

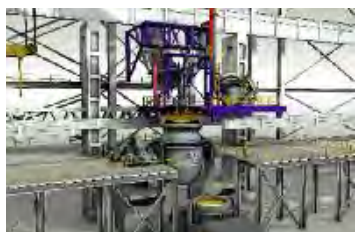
SAF BULLETIN

SMS group: Full liner in superior Submerged Arc Furnaces and Electric Smelters Technology

3rd edition



Passion for metals



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Editorial



DEAR CUSTOMERS, COLLEAGUES, AND BUSINESS ASSOCIATES,

Steel and nonferrous metals move the world. Built from these materials, aircraft take off safely, vehicles save fuel, and wind turbines reliably generate energy. This is mainly due to crucial material properties determined right at the start of production by plants and machines from the SMS group. Our equipment covers the entire metallurgical process chain from raw materials and metallurgy, through shaping, and up to finishing. It provides the materials with a wealth of functional properties plus the high quality our customers require for further processing, which have become indispensable for many final products today.

Essential for us is the success of our customers. As a system supplier and due to close interaction of all the departments and experts involved, we can deliver future-oriented overall solutions from one source. They range from consulting and planning to mechanical equipment through to electrical and automation systems as well as a comprehensive, flexible service portfolio. Today, our worldwide manufacturing and service network of workshops and sales offices covers more than 60 locations.

This means we are able to immediately, individually, and efficiently respond to our customers' wishes at their sites. And we can ensure plants and machines tailored to specific local requirements, whether new equipment or modernizations.

Our solutions give our customers a competitive edge. That's because the equipment improves product quality, cuts operating costs, boosts productivity, and reduces the consumption of resources. This also applies to the fields of metallurgy and environmental technology.

We transform the world of metals. See for yourself.

A handwritten signature in black ink, reading "Burkhard Dahmen". The signature is written in a cursive, flowing style.

Burkhard Dahmen
Chairman of the Managing Board SMS group

Product range

The SMS group is a group of globally operating companies in plant and machinery construction for steel and non-ferrous metals processing. We cover everything from pig iron production to metallurgical plant, rolling mills to strip processing lines, tube mills to thermal technology – complete with electrics and automation as well as service.



IRON MAKING



TUBE AND PIPE PLANTS



FORGING PLANTS



ELECTRICAL AND AUTOMATION SYSTEMS



METALLURGY PLANTS AND ENVIRONMENTAL TECHNOLOGY



FLAT ROLLING PLANTS



LONG PRODUCTS PLANTS



STRIP PROCESSING LINES AND FURNACE TECHNOLOGY

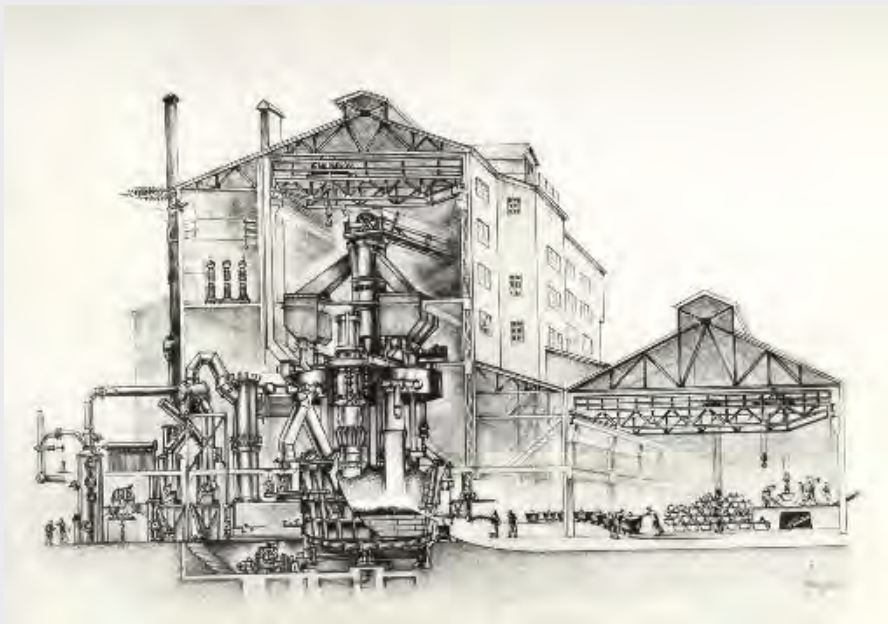


PRODUCTION

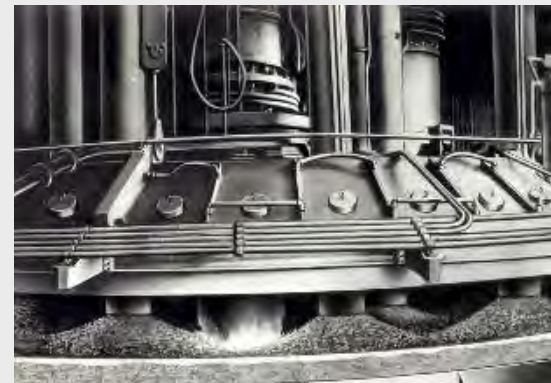


TECHNICAL SERVICE

History, expertise, mission



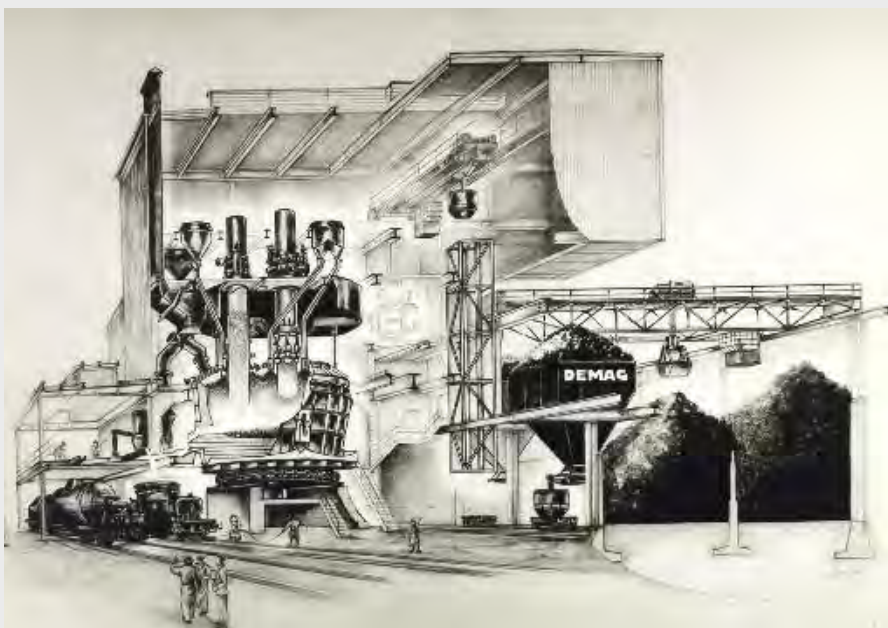
SAF of the 70ties.



Smelter of the 60ties.

MILESTONES:

- 1906: First reduction furnace
- 1956: Low-induction high current line
- 1958: Hydraulic electrode column
- 1966: Encapsulated electrode column
- 1975: Energy recovery system
- 2000: Modern furnace control
- 2006: Refining station
- 2008: Electrode column DC furnace
- 2014: Composite electrode
- 2015: Largest FeNi furnace



SAF of the 70ties.



Silicon plant illustration.

The SMS group offers a wide product portfolio for end users who process ferroalloys, PGM, NF metals, iron, and steel. Over the last 100 years, SMS has developed a whole range of processes to produce more than 60 different kinds of metals and slags (collecting in excess of 750 references).

Internationally, the SMS group ranks among the strongest players in the field of all smelter components, equipment, and plant solutions. We are the global leader in metallurgical plant and machines, not least because we have integrated top names such as Demag, Krupp, Schloemann, Concast, MAN-GHH, Paul Wurth, and Metix.

OUR ETHICS AND VALUES

As a tradition-rich company, SMS maintains high ethical standards and values. They lay the foundations of our success – sustained for decades, yet as vital today as ever.

OUR MISSION

SMS is committed to designing and building complete, innovative submerged-arc furnaces and electric smelters, as well as integrated plants and components. All of this ensures products of the highest quality, consistency, and reliability.

Our plants guarantee a quick ramp-up and safe, long-lasting operation. Equally important are their green credentials and cost-efficiency. We achieve our project goals in teamwork with our customers. Yet, even after completing the job, we remain in close contact with them.

All over the world, furnaces from SMS are hard at work. That's why SMS is highly experienced in dealing types of local conditions ranging from climate to culture, political environment, and more.

SMS supplies furnaces to many different industries, covering a multitude of applications and processes. It often happens that our customers require customized solutions. What's more, our equipment has to stand up to extreme conditions such as high process temperatures and aggressive slag compositions. This exceptional know-how is also implemented in our conventional furnace designs and is one reason why SMS furnaces are considered the most reliable on the market.



FeNi tap of circular furnace.

Introduction by Dr. Guido Kleinschmidt, Dr. Rolf Degel and Dr. Christian Fröhling

Looking at the metals market, we feel the immediate prospects appear good. Currently, the ferroalloy prices of most metals are being driven up by constant growth in the steel industry. Just as positive is the news that the nickel ore ban as well as certain developments in China indicate a recovery for the FeNi industry. Demand for silicon materials continues to rise by at least 5% per year, with a favorable effect on prices. It is predicted that the long-term price development of the non-ferrous market will remain at the same level. Therefore, SMS is optimistic about business opportunities in the future.

Recent years have been exciting for the SMS group. That's because many fascinating and challenging furnace projects have been or are now being implemented. Included here are the world's largest-ever FeNi furnace, the first large-scale FeCr production line based on DC technology, silicon plants, copper slag cleaning furnaces, FeMn plants, a FeNb furnace, smelters for the production of fused magnesia, as well as large-scale calcium carbide furnaces.

The SMS group, specifically SMS Siemag in Düsseldorf, Metix in Johannesburg, and Paul Wurth in Luxembourg, is well prepared for growing market demand for our smelter technology and auxiliaries.

There is also a healthy demand for complete solutions, and we enhanced our competencies in this field, supplying EPC turnkey projects and EPCM managing projects.

Our customers can expect the same top quality from our SAF departments that we have supplied for more than 100 years. Combined with improved upstream and downstream equipment and processes, this expertise produces sophisticated full-line solutions.

As a result of today's increasing energy costs and fluctuating raw material quality, our effective submerged-arc furnace and electric smelter technologies have become even more attractive to customers than before. Due to their excellent design and high efficiency, they ensure consistent, dependable, and reliable production at low energy consumption.

Having the twin incentives of high costs and strict environmental regulations also means our energy recovery systems have come into special focus for electric smelters. That's because the stable, uninterrupted operation of the furnaces as well as the higher chemical and sensible energy content in the off-gas achieve a recovery – depending on the process – of more than 20% of the input energy.

SMS has developed a system that recovers some of the energy from liquid slag, and looks set to take ferroalloy producers by storm.

During the last decade, the SMS group pioneered innovative smelter technologies such as:

- Large-capacity units that lower specific operation costs (applied for the production of silicon, FeNi, FeCr, CaC₂)
- AC and DC technology capable of directly processing ore fines and lower-grade ore (applied in FeCr and TiO₂ production)
- Innovative metal refining technologies for best quality ferroalloys (applied for MC and LC FeMn, MC and LC FeCr, FeNi and silicon)
- Rectangular slag cleaning furnaces for best metal recovery rates of valuable metals (Cu, Co, Pt, etc.)
- A new type of MgO smelter
- Efficient energy recovery systems that improve overall plant efficiency and reduce CO₂ emissions



Dr. Rolf Degel, Vice President Special Metallurgical Plants and Dr. Christian Fröhling, General Manager Technical Sales SAF, Gas Cleaning.



Dr. Guido Kleinschmidt, Member of the Managing Board SMS group.

All these innovations and improved processes were only possible thanks to constant intensive cooperation with our customers as well as internal research and development.

It's obvious that our target groups are keenly interested in innovative products like these.

Due to worldwide purchasing and excellent, long-lasting relations with our suppliers, we keep our overall prices low. A large percentage of price fluctuations originate with our suppliers. You can rest assured that we always pass any savings on to you.

Indisputably, for SMS, innovation has always been the key to future success. We believe in building tomorrow's furnaces today. The development of a vacuum AOD using CO₂ as the major purging medium ensures refining to LC FeMn/FeCr with a significantly lower OPEX.

There has been a new major focus at SMS over recent years on environmental solutions, including gas cleaning systems, water treatment plants, and in particular energy recovery systems. That's why we strengthened our range of expertise and increased our workforce in this field. Today, the SMS group offers efficient energy recovery systems based on boiler technology. Reflecting this change, the SMS group has set up a new department covering this innovative discipline.

Also new is a secondary gas cleaning system for casting that will reduce emissions and improve safety in silicon and ferroalloy plants.

What rounds off our product portfolio is a composite electrode that makes it possible to reduce OPEX in silicon production. The composite electrode can be used for capacities of up to 40 MW.

Finally, it gives us great pleasure to thank our customers for their loyalty in choosing technology from the SMS group. We are confident our equipment will continue to contribute to their sustained success.

Dr. Rolf Degel

Dr. Guido Kleinschmidt

Dr. Christian Fröhling

The team

SMS  group



Our international experts are passionate about SAF products. This is a field where SMS Siemag in Düsseldorf and Metix in Johannesburg pool their know-how for our customers' benefit. Furthermore, Paul Wurth provides support with refractory design and tapping/stoking equipment. We join forces with our customers to work together as a team, always devising the best possible solution. Our team is available at all times to stand by your side and help you get the results you want.



OUR TEAM IN DÜSSELDORF/GERMANY

The team in Düsseldorf handles all SAF-related projects for electric smelters and submerged-arc furnaces worldwide, except in southern Africa.



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Wynand Moolman
Projects Director, experienced in project management, has successfully executed big EPC/EPCM contracts

OUR TEAM IN JOHANNESBURG/ SOUTH AFRICA

Metix is responsible for all submerged-arc furnace and electric smelter projects in the southern African region. Additionally, Metix also offers burden pre-heating systems as well as pellet and sinter plants.



Frank Gunther
Financial Director, experienced in comm. Project Management, accounting, controlling, reporting



Ivan Hall
Technology Equipment Manager, experienced in industrial plant maintenance, equipment sales and development



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Goerge Farmer
Lead Process Engineer, experienced in various processes for the ferroalloy and non-ferrous industry



Gawie Lotter
Project Manager, experienced in Project Management of EPCM projects in metallurgical plants, operational experience in iron-making plants



Marco van Niekerk
Mechanical Engineering Manager, experienced in plant engineering and execution of EPC and EPCM contracts



Cor Brink
Project Manager, experienced in plant operation and maintenance, project management

PAUL WURTH AND TMT

The Luxembourg-based Paul Wurth Group is a leading market player for the design and construction of complete blast furnace and coke oven plants. Agglomeration plants, direct reduction plants, environmental protection technologies, as well as waste treatment and recycling facilities complete Paul Wurth's product portfolio for the primary phase of metals production.

Next in line are submerged-arc furnaces and electric smelters where Paul Wurth offers state-of-the-art equipment, such as slag and metal granulation systems and metal casting machines, and is able to provide advanced lining solutions.

Its affiliated company TMT – Tapping Measuring Technology, a joint company of Dango & Dienenthal and Paul Wurth – specializes in the design and supply of mud guns and taphole openers.



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Furthermore, the SMS Group is well represented by company offices and branches.



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Blast furnace No. 1, Hyundai Steel, South Korea.



Castfloor of blast furnace "H", Tata Steel, India.



Ingot casting at Primus® plant.



Mudgun and drilling machine (TMT).

Interview with Georges Rassel, CEO of Paul Wurth

Question: Mr. Rassel, what are the major benefits of being part of the SMS group?

Rassel: After pooling our competencies, the SMS group is now able to service the entire iron and steelmaking process chain, including hot metal production and the processes upstream of the blast furnace. We also have a more powerful position in terms of joint sales efforts and service business.

Q: How do you see your involvement in SAF technology?

Rassel: When it comes to submerged-arc furnaces, we aim for closer collaboration, because the Paul Wurth Group has many technologies and strategies to offer.

Q: Such as?

Rassel: In the past, TMT, the joint company Paul Wurth established with Dango & Dienenthal, already closely cooperated with the SAF department in tapping technologies. But our solutions in coal-based calcination using rotary hearth furnace technology and sinter plants are also interesting technological methods, particularly for FeNi, FeMn, and FeCr plants.

Q: Where do you see additional opportunities?

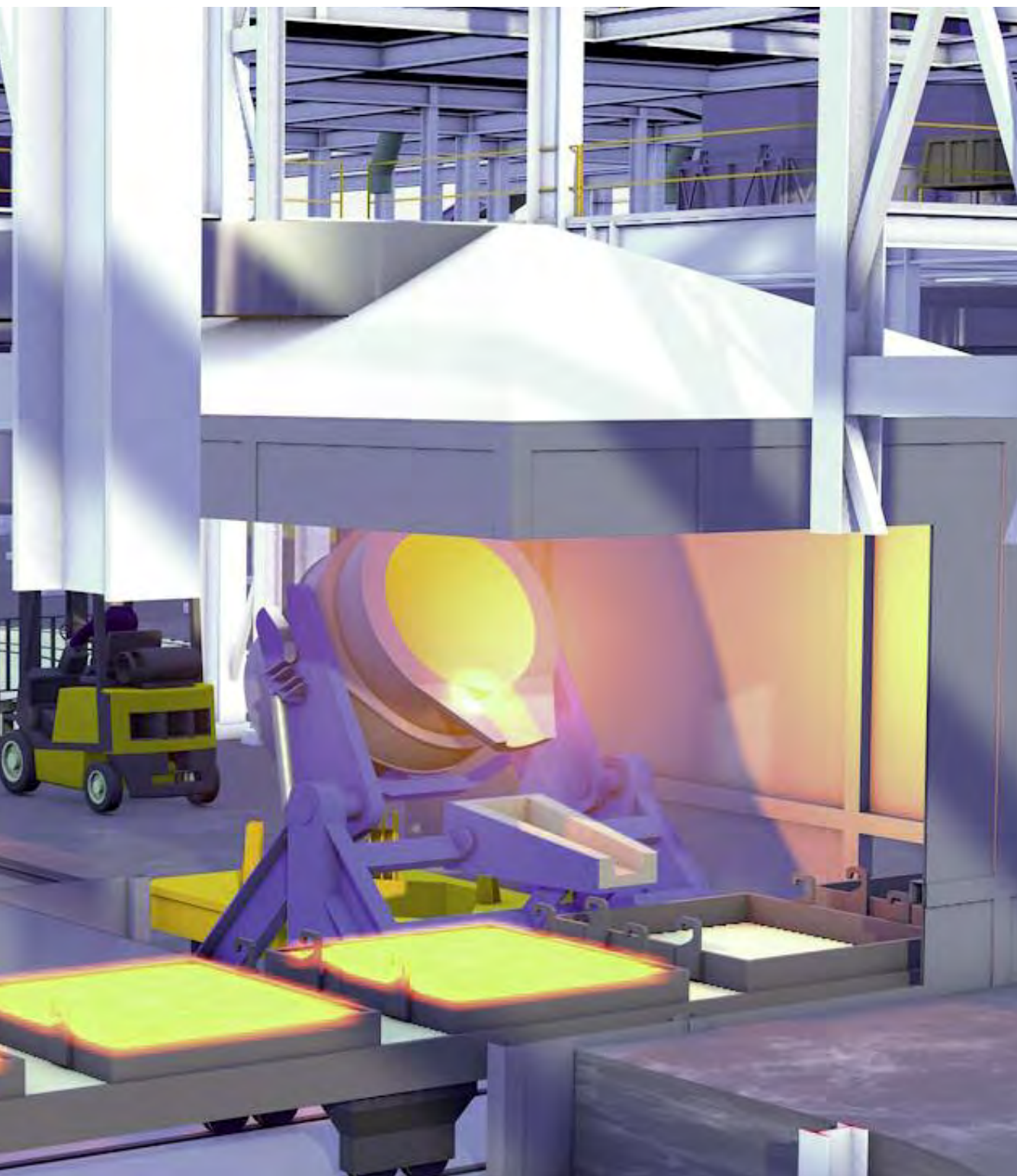
Rassel: Right now we're refining and testing our dry slag granulation process at a pilot plant in Dillingen. If we're successful in reliably granulating dry slag, this can provide significant energy savings, in particular for FeNi furnaces.





APPLICATION FIELDS – GENERAL SAF TECHNOLOGY PRODUCT PORTFOLIO

Here it's all about tailor-made solutions for best process performance. SMS provides a wide range of submerged-arc furnaces and electric smelters for the ferroalloy, non-ferrous metal, chemicals and electronics industries.



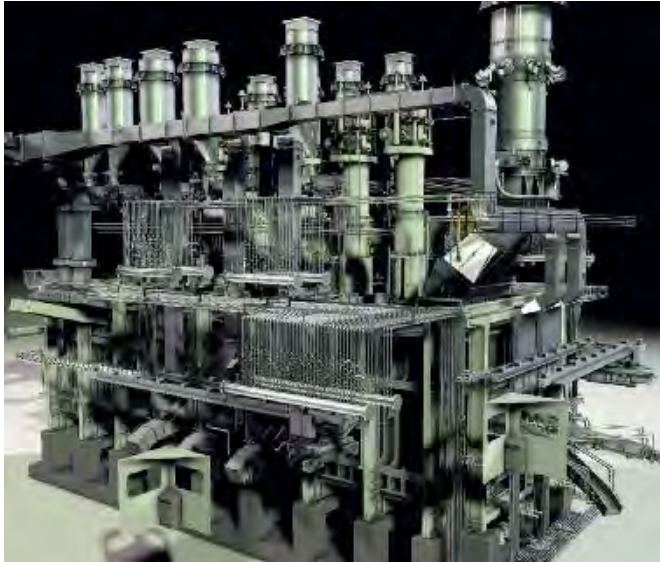
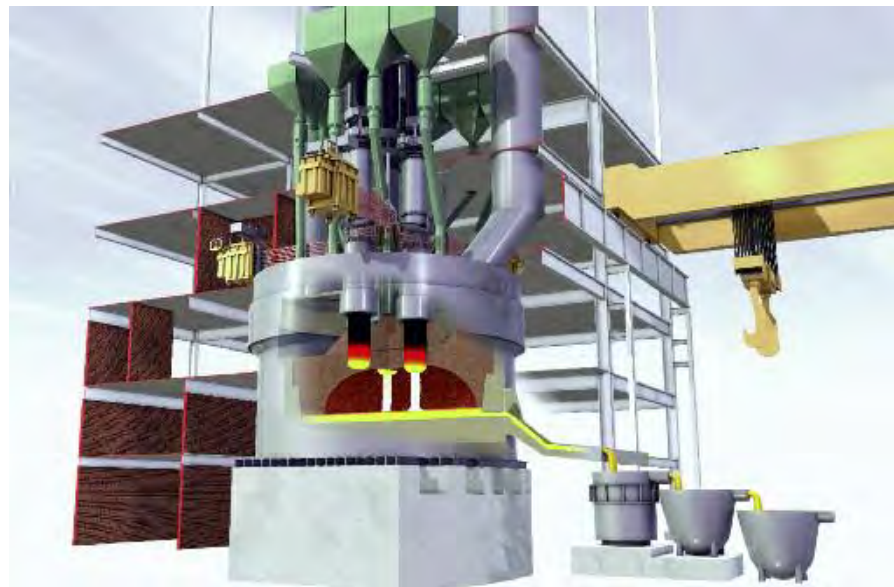


Illustration of furnace for First Quantum.



Circular ferroalloy furnace.



Illustration of silicon plant in Kazakhstan.

98

Most furnaces operate
at an availability rate of > 98%

AC-BASED TECHNOLOGY

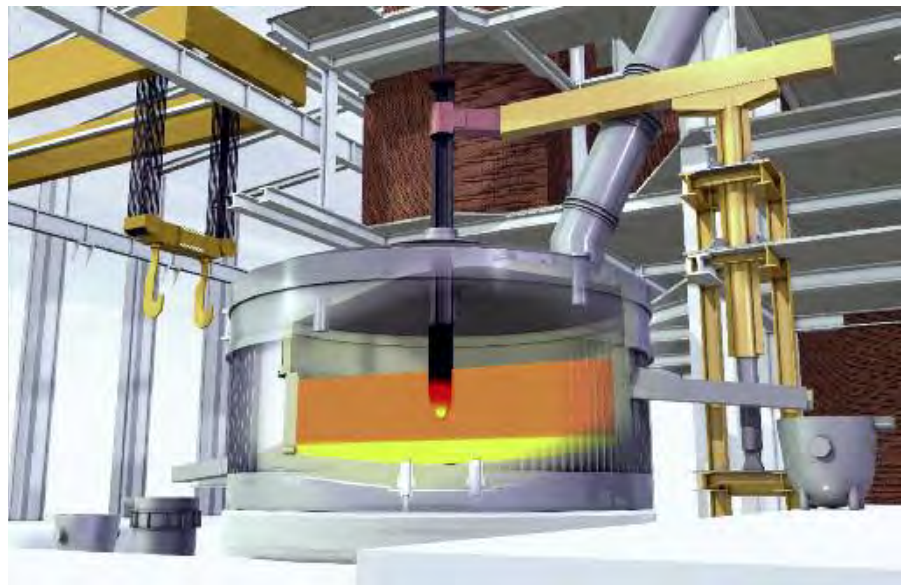
As much as 99% of smelting technology uses AC furnaces, either with three or six inline electrode systems for rectangular furnaces, or with three electrodes for circular furnaces. This will remain the dominant smelting technology over the coming decades. Furnaces are already installed with a power rating of up to 140 MVA. Furthermore, AC furnaces are well-known for their dependable and efficient operation.



Patented electrode column for DC-furnaces.

DC-BASED TECHNOLOGY

DC technology is usually applied in certain niche areas (FeCr fines, TiO_2 slag production, UG2 smelting, copper, cobalt, PGM, and recycling technology). Keen to optimize these systems over recent years, we developed a next-generation DC smelter.



DC based ilmenite smelter.



FeCr tap of DC smelter.



Roof area of a DC furnace.



Executive management team with POSCO SNNC award.



CBMM and SMS team standing around the SMS group monument at CBMM.

The joint development of electric furnace technology with SMS was the basis for the success of our company.
Mr. Clóvis Sousa/CBMM

EXCELLENCE IN DESIGN

Crucial for our excellent design are our expert personnel, plus a strong R+D department, and advanced engineering tools. All this makes it possible to calculate complex structural furnace parts and intensive thermal areas. These are capabilities even more important for designing large-capacity furnaces.

Furthermore, FEM calculation is an extra option for minimizing electrical losses with alternating magnetic fields.

We have received piles of statements from customers who confirm that our designs result in reliable and efficient plants. That's because our engineering also ensures long equipment and component service lives. Some SMS furnaces have been in operation for more than 40 years – and are still running smoothly.



Submission of design award by Posco.



Commissioning ceremony at POSCO SNNC.

General application areas

We distinguish between four major application areas for electric smelters and submerged-arc furnaces. See below for the key facts and figures.



since 1970: more than 160

Ferro alloy and silicon industry

- Ferrosilicon and silicon
- Ferronickel, ferromanganese and silicomanganese (LC, MC, HC), ferrochrome (LC, MC, HC) and silicochrome
- Special alloys such as FeNb, FeV
- CaSi



since 1970: more than 20

Nonferrous metals industry

- Slag cleaning furnaces for Cu, Ni, Pb
- Copper matte and nickel matte settling furnaces
- PGM



since 1970: more than 50

Special applications and pilot / test furnaces

- Titanium oxide slag
- Refractories and minerals
- Calcium carbide
- Tailor made test and pilot furnaces
- Chemical products



since 1970: more than 10

Waste recycling furnaces

- Steel mill waste
- Catalysts and batteries
- Ni-plant waste
- Power and waste incinerator plant flue dust and ashes
- Pig iron

70

Global market share
in electric smelters of more
than 70% (excl. China)

**INDIVIDUAL PRODUCT PORTFOLIO
FOR TOP ELECTRIC SMELTER SOLUTIONS**

During recent decades, numerous smelter solutions have been developed to cope with the specific conditions dictated by various processes. The resulting wide range is shown below.

Overview product portfolio SAF and electric smelter

Basic systems

- AC based or DC-based
- Open design, semi-closed or closed design

Furnace shell types

- Flat/dished bottom
- Cylindrical/conical/rectangular
- Stationary/rotating
- Changeable/tiltable

Electrode systems

- Pre-baked/graphite or self baking
- Composite system
- Hollow electrode system
- Soederberg

Furnace roof types

- Water cooled roofs (steel or copper)
- Brick roof/cast roof (optional air cooling)
- Flat/arched shape

Charging systems

- Hot/cold solid charging
- Hollow electrode charging
- Liquid charging (launder)



Rectangular AC-furnace for FeNi-production.

Circular DC-furnace for FeCr production.

Rectangular AC-furnace for Cu-slag.

TECHNOLOGICAL HIGHLIGHTS

It's down to our wide range of products that we can supply complete processing lines, starting with raw material charging and continuing right through to dispatch of the finished products for the metals industry.

BASIC DESIGN PRINCIPLES

Usually, smelters come in the form of open or closed furnaces. This is very much a question of the raw materials available, the process chosen, and local environmental regulations. Depending on the process and capacity, operators use rectangular or circular furnaces.



Pressure ring.



Copper pressure ring.

ELECTRODE COLUMNS

SMS electrode columns are famous for their reliable and efficient performance in all submerged-arc furnace applications. Yet we never rest on our laurels, constantly optimizing our equipment. Today's generation of electrode columns ensures safe, maintenance-friendly operation with minimized energy consumption, and represents the most modern electrode system on the market. What's important here is that different processes require specific solutions.

Our slipping device ensures very accurate operation without electrode breakages. Critical here is the exposure of the lower system to the harsh furnace environment. Depending on the process, we use various lower electrode-column parts. SMS also supplies copper pressure rings, which save energy by reducing electricity losses.

Exclusively developed by SMS is an innovative copper pressure ring for the lower part of the electrode. It reduces the electrical losses and allows very quick access to the contact clamps. These copper pressure rings are installed in numerous furnaces all over the world.

Moreover, we reduced the overall plant length by several meters to minimize the risk of electrode breakages and cut costs for civil engineering and buildings.

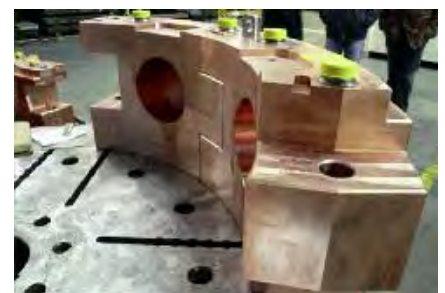
There is strong demand for composite electrodes in the silicon sector. These components slash electrode costs and allow the installation of large silicon furnaces with capacities of up to 40 MW. Not only ideal for new plants, the units can also be retrofitted to convert conventional electrode columns based on pre-baked electrodes.



Electrode column workshop.

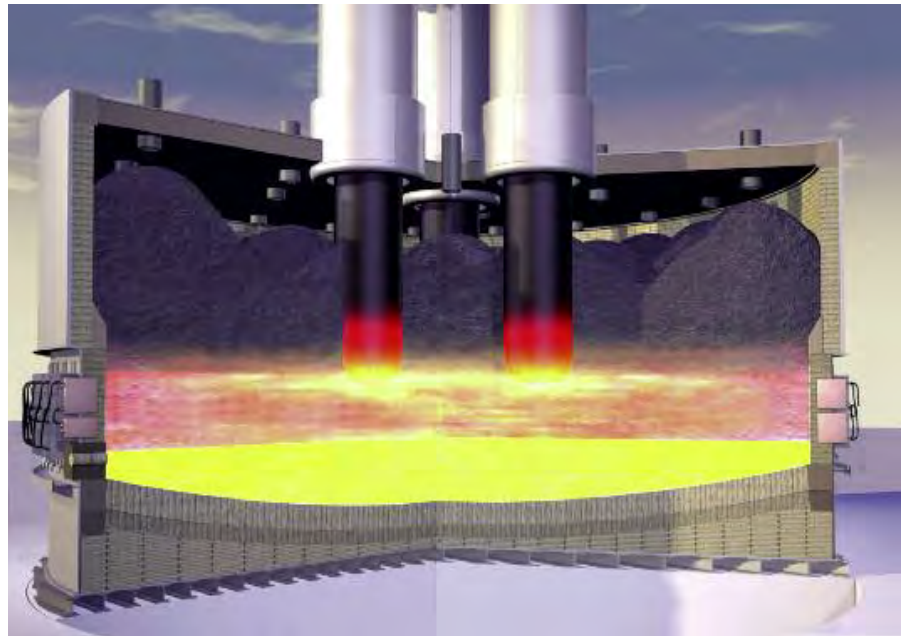


Electrode column interior.



Copper pressure ring.

Composite electrode.



Sidewall copper cooling system.

SIDEWALL COOLING SYSTEMS

Depending on the process, the choice of sidewall cooling system can have a significant effect on the plant lifetime. Our inherently safe solutions work with a minimum of required heat extraction, saving energy. Plus they are suitable for circular as well as rectangular furnaces.

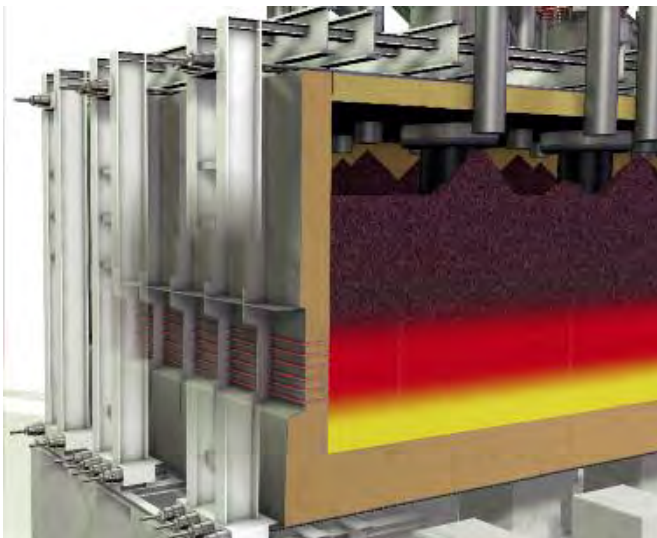
The following options are available:

- Rinse cooling/water film cooling
- Spray cooling
- Chamber cooling
- Channel cooling
- Cu-plate cooling
- Tailor-made cooling elements (fingers) for locally stressed areas
- Water-cooled tap-holes

Especially when the process requires higher cooling rates, SMS copper cooling is ideal. In terms of safety, heat removal rate, commissioning, and energy consumption, this system is by far superior to the copper cooling systems supplied by the competition.

Included among the key features are:

- Cooling outside the shell (no water within the refractory lining)
- Optimized thermal conductivity right from the start, resulting in outstanding service life
- Minimized wear on the refractory lining due to formation of a freeze line
- Cooling elements an integral part of the refractory lining, so no connection with the vessel wall
- Heat extraction of up to 250 kW/m²



Sidewall copper cooling.



Water-cooled copper roof after several years of operation.

ROOF/HOOD COOLING

SMS supplies various roof cooling options. Deciding which one is right largely depends on the maximum temperatures that occur as well as on the process type.

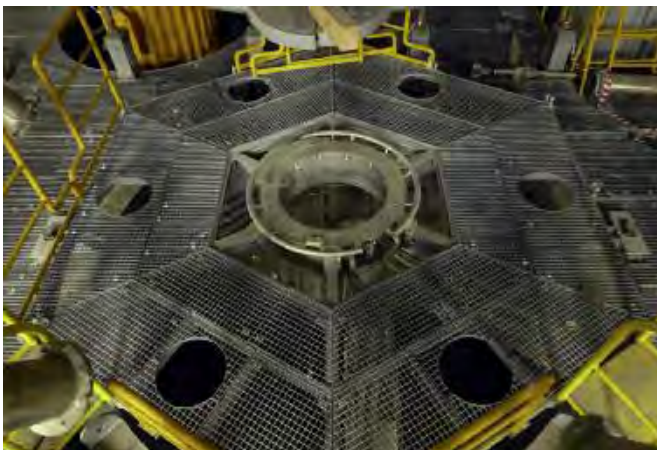
- Water-cooled steel roof with channel cooling
- Water roof with copper panels
- Air-cooled steel or refractory roof

We specially designed our copper-cooled roof for furnaces with ultra-high temperatures in the free board of the furnace (> 1000 °C) as well as extreme off-gas composition.

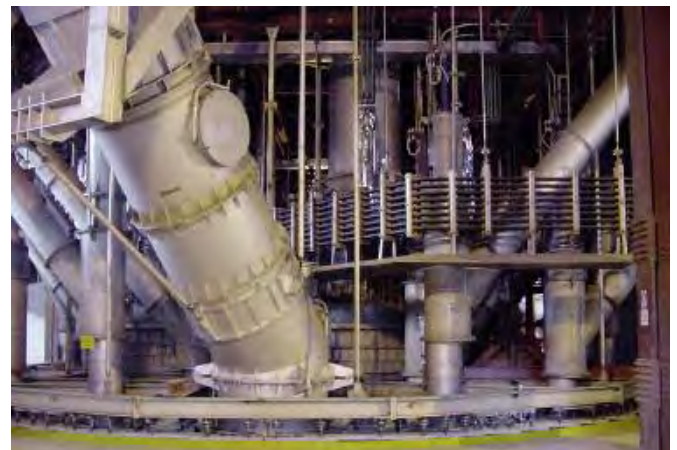
Also in the SMS program is an air-cooled roof for moderate heat stress in this area, which has been successfully in operation for years.



Air-cooled furnace roof.



Roof section of a DC furnace.



Brick-type roof of a FeNi furnace.

RELIABLE, FAILSAFE HYDRAULIC SYSTEM

There are many advantages to our failsafe hydraulic systems. They provide smooth and reliable furnace operation and allow quick movements even of heavy electrode columns. All hydraulically operated components, such as electrode columns, furnace doors, charging chute gates, and stack closures are supplied by one central hydraulic pressure-generating unit. Not only failsafe, the system is also maintenance friendly.



Hydraulic pump station.



Hydraulic piston accumulator station.



Hydraulic pump station.

CLAY GUNS AND DRILLING MACHINES

Paul Wurth recommends and applies world-class tapping technology from its affiliated company TMT – Tapping Measuring Technology, a joint company of Dango & Dienenthal and Paul Wurth. Strengthened by the inherited know-how and references, TMT has successfully extended its market position over the last 10 years.

These machines feature in almost all modern electric smelters for opening and closing the metal and/or slag tap hole as well as in a majority of blast furnaces. They guarantee high performance plus safe and quick tapping, and contribute to a long lifetime of the furnace taphole. Additionally included in the TMT product range are machines with special functions, such as rodding devices or cleaning equipment geared to specific furnace operations.



TMT tapping machine.

STOKING MACHINES

Mobile or rail-bound stoking and charging machines are ideal for stoking, distributing, mixing, and charging raw materials, as well as breaking up slag bridges and puncture-opening gas caverns. All this boosts furnace efficiency and maximizes output.

What distinguishes mobile machines is their suitability for flexible use in limited working spaces. Compact design, optimal component quality, powerful drives, and minimized maintenance ensure the top performance of this type of machine throughout the furnace lifetime. Then there are safety features such as special insulation, impact-proof cabs, as well as insulation against shocks from furnace electrodes that provide maximum operator protection and comfort.

Specific to rail-bound machines are systematic, fully automated furnace tending, and support for optimized, repeatable smelting processes. Chief among the benefits of automated stoking are energy saving, increased furnace output, and prevention of material damage or personal injuries.



Automated stoking machine.



Stoking machine in operation.



Manual stoking machine.

MINI SAF

Named Mini SAF for short, the mini submerged-arc furnace is a less complex version of a small-capacity smelter (< 12 MVA). It was developed to create the lowest possible cost unit. Charging is manual, the electrode column is simplified, and the unit does not require a hydraulic system.

Furthermore, the compact design makes civil engineering and building construction for the project much cheaper. It's important to know that the Mini SAF meets all international safety and environmental standards. These units can produce silicon, FeSi, FeMn, SiMn, and FeCr. The SMS Mini SAF is aimed at smaller companies in developing countries.



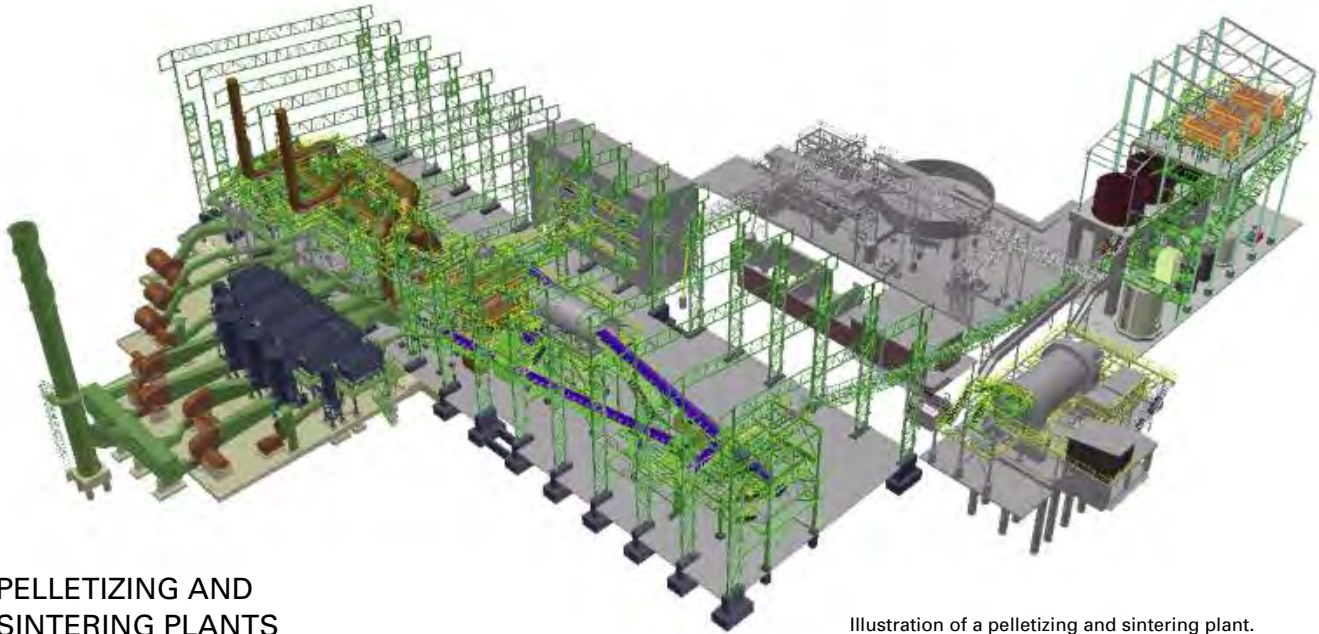
Low cost slipping device for Mini SAF.



Illustration of Mini SAF.



Illustration of Mini SAF.



PELLETIZING AND SINTERING PLANTS

Illustration of a pelletizing and sintering plant.

Operating in South Africa, Metix supplied its last five sinter plants to the country in cooperation with Outotec. The latest went online at the end of 2012 as part of the Xstrata-Merafe Tswelopele project.

Included in Tswelopele was a 600,000 tpa pelletizing and sintering plant that was executed on an EPC basis. As early as the first week of October 2012, the plant produced its first sintered pellets, and it passed the contractual performance tests within two months of startup. A total of 1,750,000 accident-free construction hours went into the project. Merafe has announced on-schedule and on-budget completion, making this yet another success for the largest FeCr producer in South Africa. The plant produces record tonnages.



Pelletizing and sintering plant.



Pelletizing and sintering plant.

DOWNSTREAM EQUIPMENT AND AUXILIARIES

SMS also supplies a wide product range downstream of the SAF. Available here is innovative equipment for solidification, refining, and metal/matte/slag handling.

- Slag granulation (static or dynamic as well as wet and dry)
- Metal granulation systems
- Hot metal charging systems to EAF and converter
- Pig casting machines
- Casting wheels and eco-casting
- Metal/alloy handling equipment
- Metal refining equipment
 - Ladle refining equipment
 - Ladle arc reheating station
 - Tilting stations
 - Skimming stations
 - Injection stations
 - Top blown converters
 - AOD converters
 - Vacuum AOD converters with CO₂ purging
- Deslagging stations
- Chemical heating furnaces
- Cooling water plants
- Heat recovery systems



Refining station for FeSi and silicon.



TBRC converter for copper production.



Tapping of vacuum AOD.

ROTARY HEARTH FURNACES

Rotary hearth furnaces (RHF) are applied in many pyro-metallurgical processes to preheat, chemically pre-reduce, or calcine the charging material fed into the electric smelters. This pre-treatment has the major advantage of enabling significant savings in operation costs, in particular by reducing electrical energy consumption. Furthermore, the unit removes undesired components such as lead and zinc which can enter the smelting stage

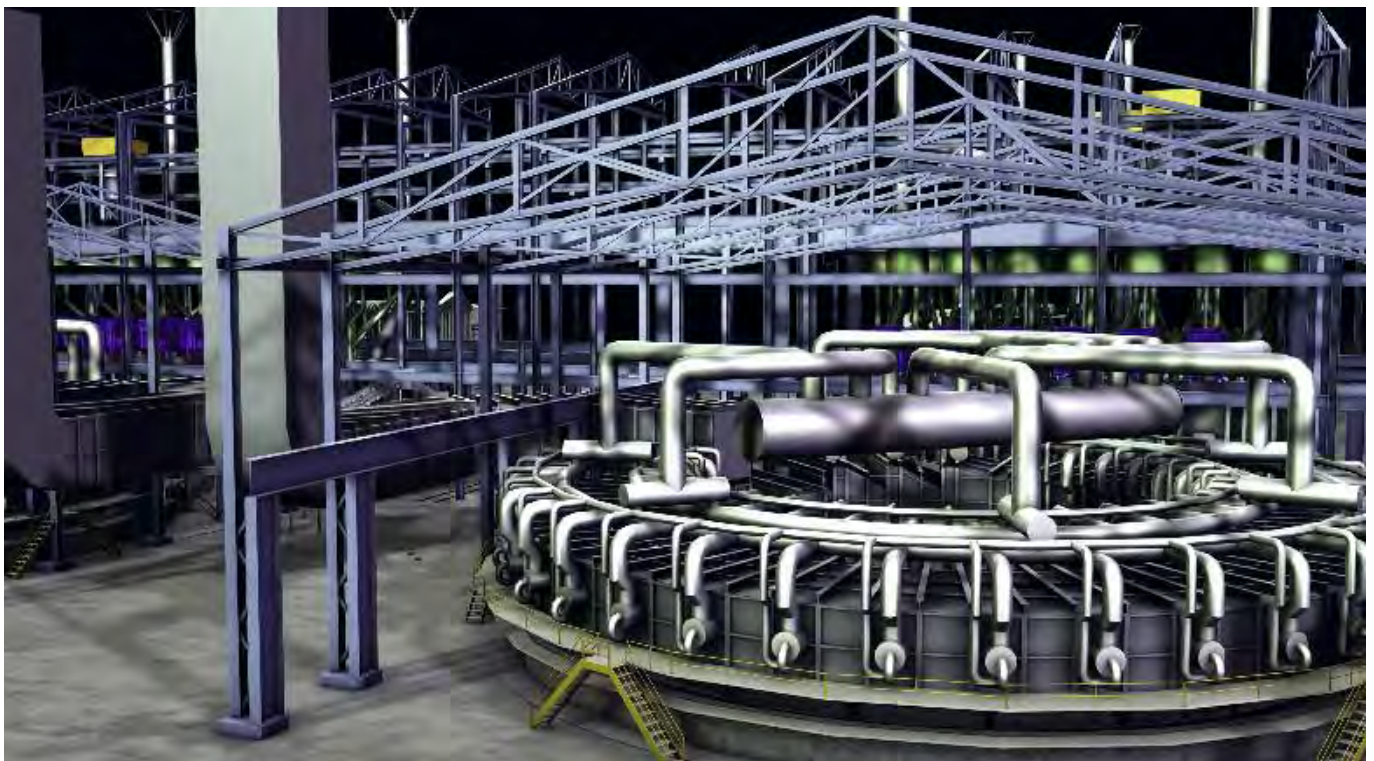
and cause process-related drawbacks. Depending on the application, the coal-based direct reduction process within a rotary hearth furnace is an attractive solution for the production of pig iron and ferroalloys.

RHFs are suitable for a wide range of metal-bearing materials, from iron ore to steel mill residues, nickel, and chrome ore that can utilize several carbon-bearing reductants ranging from coal to coke breeze.

Extensive research and testing went into analyzing and optimizing this technology for processing a wide range of metal-bearing residues and ores.



RHF, RedIron™ Plant, Lucchini Piombino, Italy.



RedIron™ Plant, Lucchini Piombino, Italy.



INBA® Pb-slag granulation.



Metal granulation storage area.

SLAG GRANULATION

Paul Wurth is the leading supplier of slag granulation systems. Recognized as a best available technology, fully automated wet granulation with INBA de-watering followed by steam condensation ensures reliable, flexible slag handling and production of slag sand.

Right now, we are developing an innovative dry slag granulation system. The aim is to combine the product quality from wet granulation with the recovery of substantial quantities of energy from the liquid slag. Meanwhile, we have successfully completed industrial scale testing in a pilot plant in Germany.

METAL GRANULATION

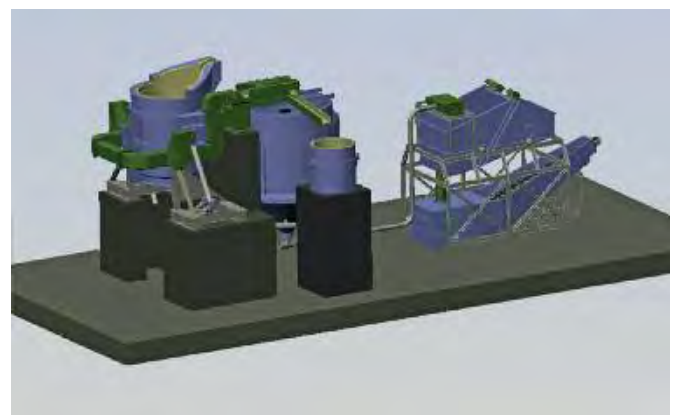
Impact disc granulation is Paul Wurth's new solidification process for producing easy-to-handle and easy-to-melt metal granulate. It's perfect for FeNi production lines and other nonferrous or ferroalloy industries. The properties of the solidified product allow re-melting or chemical processing with minimized fines generation and losses.

PIG CASTING MACHINES

Pig casting is the traditional way of solidifying hot metal produced in blast furnaces. Similar units are used to convert ferroalloys into pigs. Our systems produce pig formats according to customer specifications. To meet environmental standards, we equip our casters with effective dedusting systems.



Pig casting machine.



Impact disk granulation.

DRY SLAG GRANULATION

Newly launched on the market is the “dry slag granulation” process co-created by SMS and Paul Wurth. This technology will revolutionize the energy balance from processes that generate huge quantities of slag. It gives plant operators the choice: instead of losing energy, they can recover it. As much as 20% of the energy used in FeNi production can be saved. A test and demonstration plant is currently in operation at one of the Dillinger Hütte/Rogesa blast furnaces in Germany.

Here’s how it works: steel spheres are injected into the liquid slag stream for immediate solidification. The sensible heat from the hot mix is recovered in the form of hot air at a temperature of up to 600 °C for further energetic application. Then, after the energy recovery, the steel spheres are separated from the slag and returned to the injection area.



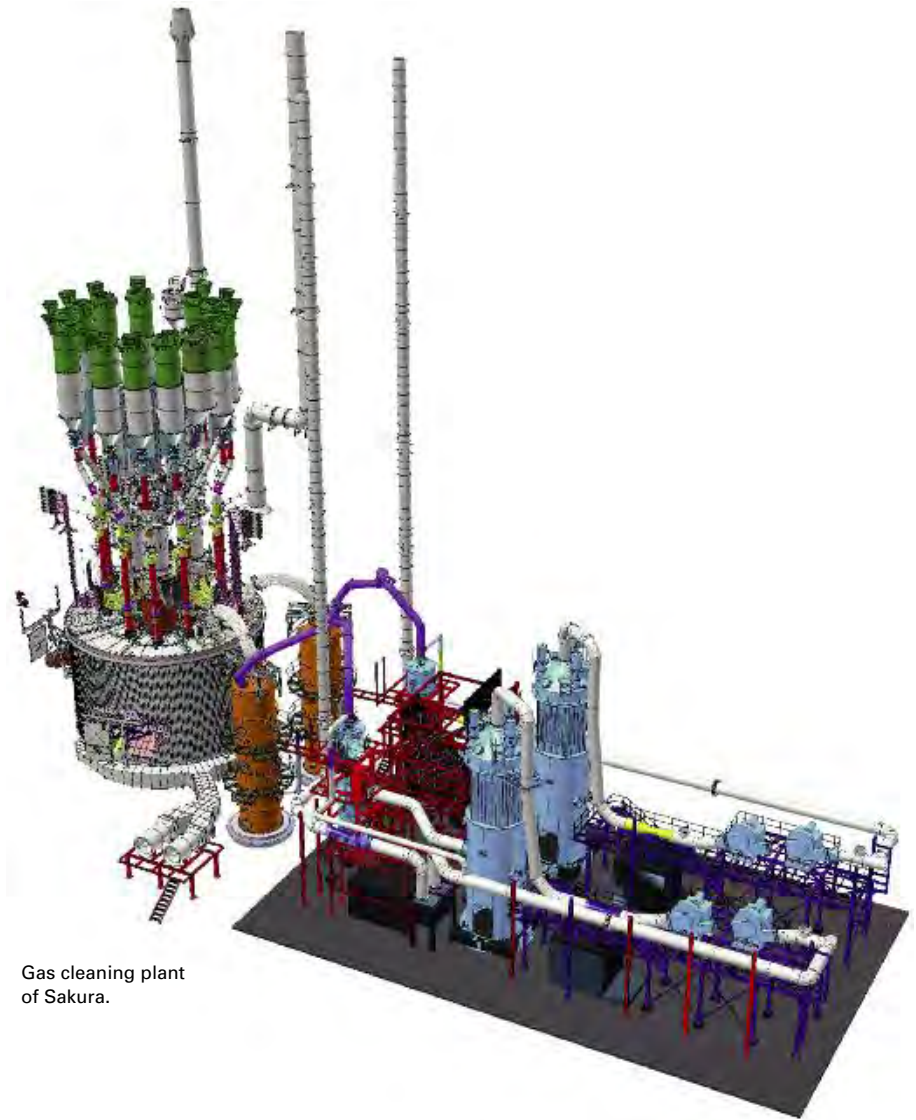
Dry slag granulation (Dillingen) Pilot plant startup.



Dry slag granulation (Dillingen) Pilot plant.

ENVIRONMENTAL PROTECTION

SMS offers a full range of energy and environmental technologies. This includes innovations in energy recovery systems, water treatment, air pollution control, by-products and recycling technologies, as well as energy management services. The label the SMS group gives to these solutions that combine sustainability and economic operation is ecoplants.



Gas cleaning plant of Sakura.

WATER TREATMENT

Water supply and treatment systems from SMS Siemag benefit from more than 100 years of experience in metallurgical plant and rolling mill engineering. That's how long we have been an expert supplier of water supply and treatment systems, with services extending from planning and design to supply and commissioning. This guarantees high quality and problem-free project handling throughout production. SMS Siemag manufactures all the process-relevant plant components. The technology is based on a know-how that ensures the optimized and reliable integration of water supply and treatment systems into a production process saving both energy and water.



Tailor-made and cost efficiently solutions.

GAS CLEANING

Air pollution control

Our dedusting department focuses on making our plants eco-friendly and keeping your workplaces clean. It draws on in-depth experience of our entire product portfolio, including dedusting and gas cleaning systems for submerged-arc furnaces, electric-arc furnaces, BOF, and other equipment used in the steel industry. SMS supplies dry and wet-cleaning systems as well as electric filter stations for primary dedusting. To date, we have been involved in the construction of more than 35 gas cleaning plants for submerged-arc furnaces.

- Innovative primary dedusting systems (based on bag house, electric filter and wet systems such as disintegrators and scrubbers)

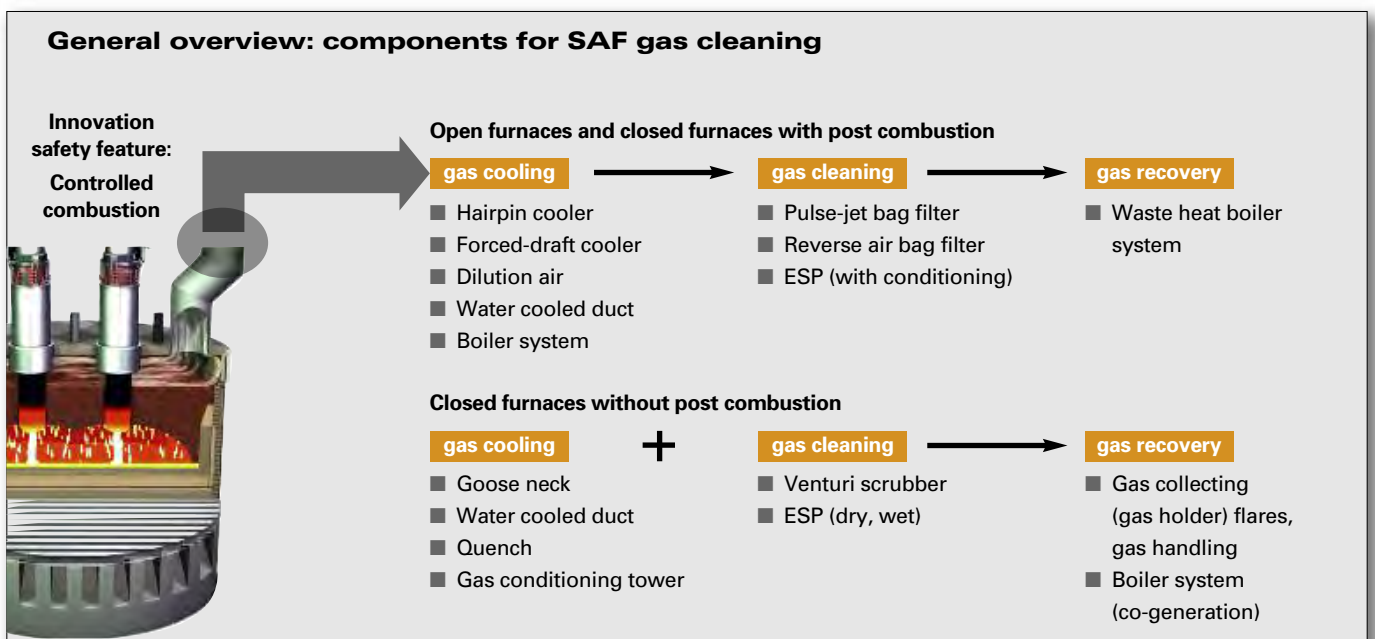
- Efficient secondary dedusting concept for a cleaner working environment and overall reduction in plant pollution
- Energy recovery system for electricity generation or steam production
- Process gas recovery



Gas cleaning plant.



Gas cleaning plant.



GAS CLEANING TECHNOLOGIES

There is a growing emphasis on eco-friendly technology worldwide. Responding to this trend, we supply overall primary and secondary gas cleaning solutions that protect the environment and keep workplaces clean.

We supply:

- Dry cleaning systems
- Wet cleaning solutions
- Electrostatic precipitators (ESP)
- Hybrid systems (combination of wet cleaning and ESP)

The hybrid system is especially suitable for plant upgrades. This involves connecting the existing scrubbers with an ESP to minimize the dust content in the clean gas. Currently we are installing a system of this type for Rainbow Minerals.

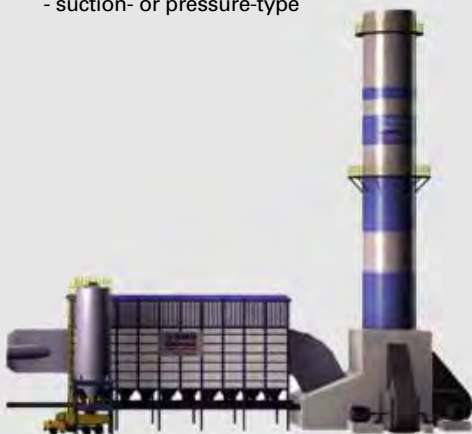


Gas cleaning plant.

Principles of dust separation

■ Bag filter

- pulse-jet or reverse air
- suction- or pressure-type



■ ESP

- dry or wet system



■ Wet scrubber

- venturi (one- or two-stage)
- desintegrator



ECO-CASTING

It's about eco-friendly casting for ferroalloys and silicon involving a tilting stand that casts the metal into casting frames. The casting is enclosed in a dog house similar to those used in steel making converters. That significantly reduces emissions from the process.

ENERGY SAVING OPTIONS

Global warming, stricter limits on CO₂ emissions, and rising prices for energy and raw materials all make greener, energy-efficient production a must. What follows is legislation regulating energy consumption and emissions, which will increasingly dictate the technical layout of projects. This means, for plant owners, environmental protection is no longer just a social responsibility, but a sustainably profitable investment, because new technology pays off. As the market leader in this field, SMS offers innovative solutions for all the relevant processes.



Illustration of the eco-casting technology.

GENERAL ENERGY SAVING OPTIONS

Forming an essential part of the production chain are electric smelters, especially used for producing ferroalloy, silicon and nonferrous metals such as copper and PGM. Yet most of these electric furnaces are extremely energy-intensive units.

It's usually the process applied that determines the level of electricity consumption. SMS has developed several ways of reducing the overall electrical energy consumption of metal production lines. Particularly effective are the following approaches:

- increased electrical efficiency with the intelligent design and application of components
- minimized furnace heat losses with balanced cooling/refractory systems
- reduced number of process steps (such as elimination of agglomeration)
- improved processes resulting in higher metal yield and higher recovery rates
- enlarged furnace capacity to lower relative heat losses
- maximized power-on time
- optimized calcine and pre-reduction stages (e.g. for the FeNi smelters)

25

Up to 25% of the sensible heat and chemical content of the off-gas can be recovered as electrical power

Types of SAF processes for potential energy recovery systems

Open furnace design AC type

- full combustion
- high off gas volume
- low dust content (8-12 g/Nm³)
- Off-gas temperature appr. 600 °C

Sensible heat

SMS Siemag
Waste Heat Boiler

Closed furnace design

DC type

- High dust load (80-200 g/Nm³)
- high temperatures (up to 1,800 °C)

- No post combustion
- Low off gas volume
- Combustible gases included (CO, H₂, CH₄, etc.)

AC type

- higher dust load (70-100 g/Nm³)
- variable temperatures (300 -1,000 °C)

Sensible heat / Chemical heat

SMS Siemag
Process Gas Boiler



Energy recovery system for silicon plant.

Energy recovery systems

for open furnaces

- Fully combustion in open type electric smelters
- Continuous SAF process allows the generation of superheated steam in the Waste Heat Boiler
- New furnace door design to control the inlet air flow and thus the off-gas temperature (average 600 °C)
- Currently energy recovery systems for two FeCr-SAF of ETI KROM in Turkey are under construction, up to 11% of input energy is recovered
- In some silicon and FeSi processes up to 25% of the input electric power can be recovered



Furnace with doors for off-gas temperature control.

for closed furnaces

- No post-combustion in closed type electric smelters: generation of combustible process gas
- Process gas can be used after treatment (wet Scrubber) in a Process Gas Boiler to generate superheated steam
- A part of the sensible heat can be used to heat up e.g. feedwater
- Use of superheated steam to generate electrical energy or as process steam for different applications
- Possibility to sell electrical energy or process steam



Process gas boiler.



20

In some processes, up to 20% of the sensible heat of the slag can be recovered as electrical power

ENERGY ADVISOR

New on the scene is the SMS energy advisor. It's a control tool, monitoring all consumption figures of an entire plant and highlighting options for potential energy savings.

DRY SLAG GRANULATION COMBINED WITH ENERGY-RECOVERY CHECK

The innovative SMS dry slag granulation system is set to revolutionize energy recovery from processes that generate huge slag quantities. Most impressively, dry slag granulation can save up to 20% of the energy used for the production of FeNi. The system is currently undergoing tests in one of the blast furnaces at Dillinger Steel in Germany. Put simply, the method involves injecting cold steel balls into the slag stream. The hot frozen slag cake has a high thermal conductivity, enabling a heat exchanger to heat air up to 600 °C. Finally, the steel balls are recycled and fed back into the slag.



Photos of the dry slag granulation plant in Germany.

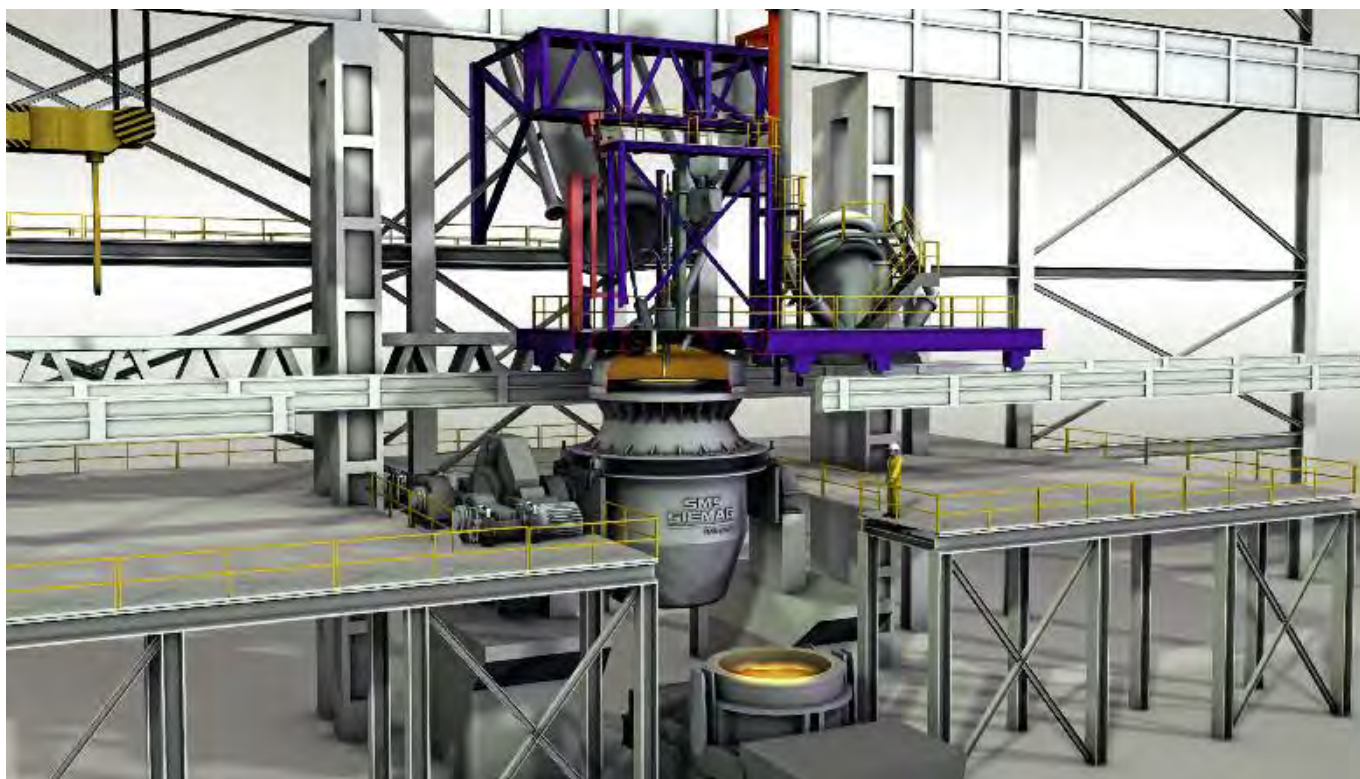
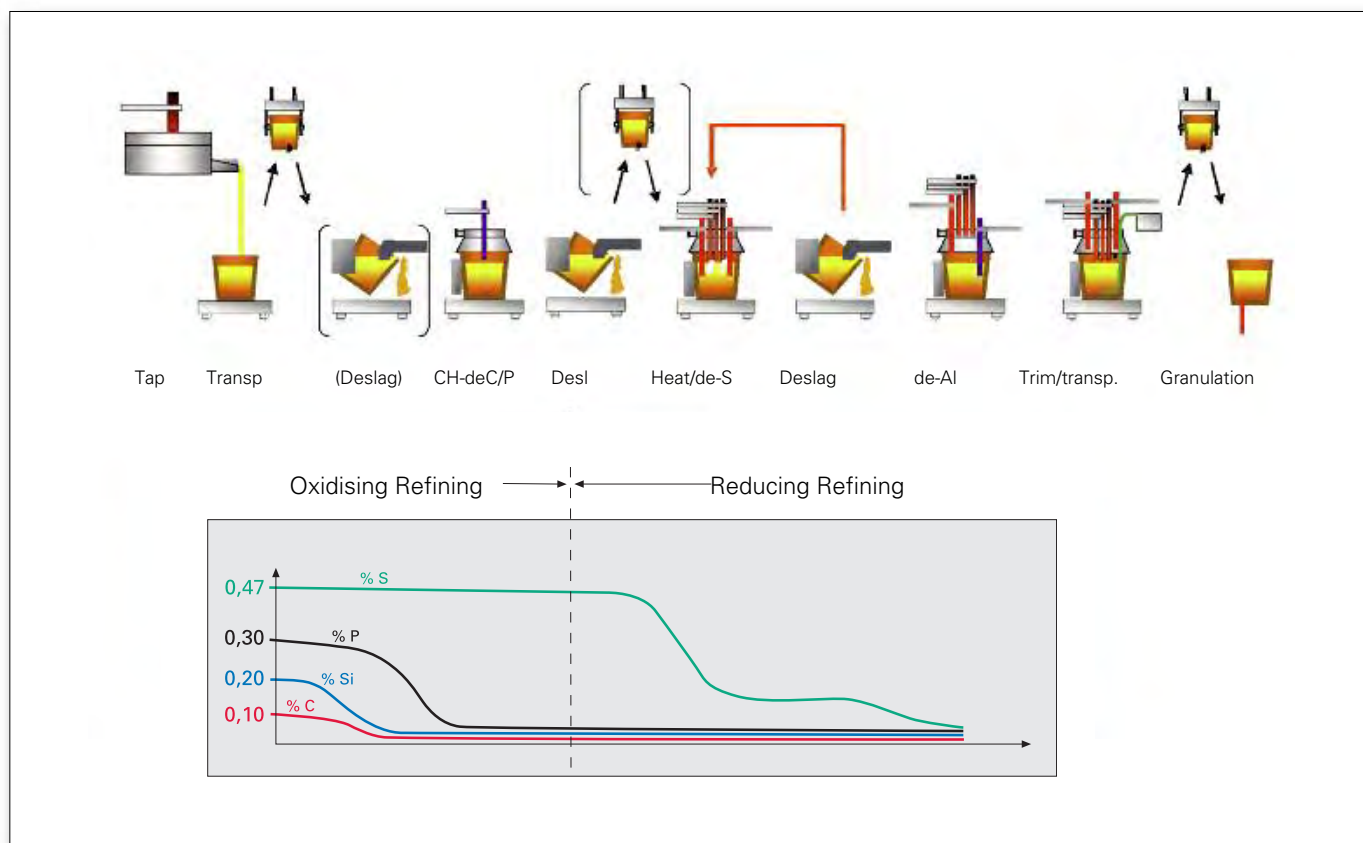


Illustration of a vacuum AOD process.



Multi stage FeNi-refining process.

SMS REFINING CAPABILITIES FOR FeNi

SMS supplies technologies for ferroalloy refining, with a focus on FeNi. Worth noting here are major references for FeNi refining, such as Pacific Metals, Falconbridge Dominicana, Cerro Matoso, and Koniambo. These are all ladle furnace solutions with auxiliary equipment (slag rake, oxygen blowing).

Also included in the product portfolio are chemical heating stations, slag rakes, ladle furnaces, and ladle cars with electro-magnetic stirring.

Another option is refining the FeNi in a conventional converter. This was the solution Greek company Larco chose.

REFINING TECHNOLOGY FOR FeCr AND FeMn

SMS can proudly look back on a long history of converter technology. There are reference lists that specify more than 200 converters supplied over the last 60 years. During this time, SMS has constantly improved the process and the technology. Today, converters with fluid flow optimized by CFD models, as well as detailed parameter studies covering vessel geometry, stirring rate, number and diameter of pouring plugs are state-of-the-art design by SMS.

Here is the range of converters available:

- Conventional BOF converters for FeNi
- AOD converters for the production of MC FeMn and MC FeCr
- X-Melt AOD vacuum converters

SMS has developed a new technology of CO₂-blowing in an X-Melt AOD vacuum converter for MC FeCr < 1.0% C. The process has already proven viable in industrial-scale application. This technology significantly lowers operation costs and the need for expensive cooling materials. Particularly impressive, the Cr yield achieved is above 95.5%.

SMS REFINING CAPABILITIES FOR NONFERROUS METALS

Another SMS strength is secondary metallurgical treatment for the nonferrous industry. All types of chemical heating stations and refining based on converter technology, e.g. Kaldo (TBRC), are available from our group.



Illustration of an AOD converter.

Material handling systems

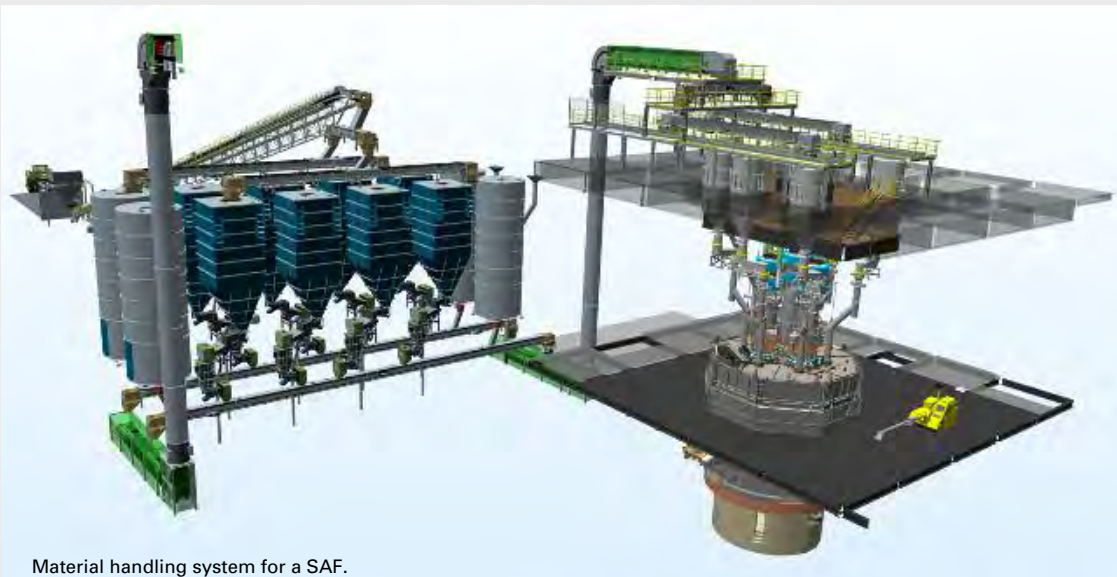
SMS is an expert in material handling systems. These solutions cover everything “from the road to the furnace” as well as “from the furnace to the road”.

There is a wide range of products and services available from SMS, ranging from equipment supply through engineering services to logistics simulations and feasibility studies. All our solutions are equipped with state-of-the-art condition monitoring and automation systems. What’s more, we design every facility to meet the individual needs of our customers. Our knowledge is based on profound expertise and a large number of references. We break this expertise down into the following divisions:

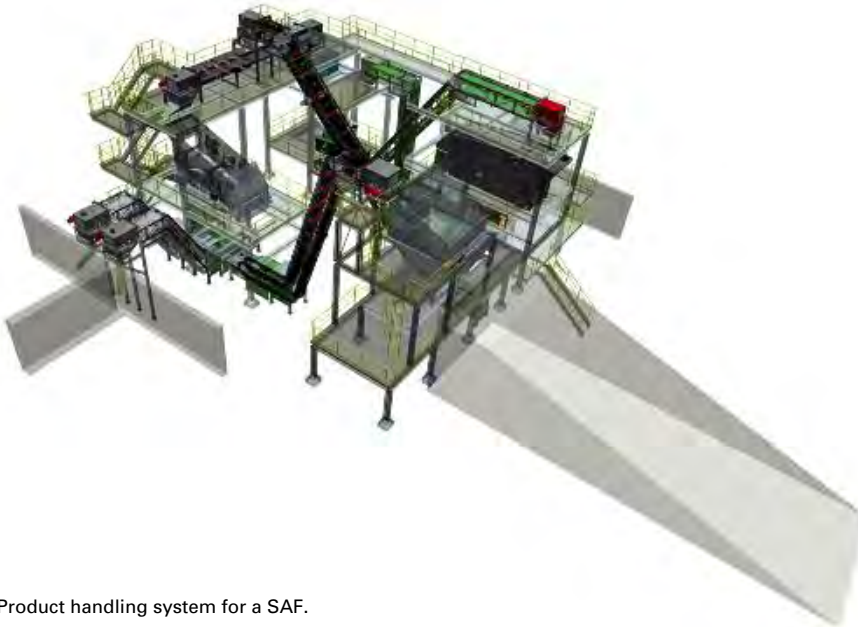


Raw material and product handling are key factors in an efficient smelter plant.

Dr. Christoph Stephany, SMS group



Material handling system for a SAF.



Product handling system for a SAF.



SAF products.

RAW MATERIALS HANDLING

It's vital that the raw materials are handled, treated, and conditioned in a way that achieves optimum furnace operation.

This is where SMS offers a wide variety of systems. Customers can choose from various setups for all the required facilities, for example:

- Unloading stations for trucks, trains, and ships
- Stock yard systems, e.g. stacker-reclaimer systems
- Material preparation, such as washing, sorting, screening, drying, agglomeration, and separation
- (Day) Storage systems
- Highly accurate batch or continuous composition of burden mix
- Conveying systems for all facilities

FERROUS PRODUCTS HANDLING

Most applications involve casting SAF melt into solid blocks. Then these blocks need further treatment to meet customer requirements for products such as bulk or powder material of defined sizes.

SMS offers a range of systems for conditioning cast products:

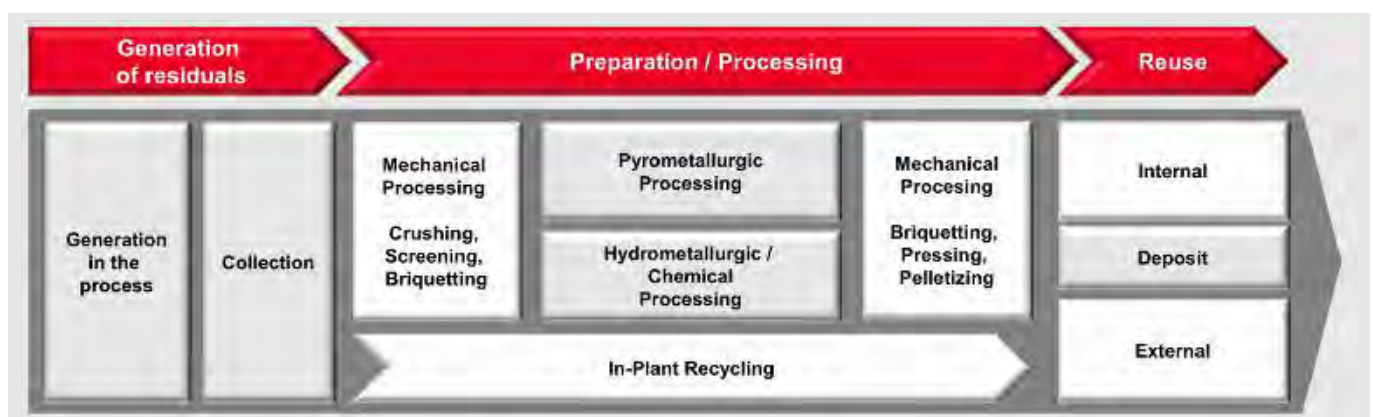
- Crushing, grinding, and milling stations
- Sorting, screening, and sizing systems
- Blending, grain spectrum confectioning, and portioning facilities
- Agglomeration and densification facilities
- Packing facilities, e.g. for big bags, plastic bags, cardboard cartons
- Loading systems for dump trucks, silo trucks, train wagons, and sea contain

BYPRODUCTS HANDLING

Smelting generates the byproducts slag, dusts, and slurries consisting of metal fractions and mineral phases. Furthermore, these byproducts contain sensible and latent heat.

This is significant because the metal content is a valuable surplus production source, while the mineral content can often be conditioned for the construction market (concrete filler, aggregates, gravel). To ensure optimum exploitation, byproducts need special treatment. Sometimes material-related environmental aspects are also important.

SMS offers expertise and systems for byproduct conditioning and cleaning, as well as for evaluating their marketability. Our solutions are customer-centered and focus on maximum value generation from low-cost recycling.



Byproducts flow sheet.

Process definition and metallurgical competencies

The past decade has seen some 60 different products processed with SAF technology for the ferroalloy, nonferrous metals, iron-making, and special applications industries.

Each process requires extensive and in-depth process know-how. You benefit from the expertise of our metallurgical department, which provides a solid basis for efficient design as well as safe and reliable operation of your applications.

We also cooperate closely with a large number of plant operators and renowned institutes worldwide. What has emerged over decades of development in this field is a metallurgical model founded on practical and scientific data. Our in-house software for complex metallurgical evaluation combined with our experienced employees provides our customers with reliable and achievable figures.

Working hand-in-hand with the metallurgical department, our experts define the right processes and furnace dimensions. This results in the perfect solution for the specific metallurgical requirements every time. Intelligent dimensioning maximizes yield, while keeping energy consumption down.



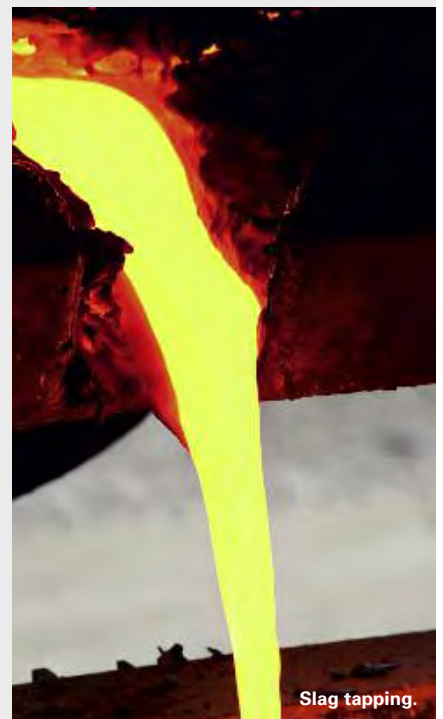
Commissioning of a furnace.



Electrode preparation.



Commissioning of a calcium carbide furnace.



Slag tapping.

PLANT DATA: FROM DATA TO INFORMATION

As furnaces get larger and loads higher, both the equipment and the process become more complex to monitor. Collecting and processing enough data without swamping the operators with irrelevant information is a constant priority of SMS engineers.

Only if the right instrumentation is envisaged from the start and the data is displayed and collected in a structured manner can both operators and managers use this information to their advantage.

There is a strong focus at SMS on optimizing the whole chain from data collection to display. This is only possible when our experts get together with the customer's staff at an early stage to design the optimal solution.

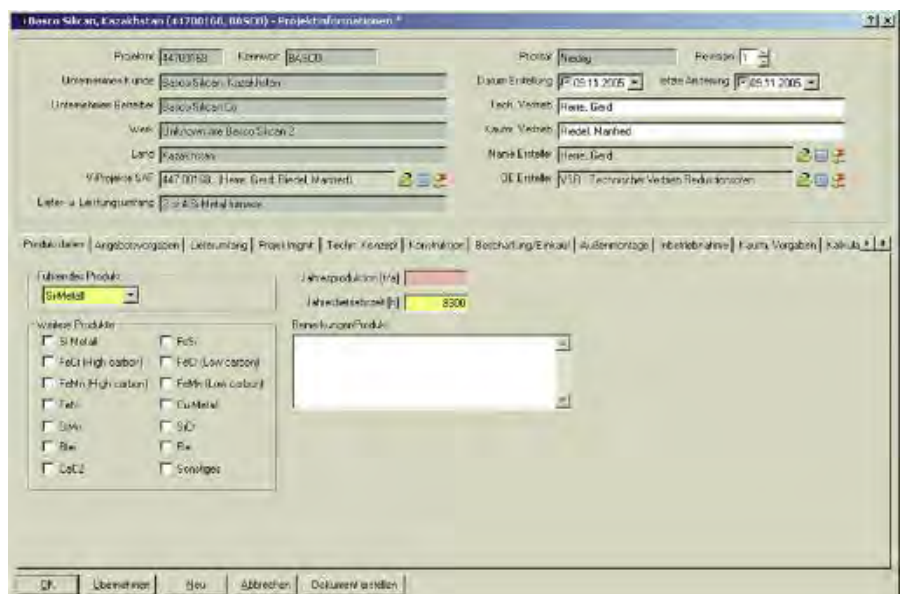
Equally usefully, SMS can apply its experience to support customers who want to upgrade their existing system. What they get is smooth operation achieved by translating raw data into information.

DATA ACQUISITION & EVALUATION

Also available from SMS are very fine-resolution data collection systems. Customers can then process this data using proprietary software, for example from Microsoft. This is possible with on-site staff, if necessary aided by SMS Siemag personnel. Another option SMS Siemag offers is online support. All it takes is to allow SMS temporary access to the customer's data, then our experts in Germany evaluate the available data and propose solutions.

60

Electric smelters can produce some 60 different types of metals and slags



Data archive system.

Electric and automation systems for submerged-arc furnaces and electric smelters

HOLISTIC SYSTEM COMPETENCE

Modern metallurgical plants from SMS are highly efficient and meet today's ever-increasing end-product quality requirements. Crucial for this are harmonized system components. These are a given with SMS, because we supply complete solutions, including overall engineering, construction, and commissioning from a single source. Our expertise covers all aspects: processes, mechanics, and electrics and automation.

X-PACT® ELECTRIC AND AUTOMATION SYSTEMS

SMS electrics and automation systems are grouped together under the brand name X-Pact®. That covers all process levels.

X-Pact® is a modular system and can be adapted or expanded to suit your particular requirements. Key here is integration of the different levels of electrics and automation in your plant. This includes all aspects of modern plant automation, from drive technology and sensors (Level 0), to sequence controls, technological controls, and process models, right up to production planning (Level 3).

SMS supplies professionally integrated hardware solutions for the electrical and automation requirements of all product sectors. They comprise the engineering and implementation of automation systems and safety engineering. Looking at the whole plant, this involves planning the layout, including electrical and operation rooms, complete PLC hardware and software engineering, as well as erection engineering for effective equipment and cable installation. Our specialists select field equipment geared to your process, safety, and standard requirements, individually for each application. Well in advance of delivery, we thoroughly test all SMS-manufactured equipment in our workshops to ensure fault-free installation on site.

Essential for successful production are effective strategies for production monitoring and operation. That means all the information from the production process must come together in the control room at the customer's plant.

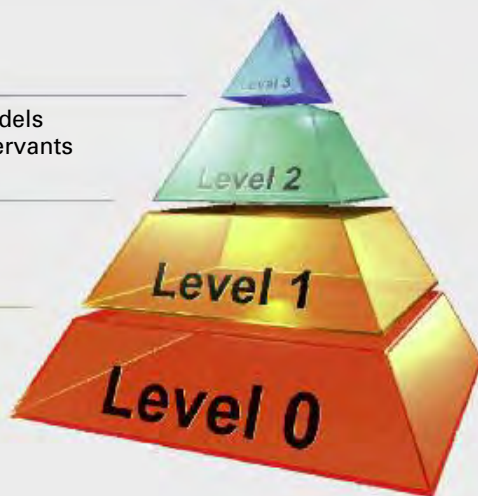
Our modern HMI system constantly supplies operators with the relevant process data. The pulpits and their control elements are ergonomically designed and create a pleasant working atmosphere. All the desks and screen masks are devised to ensure the operating personnel have a direct view of the entire production line.

Production planning systems

Technological process models
Material tracking & data servants
Reporting

Technological controls
Sequence controls
Drive controls

Energy distribution
Drives



PLANT AND PROCESS POWER DISTRIBUTION

It's important when developing the plant power supply and distribution systems to take account of the local public power grids and the available infrastructure. Essential here is taking into account all possible interactions. SMS Siemag carries out power supply studies in close cooperation with the customer. This forms the basis for a reliable plant power supply as well as for the related equipment design.

SMS designs, engineers, and supplies the entire process power equipment for all types of AC and DC furnaces. Depending on the application, this may include the complete high voltage sub-station for power intake and distribution. Medium and low voltage switchgears, as well as the entire low voltage equipment are also integral parts of the SMS supply portfolio. There is a special emphasis on power factor compensation systems. SMS supplies the entire range of such systems, including standard fixed compensation banks or the powerful static VAR compensation.

Sometimes customers have to use an "island solution" (remote area without electrical grid) for the power supply. Especially for this kind of application, we developed an active power compensation system which protects the power plant from strong load losses and simultaneously stabilizes the entire power supply system.



Modern control room.



Power distribution room.

AUTOMATION HIGHLIGHTS SAF HD MONITORING

SMS has developed a high-definition temperature monitoring system that can be implemented in almost all submerged-arc furnaces.

The monitoring model works using temperature measurements based on fiber optic technology. Due to the fiber optic technology, it's possible to install several layers of temperature measurement points every 0.5 to 1.0 meters around the furnace shell, totaling hundreds of measurement points. The result is accurate thermo-mapping of the furnace shell, in real time.

Applying an additional model and taking into account the lining type, the HD monitoring system delivers reliable information on the refractory lining condition, and can determine fine structures such as the presence of the frozen slag layer in furnaces operated with a "freeze-lining".

SAF PROCESS MONITORING

SAF plant management has to tackle multiple challenges: worldwide demands for CO₂ reductions, the need to save energy, fluctuating raw material prices, and the entry of new countries onto the market and into global competition. To stay in control within this environment, it's no longer enough to rely on empirical values for SAF operation. Also vital today is precise knowledge and transparency regarding the processes and interrelations of SAF plants.

This knowledge forms the basis of our SAF reporting system which provides key information for profitable operation.

Seamlessly integrated in the overall automation, the SAF reporting system features interfaces to the laboratory and the production planning system (Level 3).

What happens here is that the SAF reporting system logs the consumption figures for raw materials, energy, and utilities as well as the end product. The re-

ports are automatically generated from this data and made available on all production and management levels. The reporting form can be customized as required.

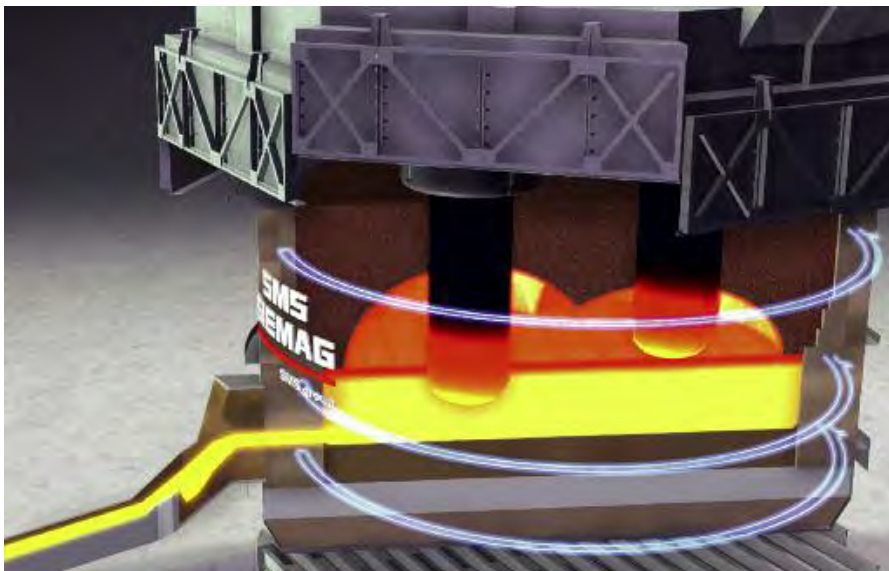
Our strategy also implements modern technologies such as wireless and internet communication. That enables the display of useful maintenance information on portable tablets, so staff can check the operation and reaction of specific equipment directly on site.

An additional web-based, user-authorized reporting system can also be implemented. This allows management to receive current plant information displayed on mobile smartphones or tablets.

FURNACE POWER CONTROL (THYRISTOR CONTROL)

Especially for high-performance FeNi furnaces, it's vital to be able to control the process power in the high-power range without disturbing the reduction process. The classic way of controlling the power is to move the electrodes up and down to modify the process parameters (impedance, voltage, current).

Determined to eliminate the stresses generated by these electrode movements, SMS patented a special furnace power control based on thyristor systems. That minimizes electrode movements to an almost steady status. The active power transferred to the process is stable and controlled fully automatically, even in the higher furnace design range.



Typical lining temperature measurement.



Integration test.

The system works under a strong maximum current limitation, providing effective equipment and network protection against overloads. That in turn extends the operating equipment lifetime. Yet the elimination of the high dynamic movements of the massive electrodes comes with even more benefits. These are reduced requirements for the hydraulic system as well as less stress on the furnace building structure.

The furnace power control system works in combination with an SVC system that compensates all disturbances produced by the highly dynamic variation of the reactive power, harmonic distortions, and voltage variations. This combination improves the power supply quality, with a positive impact on the average and total active power directly transferred to the process.

The system has already proven its effectiveness in numerous plants supplied by SMS.

FASTER COMMISSIONING WITH PLUG & WORK

Here is what you get from Plug & Work, our program that starts even before commissioning: Our Electrical and Automation Systems Division performs extensive integration tests on your system, and also instructs your personnel on how to operate it. Next in line are careful checks in the SMS test fields – long before installation at your facility. There, we test and optimize the automation system under near-reality conditions, using a simulation model that maps and simulates the entire mechanics, drive technology, and process. It's an added advantage that your future operators are trained by SMS employees on the original plant equipment.

Running through a virtual production process, your personnel learn the functions of the plant and how to react in close-to-reality operating situations. As a result, Plug & Work ensures a rapid run-up of your plant.

AFTER SALES SERVICE

Specifically for X-Pact® electrics and automation customers, the SMS internet service portal offers rapid troubleshooting support. Even during commissioning, we set up a service portal to assist with any hitches. Via this portal, worldwide SMS-authorized experts access the plant's automation system for immediate remote diagnosis and maintenance.

Additionally, we provide a wide range of after sales services:

- Spare parts service
- Updates / Upgrades
- Service entry point with 24/7 service hotline
- Training and consulting



PROJECTS & REFERENCES

The following chapters describe our latest references in the field of ferroalloys, nonferrous metals, special applications, and hot metal. The references are the basis for a successful smelter operation.



FeNi production

SUPERIOR TECHNOLOGY FOR FeNi PRODUCTION

Ferronickel is mainly produced in submerged-arc furnaces by reducing nickel ores. The process aims to transfer most of the nickel into the metal phase. Attaining a high yield depends on good carbon distribution and a specific slag metallurgy. Pre-heated and pre-reduced ores are hot charged (at temperatures of up to 900 °C) into the furnace. The final nickel reduction takes place in the submerged-arc furnace. Ferronickel furnaces are semi-open stationary-type furnaces. Usually, round furnaces are used for smaller and medium quantities, whereas large capacities are produced in rectangular furnaces.

Ferronickel specification:

FeNi 15 - 35% Ni



118

ferroalloy references
from 1970 to today

RECTANGULAR FURNACES: SUPERIOR SMELTERS FOR LARGE-CAPACITY FeNi-PRODUCTION

Most ferroalloys are produced by pyrometallurgical smelting in submerged-arc furnaces. Advanced high-power smelting units have made submerged-arc furnaces highly competitive for ferroalloys. Meanwhile, over the past decade, SMS has introduced a series of improvements. They ensure efficient and safe operation of large-scale FeNi furnaces.

Related developments followed, such as various sidewall cooling methods as well as AC thyristor controls that ensure better operation, higher and more efficient power input, and less overall maintenance.

The market also demands smelters with maximum capacity. Here are further advantages of rectangular smelter technology:

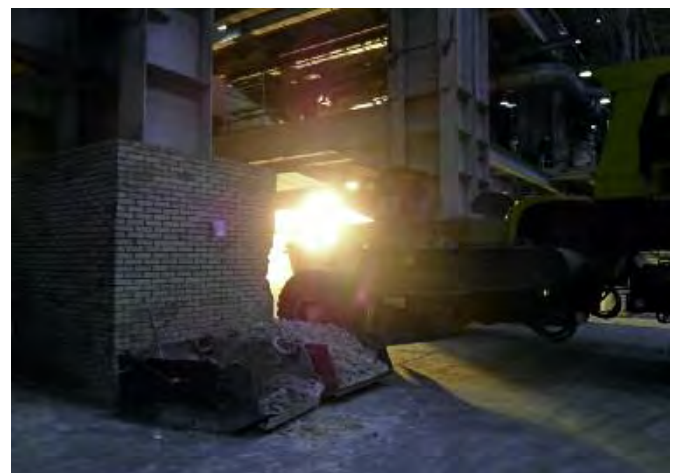
- Most effective dedusting solutions at lower specific investment
- Higher energy efficiency
- Safer and cleaner working conditions
- Less requirement for spare parts and less wear on critical parts
- Less maintenance, therefore higher furnace availability (up to >98%)
- Lower personnel costs
- Generally much lower production and investment costs
- Compliance with high environmental standards

During recent years, SMS has focused on different ways of improving the efficiency of its smelter portfolio. Due to high global metal prices, one of the most important factors driving plant efficiency is the level of recovery rates at high plant availability.

Our plants feature:

- Higher recovery rates with rectangular furnace technology
- Higher specific power input with advanced sidewall cooling systems
- Process optimization as a result of intensive FEM modeling
- Advanced process simulation tools for improved training options
- New process for faster settling of finely dispersed matte/metal particles

SMS smelters are fed either with lateritic based calcine (e.g. at POSCO SNNC/Korea, Eramet/New Caledonia, Barro Alto/Brazil or MOP/Brazil), or with limonitic based calcine (e.g. at Feni Industries in Macedonia and Larco in Greece).



Tapping of FeNi.

Cooperation with SMS is very professional and we are satisfied with the performance and reliability of the furnaces.

Jean Yves Blandin/Eramet

SLN ERAMET, NEW CALEDONIA

In 2006, SMS commissioned the first 99-MVA FeNi furnace for SLN Eramet in New Caledonia (Furnace No. 10), followed later by a second 99-MVA FeNi furnace (Furnace No. 9).

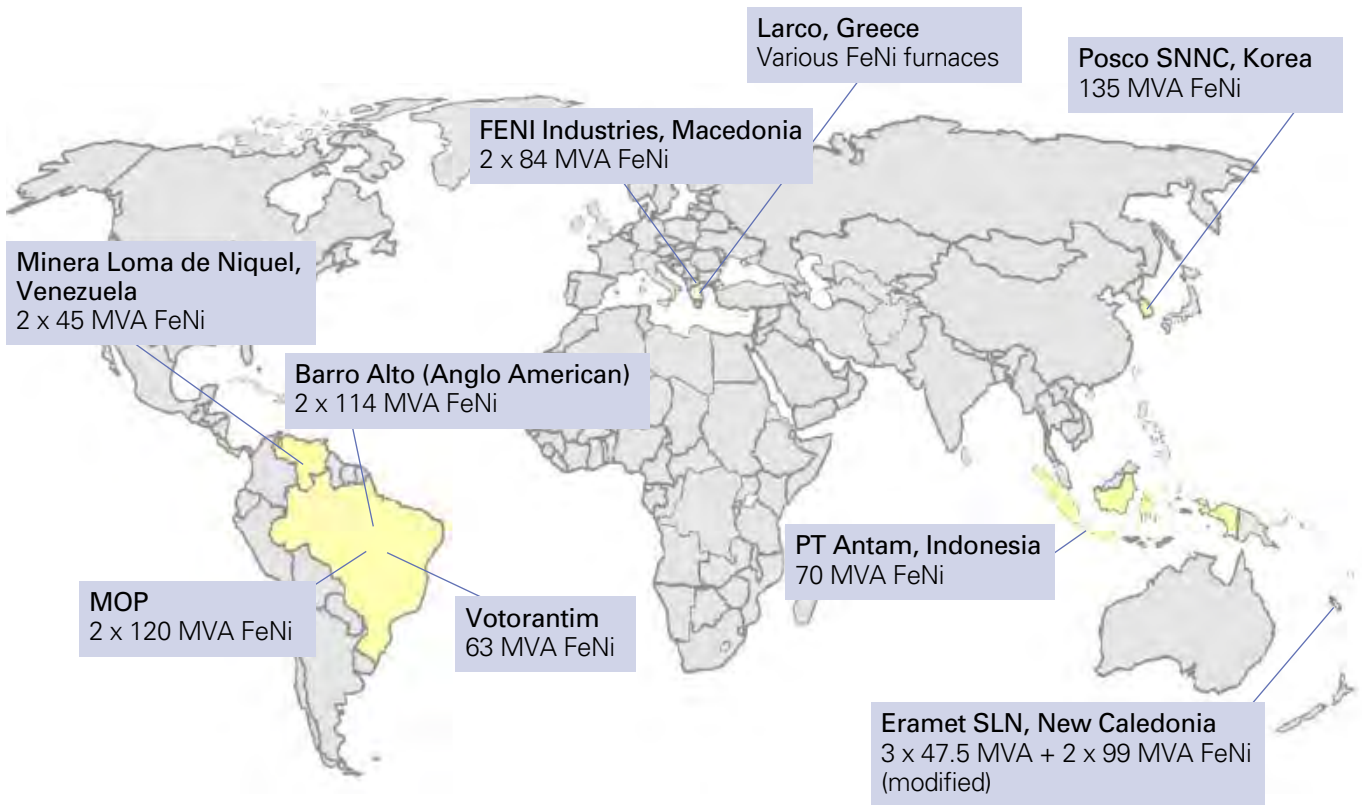
Owing to the success of this revamp, SLN decided to modify Furnace No. 9 in the same way. That more than doubled the capacity of the furnace originally installed by SMS in 1971. This remarkable increase is due to a special sidewall cooling system and a higher transformer rating. Eramet was the first customer to use the slab copper cooling principle. An impressive sight with its length of some 35 m and six series-connected electrodes, the

rectangular furnace is designed to produce up to 35,000 t of nickel per year.

This type of “furnace tuning” is particularly attractive for customers in the ferroalloys sector who want to boost their furnace capacities without having to carry out extensive modifications to associated facilities such as buildings and foundations. They can relax, because the sidewall cooling system does not have any water passages inside the lining, so it is safer than other systems available on the market.



First metal tap at MOP.



MOP, BRAZIL

Whether in terms of dimension or transformer rating, these furnaces are the largest in South America. In 2006, SMS received the contract to supply two furnaces of rectangular design with six in-line electrodes of 120 MVA capacity each.

What makes these furnaces stand out are the so-called gradators that improve the shielded arc operation in order to enhance

the production rate. To cope with the high silica rates contained in the slag, the furnace cooling system comprises our unique patented SMS copper cooling sidewall system in the slag zone, similar to the one used at SLN in New Caledonia. It's also possible to monitor each individual feeding pile in order to optimize the melting conditions and increase the melting capacity.

In particular we are very satisfied with the process control based on thyristor. This system is a new milestone for such furnaces.

Chris Doyle/Vale



Top view of the MOP plant in Brazil.



MOP plant during construction.

40

The world's largest electric smelter has a sidewall length of approx. 40 meters

POSCO SNNC, KOREA

In December 2012, SMS received an order from POSCO SNNC, a global leader in FeNi production, to deliver the world's

largest submerged-arc furnace for FeNi. POSCO SNNC is a joint venture between the Korean company POSCO and the mining company SMSP, which is based in New Caledonia. The Ni ore from SMSP's mine is shipped to the plant in Gwangyang, then converted to FeNi.

POSCO SNNC aims to boost the plant's annual capacity to 54,000 tons of Ni. To do this, POSCO SNNC is increasing the capacity of the New Caledonian mine as well as expanding the FeNi plant. This requires new units including an additional kiln for the production of calcine and a second submerged-arc furnace. The power rating of the rectangular FeNi smelter is 135 MVA, resulting in a total nominal power input of 100 MW. Such a large-capacity furnace comes with impressive dimensions of 40 x 15 x 8.5 m, which represents the world's largest electric smelter.



Illustration of the 135 MVA furnace at POSCO SNNC.



Tapping at POSCO SNNC 1.

SMS Siemag is proud to work with such a high-reputation partner on this project. Worldwide, POSCO SNNC is well known for its excellent expertise in FeNi production. Working together and applying the in-depth know-how and experience of SMS Siemag in ferroalloy furnaces, the two companies will create a new milestone in large scale FeNi-production. Numerous innovations are incorporated in our smelters.

Nevertheless, the overall cooling rate required is moderate, which improves the thermal efficiency as well as the productivity of the furnace. The effective binding

system applied here works with tie rods in the longitudinal direction and a balcony-shaped sidewall system in the transversal direction. Especially energy-efficient, the 6 inline rectangular FeNi furnaces operate with SMS electrode columns at top availability.

Furthermore, the furnaces are equipped with vistrors that allow flexible furnace operation and maximum production. The gradators prevent rapid movements of the electrode column and minimize the mechanical stresses on the equipment and the hydraulic unit. Included in our supply scope were engineering and supervision services as well as the supply of the complete furnace equipment with the above features, plus the electrics and automation.

There was reason to celebrate in November 2014 when the first tapping of the furnace took place. The smoothness of the process underlined POSCO SNNC's skills in professional execution. Impressively, the project was realized in less than two years and within budget. This is particularly remarkable for FeNi installations. The photo on this page shows the first slag tap. Soon afterward, in January 2015, the first metal was tapped, and 100% capacity operation is expected in the second half of 2015.

This contract exemplifies SMS Siemag's superior position in FeNi smelters. We have supplied all large-scale FeNi smelters of recent years.



Mr. Yoo (PM Posco SNNC), Dr. Degel, and Mr. Lim (VP Posco SNNC).

Interview with Mr. Lim

Question: You are currently commissioning the world's largest furnace.

How is it going?

Lim: Of course, we were aware of the challenges of operating the world's largest furnace. But we were confident because of POSCO SNNC's highly professional and hardworking team. The key to success with large furnaces is know-how and good staff. At this point, I'd like to thank them.

Question: So success mainly depends on internal know-how?

Lim: Exactly. We learned a lot with the first furnace and gained valuable experience. But you also need the right equipment for a good FeNi production line.

Question: How would you characterize the furnace?

Lim: Crucial with such a vast furnace is constant process monitoring and control. The control system makes sure of that.

Question: What do you think of the performance of the SMS team?

Lim: I would say the teamwork with SMS displayed typical German values: it was professional, on-time, and reliable.

We are happy with the professional execution by SMS, and POSCO SNNC is satisfied with the furnace performance. The control system works very well, which is important especially during the start up period.

Mr. Lim/POSCO SNNC

We enjoy a longstanding relationship with SMS. The furnace equipment always operates reliably.

Mr. John Gaitanos/Larco

LARCO, GREECE

Right now, Larco is steadily modifying its older Krupp furnaces for FeNi production. Since 1999, SMS has carried out numerous improvements. Greek company Larco is one of Europe's key ferronickel producers.



FeNi tapping at Larco.

BARRO ALTO, BRAZIL

SMS delivered two FeNi furnaces to Anglo-American do Brazil for their Barro Alto project. The two furnaces of 114 MVA each will supply more than 50,000 tpa of contained nickel.

In principle, the furnace dimensions and features are similar to those being installed at MOP.



Furnace building at the Barro Alto plant in Brazil.



Electrode column during installation at PT Antam.

PT ANTAM, INDONESIA

SMS is currently supplying the core equipment for furnace No. 4 at PT Antam's FeNi plant in Pomalaa, Indonesia. We are responsible for supplying the electrode columns, high-current lines, and the hydraulic unit. According to plans, the plant will go into operation in the second half of 2015.

SMS is an important strategic partner for Antam. Their FeNi know-how and technology are remarkable.

Mr. Tato Miraza/PT Antam



PT Antam and SMS during burner-on ceremony at PT Antam.

FeCr applications including overall reference situation

SMS SIEMAG FeCr REFERENCES

- Market leader in SAF technology for ferroalloy and circular smelters
- (>100 references during the last 40 years)
- 27 references for FeCr smelters
- >90 references for DC furnaces
- >16 references (including conductive hearth) for special smelters
- Extensive track record of turnkey disciplines
- Plant for Etikrom/Turkey including energy recovery system
- Four 72 MW furnaces for Kazchrome/Kazakhstan
- Core equipment for Lion/South Africa

COMPETENCIES IN FeCr

High-carbon ferrochrome features carbon contents of 4-8% and is usually applied in AOD converters for the production of alloy steel grades. Due to environmental restrictions, ferrochrome is commonly produced in closed, stationary furnaces. Medium-carbon chrome alloys and low-carbon FeCr are produced in combined process stages. Both products require special slag metallurgy to attain high chrome yields.

Ferrochromium specification

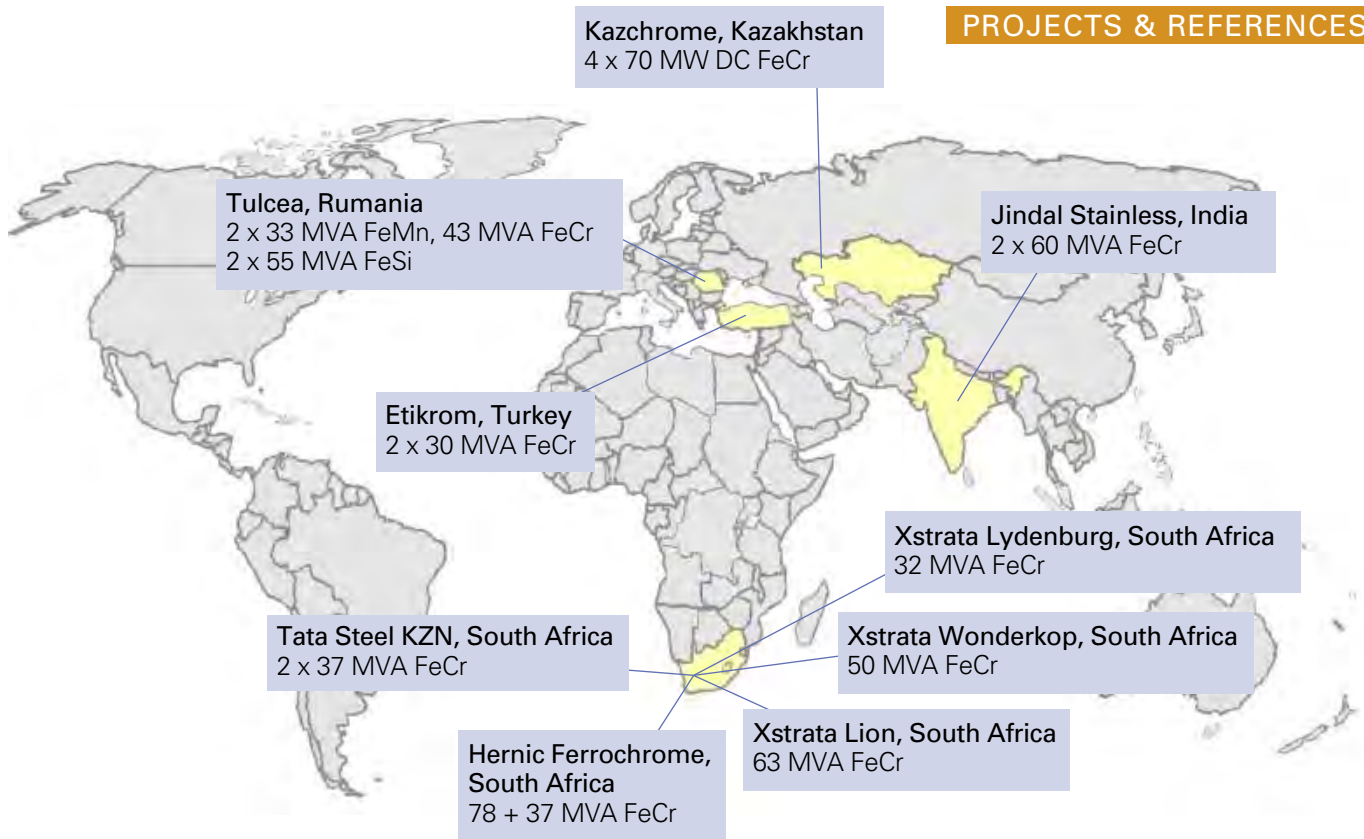
HC FeCr	4 - 10 % C
MC FeCr	0.5 - 4 % C
LC FeCr	< 0.5 / < 0.1 % C
SiCr	20 - 45 % Si



FeCr furnace at Etikrom prior to start up.



Kazchrome plant during construction.



INNOVATIVE DC TECHNOLOGY FOR METAL PRODUCTION

SMS is the world's top-quality supplier of DC furnaces for metal production. More than 80 steel furnaces and eight smelting furnaces have been installed by SMS. Especially important is that we hold patents for all bottom-anode systems (such as conductive hearth, billet-type, and pin-type systems). The furnaces of the next generation utilize a conventional electrode column system (also patented by SMS) that enables the operator to control and slip the electrode under full power. This significantly increases production levels. Furthermore, an in-house design tool provides minimized arc deflection, which increases the lifetime of the lining. The DC technology is applicable in certain niche areas such as FeCr, Co, TiO₂, and waste recycling.

Included among the benefits of DC furnaces are:

- Unique in-house know-how to minimize arc deflection (busbar routing + electrode column)
- Optimized energy consumption due to combined electrode movement regulator with thyristor ignition controller and high electrode speed
- Patented reliable long-life electrode column system that allows slipping and nipping under full power (providing maximized power-on time)
- Quick-change center-piece device essential for maximum operating time
- Intelligent feeding arrangement to maximize throughput and refractory lifetime



Illustration of DC furnace.

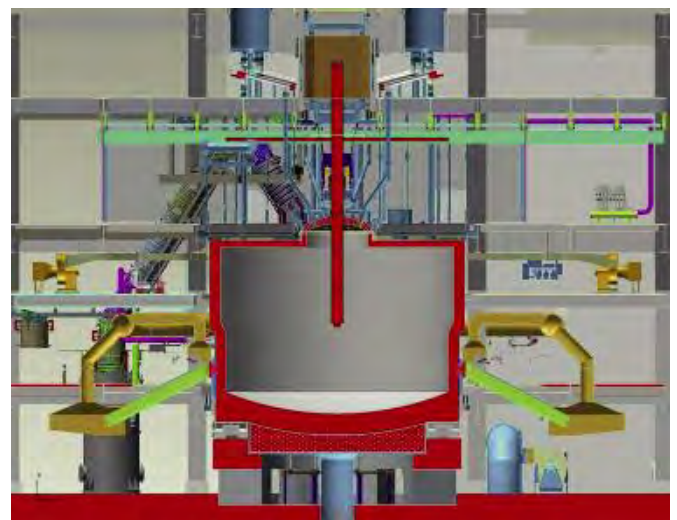


Illustration of DC furnace.

72

72 MW is the power input in each DC furnace at Kazchrome, resulting in a production of 110,000 tpy of FeCr per furnace

KAZCHROME

In September 2011, SMS Siemag received an order from Kazchrome JSC for the engineering and supply of a FeCr plant. Right now, the complex is under construction at the existing FeCr plant in Aktobe/Kazakhstan.

SMS is supplying four DC-based smelters with a power input of 72 MW for each furnace. The annual production of the plant (melt shop No. 4) is approx. 440,000 tons of HC ferrochrome. One of the world's leading FeCr producers, Kazchrome is part of the ENRC group and already operates FeCr plants in the north, west, and central regions of Kazakhstan.

The first metal was tapped in November 2014. Currently, furnaces No. 2 and 3 are in the commissioning phase. According to plans, all four furnaces will go online in 2015. Especially useful is that the furnaces can directly process the chrome ore fines. To improve operation, the system includes DC electrode columns, and the results so far are favorable. One challenge is controlling the typical high metal and slag temperature levels that result from the process and put significant stress on the lining and tap holes.

GENERAL APPLICATION OF FeCr AC TECHNOLOGY

Along with Metix, SMS Siemag played a leading role in the supply of new FeCr furnaces as well as modifying numerous existing furnaces worldwide. Most of the recent installations were in South Africa, which has the largest chrome ore deposits known today.

JINDAL STAINLESS, INDIA

Jindal Strips Ltd awarded SMS a contract in 2006 for the design and supply of two semi-closed 60 MVA submerged-arc furnaces for high-carbon ferrochrome. Included among the raw materials are chromite ore, mainly in the form of briquettes, quartzite, and reductants such as nut coke and Indian coal.



Execution team of Kazchrome.



Tapping at Kazchrome.

The plant boasts an annual production capacity of 150,000 t. It was up to SMS to carry out the basic and detail engineering as well as for the supply of the key equipment. This covered raw material handling, two submerged-arc furnaces with dedusting plants, and engineering for the plant auxiliaries (already prepared for subsequent installation of an energy recovery system). Today, both furnaces operate above their nominal capacity.



Energy recovery system erection.

We're satisfied with the furnace equipment and the work done by SMS. We hope to start up the energy recovery system this year, which is important for the location in Elazig, where energy prices are high.

Robert Yildirim/Eti Krom

ETI KROM

This contract comprises the revamp of the two existing FeCr furnaces of Eti Krom in Elazığ in Turkey. The new furnaces were connected to a 30 MVA transformer.

Included in our scope of supply were the engineering, the furnace itself, the hydraulic system, the water-cooled hood, and the electrode columns. The two furnaces are expected to produce approx. 90,000 tons of H.C. FeCr per annum. The smelters were commissioned in 2011 and have operated reliably ever since.

It was also good news that Eti Krom A. Ş. contracted SMS to install an energy recovery system connected to the two recently installed furnaces. The equipment has already been delivered to

site and erection is in progress. Not only responsible for supply and services, we also carried out the basic and detailed engineering as well as the delivery of the mechanical and electrical core components for the gas cleaning plant and energy recovery system.

What's special about the energy recovery system is that it utilizes the heat-sensible energy of the off-gas and converts it into super-heated steam. This steam then drives a power generator. We calculate that 5 MW will be recovered as electrical power.



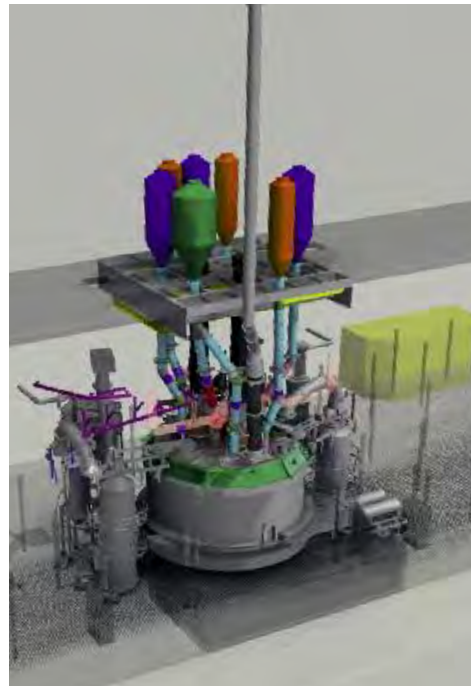
Etikrom plant.



Open-type FeCr furnace.

INTERNATIONAL FERRO METALS (IFM)

A major project in this area is the upgrading of two 66 MVA FeCr furnaces including new water cooled copper delta sections for the furnace roof, additional charging chutes equipped with solid copper feed chute tips, and modifications to the four gas cleaning plants. An earlier project we accomplished involved replacement of the entire bottom electrodes with Metix equipment.



IFM 3D illustration.

XSTRATA

A new plant named Lion 2 is being built with two 75 MVA FeCr furnaces based on Xstrata's PREMUS technology for pre-reduction. Contracted here was Metix to supply and install complete sets of electrode columns 1,600 mm in diameter. The plant was commissioned in 2013.

Previous projects on Lion 1 included the replacement of the electrode columns for the two 63 MVA FeCr furnaces along with secondary power factor correction, resulted in an increase in the power input to the furnace.



Xstrata Lion 2 project during construction.

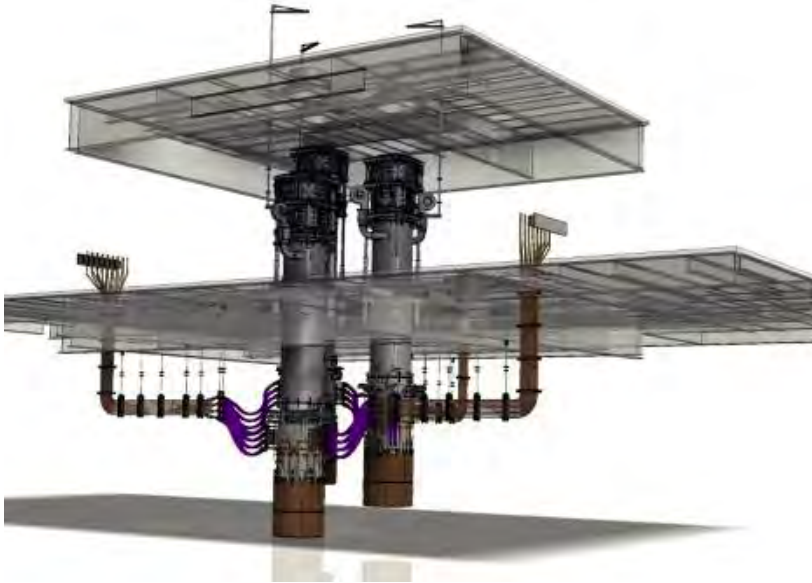


Illustration of FeCr furnace for Lion.

LION PHASE 2 PROJECT

Early in the year, Metix commissioned the first set of 1600 mm furnace electrodes with forged copper pressure rings and heat shields, followed in July 2014 by the second set. They were destined for the Lion ferrochrome complex Phase 2 (Lion II) expansion project in Steelpoort, Limpopo. This facility is owned by the diversified mining major Glencore and ferrochrome producer Merafe Resources chrome Joint Venture.



Installation of the equipment for Lion.



Installation of electrode at Lion.



Heric F4 78 MVA roof.

HERNIC FERROCHROME

One of the first major projects for Metix consisted of the overall EPCM services for HFC's F4PS2 project. This included a 350,000 tpy sinter plant and a 78 MVA closed FeCr furnace with preheating. Completed in 2005, the project marked the entry of Metix equipment into the SAF market with the supply of full electrodes (1,750 mm in diameter) to Africa's largest FeCr furnace.

Furthermore, Metix converted two existing open FeCr furnaces into closed furnaces by supplying new electrode columns, bus-bar systems, and closed roofs with copper roof deltas. Also part of the service and supply package were a new gas cleaning plant and water treatment. The plant was re-commissioned in 2010.



Heric plant at night.

TATA STEEL

Metix was the EPCM contractor for Tata Steel's FeCr plant in Richards Bay, featuring a 300,000 tpa briquetting plant and two 37 MVA furnaces that were commissioned in 2006.



FeCr plant of Tata Steel KZN.

General application of FeMn technology including overall reference situation

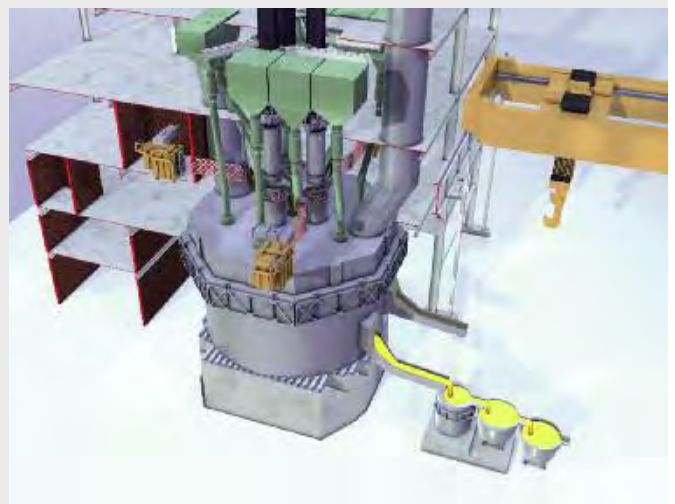
Ferro-manganese is usually available on the market as high-carbon (6-8%C), medium-carbon (1 - 4%C) or low -carbon (<0.4%C) products. There are also alloys with high Si contents (15 - 20%) known as silico-manganese. High-carbon ferro-manganese and silico-manganese are produced in open or closed furnaces.

Ferro-manganese specifications

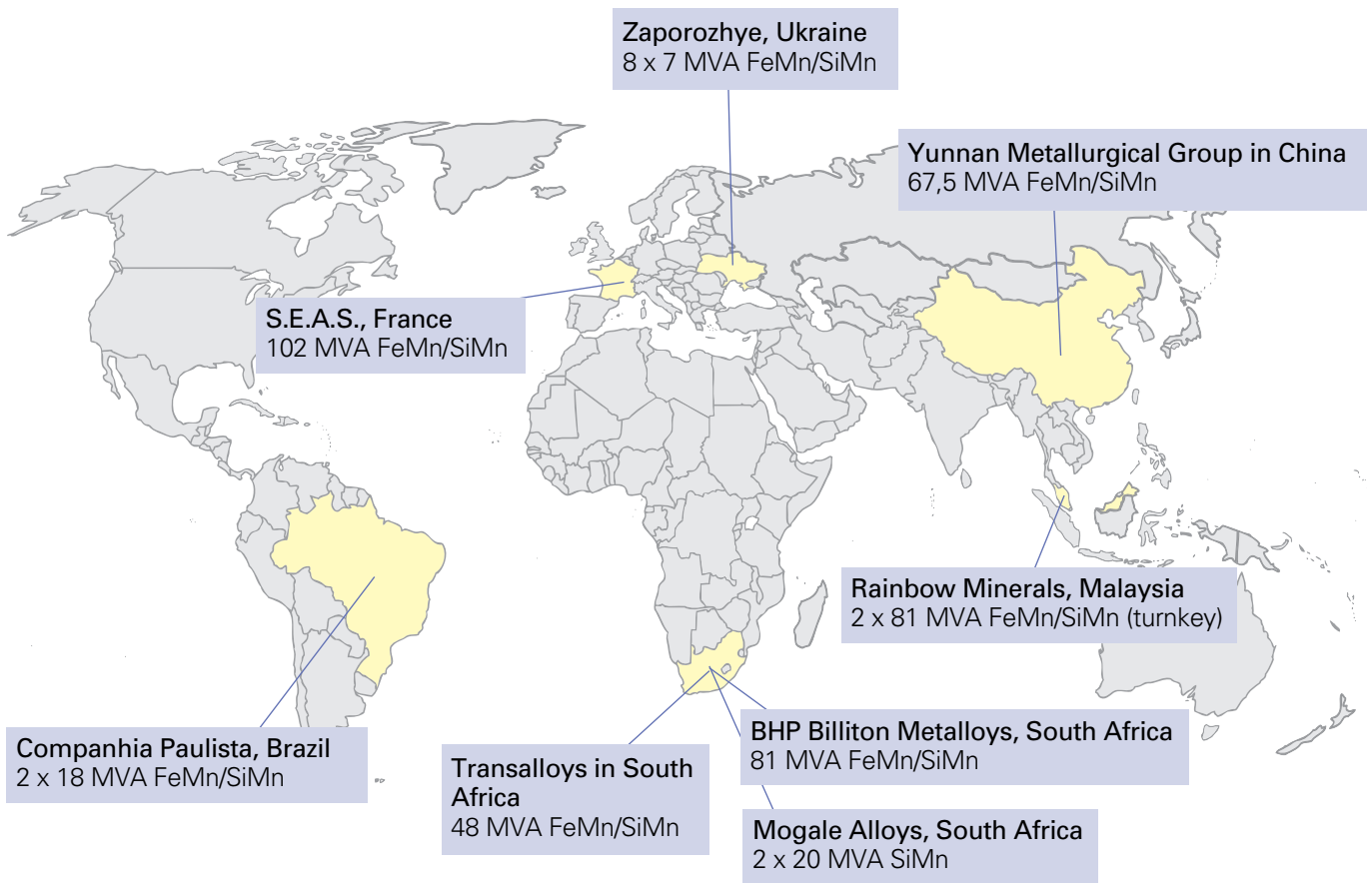
HC FeMn	6 - 8 % C
MC FeMn	0.5 - 2 % C
LC FeMn	< 0.5 % C
MC SiMn	15 - 25 % Si, 0.5 - 2 % C
LC SiMn	25 - 35 % Si, < 0.5 % C



Ferro alloy furnace.



FeMn furnace.



MOGALE ALLOYS IN KRUGERSDORP

Working for this South African customer, SMS revamped two SiMn furnaces with new electrode columns, air cooled roofs, gas oftakes, bus tubes, and flexible cables.



Mogale air cooled roof.

YUNNAN METALLURGICAL GROUP CO LTD IN CHINA

Metix carried out the basic engineering for a closed 67.5 MVA SiMn furnace – China's largest, as well as the detail engineering for core equipment. We also supplied the electrode column (1,750 mm in diameter), the copper delta roof, and the refractory freeze lining. Commissioning took place in 2011.



Forged copper delta roof.

We have a good professional relationship with SMS. We aim to commission the plant in 2015.

Brian Gilgannon/Rainbow Minerals

SAKURA EPC PROJECT

Metix attracted the full engineering, procurement, and construction (EPC) contract from Sakura Ferroalloys for a project in Eastern Malaysia. Sakura Ferroalloys SDN is a tripartite joint venture between Assmang Ltd (itself a joint venture between African Rainbow Minerals Limited and Assore Limited) of South Africa, Sumitomo of Japan, and Taiwan's China Steel Corporation. It's a big project, consisting of two 81 MVA FeMn/SiMn closed submerged-arc furnaces, gas cleaning, raw material handling, product handling, and associated services, plus infrastructure.

Commissioning of the first furnace is scheduled for the end of 2015.



Illustration of Sakura plant.



Sakura plant during erection.

General application of silicon and FeSi including refining options and general reference situation

GENERAL APPLICATION SILICON AND FeSi

Typically, the ferro-silicon grades produced in a submerged-arc furnace have Si contents of 15 - 96%. Grades with more than 96% Si are known as silicon. These applications place extreme demands on the design and material due to the high energy concentration and the process gas formation involved.

Ferro Silicon Specification:

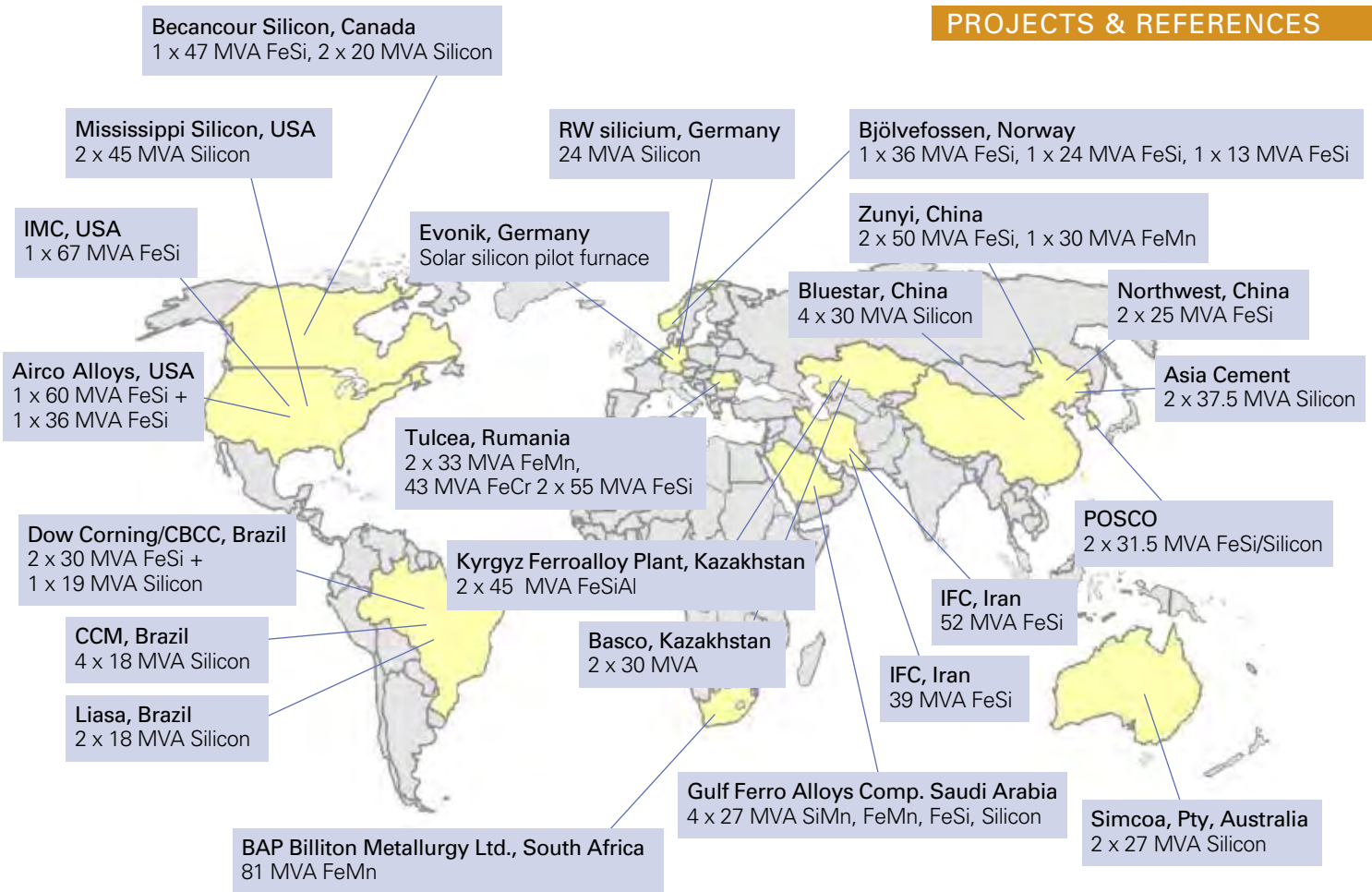
FeSi 40 – 50 % Si FeSi45

FeSi 72 – 78 % Si FeSi75

FeSi 85 – 96 % Si FeSi90



Silicon plant with energy recovery.



Characteristic of these furnaces are encapsulated electrode columns with hydraulic control, contact clamp tightening operation, and short and low inductive electrical feeders. Silicon production units generally utilize prebaked electrodes. SMS also supplies special composite electrode systems for silicon production to reduce operating costs.

Always looking for improvements, SMS has continually optimized its silicon-based furnaces over the years. The process requires a rotating gear and ideally a 25 - 60 MVA transformer. What's especially paramount for safe and reliable operation are the design and quality of the rotating gear, furnace hood, hood curtain/hood doors, the furnace proper as well as the electrode column.

The large furnace size requires the application of a composite electrode.

These are some of the key advantages as stated by our customers:

- The only supplier of Si-metal plant with a heat recovery system
- More than 90 references for large-scale Si-metal and FeSi furnaces since 1970
- SMS has a solid and sound reputation which attracts customers and project financing => best reputation for Si-metal furnaces worldwide
- Widely spread network with furnace operators, off-takers and consultants provides additional in-depth know-how
- Overall intelligent logistics design ensures smooth operation without bottlenecks => proven in many plants all over the world

BLUESTAR/CHINA

Between 2007 and 2009, two circular furnaces with a power rating of 27 MVA and two circular furnaces with a power rating of 30 MVA were commissioned in China. The four furnaces went to Bluestar, one of China's key players in the field of silicon production. Right from the start and up to the present day, the furnaces have always worked reliably.

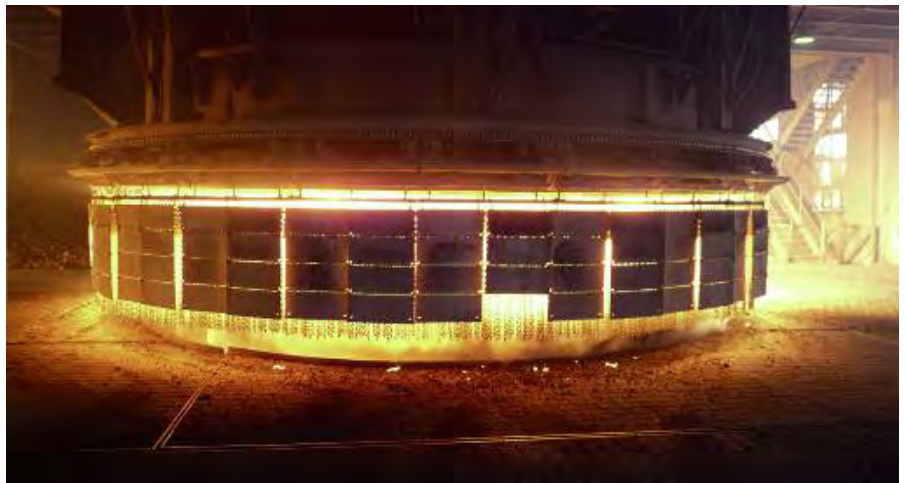
The availability and reliability of SMS equipment is remarkable considering the harsh furnace condition of the silicon process.
Stefan Bauer/RW Silicium

RW SILICIUM/GERMANY

RW silicium GmbH of Pocking, Germany, has restarted its silicon SAF after a successful revamp. The aim of the modernization was to equip the furnace for higher production. Re-commissioning took place in 2009.

Included in the SMS scope of supply and services were the layout of the air injection and cooling water system, the planning, design, and supply of three electrode lines, the water-cooled gas hood with moving chain curtain, and the high-voltage system.

RW silicium GmbH is a manufacturer of metallurgical silicon. Today, after years of operation, the equipment still reaches a very high availability of up to 99%.



Furnace at RW silicium.



POSCO FeSi plant.

POSCO/KOREA

In July 2011, SMS attracted an order from Posco in South Korea for two 37.5 MVA FeSi furnaces for high-purity FeSi. They are equipped with a rotating gear so our customer will also be able to use them to produce Si-metal at a later stage. We supplied the furnace, the main electrical supply systems, the automation system, and the hydraulic unit. The furnaces were commissioned in 2013. What particularly stands out is a suspended electrode column, making for a very precise and compact design. This minimizes electrode breaks, while also reducing building costs.



Commissioning ceremony at POSCO.

The furnaces are outstanding and we'd like to thank SMS for their good cooperation.
Winfried Baldus/Thyssen Krupp

SILICIUM, KAZAKHSTAN

This project comprised the turnkey supply of two 21-MW furnaces for Si-Metal production. Not only the furnaces themselves, but the entire plant equipment from delivery of the raw material to packing of the final product (silicon lumps) were supplied by SMS. The plant is designed to operate at extreme weather conditions, ranging from 45 °C in summer to minus 40 °C in winter.



Silicon furnace during start up.



Kazsilicon in Kazakhstan.

We chose SMS because they supply top-quality furnaces. So far, we're very satisfied with the professional execution by the SMS team.

Dave Tuten/Mississippi Silicon

MISSISSIPPI SILICON/USA

In 2013, SMS received an order to install the main equipment for a two-furnace silicon plant in Burnsville in Mississippi/USA. It's the first silicon installation in the USA for four decades. Not only responsible for most of the engineering, we also supplied the furnace charging equipment including the vessel, electrode columns, high current line, automation and control systems, transformers, and the primary gas cleaning plant.

The earthworks started in 2014, and commissioning is scheduled for 2015.

The furnace is equipped with doors for a later connection to an energy recovery system. Also prominent in the unit is the new short electrode column design.

SMS provided Mississippi Silicon with financing for the SMS share of the project as well as for some of the local supplies.



Mississippi Silicon plant during construction.

PCC/ICELAND

The PCC project is a good example of SMS's involvement in turnkey projects. SMS supported the client for project financing and for the development of the complete plant in Husavik/Iceland. The plant will run with two 24 MW furnaces. SMS will be responsible as a EPC contractor for the execution of the project for the whole plant. The financing of the project is secured and it is expected that the smelters will be commissioned in 2017/2018.

SMS gave us great support in the development of the project as well as in project financing. We look forward to continuing our excellent relationship with SMS.

Peter Wenzel/PCC

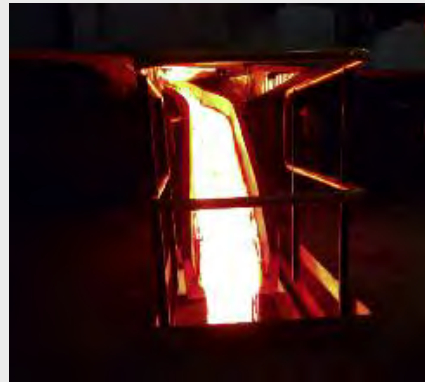


Silicon plant for PCC.

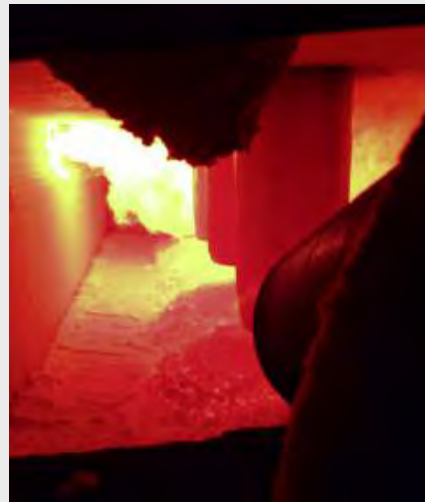
Nonferrous metals including overall reference situation

INTRODUCTION TO NONFERROUS METALS

Most smelters supplied to the nonferrous metals industry apply slag-based processes, recovering the maximum amount of precious metals out of the slag. The principles behind these processes first emerged in the 1950s.



Slag tapping area.



Inside view of a slag cleaning furnace.

Rectangular slag cleaning furnace for Kazzink.



Slag cleaning furnace during operation.

NICKEL MATTE AND COPPER MATTE

There are wide-scale similarities between the production of copper matte and nickel matte from primary smelter and converter slags in electric furnaces and the ferromanganese process. Here again, the furnaces are semi-closed, stationary-type furnaces. Usually, round furnaces are used for smaller to medium size quantities, whereas large capacities are produced in rectangular furnaces.

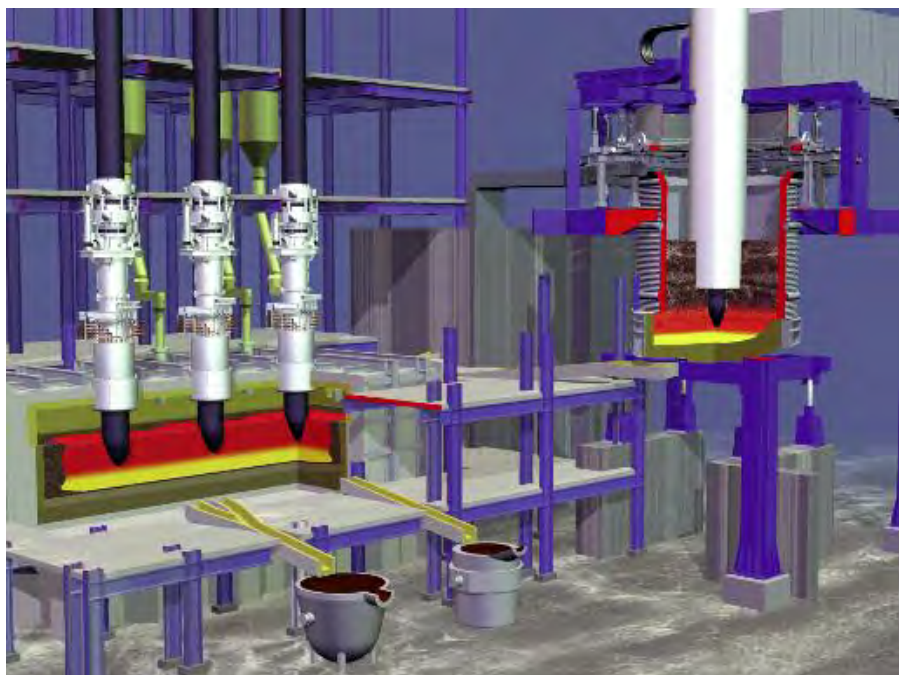
SLAG CLEANING FURNACES

SMS has supplied a number of submerged-arc furnace units for slag cleaning. To date, we can draw on experience from more than 25 references. The slag is either liquid-charged into the furnace or cold-charged in solid form via conventional feeding systems.

- Nickel
- Cobalt
- Lead (for example, from Kivcet process) and secondary lead
- Zinc
- Tin and secondary tin
- Platinum
- Palladium



Roof section of copper slag cleaning furnace.



Top lance system – SAF combination.

0.5

Using rectangular slag depleting furnaces, producers can reduce the remaining copper content in the slag to below 0.5% (depending on the discard slag specification)



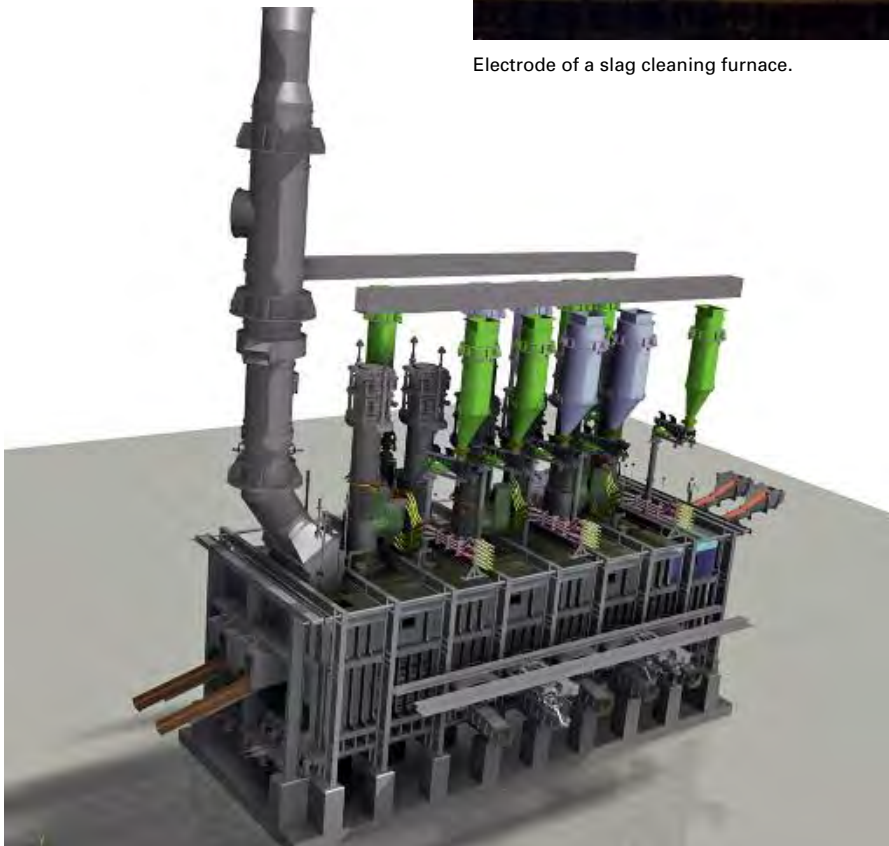
Electrode of a slag cleaning furnace.

LEAD AND ZINC

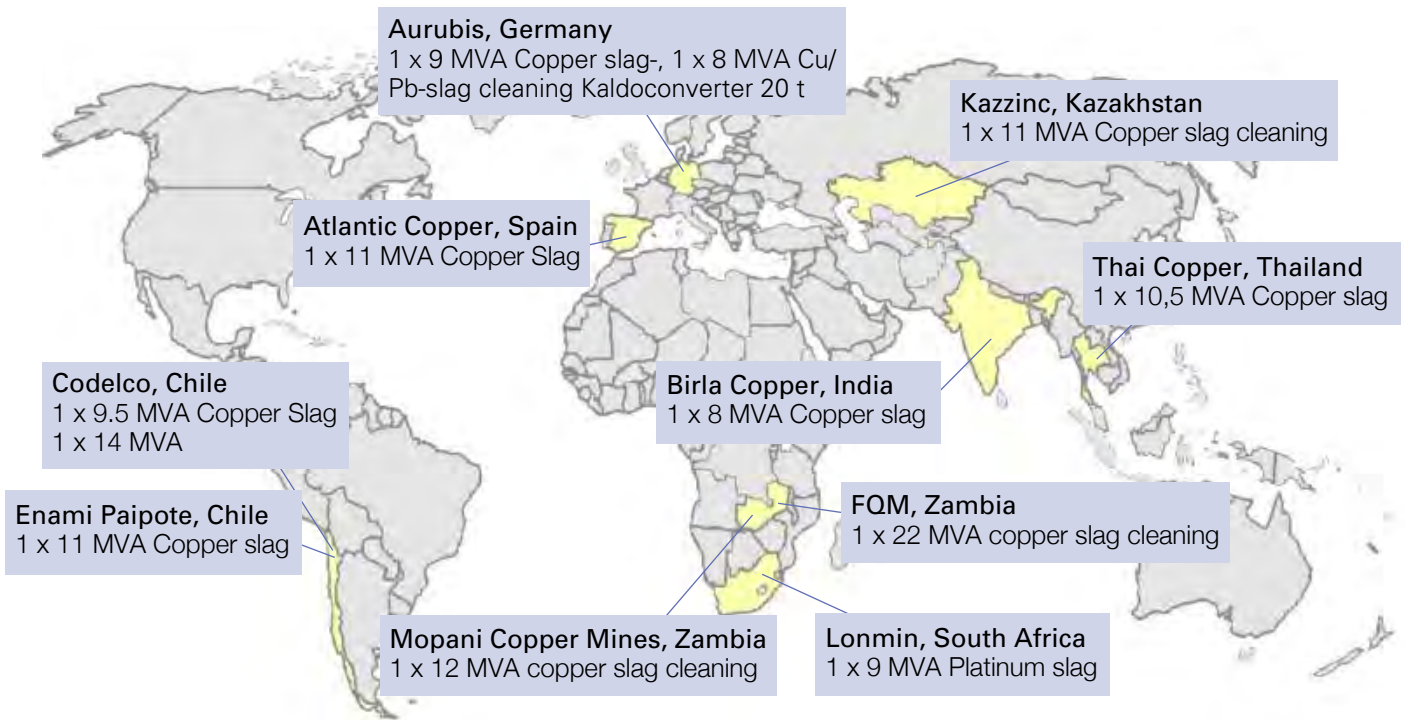
Zinc exits a submerged-arc furnace with the gas phase. Then residual metals and slag are tapped separately, evaporated, and re-oxidized. Submerged-arc furnaces are suitable for recycling flue-dust in the steel industry (e.g. EAF dust) and for recycling slag containing Pb/Zn from BF-based Pb/Zn production plants.

RECTANGULAR FURNACE DESIGN FOR SLAG CLEANING

Depending on the process, the slag is either liquid-charged into the furnace via launders or cold-charged in solid form via conventional feeding systems. The application range is very wide and units operate in copper, nickel, cobalt, lead, tin, zinc, and noble metals (PGM) production. Today we can identify a trend towards rectangular-shaped slag cleaning units.



Furnace for FQM.

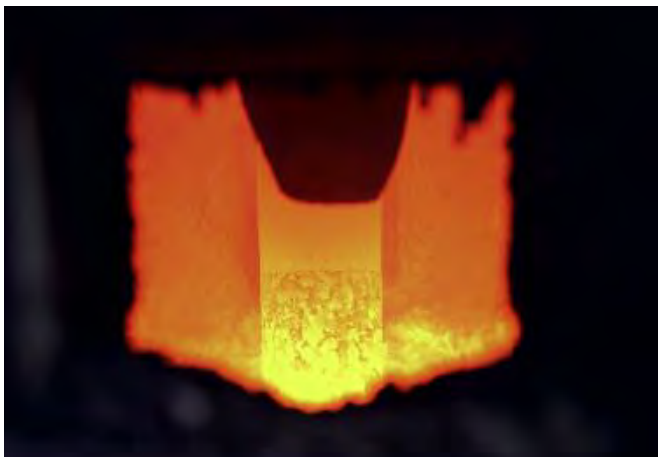


Increasingly, semi-continuous operation is becoming common for primary smelters (such as IsaSmelt or Ausmelt) as well as for slag cleaning furnaces. More suitable here are rectangular SAFs because they offer better geometrical conditions.

SMS calculates that the recovery rate of a rectangular furnace in continuous operation can be 0.1 - 0.4% higher than that of a conventional SAF (depending on the specific parameters).

Expressed briefly, the advantages of rectangular as against circular furnaces are as follows:

- Optimum settling conditions in large-capacity units (>20 MW)
- Smaller furnace cross-section due to more effective furnace volume
- Three or six electrodes in-line provide even power distribution
- Reduced dead areas between the electrodes
- Smaller transformer connecting load due to smaller furnace cross-section
- Expansion of bottom refractory controlled in both directions by frame design => no bulging
- Easier arrangement of channel cooling or copper cooling system for the sidewalls
- Easy installation of channel cooling for bottom part of the furnace
- Easy arrangement of metal/slag tapping equipment



Inside view of a rectangular slag cleaning furnace.



Inside view of slag cleaning furnace.

MOPANI COPPER MINES/ZAMBIA

These days, the rectangular furnace at Mopani Copper Mines in Zambia is primarily used for copper slag cleaning. It's installed downstream of an IsaSmelt furnace for cleaning copper slag.

The first matte and slag were tapped in September 2006. Just one look at the recovery rate confirms the good depleting conditions of such furnaces.



Mopani copper tapping area.

KAZZINC, KAZAKHSTAN

In December 2006, SMS received an order from Engineering Dobersek for a rectangular slag cleaning furnace, again placed downstream of an IsaSmelt smelter. Engineering Dobersek was the general contractor on behalf of Kazzinc in Kazakhstan. The entire plant including the depleting furnaces was commissioned in 2011.

This is yet another project after Mopani Copper that proves this plant configuration is gaining acceptance as a viable and efficient method of copper production. It's certainly a plus that the electric furnace becomes a key unit in the overall copper smelter configuration, acting as a buffer for the copper matte.

That, in turn, results in flatter operation peaks for both the primary smelter and the converters.



Slag tapping at Kazzinc.



Tapping area of Kazzinc prior to commissioning.

28

With a sidewall length of 28 meters, the copper depleting furnace for First Quantum is the world's largest installed single unit

We selected SMS rectangular furnace technology because of our good experience in previous projects. Metix is well known for its professional engineering and execution.

David de Fries/First Quantum

KANSANSHI MINING PROJECT IN ZAMBIA

In March 2012, Metix and Kansanshi Mining PLC – a company 80% owned by First Quantum Minerals – signed a contract for the design and supply of a settling electric furnace to be integrated into a major expansion of the Kansanshi copper smelter in Zambia's Copperbelt province. The furnace is a rectangular six in-line furnace with a footprint of roughly 29 x 9 meters and a 24 MVA transformer rate.

Included in the supply scope were the charging system, complete MSEF furnace with refractories, tapping equipment, electrodes, high-current system, and transformers.

The furnace treats the liquid slag directly from the Isasmelt process through minor reduction and settling of Cu matte to improve process efficiencies. It's the third furnace used for this application based on SMS Siemag technology and it was successfully commissioned in March 2015.



Installation of furnace for FQM.

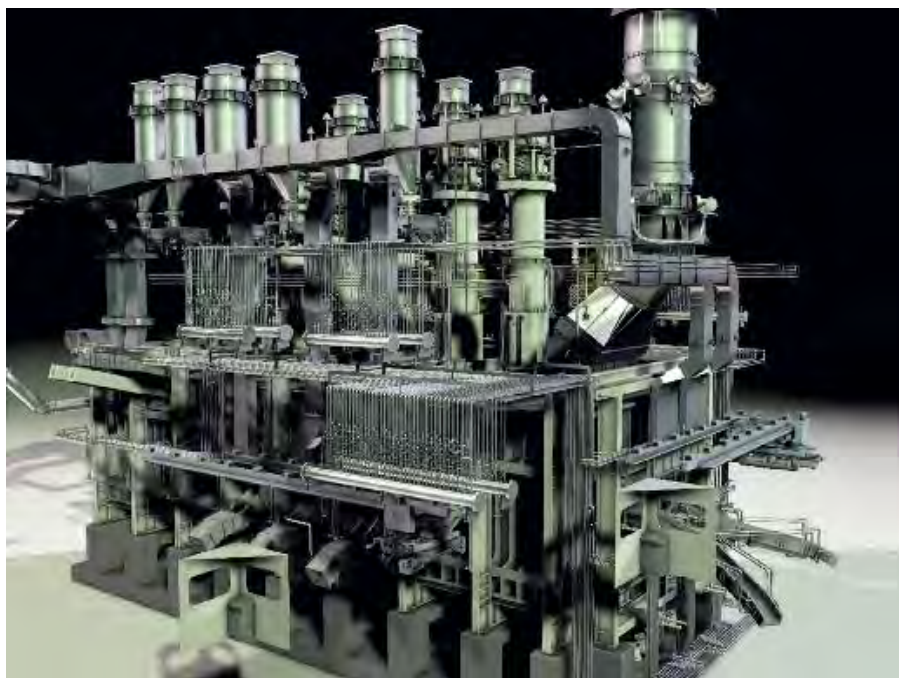


Illustration for furnace for FQM.

Special furnaces including overall reference situation

GENERAL ASPECTS OF TiO_2 -SMELTERS

What makes electric smelters for special applications particularly challenging is that they are usually tailor-made and have unique requirements. This means special know-how is necessary for their development.

Titanium slag furnaces produce TiO_2 -rich slag and pig iron as valuable byproducts. The ilmenite ore can be processed in either DC or AC furnaces. The advantage of DC furnaces is that they can smelt ore fines without any particular pre-treatment.

Normally, the specific electrical power consumption is higher due to the lower thermal efficiency of the furnace. Most smelters in South Africa are DC-based. TiO_2 -slag can also be produced in AC-based smelting units, either in circular or rectangular furnaces.

Illustration of ilmenite smelter.



*For the first large-scale DC furnace
in China, we relied on SMS technology.
Mr. Ma/Xinli*

YUNNAN XINLI, CHINA

This project involved the supply of a DC furnace for titanium oxide slag production. It was not just the engineering, SMS also supplied proprietary equipment such as the high-voltage system, furnace shell, water-cooled roof and hydraulic unit.

This most recently installed reference means that SMS has supplied the major equipment for almost all DC-based titanium oxide slag furnaces. The furnace at XinLi was commissioned in 2010.



DC furnace for ilmenite smelting.



DC furnace for ilmenite smelting.



Slag tapping of ilmenite smelter.

GENERAL APPLICATIONS FOR CALCIUM CARBIDE

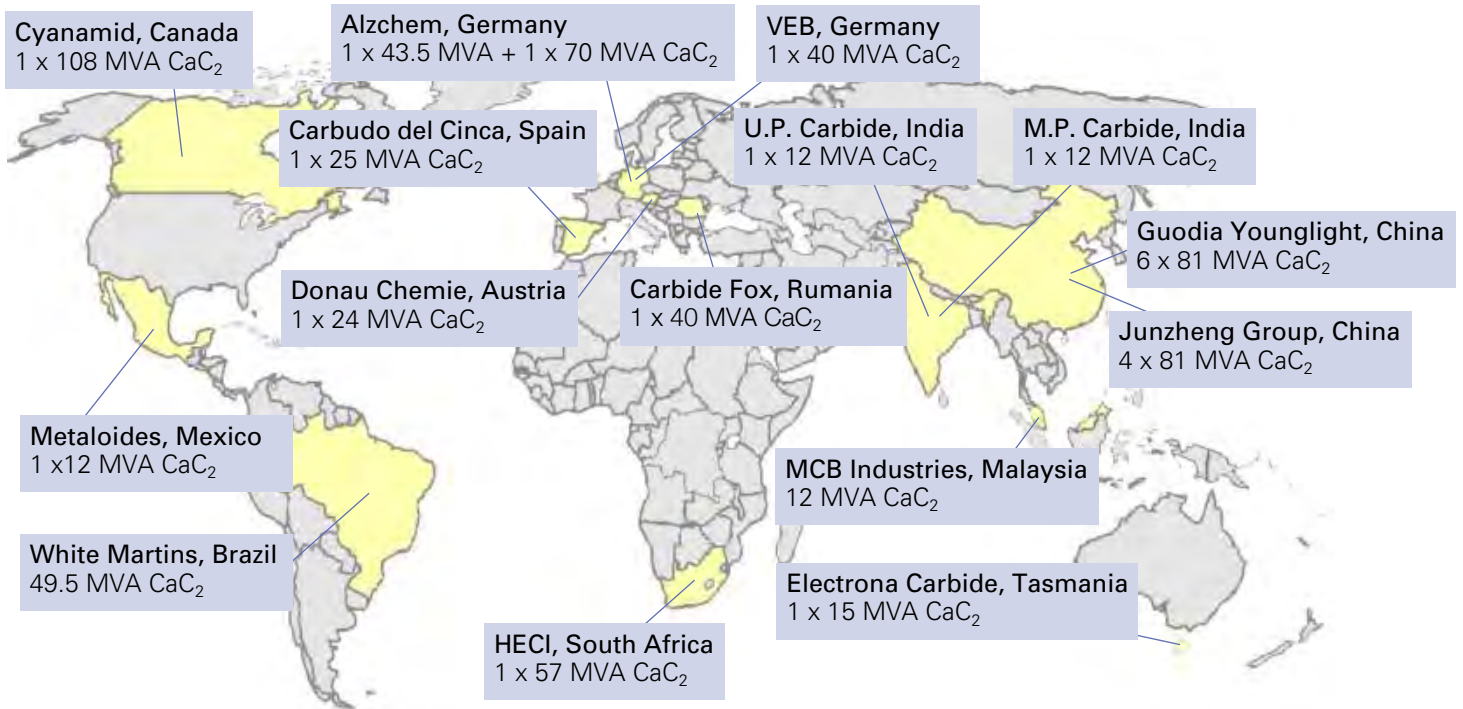
Calcium carbide (CaC_2) is the raw material for the production of acetylene and calcium cyanamide. Initially, acetylene was produced for lighting purposes, then its market was extended through welding acetylene to the manufacture of organic products. In organic and plastics chemistry, calcium carbide competes with various processes for the production of acetylene from hydrocarbons. Today, calcium carbide is mainly used in the chemical industry and as a desulfurization agent in steel production.



Tapping of calcium carbide.



Calcium carbide plant during construction.



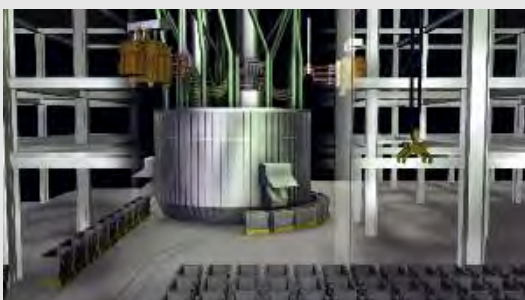
We chose SMS technology to set a new milestone in calcium carbide production in China.

Mr. Han/Guodian Younglight

750,000

Capable of an overall production of 750,000 tpy of calcium carbide, the Guodian Younglight project is the world's largest greenfield plant installation

Calcium carbide - Example: Guodian Younglight and Junzheng Energy



- Project goal: Meeting Chinese market demands for environmentally friendly and efficient large-scale CaC₂ production lines
- SMS developed efficient large-scale 81 MVA units with HES (hollow electrode system) for the direct use of fines
- Currently, three projects are under construction in Inner Mongolia: Guodian Younglight (6 furnaces for 750,000 tpy) and Junzheng Energy (4 furnaces for 500,000 tpy)
- The high quality calcium carbide produced here will be further processed in the company's internal chemical plant for the production of PVC etc.

2,500

A process temperature of up to 2,500 °C is required for the production of fused magnesia

GOUDIAN YOUNGLIGHT AND JUNZHENG/CHINA

In 2010 and 2011, SMS Siemag received contracts from two major CaC_2 producers in China for the engineering and supply of the world's largest CaC_2 furnaces. The plants come with a power rating of 81 MVA and achieve an annual production of more than 120,000 tpy each. The six furnaces ordered by Guodian Ningxia Younglight are located in Ningxia province, while the four ordered by Junzheng operate in Inner Mongolia province.

All furnaces are equipped with a hollow electrode system (HES) which is unique in PR China and is also capable of processing fine material.

Besides the basic engineering and detail engineering of the entire furnace plant, SMS supplied the proprietary equipment such as electrode columns, high-current lines, and hydraulic plants. Furthermore, SMS is responsible for the automation systems. Junzheng Energy commissioned the first furnace in 2012. Later, in 2013 and 2014, the remaining furnaces at Junzheng and Guodian Ningxia Younglight went into operation.



Calcium carbide furnace prior to commissioning.

It was our goal to bring modern furnace technology to China. We're happy with this decision, especially because the equipment is of high quality.

Mr. Du/Junzheng



Installation of electrode column.

GENERAL MINERALS

What defines the SAF principle is that it melts minerals at high fusion temperatures. This is why our furnaces are also applied in various fields for refractory and mineral production. SAFs are ideal for producing the following products:

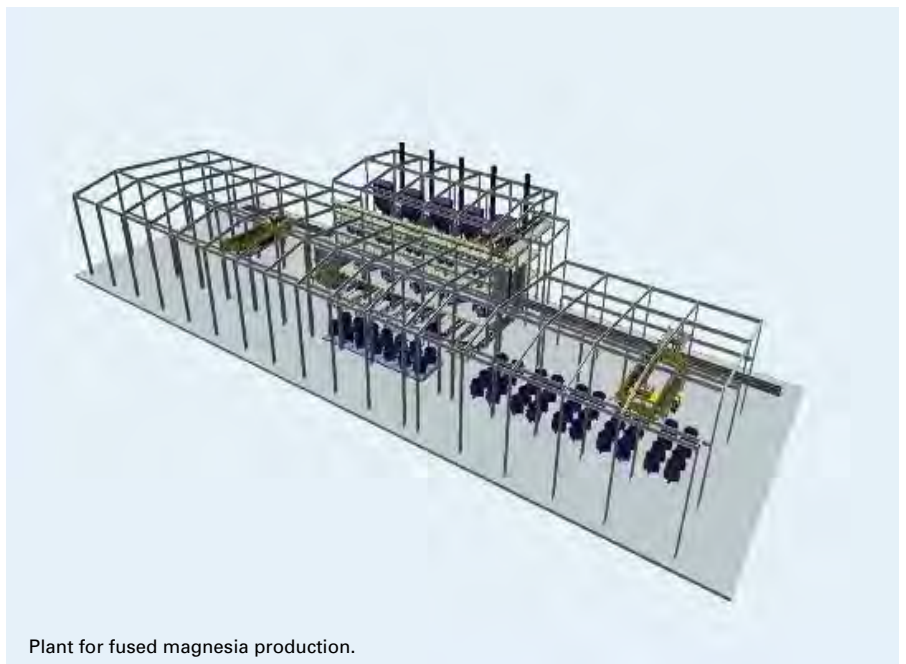
- Corundum (Al_2O_3)
- Fused magnesia
- Fused minerals
- Mineral and slag wool
- Refractory fusion furnaces



Tapping of mineral wool.

SATKA/RUSSIA MAGNEZIT GROUP

The Magnezit group headquartered in Satka/Russia awarded SMS a contract for the engineering and supply of ten smelting furnaces for fused magnesia. Five furnaces will go to the company's plant in Satka and five more to the Rasdolinsk facility. Each furnace has a transformer capacity of 8.8 MVA. They come with a capacity of approx. 10,000 tpy of fused MgO. Our supply scope includes the engineering and supply of the complete furnaces as well as the electrics and automation. Our customer plans to commission the first furnaces in 2015.



Plant for fused magnesia production.

CBMM/BRAZIL

New on the books is an order from Brazilian company CBMM (Companhia Brasileira de Metalurgia e Mineração) received on July 15, 2014. The company contracted us to supply the core equipment for the production of 123,750 tpy of de-phosphorized Nb₂O₅ slag.

Our customer aims with this project to significantly increase its output of FeNb at the location in Araxá, Brazil.

Commissioning is planned for 2016/2017. SMS is responsible for the engineering and supply of the submerged-arc furnace, the transformer, the gas cleaning plant, the water-cooling unit, as well as the electrics and automation including the compensation plant. The new submerged-arc furnace will produce refined FeNb concentrate, which is the raw material for FeNb. Highly useful in the steel industry, niobium is a micro-alloying element.

Technical data of the furnace:

- Shell diameter: 7,000 mm
- Shell height: 5,600 mm
- Water cooled roof
- Electrode diameter: 550 mm (graphite)
- Active power: 11.5 MW

SMS supplied smelters to CBMM in 1993, 1999, and 2004. The company is a leading producer of FeNb.

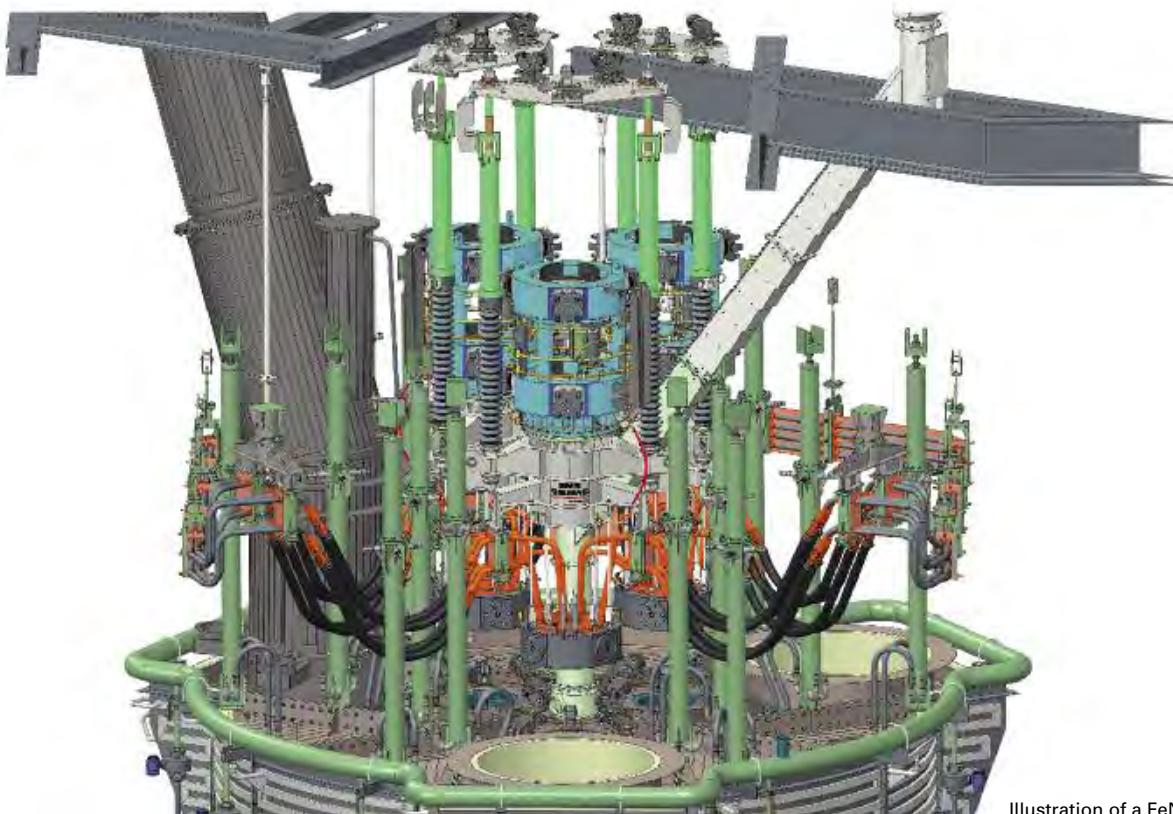


Illustration of a FeNb furnace.

Plant revamps and brownfield solutions for boosting production

Over the past 35 years, SMS has modified more than 80 submerged-arc furnaces. Revamping plants is challenging because of the nature of brownfield design. It requires the lowest possible downtime during revamping as well as adaptation of the existing plant environment.

Our intelligent solutions are designed to achieve higher production levels while retaining the approximate dimensions of both the furnace and the plant. It's also possible to boost production with intelligent logistical improvements and charging patterns.

The following options are available for optimizing our customers' plant efficiency:

- Electrode column modification
- Sidewall cooling systems
- Thyristor control systems (mainly for FeNi applications)
- Charging system/infrastructure optimization
- Furnace enlargement
- Transformer capacity enlargement
- Furnace roof
- Heat recovery
- Productivity increase
- Safety and environmental issues
- Change in product(s)

The potential capacity expansion that can be achieved with a newly-developed copper cooling system was successfully demonstrated by a rectangular submerged-arc furnace in New Caledonia. The application of AC thyristor control systems can boost the production of conventional FeNi furnaces by up to 10%. Furthermore, the system ensures smoother regulation of the electrode columns.

In applications where the furnaces run on high current (> 80 kA), it's possible to save electrical energy by using material that minimizes the electrical losses caused by induced magnetic fields. In some applications, the use of antimagnetic material pays off in less than a year.



Revamp of a FeNi furnace.



Converted silicon furnace.



Converted silicon furnace.

Applications in waste recycling and iron making

STEEL MILL WASTE TREATMENT

Increased landfill costs for steel mill waste residues, stricter environment regulations, and increasing public resistance to waste dumping is driving the iron and steel industry to apply environmentally balanced solutions on site. SMS offers a wide range of systems for the treatment of almost all accumulated steel mill waste without any negative effects on quality or plant productivity, and with minimized overall steel plant emissions.

OVERVIEW OF WASTE SOURCES IN VARIOUS INDUSTRIES

Steel mill wastes

EAF-, LF-dust, sludges (dewatered) from cooling water, mill scale, oily sludges, grinding swarf

Automotive industry

Spent catalysts, diesel engine filters

Battery industry

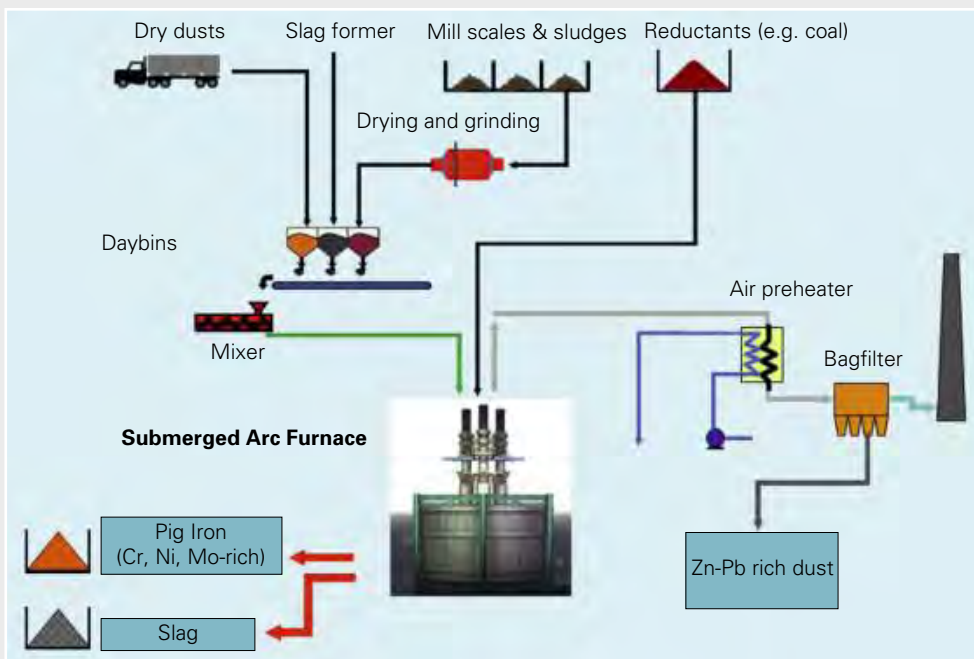
NiCd/ZnMn batteries

FeNi industry

Flue dust

Power plant flue dust

Flue dust recycling to non-leachable slag



Single-level treatment for waste recycling.

It's with the following products that SMS contributes several technologies to the field of waste recycling:

- Single smelters on AC basis
- Single smelters on DC basis
- Rotary hearth furnaces (RHF) – submerged-arc furnaces
- Fines charging with the hollow electrode system

All of the above technologies meet zero-waste steelmaking requirements:

- Treatment of all residues from iron and steelmaking operations
- Avoidance of negative side-effects of waste recycling on steel quality and productivity

- Reduction in overall emissions to the atmosphere
- Increased yields and energy utilization

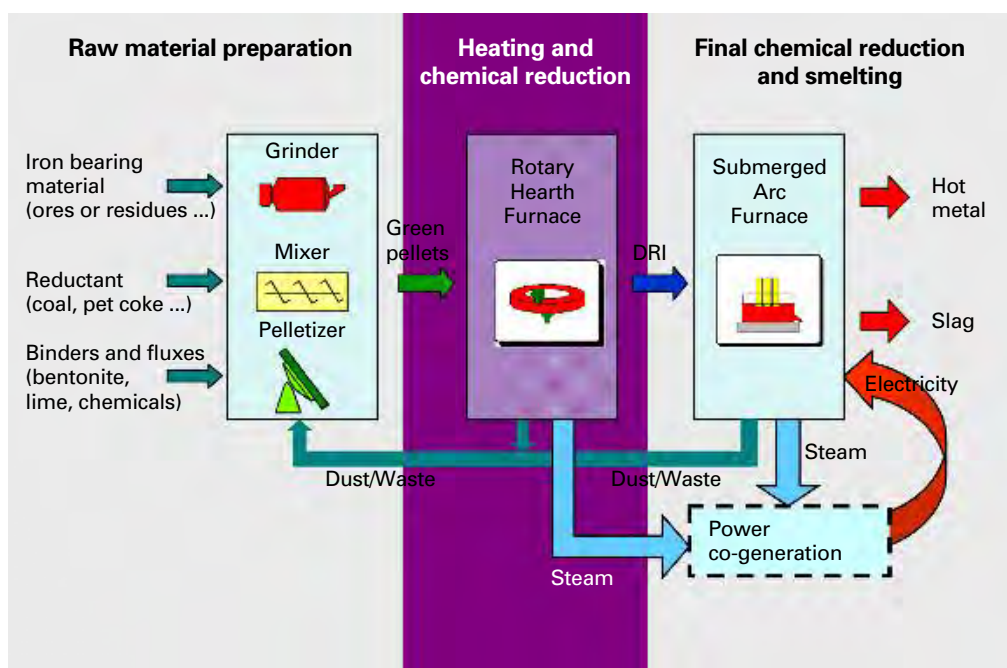
Almost all process lines generate steel mill waste products, starting with iron-making units (including raw material transport and preparation) through to finishing lines such as cold rolling and pickling lines.

What zero-waste steel-making technology does is convert the majority of these reverts into non-hazardous saleable products, and re-introduce them into iron and steelmaking lines.

Other products such as crude zinc oxide or inert slag are ideal for sale to the zinc/lead, cement or road construction industries.

The metal and metal oxide components from the waste material are almost fully transferred into the metal phase. Taking typical steel mill waste from the stainless steel industry, the smelter produces an alloy with up to 6% Ni and 15% Cr.

Equally useful is the inert slag from this process, which is a good base product for the cement and road construction industry.



Flow sheet of the RedSmelt process.

Innovation – General overview

INNOVATION: WE DEVELOP TOMORROW'S FURNACES TODAY

Key to SMS's position as a global leader in electric smelters is the open-minded creative spirit of our team. That enables us to develop new application areas for smelters while also optimizing existing designs. We evolve innovations in cooperation with our customers as well as reputed institutes and universities. This interaction with third parties constantly provides new impulses and new inspiration.

Here are just some of our partners:

- Institute for Process Metallurgy and Metal Recycling (IME) in Aachen/Germany
- Institute of Ferrous Metallurgy in Aachen/Germany
- NTNU - Trondheim Norwegian
- Sintef Institute in Trondheim/Norway
- Mefos in Luleå/Sweden
- Technical University Dortmund/Germany
- University Duisburg-Essen/Germany
- University in Delft/Netherlands
- SGA in Othfresen/Germany
- Universidad de Chile in Santiago/Chile
- Mintek in Johannesburg/South Africa
- FEhS-Duisburg/Germany

Basically, our company differentiates between strategic, fundamental, and operational developments. You can see the major topics in the table below.

Strategic developments

- Intensive DC-based slag cleaning unit
- Large-scale silicon furnaces (40 MW)
- Two-furnace concept for LC FeCr production
- New process lines with pilot smelter at Aachen University/Germany
- New waste recycling concept

Basic research activities

- Basic R&D for new process lines AC vs. DC
- Modeling of various processes

Operational research activities

- Next-generation thyristor control system
- Development of new cooling concepts



Metallurgical tests at the IME in Aachen.

The furnace is very flexible and will allow the development of new metallurgical processes on a semi-pilot scale.

Prof. Bernd Friedrich/RWTH Aachen/Germany

NEW TESTING OPTIONS AT RWTH, AACHEN

SMS has developed an electric smelter pilot furnace and donated it to the IME (Institute for Metallurgical Processes and Metal Recycling) at RWTH University of Applied Sciences in Aachen/Germany.

It's a multi-purpose furnace designed to run metallurgical smelting processes of materials such as ferroalloys, nonferrous metals, and mineral wool, as well as slag

cleaning, steel mill waste recycling, waste recycling of nonferrous and ferroalloy residues, and steel production on a semi-industrial scale. Usually, the data is sufficient for upscaling the new processes.

The heart of the furnace is an intelligent power connection, and the 1 MVA furnace can run in both DC and AC mode. Also included is a conductive hearth.



Test furnace in Aachen.

SLAG WASHING MACHINE

Currently, SMS is working on an innovative, intensive slag cleaning stage that is arranged downstream of conventional slag cleaning furnaces. This development overcomes the previously unsolved problem of finely dispersed smaller precious metal droplets that do not settle into the matte/metal phase of the furnace gravitationally.

As a result, a considerable portion of precious metals always remained in the slag phase. The new invention is a highly attractive solution especially for the copper and PGM industry.

In copper slag cleaning, the copper content of the slag can be further reduced by 0.2 - 0.5 percentage points.

SMS has successfully demonstrated the recovery of copper inclusions.

The principles of the channel-type furnace are simple. The small unit uses a permanent DC field combined with a magnetic field to generate electromagnetic stirring.

In the first zone of the furnace, the slag is electromagnetically stirred, which causes partial coagulation of the smaller metal droplets.



Slag washing machine at Aurubis.

Next in line is the second zone, where the droplets are forced by capillary motion towards the metal/matte phase, and additional electrolytic effects increase the metal recovery rate. This unit/process is patented for all metals.

The new slag cleaning stage was jointly developed by SMS and the University of Chile (UDC) in Santiago/ Chile. Recently the process was demonstrated in a large-scale trial plant at Aurubis in Hamburg/ Germany.

The plant achieved reductions in copper content in the slag of up to < 0.4% (depending on the slag copper content).

There is an excellent economic potential of this "slag washing machine" for certain applications.

The advantages of the unit are obvious:

- High recovery of PGM
- Extremely low investment because of simple principle
- Easy electrode control
- Minimum graphite anode consumption due to coke layer principle
- Bypass option will not affect daily operation and minimizes project risks
- Small compact unit will fit in almost all downstream locations of the primary smelting unit

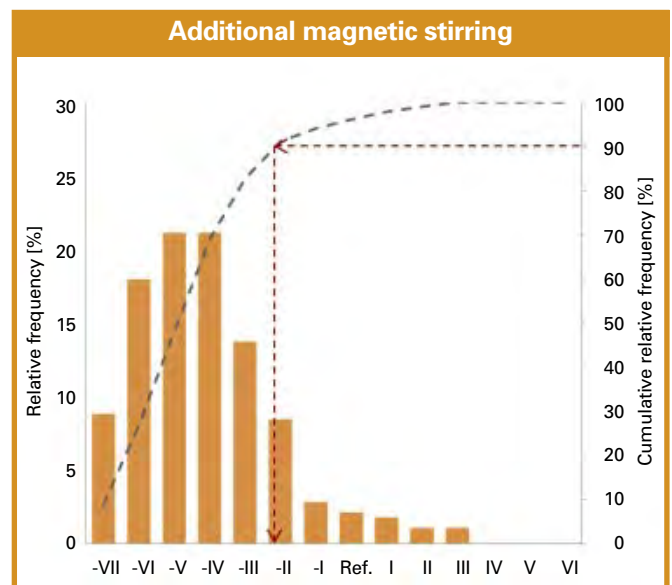
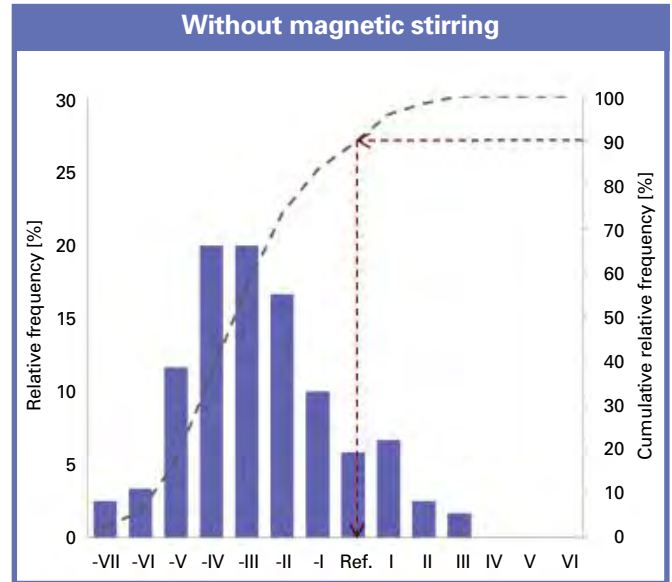
This unit is patented for all kinds of metal, slag, and matte in batch and continuous operation modes.

DEVELOPMENT FOR PRE-REDUCTION OF ORE IN ROTARY HEARTH FURNACE

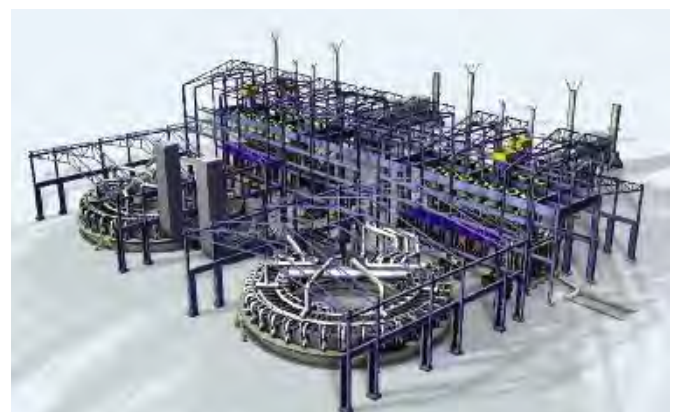
SMS is investigating the potential of using rotary hearth furnaces as a pre-reduction step for the production of FeNi and FeCr. The results of tests conducted in two demonstration plants look promising. Depending on the location, the RHF-SAF process combination could become a competitive alternative to conventional process combinations currently applied on the market.

0.2 - 0.5

additional copper recovery rate compared to conventional technology



Results of the tests at Aurubis.



Rotary hearth furnace – submerged-arc furnace combination.



SERVICE COMPETENCIES OF THE SMS GROUP



Effective and economical maintenance for high reliability, safety and quality

Drawing on 140 years of experience, SMS delivers tailor-made maintenance service solutions. As an original equipment manufacturer, we ensure longer service lives, reduced maintenance costs, and improved performance throughout plant lifetime with best-practice maintenance.





SMS service teams free you up to concentrate on what you do best, while we take care of all your on-site maintenance.



There is a major focus at SMS on preventive maintenance as the key factor for high plant availability. A valuable tool here is our Integrated Maintenance Management System IMMS®. Decades of SMS experience have gone into this CMMS software. Applying data from elaborate analyses and existing documents, the system offers plant-specific, customized packages of component-related strategies for technically and commercially effective maintenance.

SMS has developed a large range of services for maximum plant efficiency from a single source. Customers benefit from a 24/7 teleservice, effective and tailor-made inspection concepts, and efficient repair shutdowns on site. Always close to customer locations, our service centers provide professional repairs of core components and a quick supply of spare parts. These range from cables and transformers to pre-assembled units in original quality. Particularly important for the kinematic equipment of the SAF, such as the electrode slipping device, is expert manufacture and assembly know-how. Perfect functioning of the electrode has a significant influence on plant capacity. Other crucial factors are adjustment of the bottom length, correct compensation of the oxidizing loss, and precise regulation of the amperage, because they ensure a vibration-free system and avoid the risk of a flash-over. As a plant manufacturer with

longstanding experience in kinematic operating sequences and patented design, SMS supplies reliable, top-quality systems with guaranteed long service lives. Additional support such as modern warehousing concepts or end-of-life alerts for electric and automation parts completes the spare parts services of SMS.

Whenever plant owners want help with optimization, SMS is a reliable partner. Our teams of skilled experts from R&D, design, automation, maintenance, and manufacturing apply their long-term experience to improve both technology and processes. They support customers with analyses, feasibility studies, audits, or practice workshops for sintering plants, steelmaking, and metallurgy, as well as providing customized training courses. To ensure you meet market demands and remain competitive, SMS devises tailor-made modernization plans. Experienced in performing modifications for higher production rates, extended product mixes, and lower lifecycle costs, we integrate new technologies in existing plants. Our packages include supervision and control of all stages of the implementation and replacement work.

High-performance components – known as SMS value-added parts – increase plant performance by effecting simple and small changes. They replace worn components with innovative key parts to

achieve top results. Committed to fully maintaining plants and machines, SMS's long-term services cover the whole scope. Our online maintenance and various workshop activities offer an attractive, competent maintenance alternative with calculated availability of the plants. So plant owners can focus entirely on core competencies and forget about maintenance.

At TNK Kazchrome, SMS took over operational maintenance and repair of the four direct-current furnaces, all ancillary equipment, and subcontractor packages with a 240-strong team. The SAFs in Aktobe are designed for years of continuous operation. Included in the maintenance services are the entire mechanical and hydraulic equipment as well as the fluid systems and the electrical equipment plus automation systems. The worldwide SMS service network also covers professional repairs, high-quality spare parts, and new technologies. When it comes to implementation, both partners focus on effective, economic processes. Planning and continuous optimization of these processes are facilitated by the previously integrated IMMS®. Furthermore, Kazchrome's plant operators use the 24/7 teleservice as a direct line to the plant manufacturer's engineers. They also benefit from a spare parts warehousing system integrated in the IMMS®.

Service and spare parts

To keep plants at this high level of operation, sophisticated and efficient spare parts and components management as well as servicing are indispensable.

That's where our team of specialists comes in – ready to offer customer support in all spare parts-related issues. Equally important is our commitment to improving the performance of existing plant units. Total quality management always forms an essential part of our services.

When designing components, SMS also considers its customers' experience. Wear parts are repaired and manufactured in our workshops worldwide, or sourced from our qualified suppliers. Our specialists also assist locally when repair work is required.

Closeness to customers requires permanent availability, which is guaranteed through our office in Düsseldorf / Germany and our international locations. We are always at your service for any request you may have or any assistance you may require.

It goes without saying that we offer modern spare parts planning to all our customers to ensure smooth, safe, and long-term operation with maximum plant availability and efficiency. Our team will assist you with any request about effective spare parts management.



Service in teamwork.

CONCRETE LONG-TERM BENEFITS:

- High-quality spare parts
- Complete spare parts planning
- Maintenance planning
- Quality assurance for the products
- Special "older" parts available
- All features available
- Worldwide presence
- Round-the-clock assistance via internet
- Teamwork
- Extensive experience

Hydraulic equipment:

- Various valves and fittings
- Various cylinders
- Various pumps
- Various motors
- Various hoses
- Various switches
- HFC fluids
- Filter elements
- Various seals

Electrical equipment:

- HV circuit breakers
- Capacitor units
- Spare transformers
- Transformer OLTC-contacts
- Transformer oil circulation pumps
- Transducers (power, voltage, current)
- Transducers (electrode position)
- Transducers (slipping length counter)
- Thermocouples and transducers

Charging system:

- Mouth pieces
- Insulating parts
- Slide gates
- Plunger valves

Miscellaneous:

- Crane systems
- Ancillary equipment

Cooling water:

- Various valves and fittings
- Various pipes
- Various hoses
- Various couplings
- Various pumps

Utilities:

- Valves and fittings for nitrogen/oxygen systems
- Compressed air systems
- Hoses
- Couplings

Tapping:

- Tapping machine spares
- Tapping blocks
- Copper tap holes

High-current lines

- Wall bushing
- High-current lines
- High-current flexibles
- High-current rods and cables



Turnkey competencies



Kazchrome plant during construction.



SAF plant during construction.

TURNKEY SOLUTIONS MADE BY THE SMS GROUP

The SMS turnkey department is noted for its high expertise in planning and supplying complete plants of any size for ferroalloys, nonferrous metals, and other products all over the world.

As leading partners in consortiums or as plant planning specialists, we offer comprehensive know-how and a wide spectrum of services.

SMS technical service ranges from the planning and project phase to the handover of the turnkey plant. We also provide engineering for individual plant sections that are subsequently combined with other units to build an optimally designed complete plant.

Our commercial services include international financing as well as organizational services. We coordinate all activities in each phase of project planning and order handling to ensure dependable performance of every contract.

SMS has implemented many projects based on the following business concepts as an EPC/EPCM contractor:

- Business concept 1: Core equipment delivery (e.g. Barro Alto/Brazil)
- Business concept 2: Turnkey equipment delivery (e.g. BASCO/Kazakhstan)
- Business concept 3: Business concept 2 + local engineering by SMS, procurement and construction by customer with SMS's assistance (e.g. Vale/Brazil, Kazchrome/Kazakhstan)
- Business concept 4: Business concept 3 + local civil engineering and construction engineering by SMS (e.g. PCC/Iceland)

Interview with Heinz-Josef Dresenkamp

Question: Why is the smelter business also interesting for turnkey solutions?

Dresenkamp: Basically, the size of the plants is not as complex and the overall investment is lower than for large steel plants. This makes the development and - if required - the project financing more feasible.



Heinz-Josef Dresenkamp, Executive Vice President Turnkey Division.

Question: What is the key factor for turnkey success for such a plant?

Dresenkamp: In particular for smelter plants, internal know-how about the process equipment in combination with the turnkey solution is essential for developing a working plant at realistic cost.

Question: What do you mean by realistic cost?

Dresenkamp: The less familiar a company is with the equipment and process, the more contingencies they tend to include in the project costs. We know our processes better than others, so we can offer turnkey solutions at lower prices.

Question: What else is important?

Dresenkamp: The choice of the right local partner is also crucial. We are in the fortunate position that we have worked with many local companies.



There is no better indication of the SMS Johannesburg office's competence in EPC services than the impressive track record of Metix in installing plants with full budget and time responsibility. Metix has an excellent reputation, particularly in FeCr sinter plants (based on Outotec design and technology) and electric smelters.

These are the most recent references:

- Rainbow Minerals
- Heric F4PS2
- TATA Steel Richardsbay
- Bokamoso Sinter Plant
- MFC PSP3
- ASA Sinter Plant
- Mogale Furnace Rebuild
- Tswelopele Sinter Plant

The services provided by SMS in Johannesburg include:

- Engineering, Procurement and Construction (EPC) - (LSTK)
- Engineering, Procurement and Supply (EPS)
- Engineering, Procurement and Construction Management (EPCM)



Sinter plant during construction.



FeMn plant during construction.

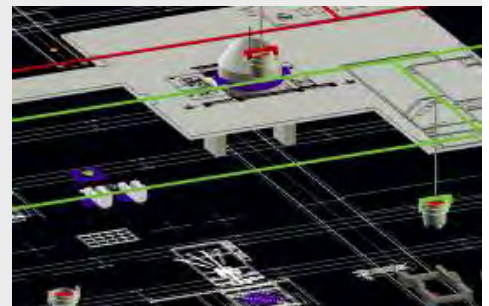


Sinter plant during construction.

Evaluation services from SMS - studies

Besides supplying engineering, equipment, and plant, we provide the following services and engineering:

- De-bottlenecking studies, plant logistics, process modeling
- Environmental studies
- Development of measures for minimization of operating costs
- Planning and supply of the complete plant
- Technical feasibility studies for new process lines
- Maintenance planning
- Product optimization programs
- Furnace dimensioning
- Commissioning planning
- Product change/enlargement of product portfolio
- Consulting assignments
- Financial and comparative studies



Project financing

The SMS group supports customers with tailor-made financing concepts.

Over recent decades, SMS has gained an excellent reputation among international banks and ECAs as a reliable and highly skilled business partner. We have also become one of the leading exporters under the Export Credit Agency Scheme of various countries (Federal Republic of Germany [EULER HERMES], Switzerland [SERV], Italy [SACE], Luxembourg [ODL], Belgium [OND], etc.).

Our experienced team of financial consultants is able to structure attractive multi-sourcing financing schemes based on export credit agency cover, long-term financing periods, and attractive interest rate levels based on fixed or floating interest rates. Usually, financing is available in EUR. Other currencies such as USD can be discussed on request.

Our support starts with the first negotiation rounds and ends with the project finalization.

It includes consulting, structuring, arranging, and coordination for dealing with potential lending banks and ECAs, applications to ECAs, assistance with handling and reviewing loan agreements, and discussion of financial models.

It's vital for this kind of project financing that you can rely on a well-trained team of export and trade specialists as well as an effective network of contacts with banks and ECAs.

Please feel free to contact us anytime for further information: jens.haupt@sms-group.com



Interview with Jens Oliver Haupt (Vice President of the Financial Services Division)

Question: Mr. Haupt, how important is financing for the clients of the SMS group?

Haupt: We are one of the top exporters under the Euler Hermes instrument. Over recent years, we have financed projects in the field of metallurgical plant to a total magnitude of > 1 billion euros. In many cases, our support contributed substantially to the project realization. This service, combined with our good reputation in the banking sector, is highly appreciated.

Question: What potentials do you see for project financing in the electric smelter field?

Haupt: Electric smelter-based plants usually have the perfect size for financing. A typical two-furnace solution requires overall investment of between EUR 100 - 300 million (depending on size and product).

Question: What about the market aspect?

Haupt: Especially for the profitability of a project, the market is very important. Electric smelters (usually supplied in projects) are partially independent of the mainstream products. The margins achievable here facilitate financing.

Question: Any examples?

Haupt: We arranged the complete financing for two silicon projects in the US and in Iceland. The market outlook is generally positive and SMS contributed greatly to arranging the ECA financing together with the clients.

SMS seminars and training options

TECademy.

SMS draws on many years of experience as well as extensive knowledge about the components used throughout the entire process chain. That gives us the expertise necessary for compiling customized training courses – whatever your field.

LET KNOWLEDGE GROW YOUR COMPANY

TECademy is the international customer training academy of SMS. It offers you hands-on workshops designed for steel producers or rolling mill operators who want to draw on our specialist expertise.

Our seminars systematically merge basic knowledge and in-depth competence. As a participant, you learn a broad range of applied know-how and thorough understanding of the plants and processes in the metallurgical and rolling mill industry. All this points to solid foundations for the learning processes which are firmly rooted in our many years of experience as a leading plant constructor.

FLEXIBLE PLANNING AND OPTIMAL ADAPTATION

We respond to your needs flexibly, identifying the potentials of your plant so you can use it optimally. This is how our experienced experts ensure optimal learning success and maximal applicability by conveying practical know-how integrated in the learning units.

Workshop in Brazil.



TRAINING METHODS

- Classroom lessons
- E-learning
- Virtual reality
- Webinars (live video conferences)

On request, we conduct the training sessions on-site at your facility, working directly on your plant.

OUR STRENGTHS FOR YOUR SUCCESS

- Proven SMS Siemag quality
- In-depth know-how
- Hands-on teaching methods and practically applicable content
- Flexible options including customized seminars, e-learning and webinars

Quality assurance and safety

TOP QUALITY – QUALITY ASSURANCE AND SAFETY ASPECTS

Excellent plant performance can only be achieved with top-quality equipment. That's why SMS demands very high standards of its subcontractors.

Especially components such as electrode columns, electrode glands, and all water-cooled parts in direct contact with the harsh furnace environment must be treated with special care.

Quality assurance is performed by our team in Germany and, if locally available, also by representatives on the spot. SMS is certified according to ISO 9001 and ISO 9002.

Whatever the plant, high safety standards are included in our engineering and operating manuals (in accordance with strict European standards). We address safety aspects as early as possible – during the sales phase of a project – and they are always integrated in the design phase.



Welding grillage beams.



6-inline furnace inspection.

Project execution department, order handling, procurement

THE SMS PROJECT EXECUTION DEPARTMENT

It's essential for success that your project is managed in a professional way. SMS project management guarantees that the execution is in line with quality, time, and contractual requirements.

One of our key factors for smooth and prompt project execution is a highly qualified project team, supervised by competent technical and commercial project managers, as well as a time schedule project manager, each with a long record of experience. This team is responsible for the project from the day of contract signature until handing over to the customer. That ensures continuity throughout the project execution.

Extra support comes from special management tools, quality gates and guidelines, and monitoring by several automated reporting systems.

We maintain the high level of SMS project execution through further training and expansion of our personnel.

Some members of the electric and automation execution team.



COMMISSIONING

Our professional support during the commissioning phase helps operators progressively ramp up their plant. With classroom training, training on the job, work situation evaluations and, when required, external experts for the specific product, SMS aims not only to get a plant up and running, but also to make sure the operators understand how it works.



Execution team at Kazchrome.

Competitiveness – total cost of ownership

Satisfied customers confirm the reliability and high performance of our plants. Our team assists customers with all their requirements concerning the plant with intensive, on-site support throughout the planning, engineering, erection, and commissioning phases. We take pride in the plants we erect, which guarantees lasting added value for our customers.

Adhering to deadlines goes without saying, yet SMS Siemag aims to do even better by achieving a steep start-up curve even before the appointed date. The nature and scope of our customers' investments are crucial for the success of their projects. Quick start-up of production and reliable, flexible work sequences at low operating costs ensure their investments pay off within a very short time.

LOW OPERATING COSTS DUE TO:

- Very high overall plant availability
- Robust and solid equipment suitable for the harsh furnace environment
- Energy-efficient process
- Long furnace lifetime
- Quick ramp-up
- Low maintenance requirement (especially for electrode columns)
- Low manpower due to high level of automation
- Maximum furnace size for the chosen location

LOW INVESTMENT DUE TO:

- The overall price level for the investment is moderate due to international sourcing
- Maximized local share of supply (if desired by customer)
- Compact furnace design lowers the costs for civil engineering and construction
- Attractive financing options



Construction of a smelter.



Nippeling area of a silicon furnace.



FeNi furnace inside view.

Information material available

(order from
saf@sms-siemag.com)

SAF BROCHURES

- SAF Brochure Passion for Metals
- Spare parts brochure
- SAF HD monitoring
- SAF Reporting system
- SMS Eco plants
- SMS turnkey competencies
- SMS waste management systems
- TMT tapping technology
- PW competencies in refractory
- Reference list of electric smelters 2015



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- Fröhling, C., Degel, R.: Ecological aspects of ferro-alloys and silicon metal plants – economical solutions, Infacon 2015 in Kiev/Ukraine

SAF and electric smelters at a glance

The SMS group is your best partner for efficient and reliable electric submerged-arc furnace and electric smelter technology to ensure the success of your projects. We offer the full range, starting with small components and spares right up to the supply of turnkey full-liner solutions.

PARTNERSHIP

- Our teams in Germany and Johannesburg work hand-in-hand with customers
- The excellent company setup provides services from our offices all over the world
- Our goal is a sustainable, lasting professional business partnership based on trust

TIME SCHEDULE

- Professional execution teams ensure adherence to the agreed time schedule and provide secure financial planning

SUMMARY

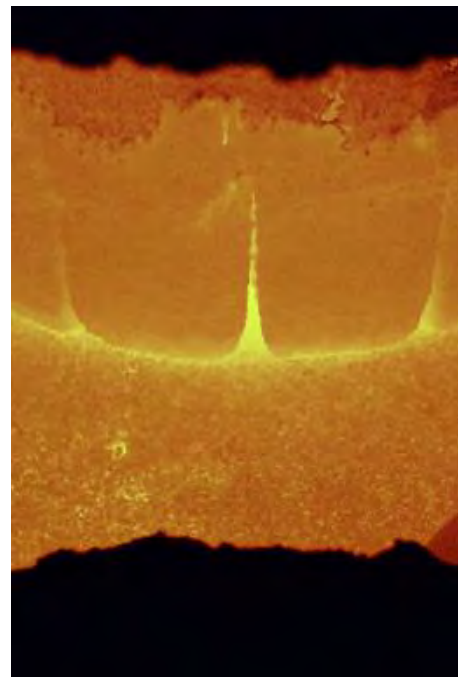
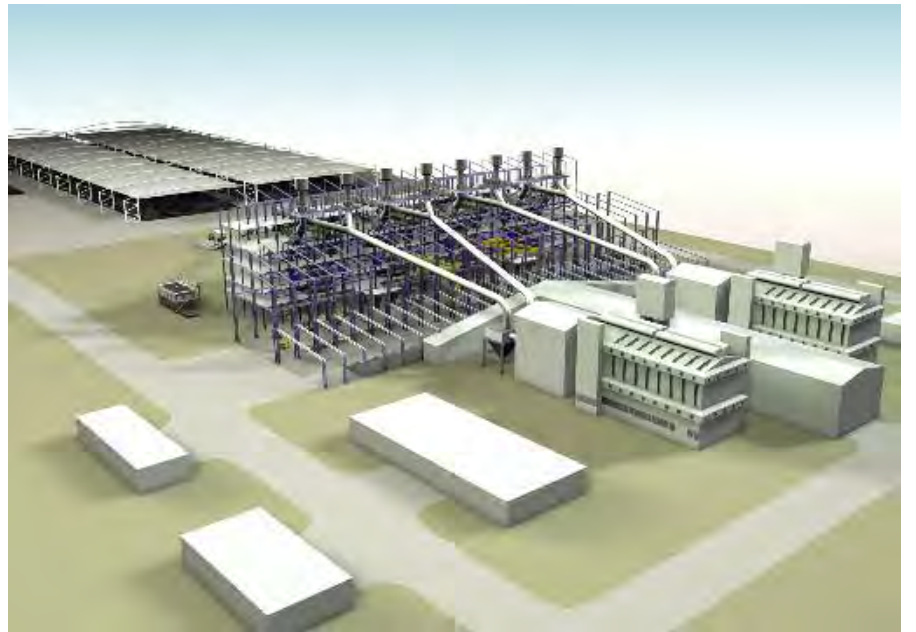
- Complete range of products and services
- Superb track record
- Trailblazing innovations
- Clear focus on service
- In-house manufacturing of core components
- Automation of all plant systems
- Financing models

TECHNOLOGICAL EXCELLENCE

- We offer best available technology solutions based on experience and references
- Economically viable and safe furnaces
- Operation with low maintenance
- Very reliable high quality design based on existing plants
- Superb safety record



Members of the SAF Team.



We transform ... the world of metals.



SMS group: Full liner in superior Submerged Arc Furnaces and Electric Smelters Technology

SMS group

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