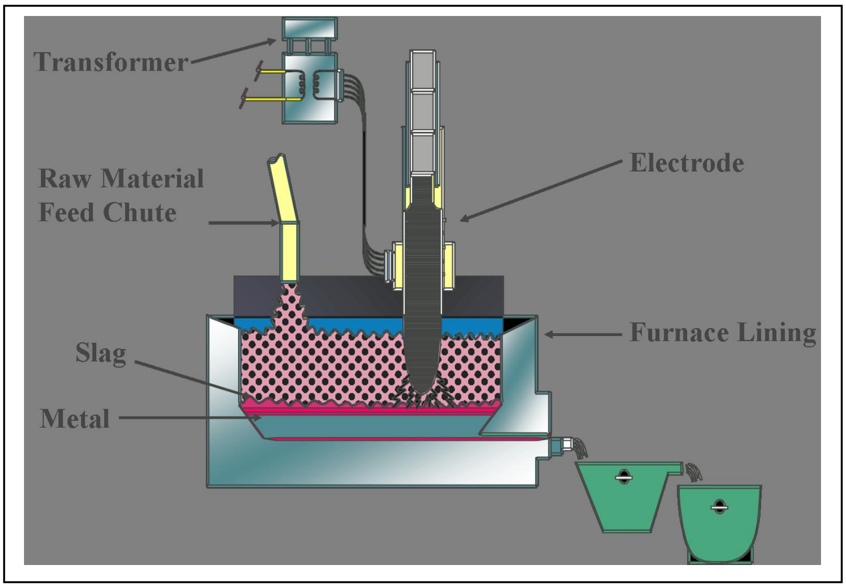

Figure 4: Schematic representation of an open furnace

In the open furnaces (depicted in Figure 4), the CO gas that forms from the reaction combines with oxygen on the furnace bed to form CO_2. In closed furnaces, the CO gas can be cleaned and burnt in a controlled way, to afford the opportunity to harness the energy. In the two closed submerged arc furnaces, the CO gas is utilised to pre-heat raw materials in a pre-heating kiln.

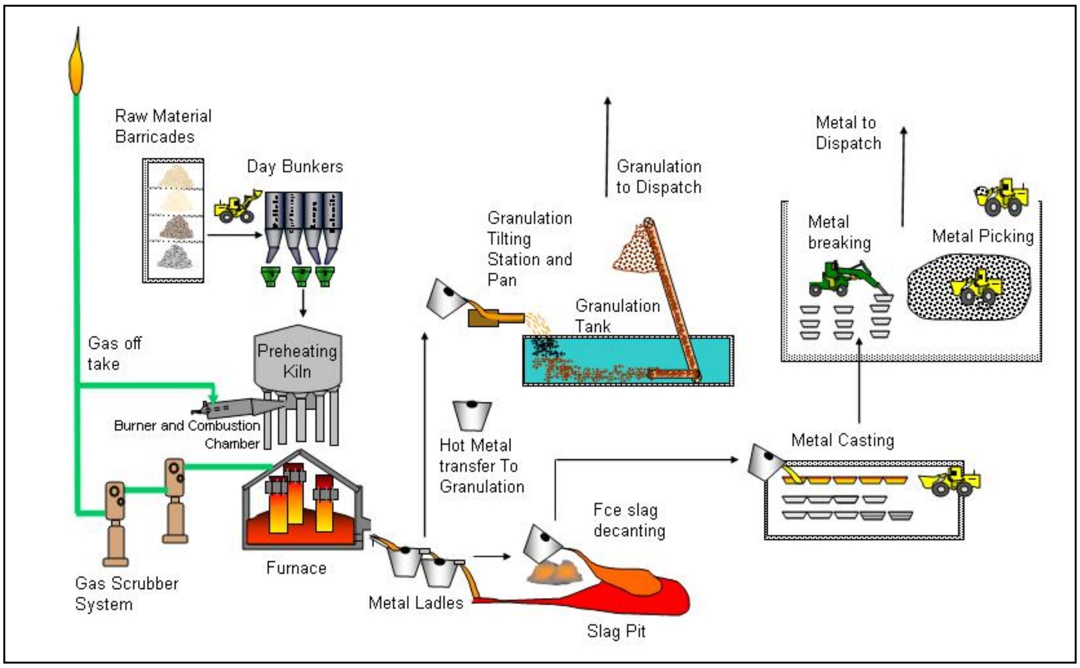

Figure 5: Schematic representation of the closed furnace process

After tapping, the alloy is de-slagged with a slag scraper or by decanting. It is then granulated, cast into ingots, or transferred to the next refining step. Ingots are broken and sized before dispatching the material to the clients.

Intermediate-Carbon Ferrochrome

Intermediate-carbon ferrochrome is a product of further refining of charge chrome. In essence, the silicon in the product is reduced to below 0.3%, and the C is reduced to less than 1.5%, for the lowest intermediate grade. This alloy is chiefly used as a trimming addition in certain stainless steel grades, in tool steels, and in alloy steels like bearing and high-speed steels.

In the production of intermediate-carbon ferrochrome, hot, molten charge chrome is transferred from the submerged arc furnaces to a CLU converter (Figure 6). The converter is a bottom blown unit using oxygen and steam (generated on site utilizing CO gas from the closed furnaces) as process gases. The Si is stripped from the metal forming SiO_2, which is fluxed with burnt lime and dolomite before the slag that forms is tapped. The C content is then lowered using the same process gases, and the metal is tapped as soon as the alloy reaches the required carbon grade. After the metal is tapped into a ladle, it is transported to a granulation plant, after which the granules are transported to the final products handling section from where the metal is shipped in bulk, in containers or in bags.

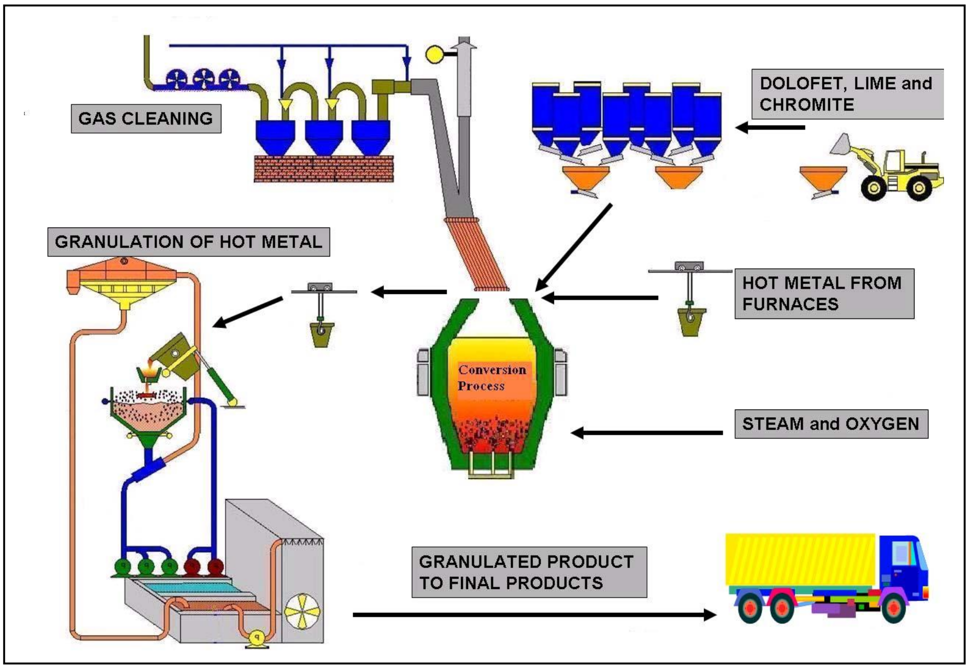

Figure 6: Intermediate-Carbon Ferrochrome production

Low-Carbon Ferrochrome

Low-carbon ferrochrome is produced by mixing ferrosilicon-chromium (FeSiCr) with a lime / chrome ore melt. Cr contents are typically around 60%, with a carbon content ranging from 0.02 to 0.06%. This alloy is used mainly for trimming additions in stainless steel production, and for specialized steels.

In the low-carbon process, charge chrome, quartzite, and reductants, are combined in a submerged arc furnace to produce ferro-silicon-chrome in a 'dry' or slag-free process. The ferro-silicon-chrome has a low C content. In an open arc furnace, chrome ore and lime are melted to form a slag. The slag is then mixed with the ferro-silicon-chrome, utilizing see-saw mixing, where the Si is stripped from the ferro-silicon-chrome by oxidizing it with the Cr_2O_3 in the slag to form low-carbon ferrochrome. The slag from this process is granulated, and the alloy is cast, crushed, and dispatched.

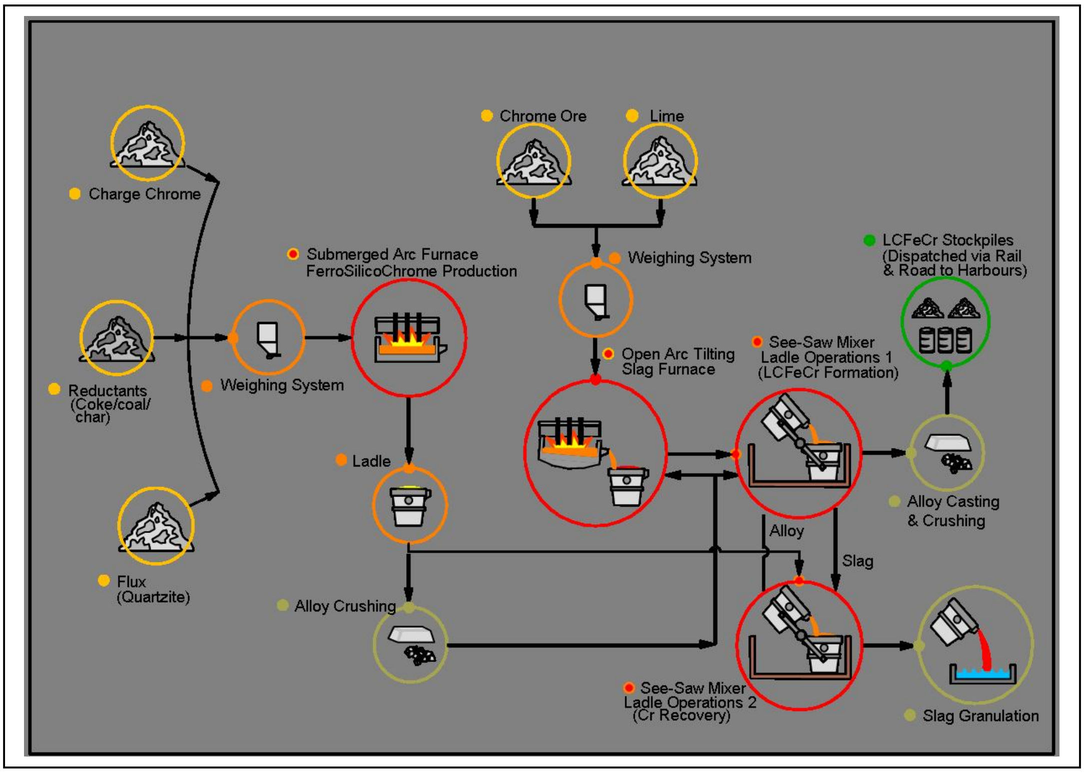

Figure 7: Low-Carbon Ferrochrome production

Electrode paste production

Samancor Chrome has formed a joint venture partnership with Highveld Steel and Vanadium to produce electrode paste, utilizing Elkem technology. This joint venture is called Ferroveld, and the plant is situated on the Ferrometals premises.

Electrode paste is a blend of sized anthracite and pitch, used in the manufacturing of Soderberg electrodes. Mild steel casings are welded together to form a hollow cylinder, with electrode paste cylinders or blocks being added into the casing cylinder. When the paste starts heating up, it melts to fill the casing, and then gets baked when the volatiles are driven off leaving a solid matrix of anthracite and binder.

In the production of electrode paste, the first step is to calcine the anthracite, to make sure that all of the volatiles are driven off. This takes place in electrical calcining furnaces. After calcining, the anthracite is crushed and screened into three different size fractions. The fines are milled, and fed in a certain ratio, with the other size fractions, into the mixers after pre-heating. Pre-heated pitch is then combined with the anthracite in the mixer, and, after proper mixing, it is either tapped into different-sized cylinder moulds, or extruded and cut into blocks before storage and dispatch.

Smelter details

Ferrometals

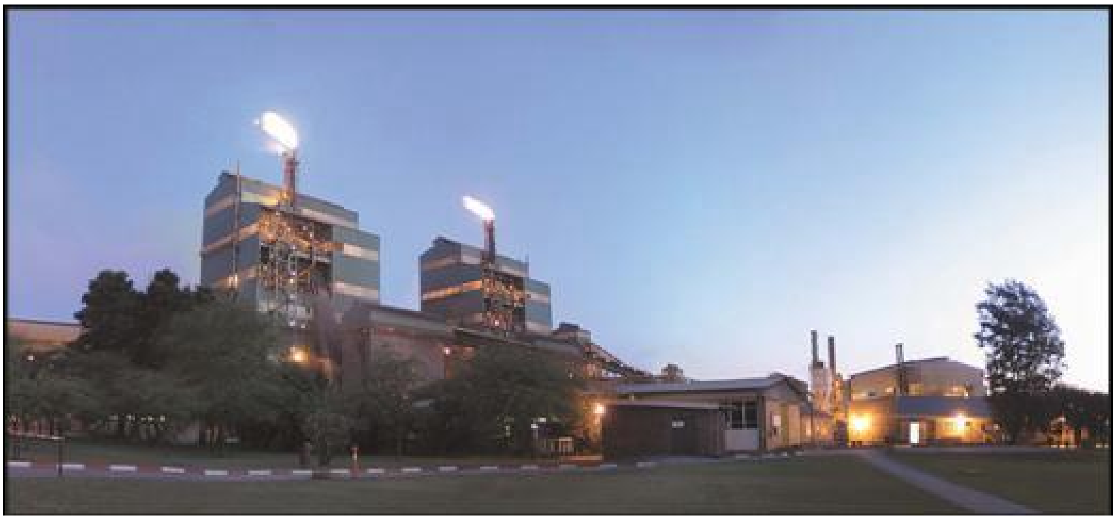

Figure 8: Furnaces F4 and F5 at Ferrometals

Ferrometals is both the oldest and the biggest of the three plants in the Samancor group, and is situated near Witbank in Mpumalanga. In 1959, Amcor acquired Wispeco, and changed the name to Ferrometals Ltd. At that stage, two 7.5 MVA ferrosilicon furnaces were in operation on the site (F1 and F2). In 1962, a 15 MVA Demag furnace (F3) was commissioned on ferrochromium. In 1970, a 48 MVA ferrosilicon furnace started up (FA, later F6), and the small furnaces were converted to ferrochromium production. In 1973, a 48 MVA furnace (F4) was commissioned on ferrochromium, with another 48 MVA ferrochrome furnace (F5) starting up two years later (Figure 8). In the meantime, a carbon paste producing plant, Ferroveld, was started up as a joint venture with Highveld Steel and Vanadium on the Ferrometals site, and the small furnaces were upgraded to a total installed capacity of 230 MVA, capable of 31 000 t/a ferrosilicon and 300 000 t/a charge chrome.

In 1986, the intermediate-carbon ferrochrome converter (IC3) started up, followed by a chrome recovery plant (1995). In 1996, the ferrosilicon furnace was converted to ferrochrome production, and, in 1997, an Outokumpu pelletising and sintering plant was added. In 2002 and 2003, F4 and F5 were upgraded to 63 MVA, with F6 (also 63 MVA) following in 2006. Total production capacity at the moment is 550 000 t/a charge chrome, of which around 78 000 t/a can be converted to intermediate-carbon ferrochrome, 577 500 t/a pellets, and 62 000 t/a electrode paste.

Ferrometals produces charge chrome in both a lumpy and granulated form, and intermediate-carbon ferrochrome in a granulated form.

Middelburg Ferrochrome

Middelburg Ferrochrome started out when RMB Alloys of Rand Mines established an operation to produce low-carbon ferrochrome, after pilot-scale test work at Driehoek, near Johannesburg, in the early 1960s.[2] By 1964, the first low-carbon ferrochrome from purely South African raw materials was produced at the site in Middelburg (Figure 9). In the late 1960s, RMB Alloys, Southern Cross Steel, and Palmiet Chrome Corporation merged and formed Middelburg Steel and Alloys (MS&A).

Figure 9: Middelburg Ferrochrome site

In 1974, the first charge chrome was produced in an 8 MVA furnace, with two 25 MVA furnaces (M1 and M2) being commissioned in 1975 and 1976 respectively. These furnaces were later upgraded to the current 48 MVA size.

In the meantime, the low-carbon ferrochrome operation was also expanded, with the biggest slag-melting furnace in the southern hemisphere being commissioned in the mid 1980s. In the late 1980s, a chrome direct reduction kiln was added, together with another submerged arc furnace (M3), which was later converted to DC arc technology.

In 1990, MS&A was split into MS&A Chromium and MS&A Stainless. In 1991, MS&A Chromium was taken over by Samancor, becoming Middelburg Ferrochrome, while MS&A Stainless became Columbus Stainless Steel.

The current capacity at Middelburg Ferrochrome is 285 000 t/a charge chrome, 200 000 t/a kiln product, 48 000 t/a slag from the open arc furnace, and 30 000 t/a FeSiCr from two submerged arc furnaces.

Tubatse Ferrochrome

Tubatse Ferrochrome (Figure 10) is situated near Steelpoort in the Mpumalanga province. It is in close proximity of the Eastern Chrome Mines.

Figure 10: Tubatse Ferrochrome

In 1975, Tubatse Ferrochrome was established as a joint venture between Gencor and Union Carbide of the USA. Three 30 MVA furnaces (T1, T2, and T3) were commissioned in 1976 on ferrochrome. In 1985, the Union Carbide shareholding was taken over by Samancor. Samancor acquired the rest of the shares in Tubatse in 1989. In 1989, a 37 MVA furnace (T4) was commissioned, followed by another 37 MVA furnace (T5) in 1990. A chrome recovery plant was also added in 1989. In 1996, another 37 MVA ferrochrome furnace (T6) was added, followed by an Outokumpu pelletising and sintering plant in 2002. Total capacity at the moment is 360 000 tons of charge chrome, and 520 000 t/a sintered pellets.

Current focus areas

Samancor Chrome has formed a Furnace Operations Council. Operational Managers from all the smelter sites, as well as technical personnel from all over the group, meet on a monthly basis to share learnings, to increase the knowledge base, and to ensure alignment towards the Samancor Chrome vision.

Some key projects have been identified, and are pursued towards a group-wide benefit. These include reductant management, furnace lining management, talent management, and operational stability. Maintenance, procurement, and safety are also driven from a corporate perspective.

CONCLUSIONS

Samancor Chrome has been in the ferrochrome business for a number of years. The product blend, technology employed, focus on the employees, and vertical integration, found in the group have ensured that Samancor Chrome is well positioned to meet the challenges and opportunities of a changing world economy. Together with the infrastructure and technical knowledge that the rest of the Kermas group possesses, Samancor Chrome will continue to be a force to be reckoned with in the ferrochrome industry.

ACKNOWLEDGEMENTS

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