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Electrical steel strip processing lines for high quality materials

Scrap preheating and charging system

750 mm diameter bloom caster

Dedusting system for the ArcelorMittal Monlevade sintering plant's primary mixer

This article presents the results obtained with the dedusting system of the primary mixer stack in the sintering plant of ArcelorMittal Monlevade in the João Monlevade works, Brazil. The dust is collected by means of a recently installed electrostatic precipitator (ESP). The wet gas of the primary mixer is heated by gases from the sinter cooler and, then, introduced into the inlet duct of the precipitator. The innovation here is the use of hot gases from the cooler to achieve this objective and to adapt the mixture for collection in the ESP.

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Introduction

The sinter plant at the ArcelorMittal Monlevade works started operation in 1978. Aiming to achieve utilization of 100% of sinter feed, it was revamped in 2002 and upgraded to utilize the hybrid pelletized sinter process (HPS). In this process, lime is the bonding material. After starting operation with the HPS process, the dust emission from the primary mixer increased significantly. ArcelorMittal signed an agreement with the Environmental Control Agency to solve this problem.

However, the secondary electrostatic precipitator (ESP) performed less than expected. The original ESP had been upgraded. ArcelorMittal Monlevade realized the necessity to dedust the stack of its primary mixer. In its sinter production process ArcelorMittal adds lime as one of the process components and mixes it in a large horizontal rotary cylinder mixer.

During the bidding process intended to find a solution to this problem, Enfil S.A. proposed dedusting of the stack as an additional point of dust collection to be added to an electrostatic precipitator, without performance loss and with the promise of totally eliminating the presented problem. The proposed system had to guarantee outlet dust emissions not to exceed 50 mg/m³ (dry, s.t.p.).

Plant data	
Altitude	650 m
Local atmospheric pressure	93,386 Pa
Sinter cooler	
Gas flow	16,000 m³/h (wet, s.t.p.)
Gas temperature	340 °C
Gas pressure	- 177 Pa
Duct diameter	550 mm
Dust concentration	0.20 g/m³ (s.t.p.)
Dust density	1,500 kg/m³
Primary mixer	
Gas flow	48,634 m³/h (wet, s.t.p.)
Gas temperature	48 °C
Gas pressure	- 20 Pa
Duct diameter (outlet)	1,150 mm
Dust concentration	0.50 g/m³ (s.t.p.)
Dust density	2,000 kg/m³

Table 1. **Input data for the dedusting system**

The installed electrostatic precipitator had the objective of collecting the particulate matter (PM) generated in numerous dust emission points, such as transfers of belt conveyors, end of the sintering machine, screening area, top of the silos, sinter cooler etc. and, additionally, the collection of gases from the primary mixer.

Materials and methods

The solution proposed by Enfil envisaged the complete dedusting of the sinter handling area (commonly named secondary sintering dedusting) in addition to the primary mixer stack. With a view to the primary mixer problem, the conditions of the primary mixer and the sinter cooler are listed in table 1. The areas considered for the project were as following:

- The dedusting system of the primary mixer was to collect the total gas flow (wet gas, 26% moisture, containing dust and lime).
- The heat generated by the sinter cooler was to be used for heating the primary mixer gas.
- Pressure drop was to be calculated and the available negative pressure in the gas suction system was to be adapted.

The mass and thermal balance was to be calculated. When mixing the sinter cooler flow with the one from the mixer outlet, the total mass flow is the sum of the two mass flows. From these data, one may calculate the temperature of the mixed gas flows from the sinter cooler and from the mixer [1]. From this mass and thermal balance, one may calculate the final flow rate of the mixed gases and the outlet temperature, as shown in table 2.

The most important point for consistence of the mixture data was to define the outlet temperature and the moisture of the mixed gases that would not impair the performance of the ESP and likewise not cause undesired fouling in the ducts and inside the ESP. Once the

		Existing sinter cooler	Primary mixer	Mixer outlet (1 + 2)
Processing gas flow	m³/h (a.t.p.)	16,000	48,634	65,933
Processing gas flow	m³/s (a.t.p.)	4.444	13.510	18.315
Processing gas flow	m³/s (s.t.p.)	1.821	10.578	12.400
Gas temperature	K	613.15	321.45	367.94
Gas pressure	Pa	-177	-17.7	-981
Gas pressure (abs.)	Pa	93,210	93,369	92,405
Dust concentration in the gas	g/m³ (s.t.p.)	0.2	0.5	0.57
Air density	kg/m³ (a.t.p.)	0.532	1.016	0.8781
Dust density	kg/m³	1,500	2,000	(n.a.)
Duct diameter	mm	550	2,000	1,150
Duct velocity	m/s	18.71	4.30	17.63
Reynolds value	-	182,234	(n.a.)	849,528
Process. gas mass flow (dust)	kg/s	0.0004	0.007	0.0071
Process. gas mass flow (air)	kg/s	2.362	13.720	16.0826
Process. gas mass flow (total)	kg/s	2.363	13.727	16.0897

Table 2. **Values calculated in the mass balance**

process conditions were defined and the calculation of this mass balance was concluded, it was possible to proceed with the constructive design for the gas mixture in the top of the primary mixer stack. Using the experience gained from the mixture of fluids in coal fines injection systems for blast furnaces (PCI – pulverized coal injection), the gas mixing device was idealized as shown in figure 1.

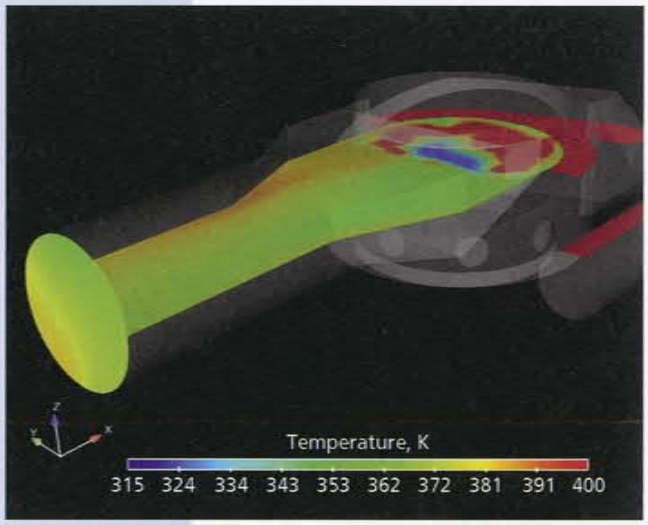

Figure 1. **Simulation of the gas temperature in the mixing device**

Results and discussion

As dedusting was performed, the total gas originating from the primary mixer stack was taken to the ESP's inlet duct that collected most of the particulate matter. Before the installation of the dedusting system, the stack of the mixer had been exhausted by natural circulation and, therefore, the stack's top permanently required cleaning of its edge, access ladder and platform.

The objective of complete dedusting of the primary mixer stack was fully achieved. Figure 2 shows the stack before the dedusting system was in operation, figure 3 shows it with the dedusting device in operation and figure 4 shows the complete system installed. The electrostatic precipitator started operation on September 24, 2007. Two days later it was connected with the mixer's stack while sinter production was taking place at normal load (5,100 t/day).

In the past, emissions in the form of gas leaks could be noticed at several slots and gaps close to the mixer. This problem was solved as a result of the negative pressure of the dedusting system, achieving complete exhausting.

Figure 2. **Stack before dedusting**

Figure 3. **Stack with dedusting device in operation**

Using part of the hot off-gas from the sinter cooler (around 300°C) made it possible to heat up and demoisture the mixer gases. (In many other plants the sinter cooler gases are usually simply released to the atmosphere.)

Despite the fact that the flow of mixed gases in the device represents only 10% of the total flow of the system, the increase in gas moisture, combined with the introduction of lime dust, improved the characteristics of dust collection. In other words, the resistivity of the collected dust decreased and, hence, the electrostatic precipitator could collect the dust more easily. It was possible to prove this fact during the performance test (measurement of particulate matter) in the electrostatic precipitator outlet.

The emission of particulate matter (indicated by the opacimeter) increased while the mixer was out of operation and returned to normal levels when the mixer was operating again. Figure 5 shows the trends measured during the tests. The design data and the measured data of the mixer are given in table 3.

The results can be summarized as following:

- improvement in environmental conditions in the local area,
- reduction of cleaning work in the stack area,
- complete dedusting of the primary mixer's stack,
- absence of leak emission close to the primary mixer,
- use of the sinter heat (energy saving),
- contribution to improved dust collection solutions.

Conclusion

Starting from ArcelorMittal Monlevade's need to dedust the primary mixer stack, a unique solution – without previous references in Brazil – was proposed. There are technical reports from Japan about using the heat generated from sinter material cooling in heat recovery boilers, but otherwise the sinter cooler heat is usually simply lost to the atmosphere.

Besides reaching the main objective (outlet dust emissions of less than 50 mg/m³ s.t.p., dry), the performance data of using the sinter cooler heat and the improvement in the precipitability conditions of the dust-containing gaseous flow made this a technically successful project. It may also contribute to new applications in sintering plants.

The initial concern of high moisture of the mixer gases and the particulate matter generated in the mixture of water, lime and the primary mixer dust did not materialize. The project's results demonstrated that the system was highly reliable, without risks and with excellent process and constructive performance. For this, studies and calculations had been necessary, in addition to Enfil's experience with dedusting systems.

The key objective was achieved as the average outlet dust concentration was reduced to 11 mg/m³ (s.t.p., dry), which is well below the guaranteed value of 50 mg/m³. The new dedusting system has been in operation for quite some time now, with good efficiency since the start-up of the ESP. ■

Figure 4. **ESP plant**

		Design data	Measured
Mixed gas flow (actual)	m³/h	65,933	30,201
Mixed gas flow (s.t.p.)	m³/h	44,640	13,850
Mixed gas temperature	°C	94.8	145.7
Particulate matter (s.t.p.)	mg/m³	570	2,328
Mixed gas moisture	% vol.	8	26.3
ESP outlet dust concentration	mg/m³ (s.t.p.)	50	9 – 13.5 (av.: 11)

Table 3. **Design data and measured data**

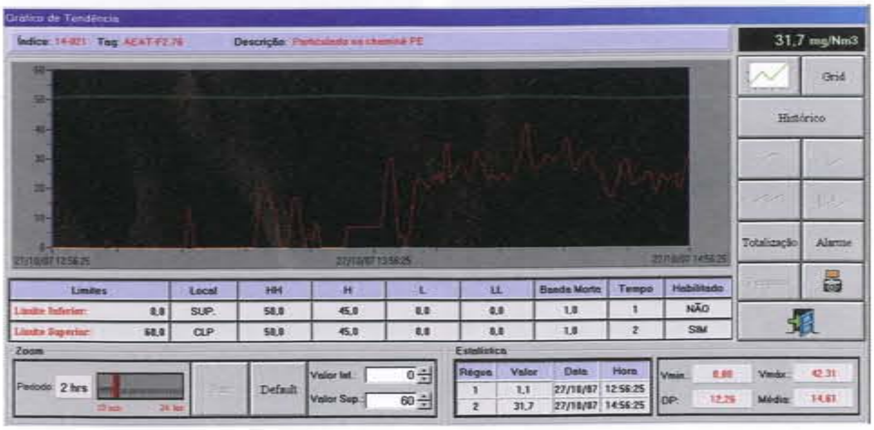

Gráfico de Tendência

Índice: 14-021 Tag: AEAT-F2.76 Descrição: Particulado na chaminé PE

31,7 mg/Nm3

Limites		Local	HH	H	L	LL	Banda Morta	Tempo	Habilitado
Limite Inferior:	0,0	SUP.	50,0	45,0	0,0	0,0	1,0	1	NÃO
Limite Superior:	60,0	CLP	50,0	45,0	0,0	0,0	1,0	2	SIM

Zoom

Período: 2 hrs

Valor Inf.: 0

Valor Sup.: 60

Estatística

Régua	Valor	Data	Hora
1	1,1	27/10/07	12:56:25
2	31,7	27/10/07	14:56:25

Vmín: 0,00 Vmáx: 42,31

DP: 12,26 Média: 14,61

Figure 5. **Opacity tendency graph (installed after the ESP)**

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