Latest generation dry blast furnace gas cleaning technology

Dry blast furnace gas cleaning technology offers great economic advantages when compared with traditional wet gas cleaning due to its improved energy efficiency, lower cost, reduced plot space, and practically eliminated water consumption. Given the improved operational economics and – in some areas – the physical or economic scarcity of water, steel producers are shifting towards the application of dry blast furnace gas cleaning systems, in which the wet scrubber is replaced with a dry secondary gas treatment stage.

The Danieli Corus solution is based on proven technology that has been applied numerous times for cleaning aluminum smelter gases and anode baking fumes. The system consists of a gas conditioning tower, reagent injection system and (pressurized) filter modules with low pressure pulse cleaning. Currently, Danieli Corus is implementing this technology for three greenfield blast furnaces in India.

This article presents the advantages of the proven technology as well as some improvements that will be applied during the ongoing projects. These improvements include steam reheat of (cold) blast furnace gas, single phase water injection in the conditioning tower and two-stage countercurrent absorbent injection.

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Fig 1 **Blast furnace dry gas cleaning**

The trend of changing from wet- to dry gas cleaning systems has been ongoing for more than 40 years. One of the first industries to shift from wet to dry gas cleaning was the primary aluminum industry. Danieli Corus has been involved in dry gas cleaning technology since the 1980s and has constructed several dry scrubbing systems for reduction lines, anode baking furnaces, green mill plants and bath facilities. The gas flows in these different areas range from 10,000 to 3,000,000Am^3/h. Within the iron and steel industry this trend has also gained attention; some sinter plants and pellet plants have been equipped with dry gas cleaning facilities**[1]**. Until recently, only blast furnaces in China and some in Russia and India were equipped with dry gas cleaning systems, all of which were built by Chinese companies**[2]**. Western companies also tried to enter this market but were not successful.

Danieli Corus has adapted dry gas cleaning technology from the primary aluminum industry such that it is suitable for the iron and steel industry (*Figure 1*). The first three dry gas cleaning systems for blast furnaces at BMM and AMNSI are now being built. The size and technology used is very similar to the so-called Fume Treatment Centre (FTC), the midsize gas cleaning technology for the anode baking furnaces for which Danieli Corus is market leader.

DRY GAS CLEANING

So why has dry gas cleaning gained so much attention? The first adopters of dry gas cleaning for blast furnaces were the Chinese. The main reason that they changed from wet to dry systems is that they were forced by the government who wanted to stop environmental pollution**[3]**. Wet gas cleaning systems generate a wastewater stream that creates environmental issues in the rivers in which the wastewater was dumped. Also, the shortage of water contributed to this change in China. It was noticed that there were several other benefits of this new dry gas cleaning technology. The footprint of the new systems was much smaller compared with the wet systems. The settlers, pump buildings, and sludge dewatering equipment were no longer needed. Another benefit was that the output of the Top-Gas Recovery Turbine (TRT) increased by 20% to 30%, as the volume of the dry gas was significantly higher.

The handling of the dry dust from the dry gas cleaning system also proved beneficial. Sticking sludge in bins and storages area was avoided and less energy was consumed in the sinter plant as the water in the sludge no longer needed to be evaporated.

There are several tasks that the dry gas cleaning plant must perform:

1. Removal of the coarse dust.
2. Temperature conditioning of blast furnace (BF) gas.
3. Removal of the gaseous pollutants by means of absorption.
4. Separation of the fine dust and spent absorbent from the BF gas stream.
5. Expansion of the BF gas / top gas pressure control.

The challenges for dry gas cleaning are in the particle size of the dust, the gaseous pollutants present in the BF gas and maintainability of the equipment, as described here.

Cyclone Dust Catcher

The first step in the dry gas cleaning process is the Cyclone Dust Catcher. Due to centrifugal forces ~85% of the dust is removed in this step. This represents the coarse dust fraction and is recovered at the bottom of the Cyclone Dust Catcher. This coarse dust contains valuable iron and carbon which can be recycled straight back to the sinter plant. The fine dust typically contains zinc, lead and cadmium – unwanted substances if present in large quantities**[4]**. The Cyclone Dust Catcher has no effect on the gaseous pollutants (HCl, HF, HCN, CNS, H_2S) in the BF gas. These pollutants will all be transported to the next step of the dry gas cleaning: the gas conditioning step.

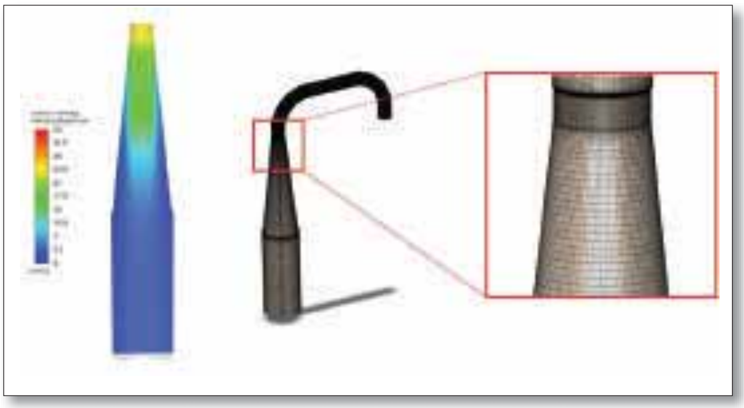

Fig 2 **Conditioning tower**

Gas Conditioning

The conditioning of the BF gas relates to the temperature of the BF gas. If the furnace runs well, there is no need to condition the BF gas and the gas can go straight to the absorbent injection step.

Cooling: Conditioning Tower

If the gas temperature is too high the gas needs to be cooled down to protect the filterbags from burning or melting. The most dangerous event is a burden slip in the blast furnace that produces very hot gas and lots of dust. The duration of this event is typically 15 to 20 minutes, before everything is back to normal. The conditioning tower is designed to handle such a sudden increase in temperature. This conditioning tower is positioned after the cyclone and the gas enters at the top of the tower (*Figure 2*). Injection of small water droplets by means of spring-loaded nozzles cools down the BF gas.

The retention time in the conditioning tower is such that all the droplets are fully evaporated. The water flow towards the spray nozzles is controlled by means of a VFD operated pump

Fig 3 **Shell and tube heat exchanger**

that monitors the inlet and outlet temperature of the conditioning tower. The controlled outlet temperature of the conditioning tower is set at 150°C. Once the temperature excursion is over, the pump and sprays will stop automatically.

At the bottom of the conditioning tower a gas diverter is installed (Chinese Hat) which forces the gas into two 180° bends. Any oversize dust or coagulated dust is not able to make these turns and will drop out towards the bottom of the conditioning tower where the oversize dust will be evacuated through a sluice system. As the BF gas has already past the cyclone, only small dust particles of <40μm will enter the conditioning tower. Due to their small size, nearly all will leave the conditioning tower as well.

Heating: Steam Heater

It could happen that the BF gas temperature becomes too low, and water starts to condense which could cement / block the filter cake on the filterbags. The most likely cause of this happening is wet burden material. The preferred response to this event would be to change the operating parameters of the BF such that the top gas temperature returns to normal values. One customer requested to solve the issue of the cold BF gas in another way: by reheating the BF gas.

Initially, the client requested a reheat burner that would inject hot combustion gases into the BF gas. After studying this concept, it was concluded that this solution could entail serious risks and disadvantages:

1. Hot combustion product could cause co-combustion in the BF gas and therefore large quantities of cooling nitrogen could be required.
2. Hot combustion product will dilute the BF gas and lower the calorific value. The stoves would become colder which would result in colder BF gas in a downward spiral.
3. "Open" connection combustion air at the BF is considered a safety risk.
4. The power consumption of a booster to pressurize the BF gas and combustion air is around 33% of required heat input – a waste of energy.

Together with the customer it was decided that a steam heater would be a much more reliable and safe solution. The starting point of the design was that the steam heater would be in operation during the monsoon season, which is typically 3 to 4 months. This would allow for cleaning and maintenance work in the dry period of the year. Another reason to select this type of heater was the availability of MP steam on site. With the help of steam heater specialists, a shell and tube heat exchanger was selected in which the steam flows through the tubes and the BF gas flows through the shell (*Figure 3*). The shell and tube exchanger will be placed in a bypass duct between the conditioning tower and the bagfilter modules. Two sets of dampers on the inlet and outlet of the heat exchanger and a set of dampers in the main gas line allow the operator to take the heat exchanger in and out of operation during production.

Damper Configuration

The two dampers in the main gas line are positioned close to the T-connections. This should prevent any dust build-up in the main gas line during the time the steam heater is in operation. However, there will be a stagnant piece of duct that will cool down and the risk of condensation / corrosion is possible. The type of dampers chosen are louvre dampers and these cannot seal 100%. In the stagnant part of the duct, the surplus of hot BF gas from the pulse cleaning boosters will be injected. This ensures an overpressure (relative to the BF gas pressure) in the stagnant piece of duct and provides heat input. The injected gas will leak through the louvre dampers into the main gas line. This would also prevent dust from the main gas line entering the stagnant part of the duct.

The butterfly dampers at the inlet and outlet of the heat exchanger are used for the hot switch over from normal to re-heat operation and back. Once the heat exchanger is out of operation, both goggle valves can be closed to isolate the heat exchanger from the main gas line. Depressurization, nitrogen flushing and venting equipment is foreseen in the design.

Steam Heater Design

The incoming BF gas is split into four portions and equally distributed over the area of the heat exchanger. The velocity of the BF gas towards the heat exchanger speeds up to prevent any dust drop out and improves the heat exchange coefficient of the heater. At design conditions the velocity at the inlet of the heat exchangerwill be 40 m/s. Although the cyclone dust catcher removed most of the dust, there is still 2-4 gr/Nm^3 of dust present in the BF gas. At velocities of 40 m/s this dust could cause corrosion of the steam bundles. Impingement rods at the inlet are foreseen to counter this threat. High pressure nitrogen soot blowing is also provided to remove any deposits from the steam pipes. For maintenance, the complete steam pipe bundle could be extracted from the shell. Due to the weight of the heat exchanger, steel wheels are proved and there is an internal rail system within the heat exchanger.

Specialized bundle pulling companies**[5]** can remove, clean and re-install the bundles in a matter of days (*Figure 4*). Spare bundles could reduce the downtime of the heat exchanger even more. Once pulled, the bundles can easily be inspected and cleaned. Access ports on the inlet / outlet and the shell of the heat exchanger ensure proper access.

CFD models have been made to ensure the proper gas distribution and to track the behavior of the dust particles within the complete re-heat system (*Figure 5*).

Absorbent Injection

From literature it is known that the acid components in the BF gas at dry gas cleaning systems can create significant damage in the ducting after the expansion of the BF gas**[6] [7]**. It is therefore required to remove the acid components in the pressurized part of the Dry gas cleaning. Hydrogen Chloride (HCl), which is a strong acid, is easy to remove with →

Fig 4 **Removal and installation of bundles**

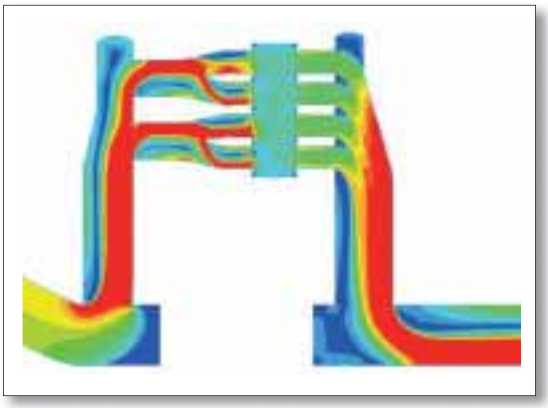

Fig 5 **Heat exchanger CFD model**

Fig 6 **Vertical radial injector**

a lime-based product. The weaker acids, such as HCN, CNS, H_2S will also be captured, but less efficiently compared to HCl. As these weak acids will create SOx and NOx emissions once they are burned (in stoves and boilers), effort was made to increase the removal of the weak acids as well.

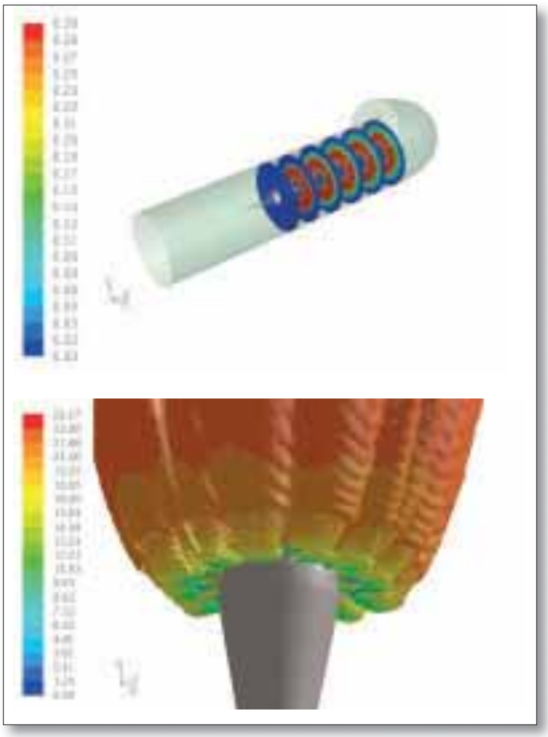

Fig 7 **Counter-current gas scrubbing**

Fig 8 **Schematic of VRI**

Vertical Radial Injector

The Vertical Radial Injector (VRI) is a proprietary piece of equipment that ensures a very good distribution of the absorbent into the gas stream (*Figure 6*). The VRI has been successfully used in the primary aluminum industry for more than 40 years. The diamond shaped VRI is hollow, has a very low pressure drop and distributes the absorbent through holes positioned in the circumference of the diameter into the (vertical) BF gas flow. Each Baghouse module is equipped with one VRI.

In the vertical duct leading towards the baghouse modules, the absorbent is fully airborne, and the complete surface area of the absorbent particle is exposed to the BF gas and the pollutants. From the aluminum projects it is known that within 0.5s, more than 90% of the pollutants are captured in the duct leading towards the baghouse.

In the baghouse the dust and absorbent are separated from the now clean BF gas. The dust and absorbent are collected in the hopper of the module. A large part is recycled back towards the VRI to ensure full usage of the injected absorbent.

The fresh absorbent is injected directly into the baghouse module. This creates a two-stage counter-current gas scrubbing effect where the bulk of the pollutants is captured with recycled material and the polishing is done with fresh absorbent, thus creating the highest possible removal efficiency (*Figure 7*).

VRI Design

As the VRI is in the pressurized part of the gas cleaning plant, it needs to be able to withstand the pressure of the BF gas. The internal and external part of the VRI is hollow. The recycled absorbent is fed to the external part and needs to be moved to the internal part. This is done by fluidizing the content of the VRI with the use of a fluidizing element, which runs all the way from the entrance to the diamond shaped part (*Figure 8*).

As the content of the VRI element is fluidized, there is a level present, which can be monitored on the sight glass. The content is therefore not pushed into the gas stream but flows into gas stream. This prevents wear of the VRI holes.

Absorbent Requirement and Recycle Rate

Depending on the raw materials used in the blast furnace, the lime consumption for a medium size Blast Furnace is estimated between 100 and 200 kg/h. This amount is injected straight into the baghouses and is intended as second stage / polishing step. This lime which still has scrubbing capacity left in it combined with the captured BF dust, is collected at the hopper of the bagfilter module. A screw brings the absorbent and dust towards the VRI where it is (re)-injected in the gas flow. The design is such that the recycle is 5 to 10x the fresh absorbent flow. This ensures proper utilization of the injected lime. The recycle screw is equipped with a VFD, so that the recycle rate can be adjusted during operation.

Concerning the dust load towards the filters: this recycle increases the dust load to values of 30 to 40 gr/Nm^3 of dust and absorbent. Compared to primary aluminum gas cleaning, where values of 600 gr/Nm^3 are normal, this value is therefore considered small.

BAGHOUSE MODULES

Configuration

The ideal number of baghouse modules is six. The size of the baghouse modules may differ, but for each volume of blast furnace it is possible to have six standard size modules in an N-1 configuration (*Figure 9*). In the N-1 configuration it is possible to take one module out of operation and maintain full BF gas flow. It is required to minimize the duration of the stop and to put the module back online as soon as possible. The main reason for doing this is to keep the module at its operating temperature and limit the pulsing frequency.

Temperature

The dust and absorbent that is used are hygroscopic. If the temperature of the module becomes too low, water may condense and react with the dust, creating a solid layer of dust which is almost impossible to remove. At a situation where N+1 is used, it is necessary to remove the dust (cake and hopper-content) completely, isolate and dry the module with (heated) nitrogen. If the spare module is put online, it will temporarily create an uneven distribution of the BF gas and cause increased dust levels in the clean gas due to the absence of a filter cake. It will take several hours to restore normal operation.

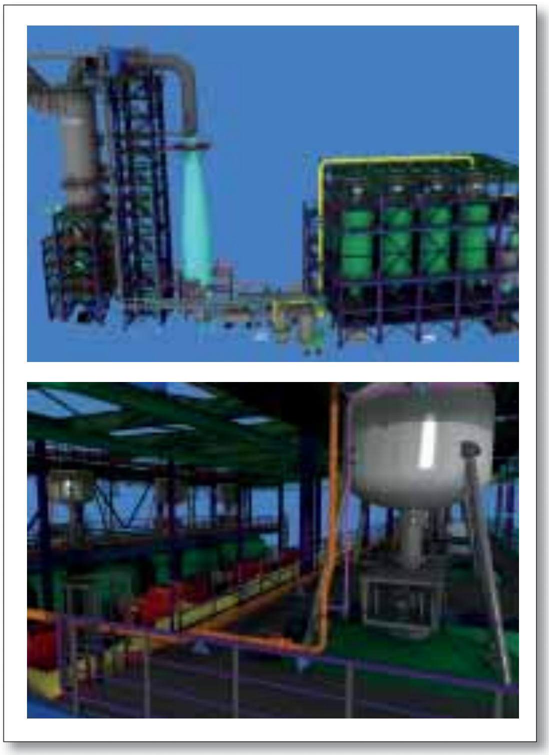

Fig 9 **Baghouse modules**

Pulsing Frequency

When all bag filter modules are in operation, a certain pulse frequency is required to maintain the set differential pressure. This pulsing of the filterbags is the main cause for the wear of the filterbags. After so many thousand pulses the fibers in the filterbag will tear and create holes. With N modules in operation the available filter area is 120% as shown in *Figure 1*, while with N-1 operation the total filter area is reduced to 100%. A reduction in the filtration area of 20% will result in an increase in pressure drop of (120/100)2 = 44% at a constant BF gas flow. The required number of pulses increases linearly with the pressure drop and consequently, the bag filter lifetime will decrease at the same rate.

Fig 10 **LPP cleaning system**

Low-Pressure Pulse Cleaning

For cleaning of the filter bags, Danieli Corus implemented Low-Pressure Pulse (LPP) cleaning technology, one of the key features of the DC designed aluminum reduction line gas cleaning plant. In contrast to the High-Pressure Pulse (HPP) cleaning system that is typically applied in dry gas cleaning plants, the LPP cleaning system pulses the bags using a low pressure (0.5-1 bar above the process pressure) and high gas volume. The advantage of the LPP cleanings system is that the pulse gas will be more evenly distributed over the bag which makes the cleaning more efficient compared to HPP cleaning which uses a high-pressure shockwave to pulse off the dust. The gentler pulse of the LPP system will also have a positive effect on the filter bag lifetime as it reduces the wear rate.

The LPP cleaning system consists of a rotating shaft with two or three pulsing manifolds which are located inside the baghouse, just above the tube sheet (*Figure 10*). The motor and gearbox are located on top of the bagfilter module and provide for a continuous rotation of the pulse cleaning arm at a very low speed of approximately 1rpm. A quick opening diaphragm valve, which is integrated into the pulse cleaning vessel, is used for cleaning. Therefore, each bagfilter module contains a single pulse valve as opposed to HPP cleaning system in which typically 20 to 30 pulse valves per module are installed.

Cleaning of the filterbags is done based on the differential pressure over the tube sheet and is a fully automated process. The pulse sequence is initiated by the signal from the differential pressure measurement once the dP reaches a certain (operator specified) setpoint. During the cleaning cycle, the bagfilter module remains online and available for scrubbing of the BF gas. This is a huge advantage compared to offline pulsing in which the module is taken out of operation for cleaning, which requires more additional bagfilter modules to maintain the scrubbing capacity during a cleaning cycle.

When bagfilter cleaning is initiated, the pulse valve opens and directs the gas from the pulse cleaning vessel into the rotating pulse cleaning arm where it is distributed over the filterbags. The arrangement of the pulse nozzles in the rotating arm and the slow rotation provides for optimal pulsing efficiency. This high pulsing efficiency in combination with the large gas volume allows for the use of longer filterbags. In cement plants, where the LPP cleaning is also used, filterbags are up to 10m long**[8]**.

Danieli Corus selected 8m long filter bags, as the optimum balance between filtration area per bag and filter bag handling (as long filterbags require multiple splits and total weight of a single filter bag and cage could be significant).

In the LPP cleaning system, the filter bags are oval shaped and arranged in rings inside the modules. Because the bag filter modules are also round (to withstand the process pressure), this circular arrangement allows for a more optimal use of the available space compared with the square arrangement that is typical for HPP cleaning systems. The filter bag arrangement in combination with the use of long filter bags results in very large filtration areas in the individual modules. Therefore, the Danieli Corus Dry GCP requires significantly less filter modules than the Chinese competition.

As mentioned earlier, the LPP cleaning system is currently in operation in the aluminum and cement industries. Using the LPP cleaning system in BF gas treatment is a new application and presents a number of challenges. In the present LPP cleaning systems, the process gas is air or inert gas at ambient or slightly negative pressure and typically air is used for pulsing. In

Fig 11 **Successful pilot test**

the BF gas treatment application, the process gas is a combustible and toxic gas at elevated pressure and therefore air cannot be used for pulsing. In order to limit nitrogen consumption and prevent dilution of the BF gas, the filter bags will be pulsed using clean, boosted BF gas as pulse medium.

For the reasons mentioned above, the BF gas LPP cleaning system needs to be suitable for operation at elevated pressure of process and pulse medium as well as high temperature pulse medium. In addition, no leakage is allowed in any part of the system. This requires extra attention to design and material selection for the pulse valve and tank assembly and the sealing of the shaft connection which penetrates through the bag filter module roof. Based on reference data and practical experience, a novel LPP cleaning system for BF gas treatment was designed by Danieli Corus. Furthermore, a successful pilot test was conducted in the workshop to prove the functionality of the equipment in different operating conditions (*Figure 11*).

Top Gas Pressure Control

A dry gas cleaning plant is equipped with a Top Recovery Turbine (TRT) that controls the top BF gas pressure in the system. The TRT is located downstream of the baghouse filters. The advantage of the operation of the TRT is the electrical power generation with an energy recovery up to 30%. The BF top pressure is controlled by the combination of:

- Turbine Control Valve upstream the TRT.
- Turbine itself (adjustable stator blades).
- TRT bypass valve – in case of excess BF gas – the TRT will continue to control the BF top pressure.

The turbine wheel/blades have to handle higher temperatures (Max. 150°C for DC dry gas cleaning). Power generation is therefore up to 30% higher than wet type TRT**[9]**. A TRT bypass control valve is typically provided in the TRT package to handle the (surplus) amount of BF gas. The capacity of the TRT bypass control valve is based on a margin of 20 to 30% from maximum clean BF gas flow rate. If the bypass is not opened, the BF top pressure may rise uncontrolled. The requirement for TRT-bypass valve is dependent on the supplier. Some suppliers have a design which includes a TRT-bypass, other suppliers have a design without a TRT-bypass and a septum valve as back-up for TRT. However, a septum valve is required as backup when the TRT is out of operation for maintenance, in case of electrical failure and for the start-up of the blast furnace since its capacity is based on the same maximum capacity (volume flow) of the TRT.

Equipment / Mode of operation BF	Dry GCP Equipment in operation: Cyclone Dust catcher	Conditioning Tower	BF Gas Re-heat System (Steam Heat Exchanger)	Baghouse Filters and Pulse Cleaning System	TRT	Septum Valve (TRT backup)	Clean BF Gas Cooling System	Flare Stack	Clean BF Gas LHV (Lower Heating value) downstream TRT/Septum Valve	Clean BF Gas LHV (Lower Heating value) downstream Cooling System – BF Gas Network
Normal operation	YES	NO	NO	YES	YES	NO	NO	NO	OPTIMAL	OPTIMAL
TRT out of operation	YES	NO	NO	YES	NO	YES	YES	NO	OPTIMAL	LOWER
Peak Temperature of the Top BF Gas due to burden slip	YES	YES	NO	YES	YES	NO	YES	NO	LOWER	LOWER
Monsoon - approx. three months per year (Cold BF Gas)	YES	NO	YES	YES	YES	NO	NO	NO	OPTIMAL	OPTIMAL
Start-up	YES	NO	NO	NO BF Gas bypass open (located upstream Baghouse)	NO Septum Valve first and switch over to TRT	YES	NO	YES Flare Stack opens and Switch over to BF Gas Network	LOWER	LOWER
Shut-down	YES	YES (might be required for short periods of time)	NO	YES	YES	NO TRT switch over to Septum Valve	NO	YES Clean BF Gas Network closes and switch over to Flare Stack	LOWER	LOWER

Table 1 Operating conditions and equipment

TRT/Septum Valve Operation and Clean BF Gas Cooling System

During TRT operation, the Clean BF gas expands for the recovery of the pressure energy, almost all of the pressure reduction takes place in the turbine and its temperature will decrease approximately up to max. 60°C. On the other hand, throughout the operation of the septum valve, the clean BF gas temperature will barely decrease, but the pressure will drop as per TRT operation and unlike TRT, the energy will be lost over the septum valve.

Due to the high temperatures (>100°C) of the clean BF gas main with the septum valve operation, a cooling system downstream septum valve might be required depending on layout and equipment limitations, such as gas holders design temperature (approx. 60°C) and short ducting lengths in the BF gas distribution system.

The DC solution for the clean BF gas cooling consists of a spray tower with recirculation of water and a dedicated secondary cooling system which reduce fresh water supply consumption and the estimated make-up water required is based on the water losses due to heat transfer between the hot clean BF gas and cooling water, and evaporation which are estimated to be up to 1vol% of the recirculated water supplied to the spray tower. The main reason for selecting a water spray cooling system instead a conditioning tower is the required BF gas outlet low temperature in the clean gas main of a max. 60°C. The BF gas at this temperature is saturated and part of the moisture content of the gas condensates as a result of the heat transfer and low pressure.

The septum valve is in operation during the following modes:

- TRT out of operation.
- Start-up of the blast furnace.
- Shut-down of the blast furnace.

START UP AND SHUT DOWN

Start-up of the Blast Furnace

Raw materials are charged to the BF top and the hot blast is supplied to the blast furnace to start the BF operation. During start-up, high volume rates of cold BF gas with high moisture content, high dust load and Low LHV are produced and directed to the gas cleaning plant. Since the BF gas moisture content in baghouse filters can cause bag filters clogging and damage, the baghouse arrangement is isolated from the GCP and the BF gas passes through the cyclone, conditioning tower and it is directed to the flare stack via the bypass valve located upstream the baghouse arrangement.

As soon as the temperature of the BF gas is higher than the dew point temperature and at low pressure (10 to 20kPa(g)) to ensure that moisture is not present, the BF gas is directed to the baghouse arrangement and it is distributed in all the baghouse vessels, the septum valve starts to open, the flare stack isolation valve opens, the bypass valve closes and the BF gas users and BF gas network are isolated from the GCP. The pressure of the BF top starts to increase, and it is controlled by the septum valve. Once a proper composition of the BF gas and a high LHV are achieved, the BF gas is directed to the BF gas users, while the BF gas network and the flare stack are isolated subsequently. Finally, the septum valve switches over to TRT with via the TRT bypass and the TRT itself.

Shut-down of the Blast Furnace

Raw material charging is discontinued to the BF top and simultaneously the wind rate is maintained as high as possible, to control the top gas temperature by spraying water which increase the gas temperatures due to H_2 formation (exothermic reactions). The top temperature aim is 150°C. However, temperatures up to 500°C will be obtained during the blowdown and are acceptable for short periods of time. In this case, conditioning tower activation is required. As a consequence of the absence of burden raw materials, the LHV of the BF gas will be lower and the top pressure will decrease. At that moment, the BF gas network and all its users are isolated from the GCP. The remaining gas is directed to the flare stack via its isolation valve. The TRT operation switches over to septum valve to control the top pressure and in the end, with almost no gas flow, the flare stack is closed and the complete dry gas cleaning unit is purged with nitrogen via bleeder and vent valves.

Isolation of the baghouse arrangement is not required due to the high gas temperatures. For an overview of the various operation modes, refer to *Table 1*.

CONCLUSION

The trend to converge from wet to dry gas cleaning systems within the metals industry started in the 1980s. Based on more than 50 years' experience in the primary aluminum industry, Danieli Corus now provides dry gas cleaning technology for blast furnaces. The difference between aluminum and iron and steel have been carefully studied. Design issues have been tackled with CFD simulations and safety aspects were handled within HAZOP and SIL exercises.

Significant savings can be achieved by the installation of dry gas cleaning systems and return on investment is less than two years. Furthermore, there is a significant energy saving that will lower the CO_2 footprint of the steel plant.

With the implementation of dry gas cleaning systems, the iron and steel industry is a step further forward in reducing cost, improving energy savings and reducing CO_2 footprint. MS

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