



**ECO SOLUTIONS -
SAVING RESOURCES, CREATING VALUE**
A COMPREHENSIVE RANGE OF
FUTURE ORIENTED ENVIRONMENTAL
SOLUTIONS FOR IRONMAKING PLANTS

ECO SOLUTIONS

SAVING RESOURCES, CREATING VALUE

As a result of increasingly stringent environmental regulations and the need to save resources and reduce energy consumption, environmental protection has become more important than ever.

ECO Solutions from Primetals Technologies stands for a wide range of services and advanced technologies that minimize the environmental impact of steel production, improve energy efficiency and optimize by-product management. Primetals Technologies offers expert consulting services, advanced processes and holistic solutions along the entire iron and steel production chain that ensure strict adherence to the emission regulations and support producers to achieve substantial cost savings. The objective is always twofold: to save resources and to create value.

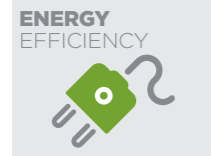
ECO SOLUTIONS

Saving resources

- Optimized use of raw materials
- Reduced energy consumption
- Significant reduction in particulate and gaseous emissions
- Efficient by-product treatment and recycling

Creating value

- Improved plant performance
- Lower conversion costs
- Reduced environmental taxes and disposal costs
- Increased energy recovery
- Substantially improved working conditions and safety



ENVIRONMENTALLY ORIENTED PRODUCTION AND LOWER ENERGY CONSUMPTION

For every metric ton of steel produced, 50 to 100 kilograms of sludge and scale accumulate and approximately 20,000 MJ of energy are consumed. There is no question that modern dedusting systems in combination with energy-recovery technologies and by-product recycling are crucial. However, the outlay for such technology should be no higher than absolutely necessary. The most important goals are high reliability, strict compliance with defined threshold values, and minimum energy consumption and maximum by-product recycling.

Primetals Technologies offers the entire spectrum of gas cleaning and energy efficiency technologies as well as by-product treatment plants from a single source, always in close collaboration with your company's iron and steel production specialists. This is our approach for creating perfectly coordinated and economically viable solutions.

YOU EXPECT

- Cost-efficient production and maximized productivity
- Low consumption levels for energy and utilities
- Maximum energy recovery
- Short delivery times and consistently high availability
- Solid production quality and expert solutions
- Designs that meet future environmental and market requirements at the lowest investment
- A reliable partner with innovative, tailor-made solutions

ADVANTAGES OF PRIMETALS TECHNOLOGIES ECO SOLUTIONS

- Full compliance with agreed-upon limit values
- Tailored ECO plants using comprehensive expertise
- Future emission requirements already considered in the plant layout and design
- More than 40 years of experience and profound knowledge in environmental technologies

ECO SOLUTIONS FOR IRONMAKING

- 1 Gas cleaning
- 2 Energy recovery
- 3 By-product recycling
- 4 Electrics and automation
- 5 Lifecycle services
- 6 Selected references



MAXIMIZED EMISSION REDUCTION OF SINTERING AND PELLETIZING

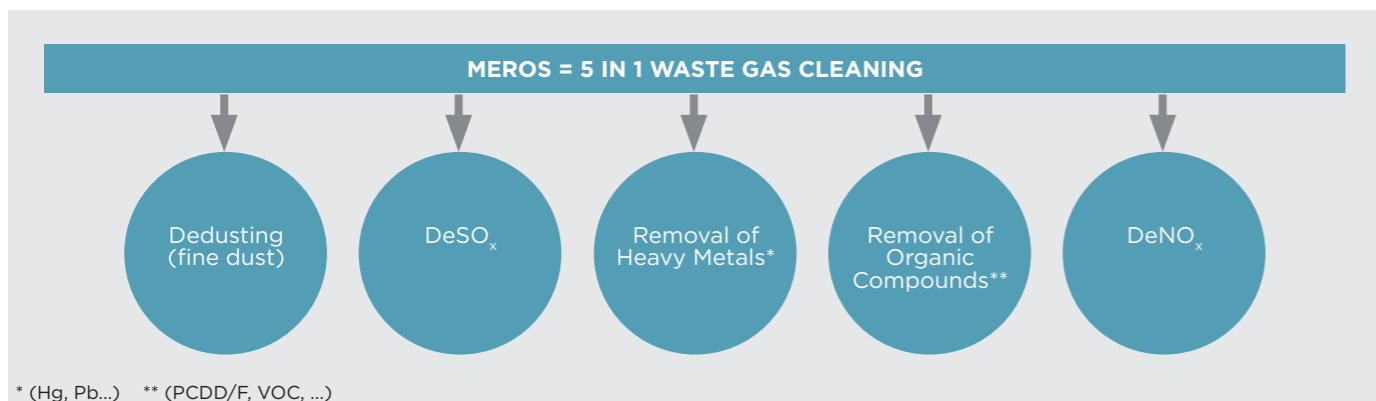


MEROS® plant at voestalpine in Linz, Austria

Developed by Primetals Technologies, MEROS® - Maximized Emission Reduction of Sintering - is a waste-water-free process for removing pollutant concentrations such as dust and harmful metallic and organic components from the sinter offgas. Through a series of treatment steps, MEROS® achieves levels previously unattained with conventional gas-treatment techniques. The world's first MEROS industrial plant was installed at the sinter plant of voestalpine Stahl in Linz, Austria, and it has been running reliably since 2007.

The MEROS® technology can be also applied for gas cleaning in pelletizing plants. In the first step, special C-based adsorbents and desulfurization agents (hydrated lime or sodium bicarbonate) are injected into the sinter offgas stream in the countercurrent direction to bind heavy metals and organic compounds.

In the second step, the gas stream passes to a conditioning reactor where the gas is moisturized and cooled to a temperature of about 90°C by means of an injected fine mist using dual-flow, i.e., water and air, nozzles. This accelerates the chemical reactions required for binding and removing SO₂ and other acidic gas components. In the third step, the offgas stream that exits the conditioning reactor passes through a bag filter equipped with special high-performance fabrics that remove the dust with the trapped pollutants. In order to enhance gas-cleaning efficiency and significantly reduce additive costs, a portion of this dust is recycled to the offgas stream after the conditioning reactor. This also accelerates the formation of a filter cake on the surface of the bag filter, which enhances the removal of fine dust in the offgas stream. The dust removed from the system is conveyed to intermediate storage silos for subsequent disposal or for use in other applications.



Pulse-jet filter



Gas-conditioning tower

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

- Up to 99% emission reduction
- Dust emission less than 5 mg/Nm³
- SO₂ emission reduction up to 99% (depending on local regulations)
- Dioxin/furan emission reduction up to 0.1 ng TEQ/Nm³
- Up to 10% (up to 200 kW/h) less energy consumption compared with other technologies

Creating value

- Outstanding availability and reliability
- Proven lifetime of filter bags of eight years through minimized mechanical stress on filter bags by using low-pressure pulse cleaning
- Treatment of MEROS® by-product possible, regeneration of soda/lime

MAIN BENEFITS

- Highest removal efficiency for heavy metals, acid gases, dioxin and other VOCs thanks to the countercurrent flow injection of additives
- Lowest rate of dust recirculation resulting in fewer filter pulse-cleaning cycles and minimal need of compressed air for filter cleaning resulting in significantly extended lifetime of bags
- Minimized mechanical stress on filter bags by using low-pressure pulse cleaning
- Dry dust recirculation prevents any dust buildup in the system
- Controlled constant process temperature ensures stable desulfurization rates or sodium bicarbonate)
- Extension with a DeNO_x system; changed to alternative flexible, modular system



SCR DeNO_x PLANTS FOR SINTER GAS CLEANING

PROVEN SOLUTIONS WORLDWIDE BASED ON MORE THAN 1000 REFERENCES



3D Modell of SCR DeNO_x plant for sinter waste gas cleaning

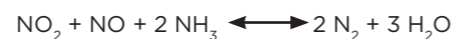
Primetals Technologies offers highly efficient selective catalytic reduction (SCR) solutions for maximum reduction of nitrogen oxides emissions.

Harmful components in the sinter waste gas, such as dust, SO₂, heavy metals and organic compounds, are efficiently removed in state-of-the-art sinter waste gas cleaning plants. NO_x emissions, however, have now become a key focus of environmental legislation. It is expected that emission limit values for nitrogen oxides will drop to very low levels within the next few years.

NO_x removal technology is already well established in other industrial sectors such as in the power generation industry. This technology is increasingly being adopted in the iron and steel industry – mainly for sinter waste gas cleaning and coke oven applications. The most efficient and reliable solution for NO_x reductions employs a selective catalytic reaction (SCR). It has been successfully applied in power plants since decades. With a few important modifications, SCR technology has recently also been applied for sinter waste gas cleaning.

Together with our partners from Mitsubishi Hitachi Power Systems (MHPS), Primetals Technologies has developed special solutions for both new and existing sinter plant gas cleaning systems. In many cases the SCR DeNO_x can be an add-on module to existing dedusting and/or DeSO_x systems. One particularly interesting solution is the modular SCR DeNO_x add-on to MEROS sinter waste gas cleaning technology.

The SCR DeNO_x process is based on the reaction of NO_x with ammonia (NH₃). Nitrogen oxides (NO_x) are reduced to nitrogen (N₂) and water (H₂O) according to the following basic reaction:

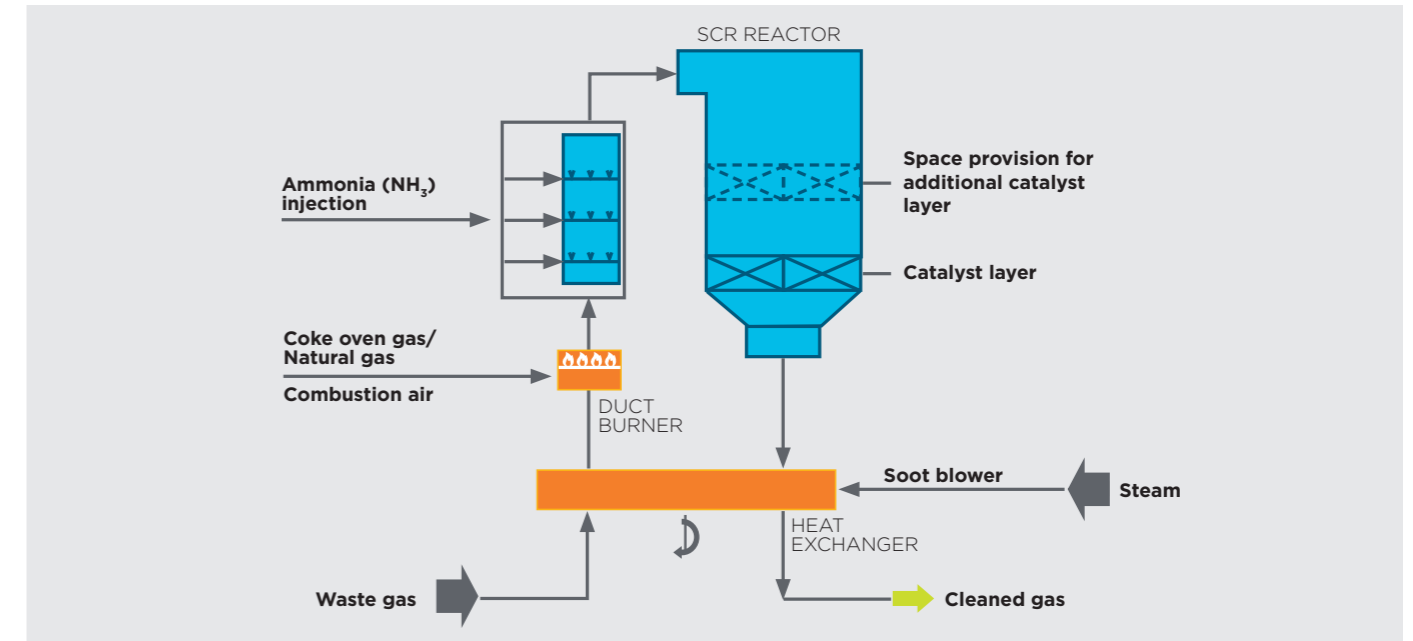


This reaction requires a certain temperature level and, most importantly, a suitable catalyst.

SPECIAL ADAPTATION OF THE SCR PROCESS FOR SINTER WASTE GAS CLEANING

Due to the low temperature level of the incoming sinter waste gas, the gas needs to be heated up to the optimum reaction temperature of approximately 280°C. This is done in two steps.

As a first step, the gas passes through a heat exchanger where the heat from the outgoing treated gas is transferred to the incoming gas. The final temperature adjustment is done by a duct burner system. Ammonia is injected through an ammonia injection grid (AIG), which ensures a uniform distribution of the ammonia across the duct before the catalyst area. The gas then passes through the different catalyst element layers. Both plate-type and honeycomb-type catalyst elements are used.



Process flow for NO_x emission reduction

ECO SOLUTIONS – SAVING RESOURCES, CREATING VALUE

Saving resources

- NO_x reduction up to 90%
- Low ammonia consumption due to optimized gas flow distribution by applying advanced CFD modeling
- Reduced consumption of heating gas due to optimized heat exchanger design ensuring a minimum temperature delta for pre-heating

Creating value

- No by-product is generated
- Optimized catalyst material depending on specific application and waste gas composition for extended lifetime
- Proven high DeNO_x-removal efficiency

MAIN BENEFITS

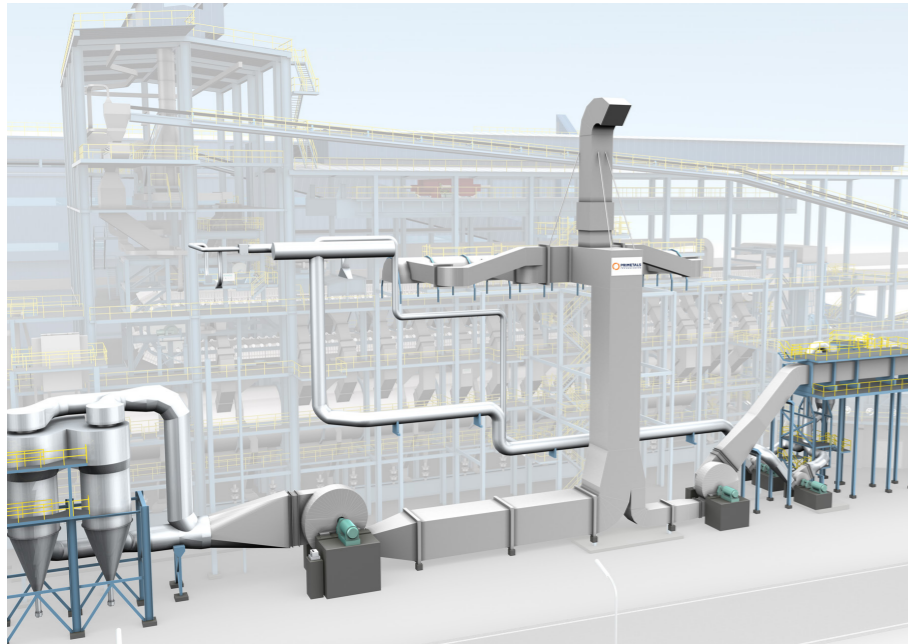
- Well proven in industrial applications
- Flexible design solutions for different applications (coke oven, sinter- and pelletizing plants)
- Lowest ammonia slip concentrations
- Retrofit solution available for existing plants

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DeNO_x SYSTEMS
SUCCESSFULLY
INSTALLED IN
SINTER PLANTS

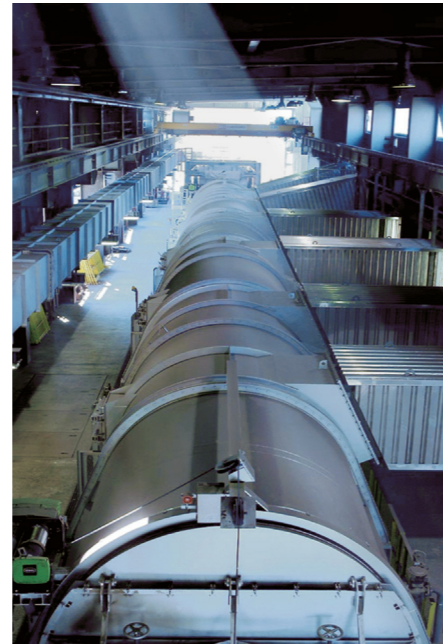
>1,030
DeNO_x UNITS
INSTALLED IN
POWER GENERATION
PLANTS*

*by our partner Mitsubishi Hitachi Power Systems (MHPS)

SELECTIVE WASTE GAS RECIRCULATION (SWGR) ENERGY EFFICIENCY FOR SINTER



Selective waste-gas recirculation system (SWGR)



Waste-gas recirculation hood

In order to save capex and opex in MEROS® plants, Primetals Technologies recommends installing a selective waste-gas recirculation system wherever technically possible.

SELECTIVE WASTE-GAS RECIRCULATION SYSTEM

Primetals Technologies has developed and implemented the selective waste-gas recirculation (SWGR) system to reduce environmental emissions from sinter production. With the SWGR system, offgas from selected zones of the sinter machine is mixed with hot cooler off-air and then recirculated to the sinter strand.

The result is a significant reduction of the specific offgas volume to the end-of-pipe gas cleaning by up to 50%.

The SWGR system enables emission reductions in sinter production to previously unattained levels. Specific investment and operating costs for gas-cleaning facilities can therefore be kept at acceptable low levels.

The SWGR system from Primetals Technologies can be installed in existing or greenfield plants.

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

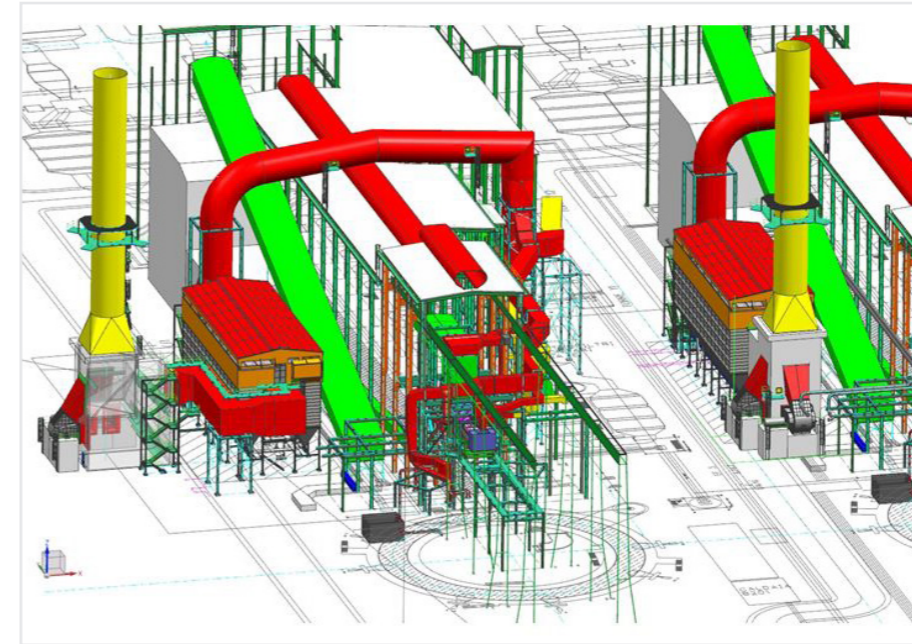
- Reduction of waste gas volume by up to 50%
- Reduction of CO₂ emissions by up to 10%
- Lower emissions of SO_x, NO_x, PCDD/PCDF and heavy metals
- Specific solid-fuel consumption decrease by up to 10% in the sinter gas due to utilization of the contained CO and elevated recirculation gas temperature

Creating value

- Significant reduced investment and operation costs for MEROS® plant

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SUCESSFULLY
INSTALLED
PLANTS

ROOM AND SECONDARY DEDUSTING FOR SINTER AND PELLETIZING PLANTS



Dedusting systems for sinter plant



Secondary dedusting system at one of the sinter plants of Ilva S.p.A. in Taranto, Italy

Aside from primary offgas treatment, it is also essential to have ambient conditions in a sinter plant that ensure a safe working environment. This is where reliable room dedusting systems from Primetals Technologies come to play.

The main task of a room dedusting system is to efficiently capture dust emissions that occur during the handling and processing of the sinter raw materials and hot sinter (e.g., conveying, mixing, discharge, sieving). The proper design and location of hoods is essential to achieve the highest dust collection possible and ensure proper working as well as clean ambient conditions in and around the sinter plant. CFD calculations help to design optimized dust capture and flow distribution in the hoods. A further advantage is minimized pressure losses in the system, which results in reduced power requirements for fans.

Primetals Technologies offers complete integrated solutions that combine primary offgas treatment (MEROS®, selective waste gas recirculation), room dedusting and the primary sintering process.

Primetals Technologies' pulse-jet filter removes dust from the raw gas stream, and assures highly efficient dedusting and increased lifetime for filter bags.

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

- 15% savings in fan power requirements as a result of optimized flow distribution and damper control
- Total emission reduction up to <5 mg/Nm³ particulate matter
- Clean working environment results in reduced maintenance costs and improved working conditions for workers

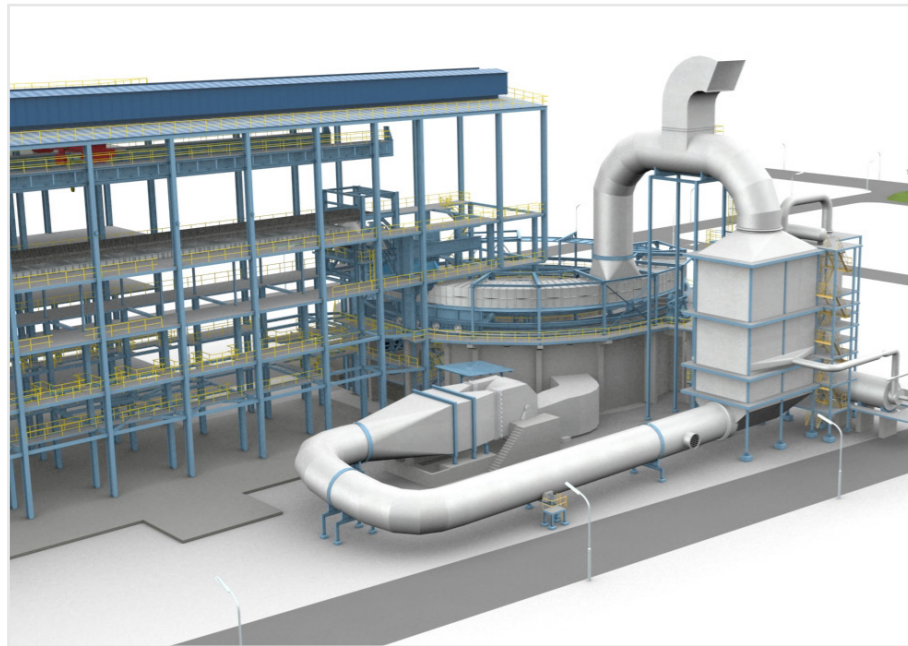
Creating value

- Complete recycling of by-products via the sinter plant is possible
- Plant availability of >99%

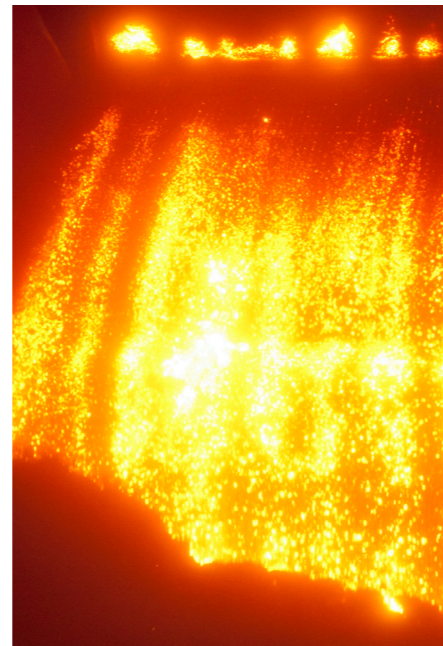
5
SUCESSFULLY
INSTALLED
DEDUSTING
PLANTS

ENERGY RECOVERY FOR SINTER PLANTS

TRANSFORM SINTER WASTE ENERGY INTO PROFIT



A sinter cooler waste-heat recovery system with boiler exhaust air recirculation to the sinter cooler



Hot sinter at the sinter machine discharge

RECOVERY OF THERMAL ENERGY FROM THE SINTER COOLER

The sensible heat of the sinter that is discharged from the sinter machine to the sinter cooler amounts to almost half of the total process thermal energy input. Conventional sinter coolers waste this huge amount of sensible heat by transferring it to the cooling air and releasing it to the atmosphere.

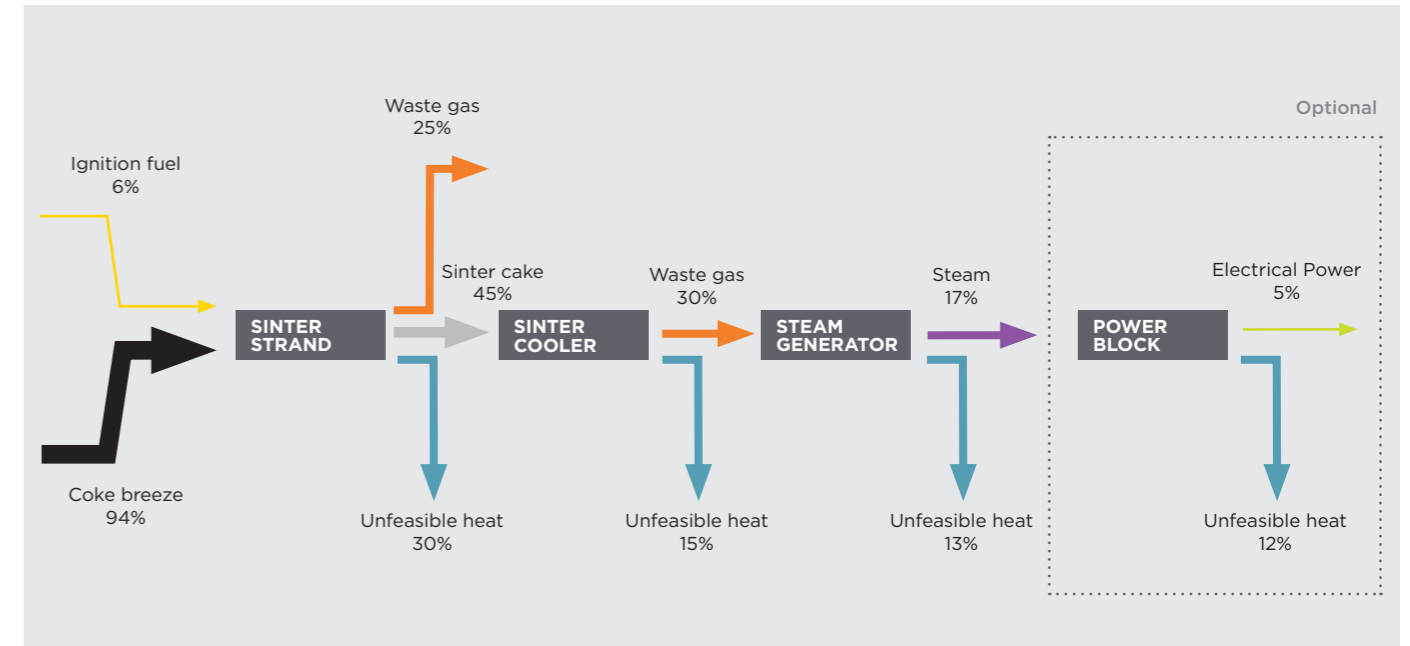
Primetals Technologies has developed solutions for efficient recovery of this sensible energy by utilization of hot waste air from the sinter cooler for production of steam in a waste heat boiler system and optional generation of electrical energy in a modular power block. Special off-air recirculation concepts lead to increased plant efficiency and additionally ensure compliance with local emission standards.

Optimum integration of the energy-recovery system in the energy network of a steelworks is decisive to ensure maximum economic feasibility.

A payback time of less than three years is realistic, depending of course on the plant size and local energy prices.

Considering the local conditions, the following process variants of a sinter cooler waste heat recovery system can be designed and provided:

- Feed-in to the on-site steam network for various process applications
- Generation of additional electrical energy in an existing power plant
- On-site generation of electrical energy in an autonomous power block at the sinter plant
- Utilization of produced steam or hot water for district heating
- Supply of steam to external consumers



Main energy flows of the sintering process with heat recovery at the sinter cooler for the production of steam and, optionally, power generation

MAIN BENEFITS

- Integrated solution in combination with sinter process by optimized sinter cooler design (sinter cooler charging and sealing) and automation level 2 burn-through point control
- Tailor-made steam generation maximized by recirculation of hot air back to the sinter cooler
- Increased plant efficiency and compliance with the individual emission standards through the efficient utilization of boiler exhaust air
- Elimination of emissions from cooler waste gas stack

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

- Reduction of dust emission up to 5 mg/Nm³
- Reduction of CO₂ emission
- Coke consumption reduced by up to 3% by recirculation of hot air back to the sinter machine

Creating value

- Reduced operating costs through the production of steam (-50-80 kWh/t sinter) or the generation of electrical power (-15-25 kWh/t sinter)
- Typical payback times of less than three years depending on the plant size and local energy prices
- Plant availability of >99%

Beside the utilization of sinter cooler waste heat for the production of steam, there are several other possible options for waste heat utilization, such as:

- Preheating of combustion air for the ignition furnace (IF) to reduce gaseous fuel demand
- The addition of a portion of sinter cooler off-air to the selective waste gas recirculation (SWGR) system
- Pre-heating of raw mix and post heating of freshly ignited sinter to reduce coke breeze consumption

A state-of-the-art sinter plant today consists of a sinter cooler waste heat recovery system in combination with SWGR and combustion air preheating at the IF to efficiently utilize the full potential of the waste heat available in a sinter plant.



MERIM

MAXIMIZED EMISSION REDUCTION AND ENERGY RECOVERY IN IRONMAKING



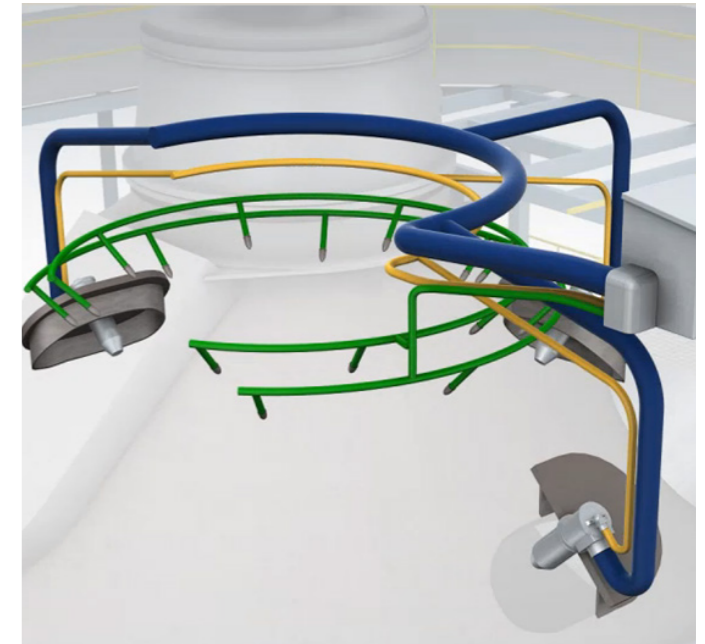
MERIM plant layout



Pilot plant



MERIM plant for Midrex



Temperature control unit with burden burner and burden spray

Primetals Technologies has developed advanced dry top gas cleaning technology for blast furnaces, Corex and Finex, with considerable benefits for the environment and customers compared to the conventional wet top gas cleaning system with its restrictions and disadvantages.

The new system for blast furnace top gas cleaning includes a cyclone for coarse dust separation and a high-performance fabric filter for fine dust removal. The cyclone produces a practically zinc-free fraction of dust, which can be reused in the sinter plant, and a highly enriched zinc fraction in the fabric filters. In order to solve the problem of temperature fluctuations in the top gas, Primetals Technologies has developed a gas-conditioning concept that allows for safe operation at low and high temperatures alike. Using this green solution, energy consumption and waste destined for landfills can be reduced to currently unachieved levels. The cleaned gas meets both current and future emission regulations, and the CO₂ footprint can be significantly reduced.

MAIN BENEFITS

- Dust product fully dry, no further sludge and waste-water treatment necessary
- Efficient separation, concentration handling and reutilization of by-products
- Advanced emission control possible due to additive injection and dust recirculation (e.g., HCl, H₂S, COS)

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

- Clean gas concentration of <3 mg/Nm³
- Dust separated at the first cleaning stage cyclone can be recycled without restrictions
- Accurate separation of zinc in the cyclone, maximizing the reusable portion of dust, i.e., in the sinter plant
- Minimized energy consumption of 6-12 kWh/t of hot metal

Creating value

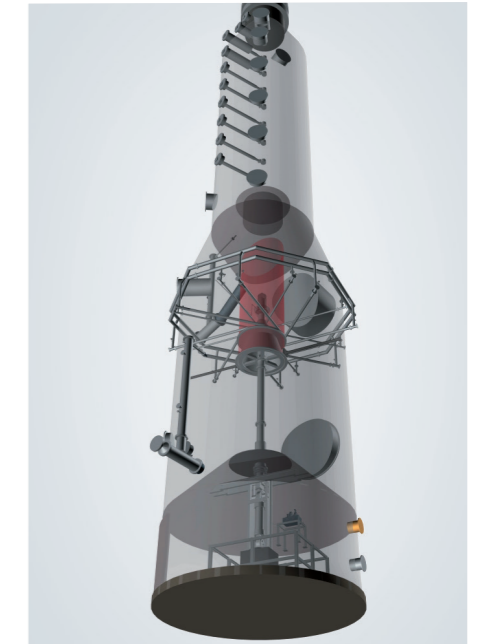
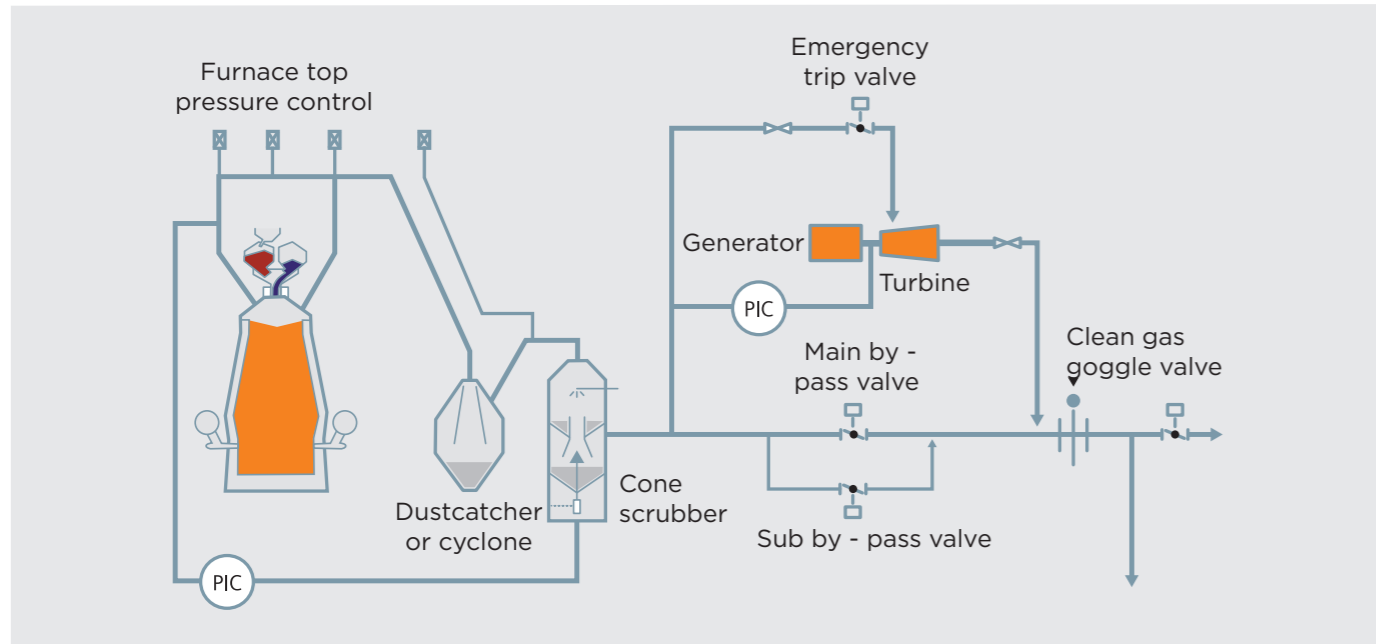
- 25% to 30% higher energy output from the top gas pressure recovery turbine (TRT) due to higher process temperatures and lower pressure losses
 - Through higher energy recovery, additional profit of €300,000 to €600,000 per million tons of hot metal produced (compared to wet dedusting processes)
- Lower operating and investment costs compared to wet solutions (e.g., electricity, water treatment)
- Minimum maintenance required
- Lower space requirements (about 40% to 60% lower compared to a complete wet-type installation)

25-30%
HIGHER
ENERGY
OUTPUT
FROM TRT

3
SUCESSFULLY
INSTALLED
PLANTS

WET DEDUSTING SYSTEM FOR BLAST FURNACES

MEETING ENVIRONMENTAL STANDARDS WITH HIGHLY EFFICIENT GAS CLEANING



PRIMARY WET DEDUSTING

Primetals Technologies offers designs for dust catchers and cyclones, or a combination of both systems. However, where there is a need to remove higher percentages of dust and to reduce water treatment requirements, the dust catcher can be replaced by a cyclone. This is the case for both new plants and for modernizations.

For the cyclone, Primetals Technologies offers two solutions:

- Single-side entry
- Triple entry, which can replace the top of existing cyclone designs that adopts swirl vanes and are susceptible to blockage or wear

A cyclone optimizes the recycling of blast furnace dusts carried over in the offgas system via higher efficiency separation. Additional benefits can also be realized in zinc carryover control.

SECONDARY WET DEDUSTING

Primetals Technologies offers multiple solutions with options for combinations of the washing/gas saturation stage and the furnace pressure control stage:

- The conditioning tower cools and saturates gas, removing a large percentage of dust particles
- The gas scrubber cleans process gas, guaranteeing dust content of less than 5 mg/Nm³ while controlling the furnace pressure to within 1.5% of its set point

Gas scrubbers from Primetals Technologies have been in operation for over 30 years with multiple units utilizing single or triple annular cone devices on furnaces of varying productivity and size. The latest generation of triple-cone designs calls for an external position, away from the main vessel, to facilitate ease of maintenance. The result is reduced vessel size and a demister bed that can be located internally.

All solutions developed for new gas cleaning plants are also ideally suited for retrofitting into existing facilities. In addition, corrosion has become an increasing problem for operators with the higher prevalence of tuyere injectants. Primetals Technologies has developed a cost-effective and robust corrosion protection system based on careful material selection and internal coatings.

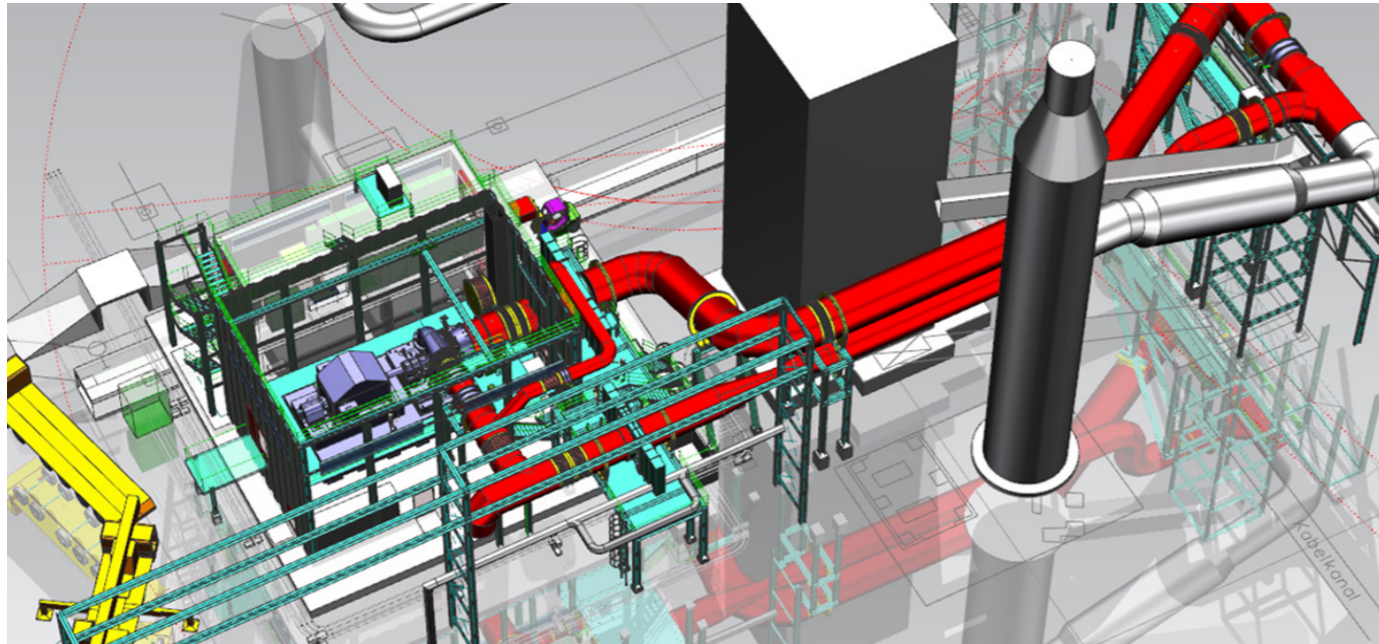
MAIN BENEFITS

- Full range of solutions for all gas cleaning requirements
- Optimized dust separation efficiency
- Fulfillment of the strictest environmental emission limitations
- Proven solutions on the basis of decades of experience

Xianghan blast furnace conditioning tower and scrubber



TOP GAS RECOVERY TURBINE (TRT) TRANSFORM OFF-GAS INTO PROFIT



3-D plant layout

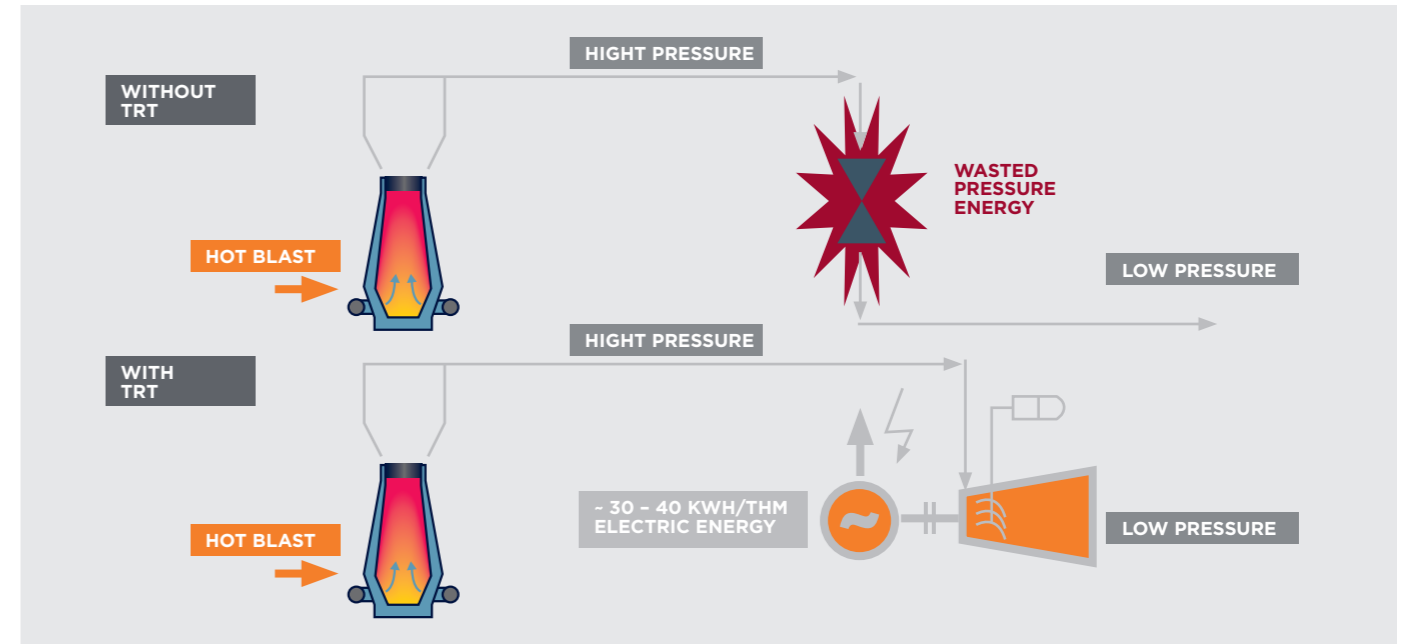
In an integrated iron- and steelmaking plant, the blast furnace and its auxiliary plants offer an important lever for improving overall energy efficiency. The blast furnace process consumes upward of 75% of the total energy in an integrated steel plant. While modifications of central design parameters usually require major investments, attractive upgrades and improvement packages can be found for many existing plants.

The TRT recovers the pressure energy of the top gas of a blast furnace by controlled expansion to low clean-gas pressure. Electrical energy from the waste pressure can be gained without any additional energy input and CO₂ generation.

MAIN BENEFITS

- Latest state of the art turbine design for the highest energy efficiency and compact plant layout
- Decreased amount of purchased electrical energy and reduction of CO₂ footprint, and even the possibility to export energy to a local grid
- Leak-proof construction allows a safe operation
- Inclusion of quick-acting valves to cope with load changes
- Implementation after wet or dry top gas cleaning possible
- Precise blast furnace top-pressure control, even in the case of an unexpected TRT stoppage
- No impact on the blast furnace operation with the installation of an appropriate bypass system

SAVING OF
30-40
kWh/t
HOT METAL



Utilization of energy from gas expansion

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

- Generation of electrical energy from blast furnace top gas (approximately 30 to 40 kWh of electrical energy per ton of produced hot metal)
- In combination with a dry gas cleaning plant, 20% to 30% higher energy output of the turbine

Creating value

- Additional revenue from blast furnace production of €1.5 - €2.0 million per ton of hot metal (basis: €50/MWh)
- Reduction of the CO₂ footprint



High efficient turbine (© MAN)

6
SUCESSFULLY
INSTALLED
PLANTS

CASTHOUSE AND STOCKHOUSE DEDUSTING FOR BLAST FURNACES



Casthouse taphole extraction



Casthouse

For casthouse dedusting, the exhaust system collects dust laden air from the widely distributed off-take points. This dust-laden air is then conveyed to a central fabric bag filter unit for dedusting. Off-take points include the hot metal and slag tapping areas as well as hot metal transfer sites.

An important factor in the waste-gas extraction and dedusting logistics is optimum dimensioning of the ductwork and the damper system to compensate pressure losses and thus reduce fan power requirements. To optimize the arrangement of hoods and ducts, CFD calculations are carried out to support the design calculations. Special design measures must be foreseen in order to assure low wear as well as easy and low-cost servicing of such a widely branched system. Bag filters are preferred for the heart of the dedusting because of their flexibility in handling varying quantities and dust concentrations in the raw gas. This state-of-the-art filtration technology is required to reach the lowest emission values of $<5 \text{ mg/Nm}^3$ in the clean gas.

Drawing on operation and process experience with blast furnaces, Primetals Technologies offers complete integrated solutions for the offgas treatment in the blast furnace area.

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

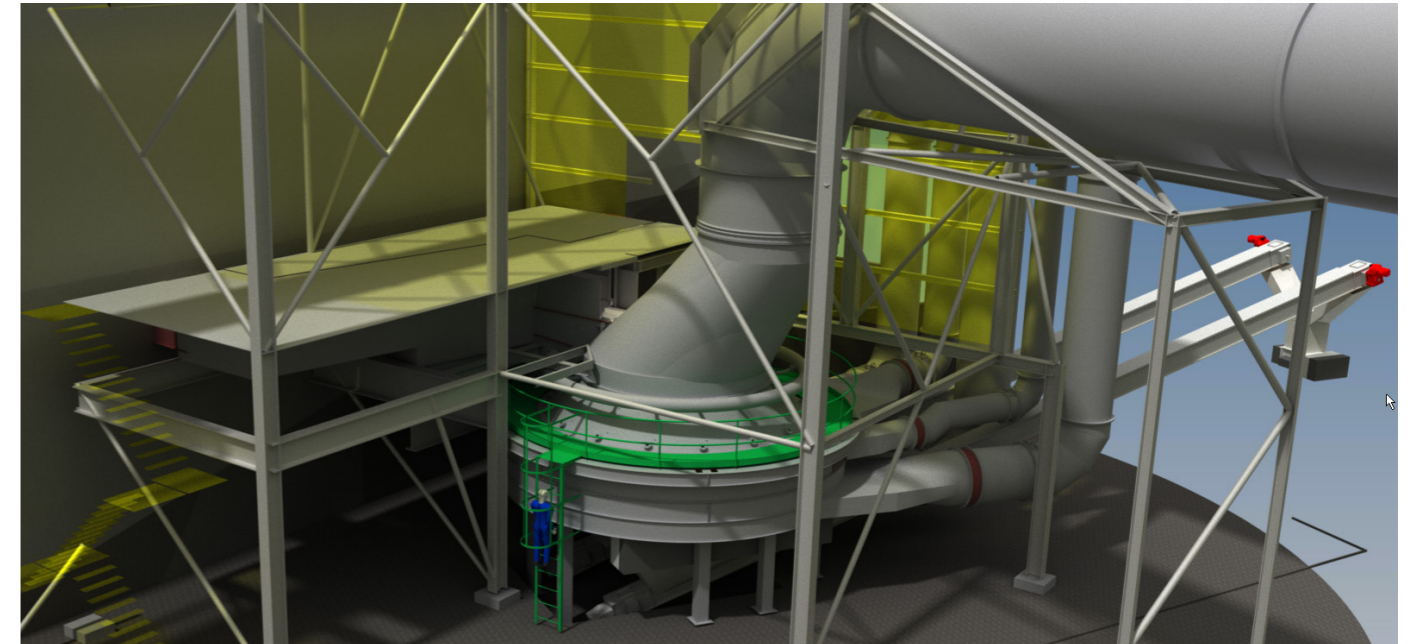
- 15% savings in fan power requirements as a result of optimized flow distribution
- Total emission reduction of $<5 \text{ mg/Nm}^3$

Creating value

- Complete recycling of by-products via the sinter plant, blast furnace or LD(BOF) is possible
- Clean working environment results in reduced maintenance costs and improved working conditions for workers
- Plant availability of $>99\%$

36
SUCCESSFULLY
INSTALLED
PLANTS

DRY SLAG GRANULATION WITH HEAT RECOVERY UTILIZATION OF BLAST FURNACE SLAG HEAT ENERGY



3-D layout of pilot plant for dry slag granulation

Each year, approximately 400 million tons of blast furnace slag are produced worldwide with a tapping temperature of around $1,500^\circ\text{C}$. The slag is normally used as a substitute for cement clinker. Currently, the slag is granulated in wet-granulation plants using large volumes of water. It has not been possible until now to utilize the remnant heat energy of approximately 1.8 GJ per ton of slag.

In an R&D project now underway by a consortium of companies comprised of Primetals Technologies, voestalpine Stahl, the FEHS - Building Materials Institute and the University of Leoben, a new dry-granulation technology is being investigated to use air to cool molten slag and recover the lost heat energy. The resultant granulated slag fulfills the same criteria as wet-granulated slag for use in the cement industry.

Phase 1 of the project, which has been completed, involved setting up a technical plant at the University of Leoben in 2012. This was followed by a series of dry slag granulation campaigns using remelted blast furnace slag. The elevated offgas temperatures and the quality of the slag product have proven that the process is suitable as an industrial application. The decision was then made to escalate the project from a pilot scale to a full-size industrial prototype plant. This phase 2 is now underway and commissioning is scheduled by end of 2016. Thus, it is expected that the rollout of this leap-frog technology can start in 2017.

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

- Reduced sulphur emissions
- Elimination of sulphur odor around the plant
- Reduction of CO_2 footprint
- Low emissions in the closed slag-granulation process with a uniform grain size
- No water is consumed

Creating value

- The dry granulation process saves $\sim 132 \text{ kWh}$ energy per ton of slag sand for product drying (assuming 10% residual moisture)
- A slag flow of 1 t/min. gives an output of approx. 29 t/h superheated steam
- The dry slag granulate can be used in the cement industry

RECYCLING OF BY-PRODUCTS

OXIDE BRIQUETTING



Briquetting



Briquetting plant

Around the world, government regulations concerning environmental care are becoming more stringent, also in regard to regulations and restrictions for depositing and storing dust and sludge generated in the iron- and steelmaking process.

These by-products such as iron-containing dust, sludge, oxide fines and scales as well as, for example, lime dusts become a valuable resource and recycling becomes a profitable activity within a plant. Up to 10% in mass of the total steel output of by-product materials are generated within an integrated steel plant with an iron content ranging from 50% to 65%. In DRI-based plants, a large amount of oxide fines, DRI sludge and DRI fines are generated, either as a result of the process itself or during material and product handling.

In many cases, these by-products may be used as feed material input in sinter plants without further processing, or sold at low value in order to avoid the space-consuming and sometimes costly option of depositing the materials in- or outside the plant.

However, in many DRI-based plants there is no sinter plant available for recycling, and the most effective way to make use of the materials is in the direct reduction plant as a partial pellet or lump-ore substitute. Not surprisingly, the reuse of these by-products in direct reduction plants is currently not state-of-the-art. Therefore, Primetals Technologies has performed comprehensive studies and tests on briquetting iron-containing by-products. To verify the physical stability and chemical reducibility of the briquetted material, extensive laboratory tests (e.g., static reduction tests) as well as field tests – so-called basket tests – have been performed and proved to be successful.



Recycling of ironmaking waste materials

ECO SOLUTIONS – SAVING RESOURCES, CREATING VALUE

Saving resources

- Reduction of raw material consumption and thus operating costs due to recycling of by-products (lump ore, pellets)
- Sinter, pellets or lump ore bring savings of up to 7%

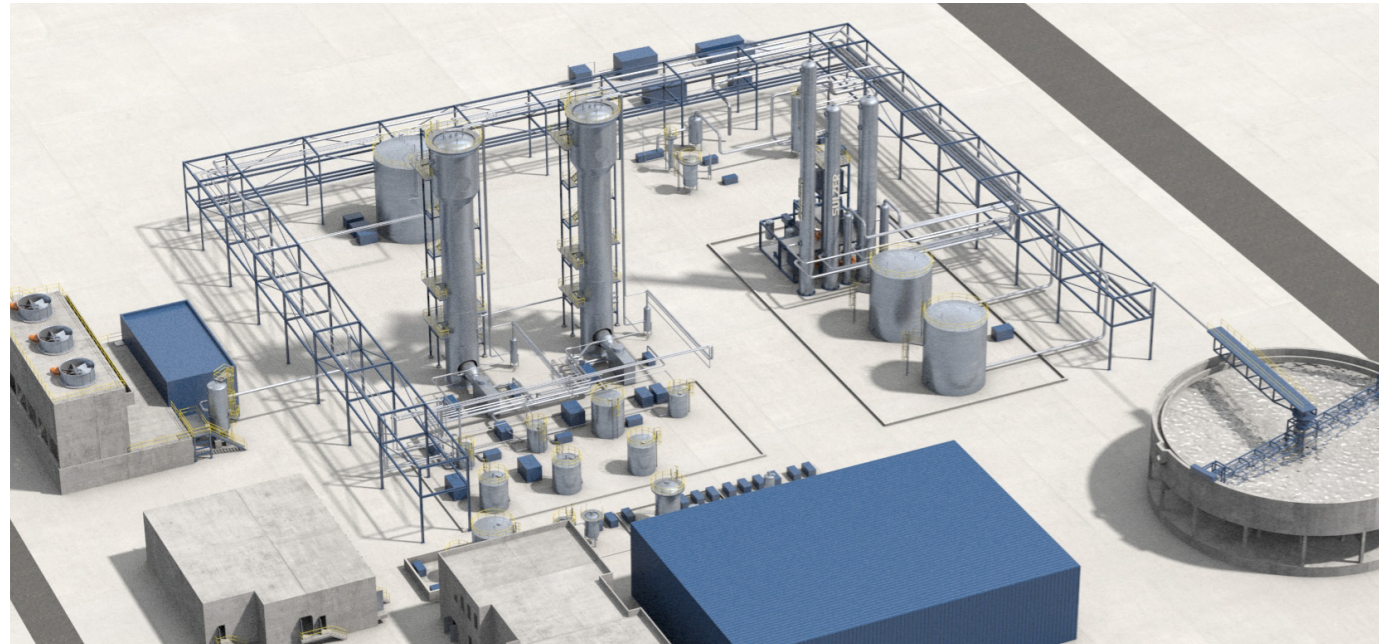
Creating value

- Minimization of landfill and transport costs
- Short payback period

17
SUCCESSFULLY
INSTALLED
PLANTS

GASFERM

GENERATION OF ADDED VALUE FOR STEEL MILL OFFGASES



3-D plant layout for a double train installation

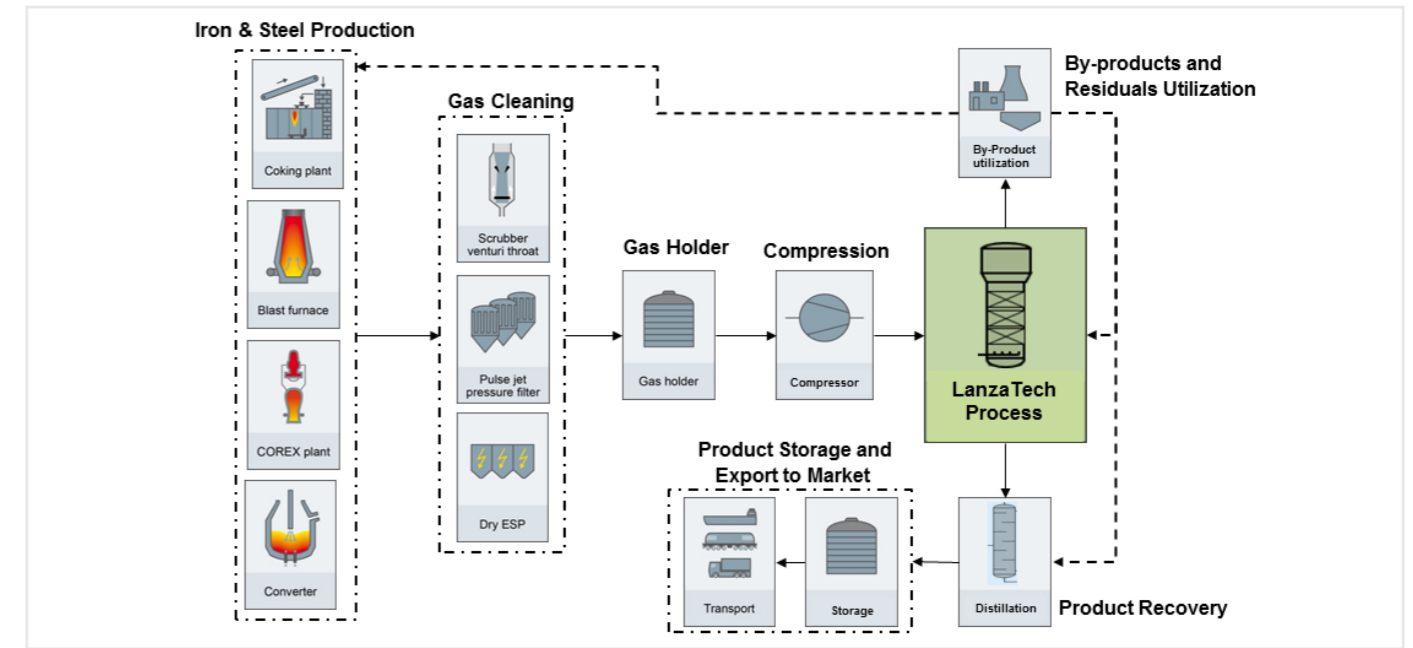
Recycling carbon emissions from steel mills provides an important new source for fuel and chemical production while simultaneously reducing a steel mill's carbon footprint. Offgases generated from iron and steel production contain significant amounts of carbon monoxide (CO), carbon dioxide (CO₂) and sometimes also hydrogen (H₂). Governments around the world are setting ambitious targets for reduction of stationary carbon emissions from industrial installations such as the steel industry, thereby adding significant costs to steel production.

GasFerm is a new development in offgas recycling that simultaneously addresses the need to reduce the steel industry's carbon footprint while improving a steelmaker's economic competitiveness through promotion of the circular economy.

Microbial fermentation of carbon and hydrogen-rich offgases, such as coke oven gas, blast furnace top gas, direct reduction gas and converter gas to produce ethanol or other basic chemicals, substantially mitigates CO₂ emissions while simultaneously reducing NO_x, SO_x and particulate emissions. The fuels and chemical products produced in this manner deliver superior economic returns. Greenhouse gas emissions from ethanol are up to 80% lower compared with conventional gasoline, and between 30% and 50% lower per MJ of energy recovered when compared with combustion for electricity generation.

This technology is developed by LanzaTech. Primetals Technologies is partner for plant implementation for the iron and steel industry.

4,5
I/Nm³ CO-Gas
ETHANOL



100% process gas recovery and utilization

MAIN BENEFITS

- Added value for carbon-rich co-generation gases
- Fuels and chemicals can be stored and globally traded, while electrical power cannot
- Chemical co-production adds diversification to the steel business
- GasFerm is a closed-loop, zero-waste process

ECO SOLUTIONS - SAVING RESOURCES, CREATING VALUE

Saving resources

- Minimum 30% reduction in carbon footprint vs. power generation
- Energy conversion efficiency is 60% compared with power generation efficiency of 35% to 40%
- No food-crop usage as in other ethanol processes

Creating value

- Net profit of ethanol produced is up to two times higher than electrical power generation
- 11 liters of ethanol per ton of liquid steel produced
- Project internal rate of return (IRR) in the range of 25% to 30%
- Production cost per liter of ethanol up to 25% lower than typical process for bio-ethanol production
- Produced biomass replaces coal in sinter or blast furnace (23 MJ/kg biomass)
- 100% process gas recovery and utilization



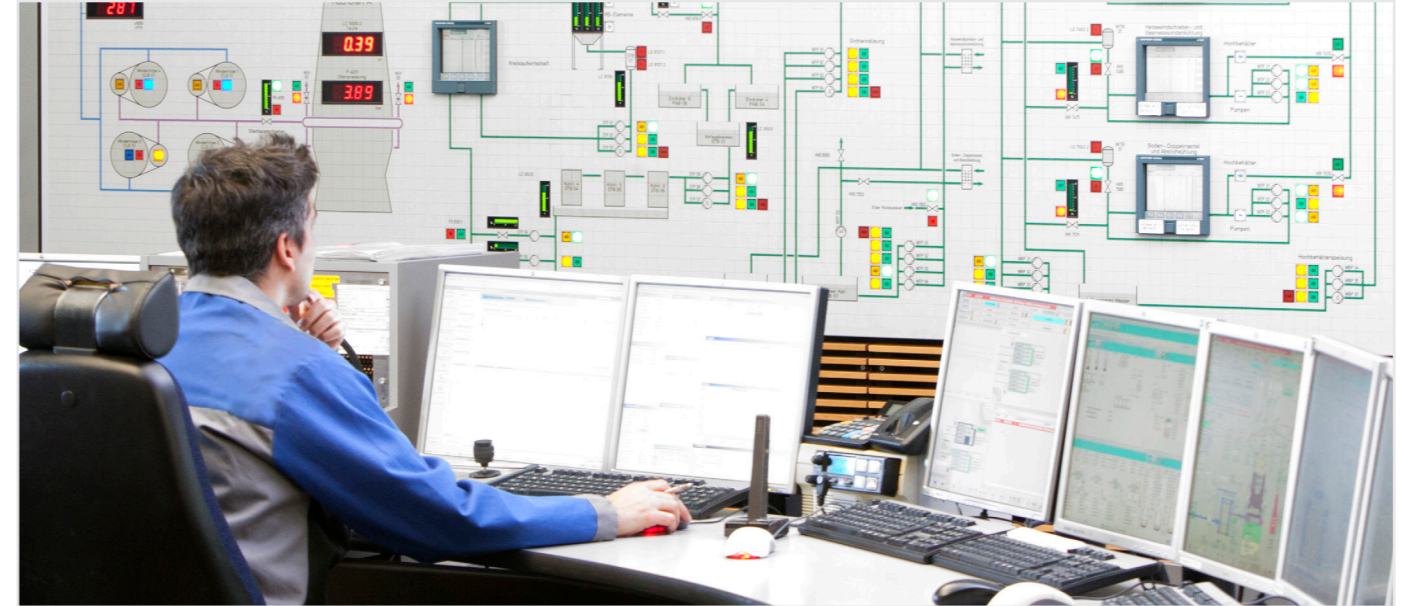
ELECTRICAL AND AUTOMATION SOLUTIONS



Electronic modules of the bag filter units



Acoustic Expert



Blast furnace control room

BAG FILTER CONTROL

The next generation of dedusting control is a flexible control of the whole system, from the damper to the stack, considering different operating points and combining the know-how of Primetals Technologies and the experience of operational personal:

Thanks to intelligent control system with electronic modules the Bag Filter Control optimizes bag filter operation, featuring significantly reduced cleaning air consumption as well as the detection of defect cleaning valves. A fast and reliable system with self-monitoring functions controls the cleaning valves, therefore increasing the life-time of valves and filter bags.

MAIN BENEFITS

- Automatic control of the entire bag filter system
- High efficiency of the bag filter cleaning process
- Pre-tested technological package including HMI, software and hardware
- Powerful electronics replace conventional relays
- Short implementation and commissioning time in new or existing bag filter
- Energy savings due to reduced cleaning air consumption
- Reduction of maintenance costs

ACOUSTIC EXPERT

In industrial plants a broad range of different equipment is used which has to be monitored and checked with high effort and different sensor strategies to guarantee it's proper function during the entire lifetime. The new Acoustic Expert system is based on measuring sound, an important property emitted by almost every device or process. With this acoustic diagnostic system, monitoring a plant gets a new dimension. Independent from all other sensor strategies now the automation systems get ears.

Typical fields of application are monitoring of bag filter plants, wear of gas tuyers, gas leakage detection in valve stations and all other applications emitting a specific sound.

MAIN BENEFITS

- Support for maintenance staff
- Preventive maintenance through trend evolution
- Easy integration in existing automation, thus no plant-shutdown for setup is needed
- Minimal hardware costs
- Immediate feedback to control system
- Reduction of unplanned plant shutdowns

HIGHEST PRODUCTION QUALITY AND COST-OPTIMIZED OPERATION - SINTER OPTIMIZATION

This system enables major cost savings and process improvements without compromising raw material selection, sinter quality, energy efficiency, and productivity. Optimized raw mix calculation allows the production of sinter material of the highest quality, while at the same time effectively reducing fuel consumption. Furthermore, the system provides a complete history of process parameters including recipe, chemical and physical raw material properties, and process measurements for a comprehensive analysis of the sinter process. The result is smooth sintering operation around the clock, an increased equipment lifetime and reduced production costs.

MAIN BENEFITS

- Monitoring of process measurements and indices becomes more efficient
- Process control practices become more uniform by using fully closed-loop operation on the basis of all provided expert system rules
- Higher productivity (increase by up to 5%)
- Stabilization of product quality (decrease of standard deviation by 5-10%)
- Reduced fuel consumption (decrease by up to 3%)

ENSURING SAFE AND COST-EFFICIENT OPERATION - BF OPTIMIZATION

The BF Optimization system was developed to operate the blast furnace in a standardized way at stable operating conditions. This closed-loop expert system corrects even small deviations by automatically executing the required counteractions. This leads to cost-efficient operation and energy-efficient production of hot metal (HM).

Stable process conditions are indicated by reduced standard deviation of quality parameters such as hot metal temperature or silicon content and result in reduced fuel consumption of the blast furnace. Core modules are product quality and energy efficiency rules, the procedures for shutdown and start-up, the 3D hearth monitoring package and the burden distribution model. At the same time, data management and analysis tools provide process engineers with a sound information basis for further process optimization.

MAIN BENEFITS

- Reduction of fuel consumption by 5 kg/t
- Increased productivity (up to 3%) HM
- Reduced standard deviation of HM temperature and Si content (by 10%)
- Stabilization of operation by avoiding critical situations

PROCESS & TECHNOLOGY CONSULTING

INCREASE PLANT PERFORMANCE AND REDUCE CONVERSION COSTS



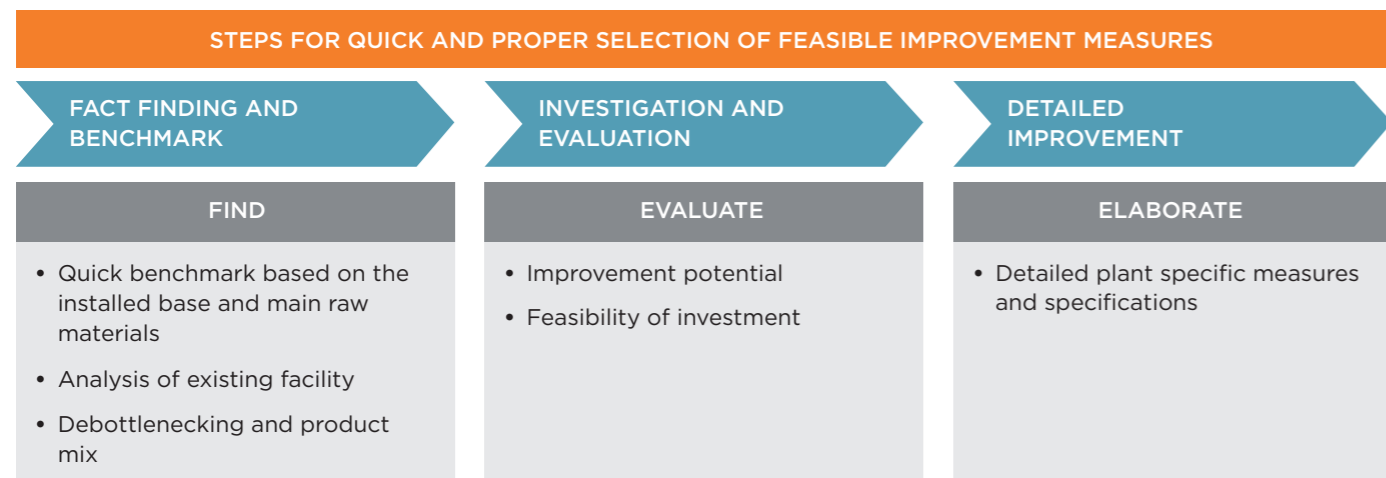
Consulting through out the whole metallurgical production chain.

PROCESS AND TECHNOLOGY CONSULTING

You can profit from our integrated process know-how and global presence. Process and technology consulting help increase plant performance and reduce conversion costs to support quick and proper selection of feasible improvement measures.

Primetals Technologies offers technology-consulting services that help operators to achieve and maintain high standards in production excellence.

On the basis of decades of experience in the engineering, installation, start-up and commissioning of steelmaking plants worldwide, our specialists are skilled in identifying potential for plant performance improvement in the course of a performance check. Detailed and individual concepts are proposed to optimize processes and adapt technological equipment to deal with different qualities of raw material. By implementing these measures, operators can ensure permanent production excellence and stay in line with environmental goals and remain cost effective.



LIFE CYCLE SERVICES FOR YOUR PLANT



OPERATIONAL SUPPORT

BENEFIT FROM OVER 50 YEARS OF EXPERIENCE

Comprehensive services for metallurgical plants, from the supply of original manufacturer components, spare and wear parts to consulting, technical assistance and training.



PLANT UPGRADES

LOW INVESTMENTS FOR STATE-OF-THE-ART TECHNOLOGY

Decades of experience worldwide in design, manufacturing and commissioning as well as consulting services for metallurgical plants ensure clients receive innovative modernizations and mechatronic solutions for their processing chain.



MAINTENANCE SERVICES

ON- AND OFFLINE MAINTENANCE AND REPAIR SERVICES

With a wide-ranging international network of customer support experts and worldwide repair and maintenance workshops, Primetals Technologies is your ideal single-source partner for maintenance services.

With a portfolio consisting of operational support, plant upgrades and maintenance services, you can focus on your core business while Primetals Technologies assures your plant's optimum performance.

With fast, reliable and experienced service and support for the metallurgical industry, Primetals Technologies strives to be a long-term lifecycle partner dedicated to your success. We offer a full range of services across the entire lifecycle of your plant, including consulting and technical assistance directly from a single provider. Our service portfolio covers all aspects: spare parts service available at just the right time; advanced staff training and technical support; component upgrades to ensure plants are technically up to date; repair service of key components for a longer lifecycle; and on- and offline maintenance. Our services reduce costs, increase productivity, improve product quality and ensure safety.

REFERENCE PLANTS HIGHLIGHTS



MEROS PLANT

Customer
voestalpine Stahl Linz, Austria
Type of plant
MEROS plant in combination with SWGR

OUR SOLUTION

A fully satisfactory, environmentally compatible solution for the treatment of the offgas arising during the sintering process has not existed until now. In response to this challenge, Primetals Technologies developed the MEROS process. In a series of successive treatment steps the dust and harmful metallic and organic components present in the sinter offgas are removed to levels previously unattained with conventional gas treatment techniques.

TECHNICAL DATA

Gas Flow:
650,000 Nm³/h

Clean gas dust content:
< 5 mg/Nm³

SO₂ removal:
technically up to 98% SO₂ possible

Dioxin clean gas content:
< 0,1 ng/Nm³



SINTER COOLER HEAT RECOVERY - SINTER PLANT #3

Customer
Dragon Steel Corp., Taiwan
Type of plant
Sinter cooler heat recovery

OUR SOLUTION

Dragon Steel Corp. was interested in recovering waste heat from the cooling process of the sintered material and utilizing it for different on-site applications.

Primetals Technologies supplied an efficient waste-heat recovery system that extracts the usable portion of the available waste heat from the circular cooler and subsequently converts it into process steam with a dedicated steam boiler.

TECHNICAL DATA

Gas Flow:
500,000 Nm³/h

Gas temperature:
335 °C

Steam production:
31 t/h

Steam pressure:
19.0 bar(g)

Steam temperature:
274 °C



ROOM DEDUSTING

Customer
ILVA SpA, Italy
Type of plant
Sinter room dedusting

OUR SOLUTION

The secondary dedusting systems are able to clean 1,5 mio m³/h each and reduce dust emissions from the sinter plants to less than 10 mg/Nm³ by application of Pulse Jet Filter technology. The new dedusting system is featuring long-life bag filters and will replace the existing systems, which are based on technically obsolete electrostatic precipitators.

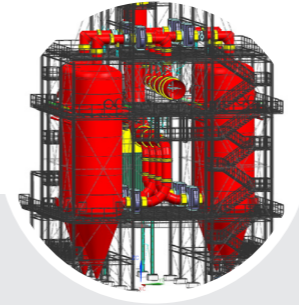
TECHNICAL DATA

Off-gas Volume:
2 x 1.500.000 m³/h

Dust emission:
less than 10 mg/Nm³

Noise pressure level:
max. 85 dB(A)

Average lifetime of bags:
minimum 2 years



MERIM - KARDEMIR

Customer
Kardemir A.S., Turkey
Type of plant
MERIM plant for blast furnace incl. top gas temperature control

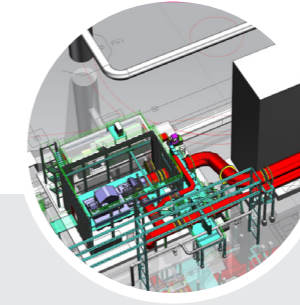
OUR SOLUTION

Primetals Technologies was responsible for the whole plant engineering as well as the supply of critical key components and supervision services during erection and commissioning. The clean gas content is max. 5 mg/Nm³ and, due to the dry gas cleaning technology, approx. 25% more electrical energy can be recovered at the downstream installed top gas recovery turbine. The plant went into operation on January 14, 2015.

TECHNICAL DATA

Blast Furnace Data:
Volume: 1650 m³
Production: 1.2 mt/y

Top gas data:
Volume: 400,000 Nm³/h
Pressure: 2,5 bar(g)



TOP GAS RECOVERY TURBINE

Customer
Vulkan Energiewirtschaft Oderbrücke GmbH
Type of plant
Top-gas recovery turbine installed at Arcelor Mittal Eisenhüttenstadt

OUR SOLUTION

The top gas pressure recovery turbine from a European source provides highest efficiency, availability, and enables the customer to recover the maximum amount of electrical energy.

TECHNICAL DATA

Blast Furnace Data:
Volume: 300,000 Nm³/h
Pressure: 1.6 bar(g)

Turbine:
Power: 6.99 MW
Speed: 3,000 rpm
Possibility for on- and offline washing

Synchronous generator:
Power: 8.44 MVA
Speed: 3,000 rpm / 2 pole



BRIQUETTING - ILVA TARANTO

Customer
ILVA SpA, Italy
Type of plant
2-line cold-briquetting plant

OUR SOLUTION

For the recycling of dust and sludge generated during iron and steelmaking processes the fines need to be agglomerated to form a stable product that can be recycled in the primary processes. Primetals has developed a process including drying of reactive sludge, mixing and briquetting that produces a stable briquette using a minimum amount of binder. The briquette product is used in the blast furnace for substitution of sinter and in the LD(BOF) converter to substitute cooling ore and scrap.

TECHNICAL DATA

Design capacity:
approx. 45 t/h
(Design: 240,000 t/y)

Binder system:
molasses/hydrated lime

Briquettes used in BF & LD(BOF) process (approx. 50%)

LD(BOF): approx. 4 t/heat
BF: approx. 1% of burden

Primetals Technologies Austria GmbH

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