Making an impact at Kohat Cement

Marc Piccinin, Process Engineer, Magotteaux, describes the optimisation of a raw mill circuit using a vertical shaft impactor in a closed circuit in front of the ball mill, and a Sturtevant® SD high efficiency separator instead of a static one.

Introduction

The Kohat Cement Company's plant is situated in the north of Pakistan near the Afghan border, 100 km from Peshawar. In 1994, KCCL contacted Magotteaux for a quote for the optimisation of their raw and cement mills. The plant target was to increase production of the existing Romanian line from 1000 tpd to 1800 tpd of clinker.

This article examines the factors related to the raw mill section.

Before modification

The raw mill is an airswept monochamber without a drying compartment, whereby material leaving the mill is drawn through a static separator.

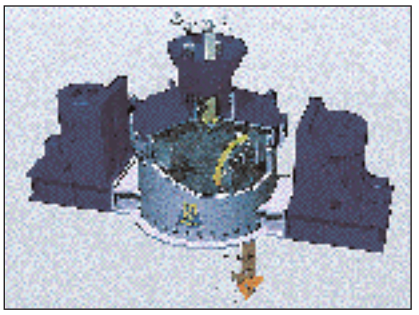
The tails are returned to the mill entrance, and the fines are passed through four cyclones where the separation between gas and finished product is realised. The gas passes to the main mill fan where part is recirculated to the mill exit (in order to help the pneumatical transport of the material), and the rest goes to the kiln electroprecipitator.

The main technical data of the circuit before modification is given in Table 1.

Problems before modification

The whole mill circuit was checked before any proposals were made. The following typical problems were found:

- Inadequate drying gas temperature, especially in the case of higher humidity content: gas was at 140 °C instead of 300-350 °C normally used.
- Granulometry of the fresh material; too coarse with 12% residues on 50 mm instead of 5% R30 mm.
- Important accumulation of uncrushed stones inside the mill itself (in the first metre and in the last part).



The Mag'impact®.

Proposed solution

Magotteaux held various meetings with the plant management in order to establish objectives and preferences. A drastic modification of the existing installation by replacing the static separator with a Sturtevant® SD third generation dynamic separator fed by a bucket elevator was chosen.

There were two main reasons for this choice.

- The retention time of the material in an airswept mill is always too short. Therefore, a finer fresh feed coming from a precrushing system, as well as a finer classified ball charge gradation would hardly be an advantage.
- It would have been necessary to use a 1000 kW fan in case of a pneumatical transport in the new operating conditions.

From a specific consumption point of view, it certainly was not the best choice.

The decision was also made to keep the existing cyclones and fan in the new configuration.

The other major modification proposed was the addition of a precrushing system in a closed circuit before and on line with the mill. This proposal was justified by the need for an important production increase requested by the plant.

All monochamber raw mills experience the problems caused by excessively coarse fresh feed and inadequate internals.

Scientific research shows that the fresh feed size must be 0-25 mm or 0-30 mm, with a maximum residue of 5% between 25 mm and 40 mm.However, these theoretical values are not practical given the well known problems facing the raw mill section, such as worn crusher hammers or no grid at the crusher outlet.

As a consequence there is often an accumulation of uncrushed particles inside the mill and a decrease of the total circuit efficiency.

The guarantee given by Magotteaux included an output of 140 tph dry or 144 tph humid if there was 3% moisture, and so, a 50% increase.

Table 1. Technical data

Mill	Circuit	Production data
• diameter: 3.8 m • length: 7.68 m (L/D = 2) • speed of rotation: 17.4 t/min (80.2%Vcrt) • installed power: 1600 kW • ball charge: 91 t of balls or 24.8%VL • initial ball charge gradation: ø90 mm 6.5 t ø80 mm 11 t ø70 mm 7.5 t ø60 mm 18 t ø50 mm 17 t ø40 mm 19 t ø30 mm 12 t Total 91 t	• static separator: 5.5 m • 4 cyclones • mill fan: 220 000 m^3/h, 80 °C, 650 mm WG, 630 kW, 1000 rpm	• average fresh feed: 95 tph • composition: mix stockpile: 95-100% clay-limestone: 0-3% laterite: 0-2% • average moisture: 2.5% (up to 5-6% during the wet season) • average fineness of product: 21-24% R90µ • mill absorbed power: 1400 kW • specific power (mill only): 14.74 kW/t • mill inlet gas temperature: +/-140° (gas coming from the cooling tower)

Fineness on the 90µ sieve of 21% residue was also assured. In order to reach this guarantee, the flow-sheet shown in Figure 1 was chosen.

New equipment

The precrushing system

The fresh material is stocked in three small silos after the stock pile. Three weigh feeders feed a conveyor belt to the vibrating screen. A metal detector is installed on this conveyor, but the plant has now also installed a metal extractor in order to avoid untimely stoppages.

The vibrating screen, made by Haver & Boecker, has a capacity of 300 tph, an angle of 15°, a first deck of 25 mm and last one of 10 mm.

The material is screened in this section in order to get a passage of 0-10 mm. The tails (or material higher than 10 mm) fall from a conveyor belt onto the MAG'impact® precrusher.

The main characteristics of the MAG'impact® model 2400 are:

- Table diameter: 960 mm.
- Impellers number: 5 (with H+ inserts).
- Installed power: 200 kW (1 motor).
- Maximum speed of rotation: 1500 t/min.
- Maximum feed size: 130 mm.
- Maximum output: 350 tph.

The raw material is precrushed and the outlet product transported by another belt conveyor to the fresh material conveyor.

All components of the precrushing system are thus linked by belt conveyors. This system is more extensive in a horizontal area than in a vertical one because the plant was unwilling to use a bucket elevator in this circuit.

Finally, the passing product from the vibrating screen feeds the ball mill. Both circuits are directly on line without an intermediate silo.

The ball mill

The mill was equipped with a poor lifting lining without classification effect. The new internals proposed are described in Table 2.

The separator circuit

The separator is a Sturtevant® SD120 with air re-circulation. The existing cyclones and mill fan were used in the new configuration.

The separator has the following features:

- Cage diameter: 2.94 m.
- Installed power: 110 kW.
- Cage speeds: 90-230 rpm.
- Maximum air quantity: 200 000 m^3/h.
- Fines output: maximum 180 tph.
- Feed quantity: 160-500 tph.

Table 2. Proposed internals of ball mill	
Lining:	
on 1.50 m (or 20%): Monostep lifting	
on 6.18 m (or 80%): Classodrift classifying	
Installation of an OPTIMEX outlet diaphragm	
Ball charge:	
102 t of ø90-80-70-60-50-40-30-25 mm or 28% volume load	
Detail of the charge at 80% and before optimisation (t):	
80 mm dia	15
70 mm dia	13
60 mm dia	1
50 mm dia	10
40 mm dia	7
30 mm dia	23
Total:	79

The mill gas also passes through the separator and the same quantity leaves the circuit after the fan and enters the kiln's electroprecipitator (Figure 1).

Optimisation and results

First step at 80% of the ball charge

The mill was producing an average of 110-115 tph with an average fineness of 18-20% residue on 90µ. In order to add the last 20% of balls, Magotteaux had to carry out an axial test inside the mill (Figure 2).

These curves clearly show that there are no uncrushed particles as from sample 3.

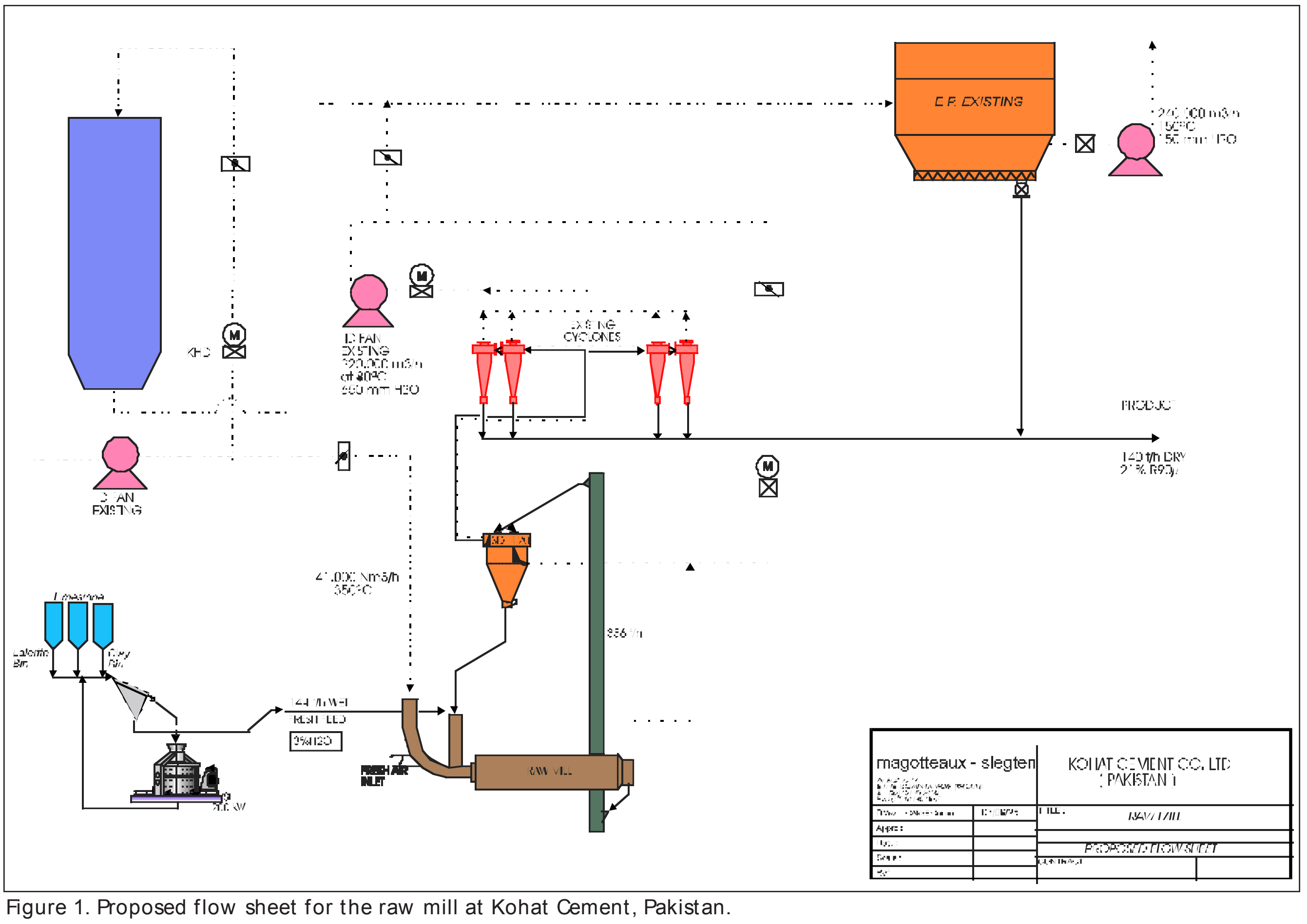


Figure 1. Proposed flow sheet for the raw mill at Kohat Cement, Pakistan.

Table 3. Final ball charge		
mm dia	t	%
80	15	14.6
70	14	13.6
60	12	11.6
50	11	10.7
40	12	11.
30	28	27.2
25	11	10.7
Total: 103		

Table 4. First sample in precrushing system (80% of ball charge)									
% of passing	1 mm	2.8 mm	4.75 mm	6.7 mm	9.5 mm	16 mm	20 mm	25 mm	31.5 mm
Fresh feed	25	39.4	49.6	57.5	65.9	79.3	84	87.4	91.5
Screen feed	25.8	39.3	50.3	59.1	69.1	82.8	87.1	91.7	95.4
VSI inlet	0.5	0.5	0.6	0.8	12.3	56	68.6	78.8	89.6
VSI product	20.1	42.1	58.9	72.6	82.9	93.7	95.5	97.1	98.3
Screen passing	34.9	59.6	77.2	90.6	100	100	100	100	100
Circul. load	1.36	1.52	1.54	1.54	1.54	1.64	1.70	1.64	1.79
Efficiency	19.7%	41.8%	58.7%	72.4%	80.5%	85.7%	85.7%	86.3%	83.7%

Table 5. Second sample in precrushing system (100% of ball charge)									
% of passing	1 mm	2.8 mm	4.8 mm	6.7 mm	9.5 mm	16 mm	20 mm	25 mm	32 mm
Fresh feed	25.1	46.6	49.3	57.8	67.8	81.4	85	88.7	91.7
Screen feed	19.8	38.4	49.7	57.9	67.3	80.5	87.5	91.1	94.1
VSI inlet	0.8	0.8	0.8	1.9	11.7	52.6	65	77	87.8
VSI product	26.6	42.2	57.5	75	83.3	89.7	90.6	95.3	97.5
Screen passing	34.6	62.4	77.9	90.2	99	100	100	100	100
Circul. load	1.78	1.64	1.58	1.58	1.57	1.70	1.56	1.63	1.94
Efficiency	26.0%	41.7%	57.2%	74.5%	81.1%	78.3%	73.1%	79.6%	79.5%

The last 23 t could be a majority of small balls. The final ball charge is shown in Table 3.

A complete sample was also taken in the circuit of the precrusher in order to know the material flows, the efficiency of the MAG'impact® and the granulometry of the material going to the mill (Table 4).

Prior to the mill crash stop, the production data was as follows:

- Output: 116 tph.
- Circulating load to the separator: ±1.5 (A/F).

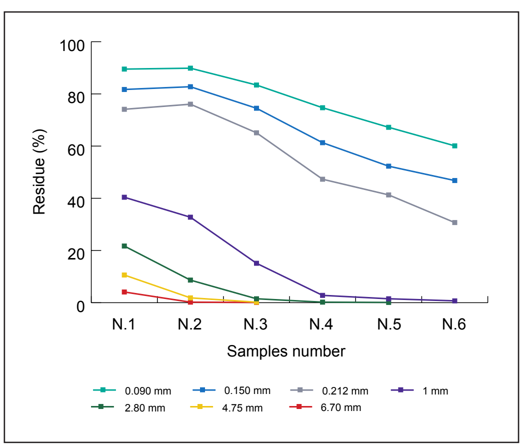


Figure 2. The results of the axial test inside the mill.

- Mill power: 1270 kW.
- Mill specific power: 10.95 kW/t.
- MAG'impact® speed of rotation: 1500 t/min.
- MAG'impact® power: 104 kW.
  - MAG'impact® specific power: 0.9 kw/t of finished product.
  - Total specific power: 11.85 kw/t.
  - MAG'impact® specific power on the precrushed product: 1.65 kw/t.

The circulating load is relatively low because the fresh feed is fine. A rate of 116 tph means that only 63 tph are precrushed in the MAG'impact®. The efficiency on the sieve of 9.5 mm is an impressive 80%. Figure 3 shows the particle size distribution of the samples.

Final step at 100% of the ball charge

A second sampling in the precrushing system was taken at maximum production. The results in Table 5 show that the system is stable and reliable.

The circulating load, efficiency and particle size distribution of the material going to the mill are very similar to the results found at 116 tph.

Figure 4 shows the particle size distribution of the different samples at 100% of the ball charge.

Before the sampling was implemented, the production data was as follows:

- Output: 151 tph.
- Circulating load to the separator: ±1.65 (A/F).
- Mill power: 1560 kW.
- Mill specific power: 10.33 kw/t.
- MAG'impact® speed of rotation: 1500 t/min.

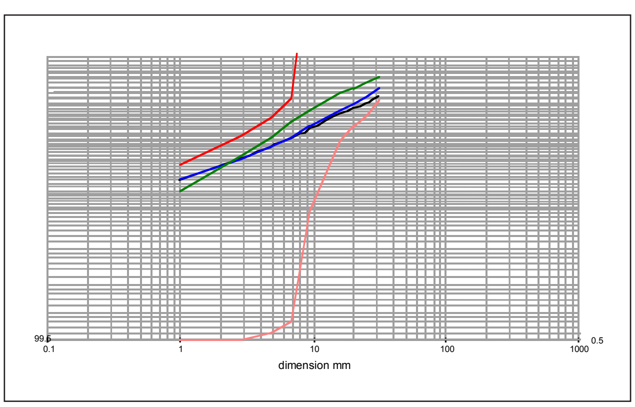


Figure 3. Particle size distribution of samples at 80% of the charge.

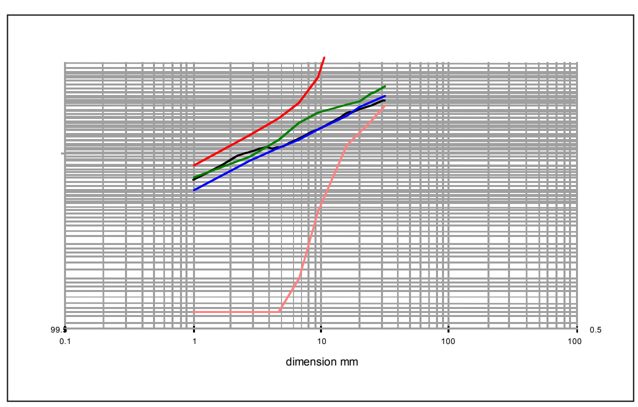
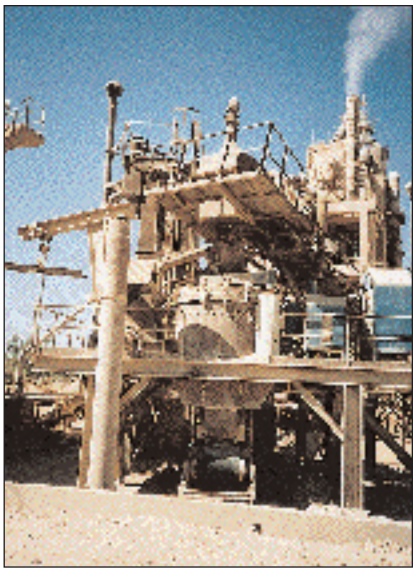


Figure 4. Particle size distribution of samples at 100 % of the charge.



The Mag'impact® in Kohat.

- MAG'impact® power: 136 kW.
- MAG'impact® specific power: 0.9 kW/t of finished product.
- Mill+ MAGimpact® specific power: 11.23 kw/t.
- MAG'impact specific power of the precrushed product: 1.65 kw/t.

Final result

The commissioning which began on the 13th March 1997 was achieved with the following results. During 16 hours from 18.00 on 21/3/97 to 13.00 on 22/3/97, the average production data was:

- Mix stockpile: 147.75 tph.
- Laterite: 2.84 tph.
- Total: 150.6 tph.
- Fineness: 20.2% R90µ.
- Moisture fresh feed: 1.9%.
- Tails of separator: 137 tph (i.e. a circulating factor off 1.9).
- Separator speed: 33-34%.
- Mill completely in manual.

It was not possible to continue the trials because of problems on some old existing auxiliaries.

Table 6. Improvements arising from circuit modifications

	Before modification	After modification	Improvement (%)
Output (tph)	95	150	58.5
Millpower (kW)	1400	1560	11.4
Precrusher power (kW)	-	136	-
Mill specific power (kW/t)	14.74	10.36	29.7
Precrusher specific power (kW/t)	-	0.9	-
Total specific power (kW/t)	14.74	11.26	23.6
Fineness			±10

Conclusion

Improvements arising from the circuit modifications are summarised in Table 6.

In conclusion, the modification of a raw mill circuit by replacing the static separator with a high-efficiency one and adding a precrushing system can lead to an important production increase and a representative efficiency improvement.

Acknowledgement

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