



Pyrometallurgical processes and equipment

MINTEK has been closely involved with the South African pyrometallurgical industry since the 1970s, and is a world leader in the development and implementation of DC arc furnace systems for smelting, fuming, re-melting and slag-cleaning processes. Other areas of expertise include pre-reduction, fluidised-bed technology, metal condensation, and flowsheet development.

Processes have been developed for ferro-alloys, non-ferrous metals, precious-metals concentrate smelting, and metallurgical waste treatment.

Equipment and scale of operation

Feed preparation and pre-treatment

- Computer-controlled circulating fluidised-bed facilities for continuous tests at temperatures of up to 1 100°C and 100 kg/h throughput;
- 0.5 t/h and 3t/h rotary kilns for drying, roasting and calcining; and,
- A 3 t/h externally heated rotary kiln for pre-heating the feed to smelting furnaces up to 900°C.

Smelting

- Pilot-scale AC-arc furnaces (60 and 300 kVA) for conventional smelting testwork at feed rates up to 1 t/d;
- Pilot-scale DC-arc furnaces from 100 kVA to 3.2 MVA (50 kg/h to 1 t/h feed);
- A demonstration-scale facility comprising one or two DC arc furnaces with a total power rating of 5.6 MVA; and,
- Feed rates of up to 3 t/h can be achieved with pre-heated material, at power fluxes up to 700 kW/m². All the furnaces are fully equipped with control, instrumentation, data-logging systems and off-gas handling plants. DC-arc furnaces can be converted to AC operation if required.

Converting

- Top-blown rotary converter with a 15 litre liquid capacity.

Metal condensation

- Zinc condenser up to 300kg/h (lead-splash type); and,
- Magnesium condenser up to 100 kg/h.

Modelling and simulation

- Process flowsheeting and techno-economic studies are carried out using Mintek's Pyrosim software for the calculation of steady-state mass and energy balances in pyrometallurgical processes.

Processes implemented industrially

A DC-arc smelting process for the production of ferro-chromium

from 100% < 6mm ore, anthracite and fluxes. Two furnaces have been installed in South Africa (28 MW and 40 MW).

A DC-arc smelting route for producing high titania slag and pig iron from ilmenite concentrates was developed in conjunction with Anglo American Corporation. The process has been implemented at an industrial scale (25 MW and 35 MW).

Recoveries of 98 per cent for nickel and over 80 per cent for cobalt from non-ferrous furnace and converter slags have been demonstrated using DC arc technology up to 2 MW scale. This technology has been implemented at Chambishi Metals in Zambia at the 40 MW scale.

About 1 700 t of stainless steel plant dust was smelted at 1.4 MW to recover chromium, nickel and iron into an alloy for recycling. This technology has been implemented industrially at a 20 MW scale.

Processes developed to pilot scale

The major process requirements for successfully producing zinc from electric arc furnace (EAF) dusts have been established and demonstrated at a 1.3 MW scale. About 50 t of material was treated, producing Prime Western (PW) grade zinc metal and a slag that conforms to US Environmental Protection Agency (EPA) disposal criteria.

More than 1 000 t of lead blast-furnace slag have been treated at a 1 to 2 MW scale to yield disposable slag and PW grade zinc from a DC furnace linked to an ISP lead-splash condenser.

Smelting of calcined nickel laterite fines has been successfully demonstrated at up to 3 MW and 3.5 t/h, with better than conventional levels of nickel recovery at 25 to 35 per cent FeNi grades.

More than 2 500 t of off-grade ferro-manganese fines have been re-melted and refined in the DC arc furnace, at a rate of about 30 t/day, to yield a saleable, lumpy medium-carbon product.

The technical viability of continuously fuming and condensing high-purity magnesium metal from calcined dolomite at atmospheric pressure has been demonstrated in a purpose-designed 100 kg/h pilot plant.

A large-scale smelting project is underway to treat a process stream containing PGMs and elevated chromium levels, recovering the precious metals into an iron alloy for recycling. More than 17 kt of this material has been processed at a rate of 1 000 t/month. The work also serves to demonstrate the smelting step in the DC arc-based ConRoast process for recovering PGMs from concentrates.

Deliverable technologies

Melting of metal and alloy fines and dusts in an environmentally acceptable manner, using DC-arc furnace technology up to 10 MW. Service work to test amenability is available on a pilot plant scale. Examples include nickel, chromium, manganese, vanadium, and silicon-containing alloys.

Toll smelting services

These facilities are available to provide toll-smelting services. Materials are typically treated at a rate of 500 to 1 500 t/month for periods of 6 to 36 month.

Key Staff

Tom Curr - Manager. Twenty-nine years' experience in managing research and development in pyrometallurgy.

Rodney Jones - Specialist Consultant. Twenty-one years' experience in computer simulation and design of high-temperature processes, and the development of thermo-dynamic software. Expertise in platinum-group metal smelting and cobalt recovery.

Glen Denton - Specialist Consultant. Twenty years' experience in process development for DC arc furnaces and plant design. Expertise in ilmenite, cobalt, and zinc smelting processes.

Herman Lagendijk - Head: Process Demonstration. Twenty-two years' experience in process development for nickel and manganese ferro-alloys, and non-ferrous metals.

Isabel Reinecke - Head: Commercial Applications. Ten years' experience in planning and running large pilot-plant campaigns. Expertise in ferro-nickel.

Kabwika Bisaka - Head: New Technology. Seventeen years' experience, including nine years in industry. Expertise in ferro-alloys and base metals.

The operations group consists of 30 to 120 people of various disciplines, responsible for the assembly, maintenance, and operation of the pilot plant and laboratory facilities.

ISO 9001 ■■■■
QUALITY
MANAGEMENT SYSTEM

ISO 14001 ■■■■
ENVIRONMENTAL
MANAGEMENT SYSTEM

ISO 17025 ■■■■
TESTING AND CALIBRATION
LABORATORY

OHSAS 18001 ■■■■
OCCUPATIONAL HEALTH AND
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