For more than 100 years it has been our business and tradition to work out solutions in the submerged-arc furnace area which assure the success of our customers in the ferro alloy and non ferrous metal industries.

The plants are characterized by state-of-the-art design and high-end manufacture. References all over the world demonstrate the economic success in stable and safe operation.

**SMS DEMAG AG**

Our company is a world-class manufacturer of metallurgical plant and rolling mill equipment. First-rate, high-performance products along with a customer-focused approach featuring extensive services form the basis of our company’s good reputation. Equally convincing are our concepts and plants because they provide state-of-the-art technology and cost effectiveness as well as quality and reliability.

**IRONMAKING DIVISION**

The submerged-arc furnace technology and related equipment is represented by the ironmaking division which covers the full range of products for ferroalloys, non-ferrous, special applications and pig iron.

Inline with well known SMS Demag customers-oriented approach, the division supplies turnkey solutions, from single units up to complete plants including their control and optimization systems as well as any necessary engineering service and on-site assistance.
OUR MISSION

To design and build complete state-of-the-art submerged arc furnaces, complete plants or components that will produce a product of the highest quality and consistency, delivered on a reliable basis. The plant is designed and built in such a manner that quick ramp-up and safe, long-lasting operation is assured.

The plant is designed operating in an environmentally responsible manner and produces maximum value for the customer and shareholders. We achieve the best project goals in teamwork, hand-in-hand with the client. After the completion of each job we remain in close contact with the customer.

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EXPERIENCE and INNOVATION

The ironmaking division is the pioneer in terms of innovative submerged-arc furnace technology. Almost 500 references have been installed worldwide. The first few furnaces were commissioned in 1906. By 1913, the first SAF with 6 electrodes was operating successfully. In 1950, the first furnaces exceeded the 40000 kVA power rating benchmark. During the last decade around 100 different products have been processed with SAF technology for the ferro alloy, non ferrous metals, pig iron and special application industries. Each individual process requires extensive and detailed process knowledge. The metallurgical department of our division is the foundation for the correct design and operation of each furnace. The metallurgy determines the complete process line.

TEAMWORK/ COLLABORATION

It is our philosophy to keep good contacts with the customer after contractual obligations are fulfilled. Furthermore, we discuss new technological challenges and common day-by-day tasks with numerous companies, universities and research and development institutes. Optimizing technological solutions with the customer is our strength.

DATA ACQUISITION

Data constantly acquired in newly installed plants are analyzed to optimize the process in existing facilities and to develop future concepts.
DATA EVALUATION

We offer on-line assistance in running plants worldwide, which provides us with the necessary information sources for optimizing processes. Joint work with many customers all over the world has been established.

DATA ARCHIVE

An important supporting tool is the data collection within our organization. Data from the last few decades of almost all operating plants are stored and provide helpful process parameters on a case-to-case basis.

SOFTWARE

Metallurgical evaluations are supported by inhouse developed software which is also partially implemented in the automation systems.

Major customers benefits:

- extensive data base available
- extensive experience of industrially operating plants for various applications
- innovative process development based on past experience
ECONOMIC SUCCESS
with SAF technology

YOUR SUCCESS is OUR SUCCESS

We can only succeed in the long term, if our clients are successful with our products.

Especially in the submerged-arc furnace area we can proudly look back on numerous success stories, where SMS Demag equipment assured a long-lasting value for customers and shareholders.

Many customers all over the world confirm the good performance of our reliable equipment and our on-site representation/support during the planning, engineering, installation, and commissioning period.

PROGRESSIVE START-UP CURVE

A progressive start-up curve on time or even before the scheduled dead line is our goal for each project.

FEASIBILITY STUDIES

We offer complete feasibility studies which in many cases form the basis for project financing.

FINANCING OPTIONS

Reliable equipment and good plant engineering is a key factor in financing a project. We as a strong project partner would appreciate to support your project in this matter.

Success story 1
SEAS Plant: Turnkey job, completion 12 months after order effective date

Success story 2
Enami: Turnkey job, completion after 14 months, design capacity was reached after 2 weeks
R.O.I. OF CERTAIN PROJECTS

In each project your investment contributes to the project success. Quick start-ups, reliable flexible operation at low operating costs ensures that your investment will be returned to you within the shortest possible time. R.O.I.’s of less than 2 years have been established in several projects.

FLEXIBLE FINANCIAL ENGINEERING by SMS Demag

If required by the customer, SMS Demag can also offer flexible financing models.

Major customers benefits:

- quick R.O.I.
- safe operation at low maintenance
- strong technology supports financing structure
- assured long-lasting operation
- progressive start-up curve
- extensive reference list of satisfied customers

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GENERAL ASPECTS

During the last decades a large variety of submerged-arc furnace designs has been developed to suit the individual requirements of the customer. The following briefly describes options which are available within our division and can be chosen to fit perfectly to each specific process.

DESIGN TOOLS

Our division is equipped with advanced engineering tools such as AutoCAD 2000, ProEngineer, Fluent, Ansys.

The furnaces can be supplied with several features which take into account specific process requirements. In the following, you will find a brief description of specific design features.

SAF GENERAL DESIGN FEATURES

- Open design
- Semi closed design
- Closed design
- Special design

Major customers benefits:

- all features available for the design of an optimized furnace which meets all process requirements

Furnace charging
- manual/automatic
- hot/cold charging
- batch/continuous feeding
- fines charging through HES (hollow electrode system)

Furnace gas hood
- round
- open/closable design
- high/low-temperature design
- chain/plate curtain
- raising/sliding doors
- air/fume injection systems
- water cooled steel structure
- inert atmosphere option

Fe-alloy.

Suspended electrode column (closed furnace).
Furnace shell
- round/rectangular design
- flat/curved bottom
- cylindrical/conical shape
- stationary/rotating shell
- open/covered bath operation
- changeable/tiltable
- sidewall, bottom cooling
- water/air cooling

Furnace shell cover-closed roof
- round/rectangular shape
- cylindrical/conical shape
- water cooled steel structure
- suspended brick roof/cast roof
- flat/arched shape

Si/FeSi furnace.

Electrode columns
- selfbaking electrodes
- graphite/prebaked electrodes
- extrusion electrodes/compound electrodes
- hollow electrode system
- suspended/supported design
- below above roof maintenance
- clamp position below/above the roof
- intensive water cooling
- cooling shields & protection ring
- various seal features

Supported electrode column (closed furnace).

High current supply system
- copper tubes/bars
- parallel/triangle arrangement
- water/air cooled flexibles
- flexibles inside/outside of the hood
- interleaved/parallel arrangement
- forged contact clamps

Slag cleaning furnace.
ELECTRODE COLUMN

SMS Demag’s electrode column has been known for decades for its reliable and good performance in all submerged-arc furnace applications.

A new generation of SMS Demag’s electrode column ensures safe, maintenance-friendly operation at minimized energy consumption.

MAIN FEATURES of the system are:

- fail-safe hydraulically actuated electrode holding and slipping device
- durable contact-clamps for even electrode baking provide highest possible energy transfer to the electrode
- reliable electrical insulation up to 1500 volt
- electrode welding/nippling under operating voltage
- electrode slipping under full load-current
- efficient column sealing prevents exhaust of furnace gases
- little maintenance, easy to handle
- compact units, minimized space requirements for the system
- central hydraulic pressure supply
- wear resistance assures long life even under higher stresses and challenging environment

ELECTRODES

In general we supply all available electrodes suitable for each individual application. The choice of the right electrodes is a function of economic, metallurgical aspects and the process sequence.

PRE-BAKED electrode systems

Pre-baked electrodes are available in several grades and sizes and can be used for all applications.

SELF-BAKING electrode systems

Self-baking electrodes lower operating costs and are usually utilized in furnaces with higher capacities in the ferro alloy, pig iron, non-ferrous and CaC₂ production.

HOLLOW electrode systems

Hollow electrode systems are used to charge fines into the furnace, to lower production costs and to increase the recycling rate and therefore process efficiency. 17 systems have been installed in various plants.

STRUCTURAL FURNACE PARTS with minimized electrical losses

The design of our structural furnace parts minimizes electrical losses caused by alternating magnetic fields. Components are checked by FEM calculations. In some cases, 3-5% power could be saved with the new design features.
SAF DESIGN HIGHLIGHTS

COOLING CONCEPTS

All cooling concepts ensure a stable, safe and long furnace campaign. Ideal balance between safe operation, long furnace life at minimized heat losses of the cooling system.

OPTIMIZED COOLING CONCEPTS

Roof:
- Spray cooling
- Panel roof cooling

Wall:
- Rinse cooling
- Spray cooling
- Chamber cooling
- Channel cooling
- Cu-Stripe cooling
- Tailor made cooling elements (fingers) for locally stressed areas
- Water cooled tapholes

Bottom:
- Air cooling
- Spray cooling
- Channel cooling

REFRACTORY CONCEPTS

The lining of each SAF is carefully selected. During the last decades, the refractory material and lining concepts have been steadily improved. An optimized balance between cooling principle and lining concept provides a long, safe and efficient operation. Some furnaces showed impressive campaigns of approx. 15-20 years with one lining. Heat transfer calculations (including control systems) are standard products in our division.

RELIABLE FAILSAFE HYDRAULIC SYSTEMS

Failsafe hydraulic systems provide smooth and reliable furnace operation and allow quick movements even of heavy electrode columns. All hydraulically operated components, i.e. electrode columns, furnace doors, charging chute gates, stack closures, etc. are supplied by one central hydraulic pressure-generating unit. During the last decades the system has been optimized and today is failsafe and maintenance friendly.

TAPHOLE DESIGN

The tapholes can be offered in conventional design. For applications with higher stress requirements, water-cooled elements are available for metal, matte and slag tapping.

Major customers benefits:
- best available design for SAF
- high quality manufacture
- components based on experience and company know-how
- on-going innovation for most segments
Stripe cooling concept (vertical option).

Furnace roof suspended brick design of round type furnace.

Furnace roof suspended brick of rectangular furnace.

Hydraulic unit.

Water cooled tapholes.
The submerged arc furnace today is the most widely used technology in non-ferrous application. Plants are often located at the mines in countries where mains conditions are poorly developed. The electrical concepts of SMS Demag always allow the application of submerged-arc furnace technology even with strong grid restrictions.

Our company has experiences in AC and DC applications. The technology is chosen according to the process requirements.

**AC TECHNOLOGY**

Metallurgical reactions in the submerged-arc furnace take place at high temperatures. The required electrical energy is taken from the supply mains and fed into the reaction zone via a variable-ratio transformer, the high-current lines and the electrodes.

The transformer, high current lines and electrodes form an electrical circuit together with the reaction zone. Various arrangements and types of connections for the transformer are available, depending on the furnace capacity and requirements.

Our program offers AC or DC solutions, depending on the local conditions and the chosen process. In-house engineering and intensive discussions with the client determine which technology is most suitable.

**ELECTRICAL ASPECTS**

AC-option 1
Three-phase variable-ratio transformer with low-inductance high-current line routing and delta connection at the electrodes for round type furnace shell.

AC-option 2
Three single-phase variable-ratio transformers arranged symmetrically around the furnace, with delta connection at the electrodes for round type furnace shell.

AC-option 3
Three single-phase transformers with fixed ratio; one preceding three-phase variable-ratio transformer and delta connection at the electrodes for round type furnace shell.

AC-option 4
Three single-phase variable-ratio transformers for 6-electrode furnaces, with in-line electrodes for rectangular type shell furnace.

AC-option 5
Three single-phase variable-ratio transformer for 6-electrode furnaces, electrode arranged in 2 parallel lines for rectangular shaped furnace shell.

**Major customers benefits:**
- reliable failsafe operation
- plant installation also possible when mains conditions are poor
- long lasting solution
- extensive AC and DC experience
**DC TECHNOLOGY**

Our company developed the DC technology in the seventies especially for electric steel plants, which were placed in locations with poorer electric grid conditions. The DC technology, in combination with new control systems, can reduce flicker up to 70% in comparison with conventional AC technology.

DC furnaces are usually also characterized by a lower electrode consumption. Furthermore, this technology can be designed in such a way that stronger stirring and better fuming rates in the furnace can be achieved.

With respect to DC furnace technology, SMS Demag early in 1993 commissioned the first DC electric arc furnace with billet anodes in Belgium. This furnace was at that time the world most powerful DC EAF with 95 MVA and 85 t tapping weight. Late in 1994 the second DC EAF of this configuration with 155 t tapping weight and a 140 MVA transformer rating was successfully commissioned in Luxembourg. Meanwhile, numerous DC EAF’s have been built or are under construction.

A SMS Demag DC submerged-arc furnace for smelting titanium slag has been delivered to Kumba in South Africa in 2002. The right anode needs to be determined from case to case, depending on the process requirements.

All systems ensure:
- Optimal furnace operation
- Minimized electrical losses
- Maximizing of lifetime of bottom anode and furnace bottom

SMS Demag offer two different bottom anode systems:
- Billet type anode
- Pin type anode
Automation is the key item in SMS Demag’s Submerged-Arc Furnace Technology and includes:
- Control system
- Instrumentation
- Advanced process control.

The main concepts of SMS Demag’s solution for the control system are:
Modularity, consisting of independent control units allocated to different plant sections connected with each other to form an integrated system. Modularity allows the expansion of the system in different time steps.

Easy management: the operator is provided with the essential information about the plant and the process condition by dynamic video displays, enabling him to intervene at any time with simple control commands. Particular design efforts are dedicated to the engineering of the control room from an ergonomic point of view.

Reliability and maintainability: high availability of fully automatic mode is obtainable by using integral back-up configuration. Hw and sw diagnostic programs allow any failure to be easily identified.

Besides the normal instrumentation, SMS Demag developed measuring systems for:
- Metal and slag level in the furnace
- Metal temperature continuously measured in the runner
- Charge level
- Gas analysis systems

Its automation architecture is based on fully integrated configuration and state-of-the-art information technology. Original well-proven mathematical models are the key components of the automation proposal:
The process automation and instrumentation is one of the highlights in our program. The systems were constantly upgraded. Several highly developed systems also from the blast furnace application have been adopted and optimized accordingly to ensure a stable and safe operation with 100% control over the process at all times.

- Off-line kinetic mode
- Burden optimization and calculation model
- Charging model
- Final mass and energy balances
- SAF parameter calculation
- Lining temperature monitoring
- Hearth erosion monitoring
- Data reconciliation
- Operating guidance (expert system)

**Major customers benefits:**
- Automation and monitoring ensure safe operation at low energy consumption and equipment wear
SMS Demag’s technological know-how and in-house capabilities ensure a complete coverage of the entire submerged arc furnace plant including the down- and upstream units. Especially for closed furnaces, the off-gas treatment is one of the key components because the furnace pressure is a critical parameter and needs to be controlled in a narrow range. Throughout the years reliable, accurate systems have been developed which allow this tight furnace control at highly efficient cleaning rates.

SMS Demag also provide complete solutions for water treatment. Basically two principles of off-gas cleaning systems are provided:

**Wet System:**
Desintegrator (collaboration with Theisen)

**Dry System:**
Bag filter suction/pressure/reversed air type
Filter dust compacting for Si-metal and FeNi-furnaces optional (collaboration with Filtermedia)

**Electrofilter:**
Electro-static precipitators

- Since 1972 more than 60 dry cleaning filter systems have been installed
- Equivalent to approx. 1300 MVA total SAF power rating
- Since 1972 more than 30 wet cleaning systems have been installed

**Major customers benefits:**
- clean operation in an environmentally responsible manner
OUR SERVICE

Planning:
Sound planning is the key to extensive investigation into feasibility and reliability of the technical and economic concepts. Planning includes tailor-made design for each specific customer. We work out hand-in-hand with our clients and project partners the best specific concept, e.g. best location, most ergonomic and economical arrangement, high-quality machinery and equipment, optimized operation, a saleable product at market value. Local rules and regulations, cultural habits or ethic restrictions are always considered in the planning phase.

Engineering:
Our engineers and technicians have always been pioneers and explorers in submerged-arc furnace projects. Experienced staff with a remarkable know-how of process, metallurgy, engineering, design, construction, commercial and economic issues are available to serve the project.

Procurement:
More than 95% of our orders come from customers outside of Germany. Thanks to this experience, we can execute complex projects in keeping with nearly all local conditions. Cooperation with worldwide partners and the involvement of local companies are our approach for a successful project. We find the technically most viable solution at minimized costs. Local representatives are available for direct contact and project support in many countries on the globe.

The execution of the orders is supported by advanced IT systems for office communication and highly sophisticated PC application for project management, scheduling, engineering, manufacturing, transportation, installation and start up, training programs, operating & maintenance instructions and internal project archiving.

- We offer services for "smaller jobs" as well as for complex turn key projects
- Covering all necessary engineering activities for modernization and new plant
- Coordination, consulting, supervision and systems engineering
- Application of international standards and regulations

Commissioning:
SMS Demag’s qualified commissioning engineers, process experts and metallurgists accompany the project during the cold and hot commissioning period.

Training:
Client’s operating personnel will be trained in our head office, at similar units abroad and on site location. SMS Demag’s commissioning team is also available to instruct client’s operating personnel during the commissioning stage.
The following **SERVICES** are supplied by SMS Demag:

- De-bottlenecking study, process modeling studies (including material handling, furnace process, electrical/mechanical items, gas cleaning/dedusting, metal/alloy and slag handling)
- Refractory studies
- Environmental studies
- Control system modernization
- Furnace power management studies
- Development of measures for operating cost minimization
- Planning and supply of complete plants
- Feasibility studies
- Project studies
- Finite Element Analysis (FEA)
- Maintenance planning
- Product optimization
- Furnace dimensioning (vessel + roof)
- New cooling systems for capacity, lifetime and safety improvement
- Furnace modeling
- Simulation of plant logistics
- Plant commissioning (supervision)
- Supervision of erection

- Research and development:
  - Smelting tests
  - Refractory tests
  - CFD analyses, numerical calculations

**Installation:**
SMS Demag provide experienced site staff. High-qualified erection specialists, setup installation manuals, erection sequence, scheduling, site inspection and warehouse organization. Coordination of logistics, transportation & storage, setup of inventory and reporting system proving completeness and proper delivery can be provided by us. Under the direction of SMS Demag’s specialists, local companies could supervise the specialist manual work on the installation.

**SMS Demag SUPERVISION and MAINTENANCE CONTRACT:**

If requested by the customer, we can also provide a full service in terms of maintenance, process support, product improvement.

**Major customers benefits:**

- experienced staff for planning, engineering, procurement, commissioning and training
- teamwork
- strong background in international project execution
APPLICATION for FERROALLOY

FERRO-SILICON and SILICON METAL

The ferro-silicon grades produced in a submerged-arc furnace have Si contents of 43-96%. Grades with more than 96% Si are known as silicon metal. These applications stringent demands on the design and material due to high energy concentration and the process gas formation involved.

The furnaces are characterized by:
- encapsulated electrode columns with hydraulic control
- contact clamp tightening operation
- short and low inductive electrical feeders

Silicon metal production units generally utilize pre-baked electrodes. SMS Demag also provide special extrusion electrode systems for the Si-metal production to reduce operating costs.

**Ferro Silicon Metal Specification:**

<table>
<thead>
<tr>
<th>Possible Range</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>FeSi 40 – 50% Si</td>
<td>FeSi45</td>
</tr>
<tr>
<td>FeSi 72 – 78% Si</td>
<td>FeSi75</td>
</tr>
<tr>
<td>FeSi 85 – 96% Si</td>
<td>FeSi95</td>
</tr>
</tbody>
</table>

FERRO-MANGANESE and SILICO-MANGANESE

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

**Ferro-manganese specification**

| FeMn 4 – 8% C |
| FeMn 1 – 4% C |
| FeMn < 0.4% C |
| SiMn 15 – 25% Si |

FERRO-CHROME and SILICO-CHROME

High-carbon ferro-chrome is produced with carbon contents of 4-8% and is usually used in AOD converters for the production of alloy steel grades. Due to environmental restrictions, ferro-chrome is commonly produced in closed stationary furnaces. Medium-carbon chrome alloys (0.5-2%C) and low-carbon FeCr (<0.5%C) are produced in combined process stages.

Both products are produced with special slag metallurgy with the objective of attaining high chrome yields.

**Ferro-chromium specification**

| FeCr 4 – 8% C |
| FeCr 0.5 – 2% C |
| FeCr < 0.5% C |
| SiCr 20 – 40% C |

FERRO-NICKEL

Ferro-nickel is produced in submerged-arc furnaces by chemical reduction of nickel ores. The aim is to transfer most of the nickel into the metal phase and iron into the slag phase. Good carbon distribution and a specific slag metallurgy are important to attain a high yield. Pre-heated and pre-reduced ores are hot-charged (at temperatures up to 900°C) into the furnace.

The final nickel reduction work is carried out in the submerged-arc furnace. Ferro-nickel furnaces are closed stationary-type furnaces. Usually, round furnaces are used for smaller and medium quantities, whereas large capacities are produced in rectangular furnaces.

**Ferro-nickel specification**

| FeNi 15 – 30% Ni |
PLANT HIGHLIGHTS

Yermakovsky, Kazakhstan
2 x 80 MVA MVA SiMn/FeMn

RDME, France
102 MVA SiMn/FeMn

SKW Becancour, Canada
1 x 38 MVA FeSi, 2 x 20 MVA Si-metal

Tulcea, Rumania
2 x 33 MVA FeMn, 43 MVA FeCr, 2 x 55 MVA FeSi

Zunyi, China
2 x 50 MVA FeSi, 1 x 30 MVA FeMn

Hunan Ferroalloy, China
30 MVA SiMn

Gulf Ferro Alloys Comp. Saudi Arabia
4x27 MVA SiMn, FeMn, FeSi, Si-Met

Eramet SLN, New Caledonia
3x48 MVA FeNi

Middleburg Steel and Alloys, South Africa
33 MVA FeCr

Minera Loma de Niquel, Venezuela
2 x 45 MVA FeNi

Major customers benefits:

- market leader in SAF technology for ferro-alloy production
- extensive process know-how
- reliable equipment
- high efficiency at low energy level
APPLICATION for NON-FERROUS

NICKEL MATTE and COPPER MATTE

The production of copper matte and nickel matte in electric furnaces is similar to the ferro-nickel process. The furnaces are 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

We provide several submerged-arc furnace units for slag cleaning. To date, more than 20 plants have been installed worldwide. The slag is either liquid-charged into the furnace or can be cold-charged in solid form via conventional feeding systems.

For various applications such as
- copper (e.g. from Teniente converter, Pierce Smith converter, Outokumpu flash smelter, Noranda converter, reverts)
- nickel
- cobalt
- lead (e.g. from Kivcet process) and secondary lead
- zinc
- tin and secondary tin
- platinum
- palladium

LEAD and ZINC

Zinc exits a submerged arc furnace with the gas phase. Residual metals and slag are tapped separately. Submerged-arc furnaces are suitable for the recycling of flue-dust from the steel industry (e.g. EAF-dust) and for the recycling of Pb/Zn-containing slag from BF-based zinc/lead production plants. Zinc fuming and slag cleaning furnaces can also be offered with a DC-power supply.

Major customers benefits:
- market leader in SAF technology for non-ferrous application
- extensive process know-how reliable equipment
- high process efficiency at low energy level

PLANT HIGHLIGHTS

CEGP, France
3 MVA copper slag

Atlantic Copper, Spain
11 MVA copper slag cleaning

2 x Enami, Chile
9, 8 and 11 MVA copper slag cleaning

Codelco, Chile
14 MVA, copper slag cleaning
CEGP: copper scrap recycling furnace.

Enami, Chile: Cu-slag cleaning furnace.

Liquid charging to SAF.

Copper matte tapping.
SPECIAL ALLOYS

Usually, special alloys are produced in smaller units
- Fe-tungsten
- Fe-vanadium
- Fe-tantalum
- Fe-niobium

CaC₂, CaSi
Calcium carbide (CaC₂) is used for the production of acetylene and calcium cyanamide. Calcium carbide and calcium silica are also used as a desulfurization agent in the steel industry.

TiO₂-slag
Titanium slag furnaces are similar to pig iron furnaces. Major products are TiO₂ rich slag and pig iron as a valuable “by-product”.

Phosphorus
Phosphorus is usually produced in mid-size units. Phosphorus leaves the SAF via the off-gas. Generally the furnace is offered with a closed roof due to the pyrophoric characteristic of the product. Ferro-phosphorus is a by-product and can be sold to foundries.

SLAG CLEANING and RECYCLING

The SAF converts reverts ashes to non-hazardous, non-leachable slag. The furnaces recycle steel mill waste such as mill scale, electric arc furnace dust, blast furnace flue dust and sludges to slag (and for zinc-containing reverts to zinc-crude oxide which is collected in the filter-station). Flue ashes of power plants can be also recycled with the SAF at low costs in an environmentally friendly manner.

The SAF is suitable for cleaning various slags which accumulate in the ferrous and non-ferrous industry. In addition, several flue ashes are converted to a non-hazardous, non-leachable slag. Typical applications in this regards are
- slag cleaning furnaces (copper, lead, zinc containing slag)
- waste oxide recycling furnaces for steel mill wastes
- waste oxide recycling furnaces for flue ashes from power plants or waste incineration plants

REFRACTORY and MINERALS

The principle of the SAF allows the melting of minerals with high fusion temperature. Therefore, our furnaces are also applied in various fields for refractory and mineral production. The following products can be produced with SAFs:
- corundum (Al₂O₃)
- fused magnesia
- solar silica
- basalt
- fused minerals
- mineral wool
- refractory fusion furnaces

SPECIAL FURNACES

We also deliver tailor-made test furnaces in laboratory or pilot size.

Major customers benefits:
- all required unique concepts available
- wide product range available including upstream and downstream items
- detailed experience in various processes

Corundum furnace with electrode arms.

PLANT HIGHLIGHTS

**MCB Industries, Malaysia**
12 MVA CaC₂

**Kumba Recources, South Africa**
2x36 MVA Ti-slag
**APPLICATION** pig iron/RedSmelt and steel mill waste recycling

The submerged arc furnace can produce hot metal up to 800,000 tonnes per unit. This can be only achieved with pre-reduced iron ore pellet charge. SMS Demag provided the RedSmelt technology for pig iron production which combines a rotary hearth furnace for ore pre-reduction with a submerged-arc furnace. Pig iron is also produced in a submerged arc furnace as a “by-product” in the Titanium slag furnaces (e.g. at Kumba). The submerged-arc furnace is capable of producing pig iron grades with adjustable carbon content between 2-4.0% C. Another concept recycles waste material from integrated steel plants and mini mills to pig iron with RedSmelt technology.

**Pig iron specification**

C: 2 – 4.0 %
EQUIPMENT UPSTREAM of the SAF

The full range of products is available in the areas raw material preparation, handling, agglomeration and processing. Besides the equipment, SMS Demag also offer the complete automation for all components which can be linked with the main control system of the submerged-arc furnace unit or other destinations.

Raw material preparation
- crushing
- grinding
- mixing
- blending

Raw material agglomeration
- sintering
- pelletizing
- cold briquetting
- hot briquetting

Raw material handling
- transport
- storage

Raw material processing/pretreatment
- drying
- heating
- reduction
- calcination
- roasting
EQUIPMENT DOWNSTREAM of the SAF

We also provide an extensive product range downstream of the SAF. State of the art equipment for solidification, refining and metal/matte/slag handling is available.

- Granulation (static or dynamic)
- Hot metal charging systems to EAF
- Pig casting machines
- Casting wheels
- Metal/alloy handling equipment
- Metal refining equipment
  - Ladle refining equipment
  - Ladle arc reheating station
  - Top blown converters
  - AOD converters
- High-voltage substations
- KW-units

Major customers benefits:

- full range equipment up- and downstream of the SAF for optimized process requirements
- clear battery limits and responsibilities during project phase
Our **GOAL** is to supply tomorrow’s submerged-arc furnace already today
SMS Demag constantly improve their furnace design by research and development programs combined with long-standing experience in industrial units.

The **FOCUS** of our current R+D activities is on:
- DC-technology
- cooling concepts
- refractory optimization
- increase of process efficiency
- logistic improvement
- process modeling
- slag management
- improved tapping systems
- numerical process simulation, finite element methods

**COOPERATIONS**
- Institute for process technology and metal recycling in Aachen/Germany
- Institute for Ferrous Metallurgy in Aachen/Germany
- Technical University Dortmund/Germany
- University Duisburg/Germany
- Slag-Institute Rheinhausen/Germany
- Universidad de Chile in Santiago/Chile
- University in Delft/Netherlands
- Institute for ore beneficiation in Othfresen/Germany

**TEST FURNACE IN AACHEN/GERMANY**

**Technical data**
- Transformer connection load: 520 kVA
- Maximum electrode current: 5.3 kVA
- Maximum secondary voltage: 110 V
- Furnace shell diameter: 980 mm
- Furnace shell height: 1250 mm
- Electrode diameter: 150 mm
- Electrode hole diameter: 65 mm

**Special features**
- DC + AC application possible
- Hollow electrode (optional)
- Dry and wet gas cleaning system attached
# REFERENCES/STATISTICS

## FERRO ALLOYS
- **1970 - 79**: 37
- **1980 - 89**: 42
- **1990 - today**: 39
- **Total**: 118

## NON FERROUS
- **1970 - 79**: 7
- **1980 - 89**: 14
- **1990 - today**: 16
- **Total**: 37

## SPECIAL PROCESSES
- **1970 - 79**: 10
- **1980 - 89**: 10
- **1990 - today**: 15
- **Total**: 35

## PIG IRON / RED SMELT
- **1970 - 79**: 13
- **1980 - 89**: 1
- **1990 - today**: 1
- **Total**: 15

## ENGINEERING STUDIES
- 6 – 10 studies each year
- **1970 – today**: Approx. 200
SAF at a glance

**PROCESS KNOW-HOW**

- Extensive process know-how, strong metallurgical background based on industrial experience
- Over 500 references installed worldwide
- Experience in over 100 products
- Market leader for SAF technology (70% market share)

**ECONOMICAL ASPECTS**

- Economical success with solid state-of-the-art technology
- Progressive ramp up curves
- Quick return on investment

**DESIGN**

- All features available
- Worldwide best electrode column system
- Maintenance-friendly systems
- All types of electrodes available
- Suitable cooling concepts
- Water cooled tap holes
- Suitable refractory concept in combination with balanced cooling guarantees long refractory life at minimum operation costs
- Failsafe hydraulic system
- State of the art electric systems
- Automation system ensures reliable and easy operation

**ENVIRONMENT**

- All systems for clean operation in an environmentally safe manner

**SERVICE**

- We work together with the customer in a team
- Experienced team for proper planning, engineering, procurement, commissioning and training
Why SMS Demag?

- Extensive experience in metallurgical plants
- Overall strong partner for construction
- Turn-key experience
- Strong metallurgical background in iron, non-ferrous application
- Continuous innovation
- Extensive experience regarding upstream and downstream technologies