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Field report of a cement plant modernisation with the compact 2-Stage Koesep air classifier

During 2015 the Austrian cement manufacturer Schretter & Cie GmbH & Co KG modernised its grinding process. The former system with a high pressure grinding roll (HPGR) working in a pre-grinding mode was upgraded to a grinding circuit with an HPGR in semi-finish grinding mode. A compact 2-Stage Koesep air classifier, the latest development of Köppern, based in Germany, was installed. The new combined air classifier was implemented during ongoing operation with total plant downtime of just 40hr. One year after re-commissioning of the grinding system it can be noted that the modernisation improved production, stabilised the process and reduced energy consumption. This article reflects experiences made throughout the first year of operation and shows effects with regard to production and energy consumption.

Introduction

Cement production is among the most energy-intensive procedures in the processing industry. Therefore cement producing companies are always aiming to decrease the energy demand by improving plant technology. With regard to the grinding circuits, mills and air classifiers are the main loads in terms of energy consumption.

By using a high pressure grinding roll (HPGR) in pre-grinding or semi-finish grinding mode, savings of specific energy consumption up to 30% compared to ball mill in closed circuit can be achieved. The state-of-the-art technology is a HPGR in semi-finish grinding mode. For this, two types of air classifiers and thus two machines are usually required, these being one static and one dynamic classifier. In general, air classifiers are proven devices for classification of mineral resources. They are used in grinding circuits together with ball mills, HPGRs and vertical roller mills. Due to the importance of reducing power consumption per tonne of product and simultaneous increase of production of existing grinding systems, research and development is ongoing.[1,2]

Optimisation of the air classifying system offers process and commercial benefits. Schretter & Cie realised an opportunity to upgrade its existing grinding unit. Prevously it had used an HPGR for pre-grinding in combination with a downstream ball mill in a closed circuit with a dynamic air classifier, for about 25 years. In 2014, the company decided to upgrade the system in cooperation with Köppern. The aims were to reduce both energy consumption and CO_2 footprint while increasing production capacity. The operation of the HPGR was changed to semi-finish grinding and, instead of installing the two separate air classifiers, a decision was made to install the newly-developed Köppern 2-Stage Koesep air classifier. This machine combines the two main groups of air classifiers in one compact housing. The HPGR product passes the static part of the classifier before it partially enters into the dynamic part. The ball mill product is fed directly into the dynamic part of the classifier.

The modernised grinding system has now been in operation for more than one year. Results and experiences are reported.

Below - Figure 1: The Schretter & Cie cement plant in Vils, Austria.[4]

The 2-Stage Koesep air classifier at Schretter & Cie

Schretter & Cie is a medium-sized company in Austria, which has been processing cement, lime and gypsum since 1899. The plant in Vils produces a wide range of products to different specifications. Due to the high flexibility of production process, the company is able to provide specific products tailored to customers' requirements. A lot of special binders and custom-made building materials are available.[3]

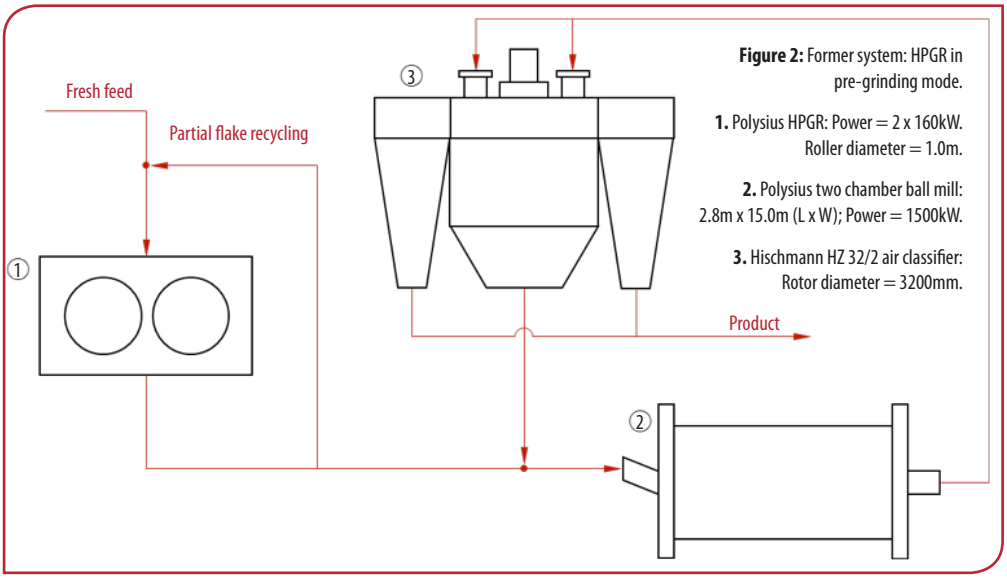


Figure 2: Former system: HPGR in pre-grinding mode.

1. Polysius HPGR: Power = 2 x 160kW. Roller diameter = 1.0m.

2. Polysius two chamber ball mill: 2.8m x 15.0m (L x W); Power = 1500kW.

3. Hischmann HZ 32/2 air classifier: Rotor diameter = 3200mm.

Former and upgraded system

Before Schretter & Cie installed the new 2-Stage Koesep air classifier, the grinding system consisted of an HPGR in pre-grinding mode with partial flake recycle and a ball mill in a closed circuit with a Hischmann 2nd generation air classifier. A simplified flowsheet of the former grinding system is shown in Figure 2.

Schretter & Cie, in cooperation with Köppern, developed a concept to integrate a combined air classifier in the existing plant. The upgraded flowsheet of the cement grinding unit is shown in Figure 3. The HPGR and the ball mill are now both operated in closed circuit with the new 2-Stage Koesep air classifier.

It was a high priority to ensure that the old grinding system could still be used even during the ongoing modernisation project. Finally a strategy was developed that allowed the use of either grinding system. The old separator is still available to provide a fall-back option if necessary. The main advantage of the new semi-finish grinding system is the removal of fines from the grinding circuit after the first comminution step in the HPGR. Hence this material is not fed to the ball mill anymore, which removes the need for a second comminution step for this material. Overgrinding of fine material is reduced, leading to better performance of the ball mill and increased production.

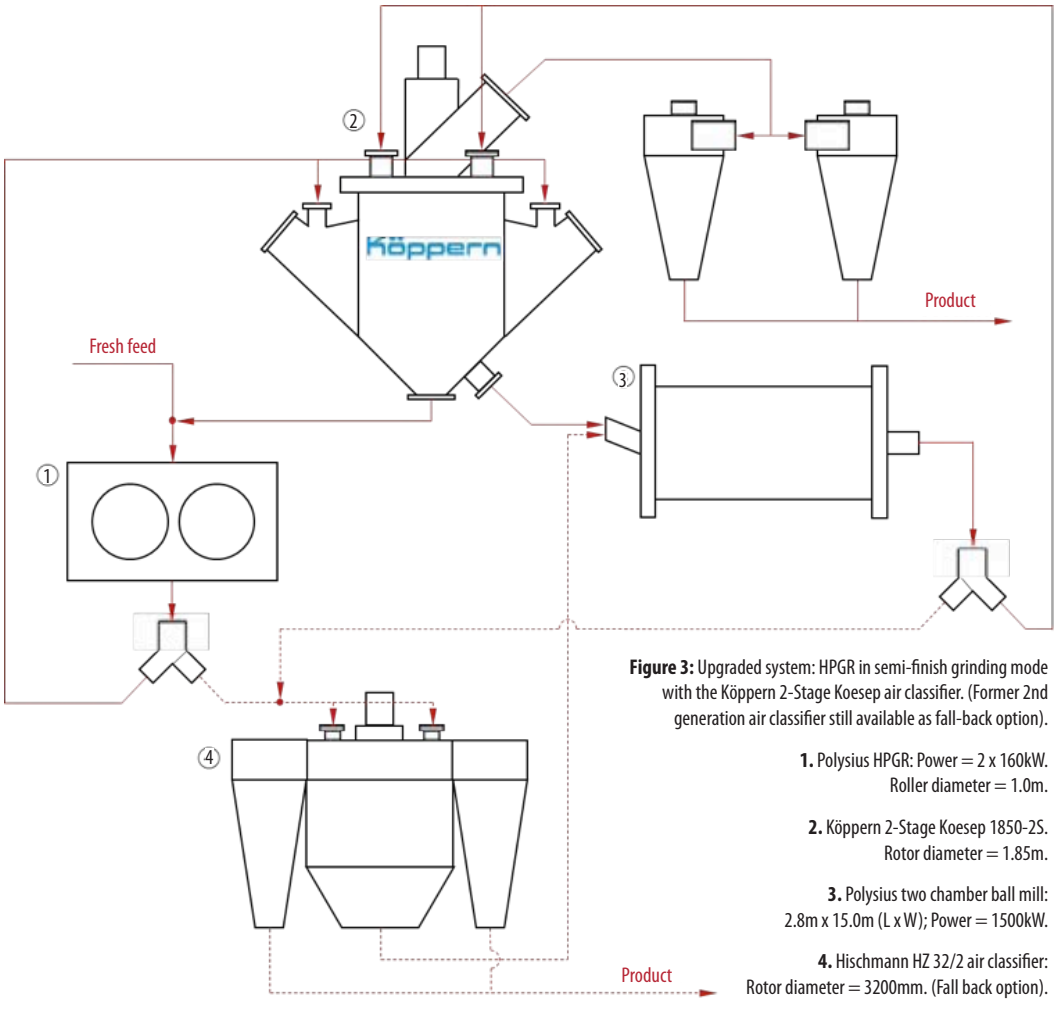


Figure 3: Upgraded system: HPGR in semi-finish grinding mode with the Köppern 2-Stage Koesep air classifier. (Former 2nd generation air classifier still available as fall-back option).

1. Polysius HPGR: Power = 2 x 160kW. Roller diameter = 1.0m.

2. Köppern 2-Stage Koesep 1850-2S. Rotor diameter = 1.85m.

3. Polysius two chamber ball mill: 2.8m x 15.0m (L x W); Power = 1500kW.

4. Hischmann HZ 32/2 air classifier: Rotor diameter = 3200mm. (Fall back option).

To efficiently separate HPGR product it is necessary to first deagglomerate and coarse-classify the flakes, which is done by means of a proven static cascade separator. Here the fine fraction can reach fineness up to 2500cm²/g (Blaine). To further classify the fines leaving the static classifier unit, a dynamic separator is used. Thereby the fine flow is divided into material with the required product fineness and so called fine coarses, which are rejected to the ball mill. The Köppern 2-Stage Koesep air classifier combines these two functions in one machine with an exceptionally compact design.

2-Stage Koesep air classifier

Maschinenfabrik Köppern GmbH & Co. KG, headquartered in Hattingen, Germany, is specialised in the design and manufacture of machines for the cement and mineral processing industries. One of its latest developments is the 2-Stage Koesep air classifier, which is shown schematically in Figure 4. It is mainly intended for use in combination with a HPGR and a ball mill in cement semi-finish grinding circuits, but can be adapted to finish grinding systems with only a HPGR or even single ball mill grinding units.

Generally, the air classifier consists of two main parts: the static separator and the dynamic separator. Depending on the application, the static separator can be equipped with a different number of cascades. As shown in Figure 4, two cascades are installed at the plant in Vils. The product of the HPGR is fed through the inlet (1) into the static cascade separator, where it is crossed by the primary separating air (2). The drops and impacts on baffle plates (3) and guiding plates (4) for disgglomeration. The coarse rejects of the static separator move downwards through the outer cone (5) and are discharged at the outlet (6). This material goes back to the HPGR.

Fines are carried upwards by the airstream and enter the dynamic part of the classifier. This material passes through guiding vanes (7) before reaching the rotating cage (8) driven by a motor (9). Coarse grains are rejected due to higher centrifugal forces, whereas finer particles pass through the rotating cage.

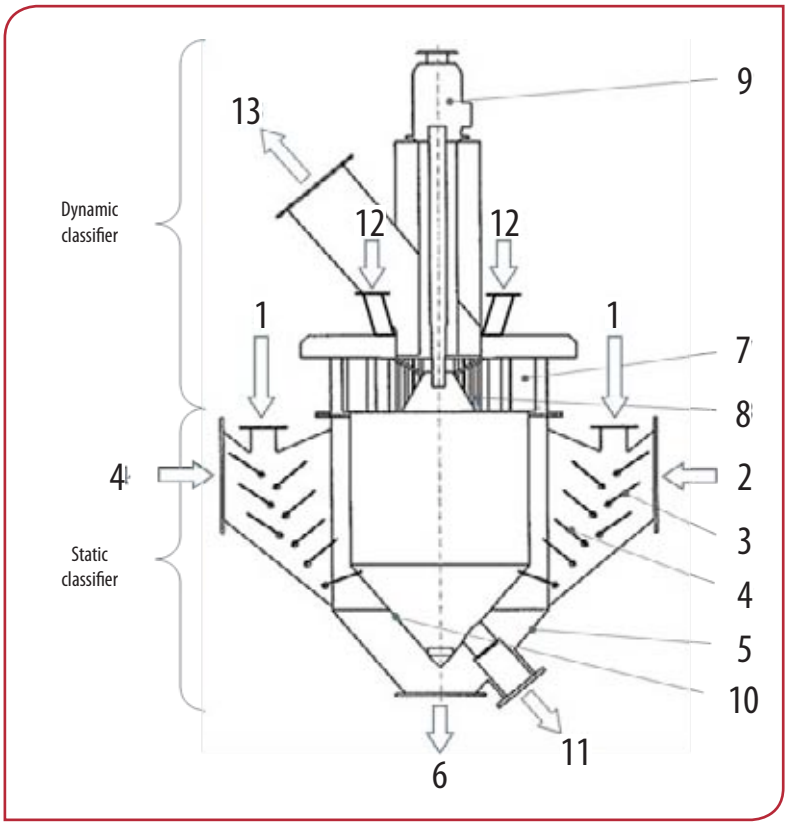
The rejected coarse material of the dynamic separator falls through the inner cone (10) and is discharged as middlings at the outlet (11). This material is fed to the ball mill. The ball mill product is directly fed to the dynamic separator at the inlet (12). All material with the required product fineness leaves the classifier together with the separation air at the outlet (13) as the final product of the grinding system. The set-up of the 2-Stage Koesep is already patented in Germany[4] and Europe.[5] The system is summarised in Table 1.

Below right - Table 1: Parameters of the Köppern 2-Stage Koesep at Schretter & Cie, in Vils Austria.
* Static and dynamic separator including drive.

Feature	Property / Value
Machine type	Köppern 2-Stage Koesep
Diamater of rotating cage	1850mm
Total height*	1070mm
Number of static separators	2
Circumferential speed of rotating cage	5-35m/s
Fan power consumption	110kW

Below - Figure 4: Set-up of Köppern 2-Stage Koesep air classifier.

1. Feed (product from HPGR).
2. Primary air inlet.
3. Baffle plates.
4. Guiding plates.
5. Outer cone.
6. Coarse discharge back to HPGR.
7. Guide vanes.
8. Rotating cage.
9. Motor.
10. Inner cone.
11. Middlings discharge to ball mill.
12. Feed (product from ball mill).
13. Product and air discharge.



Commissioning and operating experiences

After the decision to install the new air classifier in 2014 by Schretter & Cie, Köppern received material for trials with the 2-Stage Koesep pilot plant. After successful tests, the planning and construction of the plant started. The erection of the new building began in December 2014. After delivery of all plant components, including the air classifier itself, fans, material handling equipment and cyclones, the erection commenced in April 2015. Construction work continued until June 2015 (See Figure 5). Schretter & Cie switched production over to the new overhauled grinding system with the 2-Stage Koesep air classifier in July 2015.

The first priority was to achieve the former product characteristics for each and every cement type. After a trial period of approximately two weeks all requirements for the first cement type had been fulfilled. This was possible due to the easily-adjusted parameters of the separator.

Laboratory results showed that the cements produced with the new 2-Stage Koesep achieve higher strength values throughout the product range. As a

Left - Figure 5: 2-Stage Koesep air classifier during erection.

Due to the compact design of the 2-Stage Koesep air classifier and a clear-sighted layout of the new material transport equipment, the upgrade of the grinding plant could be erected while the old system was still in full operation. The integration of the new classifier and the switch-over to the new grinding circuit was then realised with just 40 hours downtime.

After one year of operation it is proven that the upgrade was worth the effort. The energy consumption of the grinding circuit has been reduced by approximately 13%, whereas the product rate increased on average by 19% over the same period for the cement types shown. To further improve the performance of the air classifier, Köppern continues to conduct research projects at the pilot plant 2-Stage Koesep air classifier at its test facilities at the University of Freiberg in Germany. Test results are evaluated on the industrial air classifier at the Schretter & Cie plant in Vils.

Due to the professional cooperation between Schretter & Cie and Köppern, the two partners look forward to future projects.

Cement type	HPGR in pre-grinding mode		HPRG in semi-finish mode with 2-Stage Koesep (Same 2 and 28 day strength)		
	Spec. surface area (Blaine) (cm^2/g)	Capacity (t/hr)	Spec. surface area (Blaine) (cm^2/g)*	Capacity (t/hr)	Production increase (%)
A	5000	22	4900	26	18.2
B	4200	27	4100	32	18.5
C	4200	34	4000	40	17.6
D	4800	26	4700	32	23.1

Left - Table 2: Process data of former and upgraded grinding systems.

* = Specific surface could be decreased still achieving required 2 and 28 days-strength.

consequence it was possible to reduce the Blaine values of the cements, which positively influenced the production rate of the entire grinding system. After final adjustments of the ball mill's ball charge gradation at the end of 2015, the plant throughput was increased once again.

The changeover of the different cement types to the new grinding system went smoothly without major problems. Once settings were found after a short period of testing, the same results could be repeatedly achieved with regard to product quality. Furthermore it was found that the Köppern 2-Stage Koesep has a fully reproducible and stable performance. This makes it very easy to switch between different cement types without noteworthy waste production.

During the first few weeks of operation after initial commissioning the capacity of the plant was increased further. Table 2 shows a summary of process data as comparison of the former and new grinding system.

Conclusion and future developments

Schretter & Cie upgraded its cement grinding unit by implementation of the new Köppern 2-Stage Koesep air classifier. By converting the former pre-grinding into a semi-finish grinding High Pressure Grinding Roll, the company significantly increased the grinding capacity at the plant in Vils.

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