PRIMETALS TECHNOLOGIES

MERIM
MAXIMIZED EMISSION REDUCTION AND ENERGY RECOVERY IN IRONMAKING

ADVANCED TOP GAS CLEANING FOR BLAST FURNACES, FINEX AND COREX

YOUR CHALLENGE

Demands placed on availability, product quality and productivity of ironmaking plants are continuously increasing, and these can only be met with advanced solutions suitable for the rugged iron- and steelmaking environment. At the same time, stricter environmental regulations necessitate extensive investments, and these are having a direct impact on ironmaking plants with their high quantity of environmental emissions.

As plant designers, our job is to offer the best possible solutions that simultaneously satisfy environmental requirements and economical necessity. While there is significant market potential for new investments in the growing markets of eastern Europe, Asia and India, industrial nations are focusing more on plant modernizations and reducing the environmental impact.

Conventional wet-type top gas cleaning technologies have a high water demand and require expensive sludge and waste water treatment. In addition, wet cleaning leads to substantial pressure and temperature drops which result in reduced efficiency of the downstream top gas recovery turbine.

OUR SOLUTION

A fully satisfactory, environmentally compatible solution for the treatment of top gas from the ironmaking process has not existed until now. In response to this challenge, Primetals Technologies recently developed the MERIM process, which stands for Maximized Emission Reduction and energy recovery in IronMaking. In a series of successive treatment steps the dust in the offgas is removed to levels previously unattained with conventional wet-type top gas-treatment techniques.

The MERIM is mainly designed for blast furnace top gas cleaning but can also be successfully applied for Corex and Finex. The new system includes a cyclone for coarse dust separation and a high-performance fabric filter for fine dust removal. In order to solve the problem of temperature fluctuations in the top gas, Primetals Technologies developed a gas conditioning concept which allows for safe operation even at extreme low and high temperatures. This system consists of a burden burner and an advanced burden spray system.

Using this green solution, energy consumption and land filling can be reduced to currently unachieved levels. The cleaned gas meets both current and future emission regulations and the CO_2 footprint can be significantly reduced.

THE LIFECYCLE PARTNER

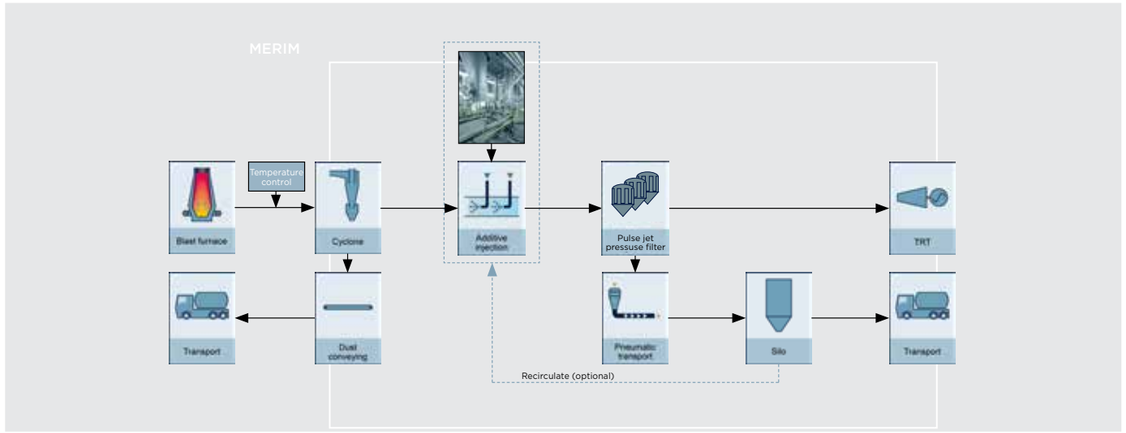
Primetals Technologies is one of the world´s leading lifecycle partners for metals industry. We offer a comprehensive technology, modernization, product and service portfolio as well as integrated automation and environmental solutions covering the entire life cycle of plants to improve our customers´competitveness.

High energy recovery potential in combination with low investment and operating costs compared to wet-type solutions for blast furnace top gas cleaning.

ADVANTAGES OF MERIM:

- No sludge and waste water treatment necessary
- Clean gas concentration of < 3 mg/Nm³ achievable
- 20 to 30% higher energy output from top gas recovery turbine due to higher process temperatures and lower pressure losses
- Easy reutilization and handling of by-products
- Lower operating and investment costs compared to wet solutions (e.g. electricity, water)
- Less maintenance and increased availability
- Less space requirements (about 40 to 60% less compared to a complete wet-type installation)
- Advanced emission control (e.g. HCl, H2S) is possible due to additive injection and dust recirculation

MERIM
TOP GAS CLEANING PROCESS WITH HIGHEST ENERGY RECOVERY



Typical MERIM process

PROCESS DESCRIPTION

In the first step of the MERIM process, optimized coarse dust separation takes place in a cyclone. Thanks to the design of the cyclone, the recyclable fraction is enriched and the fraction for waste that contains zinc is minimized.

The heart of the process is the set of pulse jet pressure filters where fine dedusting takes place. In this step, the gas enters several pressure-resistant filter vessels where the dust is collected on high-performance filter media. The removed dust is discharged through the bottom of the filter and transported via a pneumatic conveying system to a storage silo.

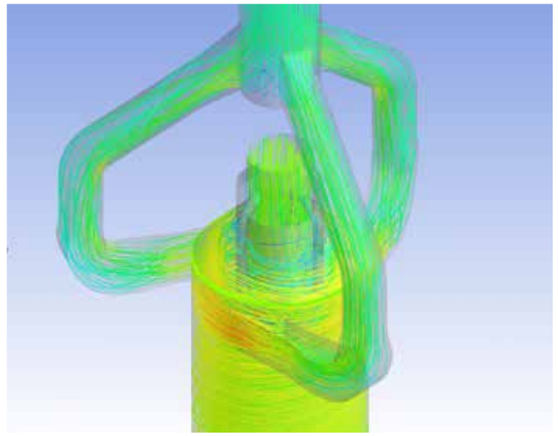
The cleaned top gas then enters the top gas recovery turbine. The dry solution has a 20% to 30% higher energy output compared to common wet-type dedusting systems due to higher process temperatures and lower pressure losses. Depressurization valves (Septum Valves) are also installed to control the furnace pressure when the top gas recovery turbine is not in operation.

The temperature control unit consists of a burden burner and burden spray system that ensures that a specific temperature range (usually 100-250°C) is maintained. This prevents damages to the fabric filter and gas ducts.

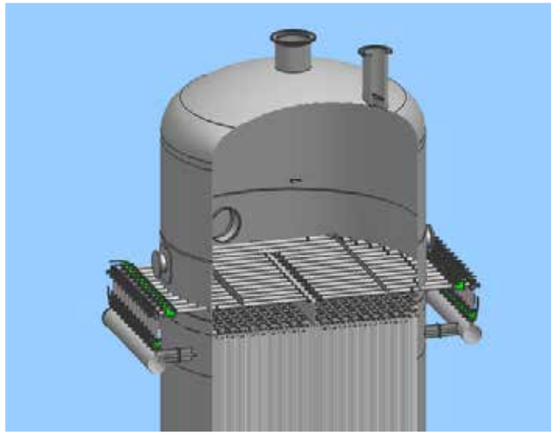
Optionally, an additive dosing station and a recirculation system can be installed. A mixture of recirculated dust and additives can be injected into the raw gas stream in front of the fabric filter for the removal of other harmful gas components (e.g., HCl, H2S).

Blast furnace top gas cleaning is normally carried out in a two-stage dedusting process that comprises of a dust catcher or cyclone (first stage) and a scrubber. Waste water must then be treated in a dedicated water treatment plant.

With MERIM the whole waste water treatment can be avoided, operating costs and space requirements are reduced and the dust and harmful components present in the offgas are removed to very high levels.



3-inlet cyclone



Pulse jet pressure filter

CYCLONE

In this step, the offgas passes through a cyclone designed to ensure an optimized separation into recyclable dust and fine dust with a high zinc fraction. This maximizes the dust collecting efficiency and thus reduce the dust load at the filter. Thanks to the new three-inlet cyclone design, the downcomer can be supported centrally through the cyclone vessel and maintenance is made significantly easier.

Approximately 85% of the dust is removed in the highly efficient cyclone and thus optimize iron recovery. The generated dust can be easily reused in the sinter plants. However, not all top gas dusts are suitable for recycling in the ironmaking process. High concentrations of heavy metals in the burden, especially zinc, can potentially affect blast furnace operation. Therefore, this optimized dust separation device in the first stage of top gas treatment is important from an operational and cost perspective.

MAIN BENEFITS

- Separation efficiency of approx. 85%
- Minimization of landfill costs
- Adjustable separation efficiency for optimal zinc separation

PULSE JET FILTER

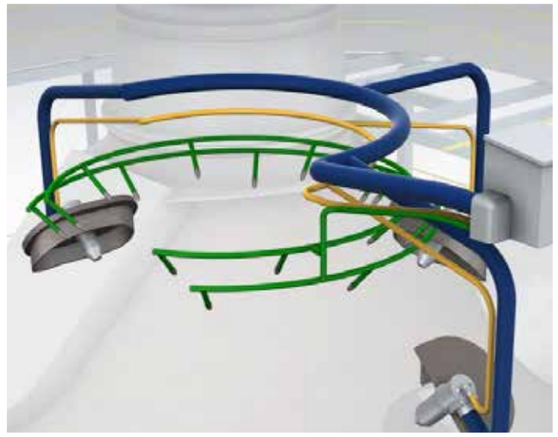
In a next step, precleaned gas from the cyclone is carried to the pulse jet filter. This system consists of several pressure-resistant vessels which contain a number of filter bags. The dust particles remain on the outside surface of the filter cloth and the filter cake is built up at the surface of the membrane. The design of the filter media and its membrane ensure a high separation efficiency.

When a certain pressure drop is reached over the filter, the N2 pulse jet system is activated and the filter cake falls off the cloth surface. The separated dust is collected in the filter hoppers and further transported to the residue silo via pneumatic or mechanical dust conveying systems.

The cleaned top gas from the filter vessels is collected in a main duct which guides the gas stream directly into a top gas recovery turbine where the high energy content of the clean gas is converted into electricity.

The pressure drop at the fabric filter is lower than 20 mbar (average 15 mbar), which is for less than the pressure drop at a scrubber. Together with a lower temperature loss at the fabric filter, this leads to a 20 to 30% higher energy output at the top gas recovery turbine.

MERIM
STEP BY STEP TO HIGHER ENERGY OUTPUT



Temperature control unit

Additive dosing station

TEMPERATURE CONTROL

Special attention must be paid to the top gas temperature, as the filter bags can only work properly in a temperature range of 100°C to 250°C. Primetals Technologies has developed a top gas conditioning concept which allows for high and low temperatures. This concept comprises of a burden burner and an advanced burden spray system.

BURDEN BURNER

- Prevents condensation at the filter cloth - avoids clogging
- Corrosion protection of gas ducts and gas cleaning equipment
- High velocity burners achieve optimized temperature distribution in the top gas

BURDEN SPRAY

- Fast temperature control due to fine water droplet distribution
- Protects gas ducts and gas cleaning equipment against high temperature impact during slips
- Less water required compared to common burden sprays
- No wetting of the burden due to fast and effective evaporation of the water droplets

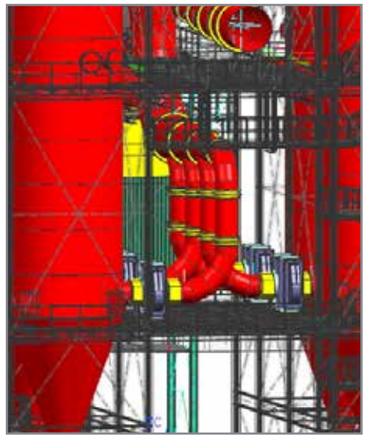
ADDITIVE DOSING AND INJECTION (OPTION)

In the additive dosing station, additives and recycled dust can be mixed. The mixture is then injected into the raw gas stream in front of the fine dedusting fabric filter. Depending on the gas cleaning requirements, different additives can be used.

MAIN BENEFITS

- Gas components such as HCl or H_2S can be removed
- Dust recirculation allows for higher exploitation of the additives
- Longer filter bag lifetime due to fast filter cake generation

REFERENCES
MERIM PLANTS



Filter vessel

Pilot plant for COREX

Pilot plant for FINEX

MERIM PLANT FOR KARDEMIR A.S., TURKEY

In the year 2012 Kardemir A.S. ordered a MERIM plant including top gas conditioning system for their new Blast Furnace #5. The furnace is having a working volume of 1650 m^3 and is producing around 1,2 mio tons of Hot Metal per year. The dry top gas cleaning plant is designed for a gas volume of max. 400.000 Nm^3/h and top gas pressure of max. 2,5 bar(g).

Primetals Technologies was responsible for the whole plant engineering as well as supply of critical key components and supervision services during erection and commissioning.

The clean gas content is max. 5 mg/Nm^3 and due to the dry gas cleaning technology approx. 27% more electrical energy can be recovered at the downstream installed Top Gas Recovery Turbine (TRT).

The plant went into operation on Jan. 2015.

MERIM PLANT FOR JSW

High-pressure gas cleaning for Corex gas based direct reduction plant
The top gas from the Corex plant is cleaned by three filter vessels in order to achieve very low clean gas dust concentrations to reduce abrasion at the gas compressors. The cleaned gas is subsequently used at the Midrex plant to produce hot DRI.

Technical Data:

- Volume: 600,000 Nm^3/h; 1 bar(g)
- Clean gas dust concentration <5.0 mg/Nm^3

PILOT PLANT MERIM FOR FINEX

A pilot installation at an ironmaking plant designed to treat 6,000 Nm^3/h of offgas was installed to better investigate the dry dedusting filter system.

HANDLING OF EXTREME SITUATIONS

- Temperature permanently >220°C
- Dust load of 20 to 40 g/Nm^3
- High content of (sticky) hydrocarbons >250 ppm
- Fine particles of D(v,0.90) 20 µm and D(v,0.5) 8 µm

During testing, a clean gas dust concentration of <1 mg/Nm^3 was achieved, which shows that the fabric filter system is capable of meeting top gas cleaning requirements.

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