New off-gas de-sulphurisation process for sinter plants

Sinter making produces large quantities of dust and gaseous pollutants, requiring extensive removal and recovery systems. As environmental standards continue to tighten, Redecam has developed an improved system for cleaning waste gases and dust removal, called RDS. The technology is based on that used in other industries, but specifically adapted to the steel industry. The benefits are lower levels of pollution in waste gases, better dust removal and lower CAPEX and OPEX.

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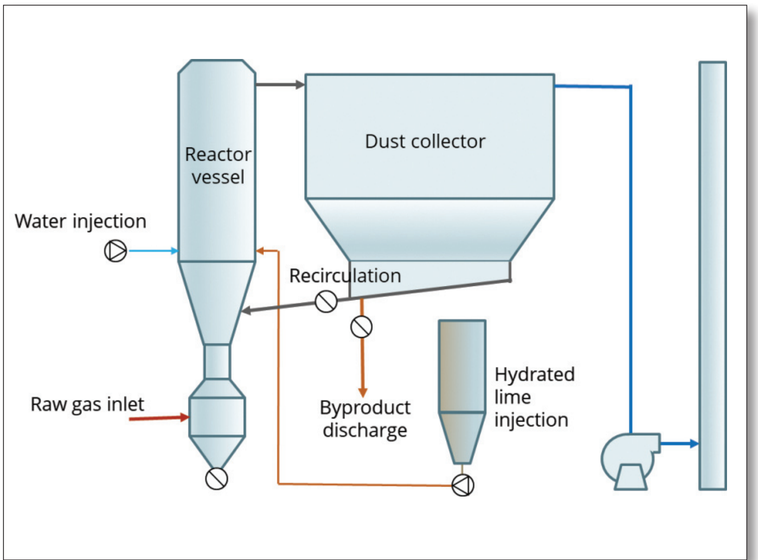

Fig 1 **RDS schematic**

The need to reduce emissions from industrial processes leads producers to adopt the best methods available at any moment in time, such as the Best Available Technology (BAT) system as used in Europe. It is important for industrial sector operators to have a broad spectrum of possibilities available when selecting the best emission reduction technology for their plants.

Several factors have to be considered during this selection, such as:

- The possibility to achieve the required emission target
- Technology reliability
- Interaction with other gas treatment technologies
- Technology flexibility
- By-products recovery
- The specific skills required to operate and maintain the emission reduction plant
- Operating and investment cost

For integrated steel plants, which are used for about 60% of steel production globally, one of the major sources of pollution is in the so-called 'agglomeration area', especially the sinter plants. Most of the emitted dust is in the PM_{10} fraction and contains various heavy metals, acid gases (SO_2, HCl, HF, NOx), ammonia and organic compounds which contribute to the formation of secondary aerosols in the atmosphere.

BACKGROUND

Redecam Group is an Italian company with more than 30 years' experience, providing high quality and highly technological products and services to many industrial sectors. It specialises in the design, manufacturing and installation of solutions ranging from simple filtration equipment to complex flue gas treatment systems.

Using this expertise, Redecam has developed a new de-SOx technology based on a Circulating Fluidised Bed (CFB) semi-dry reactor with the trade name: Redecam semiDry System (RDS).

This technology is already widely used in the power and Waste to Energy (WTE) sectors. Although there are process differences Redecam have adapted it for use in sinter plants where the characteristics of the process, raw materials or fuels require a waste gas de-SOx treatment to achieve lower emissions. Sinter plant emissions are characterised by a generally high gas flow, a low moisture content (5-6% H_2O), and lower temperatures (around 120°C), compared to other industrial sectors. These features allow the application of the RDS system, minimising water consumption and reducing the gap with respect to the dew point temperature without risk of condensation.

RDS PROCESS PRINCIPLES

CFB scrubbing technology is based on the fluidised bed principle. Hydrated lime powder (15-20m^2/g BET specific surface) and water are injected into a reactor (*see Figure 1*) where the powder is suspended and mixed using a high velocity stream of flue gas entering from the bottom. The intense mixing between acid flue gas, solid reagents and water, and the presence, for a given time, of water over the reagent particles, allows SO_2 reduction efficiency of over 95%. In the field of sinter technology, typical SO_2 values are 500-700mg/Nm^3 at the inlet, and less than 50 mg/Nm^3 at the outlet, but of course higher baseline values are possible depending on the sector. Since the reaction between lime and SO_2 is more efficient the more we approach the dew point, temperature is an important parameter which is controlled through the water injection flow rate.

A simplified chemical reaction can be described by:

$$Ca(OH)_2 + SO_2 = CaSO_3 + H_2O$$

The system also removes HCl, HF and mercury at an efficiency in excess of 90%. Other trace metals can also be removed using no other reagents than lime.

Once mixed and reacted, the gas flow carries the solids out through the top of the reactor on to a fabric filter that separates the dust from the flue gas. The clean flue gas is then conveyed to the stack.

The dust is continuously recycled into the reactor; the recirculation rate can be some hundred times greater than the fresh lime injected. Since water is injected directly into the reactor, hydrated lime is fed in powder form, and no slurry handling is necessary. Moreover, as the water is totally evaporated in the reactor there is no wastewater to be treated and the final product removed from the filter is totally dry so there is no need for drying equipment. The dust is removed through airslides installed in the bottom of the hoppers, followed by a rotary airlock. Use of airslides was selected from experience, since they have proved to be the best way to assure a constant and stable recirculation.

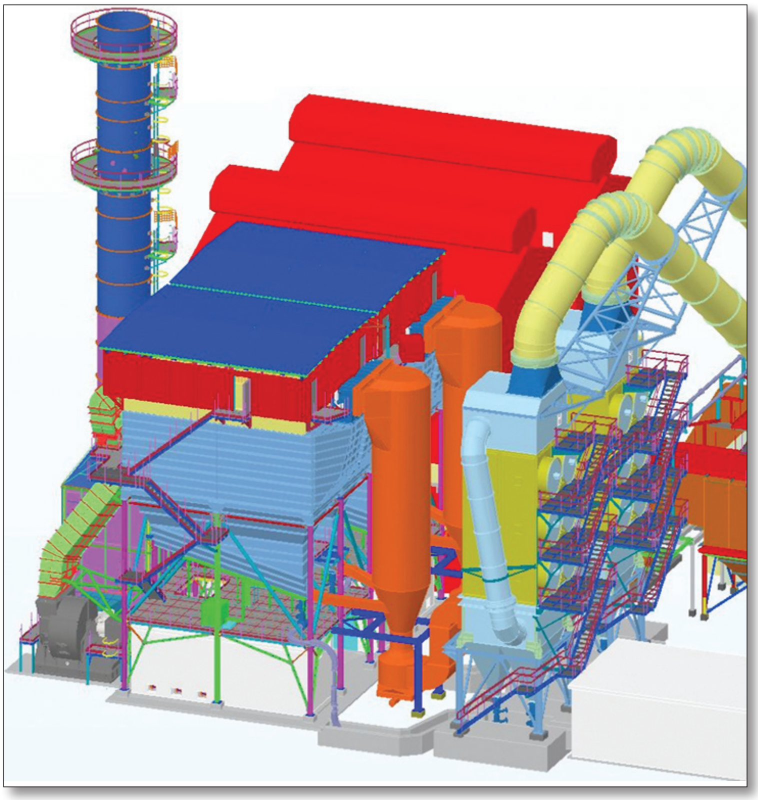

Fig 2 **3D visualisation of RDS**

Airslides are also commonly used to convey the dust from the filter hoppers in other sectors such as cement.

There are no internal moving parts inside the reactor as there is no need for a high-speed rotating atomiser, so there is less wear and consequently lower maintenance costs.

Thanks to the efficient bed mixing, the lime conversion rate is high, even when elevated acid gas reductions are required, so allowing a Ca/S molar ratio around 1.8 or less. There is a fast response to SO_2 fluctuations aided by SO_2 analysis of incoming gas and closed loop response. Additionally, due to the very high recirculation rate, there is always a large amount of lime available to cope with SO_2 peaks at the inlet – and the enhanced design supports stable operation at 50% of design flow without gas recirculation.

The fabric filter and internal design have been specifically designed for this application, taking into account the following factors:

- High dust load coming from recirculation
- Relatively low operating temperatures (usually 20°C above the dew point, typically about 80°C)
- Low air to cloth ratio
- On-line cleaning (no compartment inside the filter casing)
- The need for optimal distribution of the flow thanks to dual phase raw gas and dust

		RDS	Wet FGD
Reagent used	-	Medium quality hydrated lime	Pulverised high grade limestone (>95%)
Molar ratio Ca:S	-	1.7	1.2
Reagent consumption	t/y	4,953	4,727
Reactor pressure	mbar	10	Negligible
Power consumption	GWh/y	8.6	14.3
Water consumption	m^3/d	432	842
By-products (excl. kiln dust)	t/y	8,323	7,380
By-products recovery	-	Building materials, binders, etc.	Gypsum for cement making
Other issues	-	-	Visible plume at the stack

Table 1 **Process main technical features**

The final by-product is not usable in the place of gypsum as cement regulator, since it contains mainly $CaSO_3 * ½H_2O$ (and only a minor fraction of $CaSO_4 * 2H_2O$), but has a wide range of other uses:

- Fertiliser in agriculture
- Building material additive for production of screed and mortar
- Additive for production of building bricks and lime sand brick, fibreboards, etc.
- Production of binders in road construction
- In surface and underground mining as an additive to the mining mortar or filling mortar
- Conditioning of sewage sludge

In this regard, RDS becomes a competitive option in cases where high %S reduction is necessary or when the operating cost of Dry Sorbent Injection (DSI) technology is not sustainable. The flexibility of this solution is really appreciated when there is a necessity to revamp an existing de-dusting system: in fact, it can be easily installed downstream of an Electrostatic Precipitator (ESP) or Multicyclone without long interruption to the production process. It also keeps a separation between the regulation of sinter machine or boiler by the existing fan and regulation of the new flue gas treatment with a dedicated ID fan located after the bag filter.

PLANT OPERATING DATA

Tables 1 and *2* provide a comparison, at a level of process calculations, between an RDS as typified by the schematic shown in *Figure 2* and a Flue Gas Desulphurisation (FGD) wet scrubber for a 680,000Nm^3/h sinter plant (100m^2) where it is required to reduce the SO_2 emissions by 95% (from 500mg/Nm^3 to <30mg/Nm^3).

The operating cost was evaluated starting from a hydrated lime cost of \$110/t and a power cost of \$50/MWh. The total operating cost of the two options is very similar: the higher reagent cost of RDS being balanced by the higher power and maintenance cost of the wet FGD. As the size of the plant decreases the comparison favours the RDS because the maintenance cost does not linearly decrease with plant capacity.

	RDS	Wet FGD
Reagent cost	544	35
Energy cost	429	716
Process water	42	82
Maintenance cost	267	480
Gypsum recovery saving	-	-67
Total operating cost	1,131	1,360

Table 2 **Operating costs in K\$/y**

Additional benefits are that RDS is very competitive with a wet FGD regarding investment cost and, additionally, its footprint is smaller (no sections for slurry treatment and by-product drying), and does not require specific skills or additional personnel both for operation and maintenance.

Finally, due to the necessity to have a specific filter design, RDS is a very interesting option to consider when it is required to reduce both SO_2, heavy metals, HCl, etc.) and dust emissions. A typical application could be when de-dusting is performed by an ESP or baghouse systems that have to be revamped. In this situation, an RDS installed downstream, or in the place of, the existing equipment can solve both gaseous and powder emission issues, without requiring heavy financial investments or large layout modifications. **MS**

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