Dynamic separator advances

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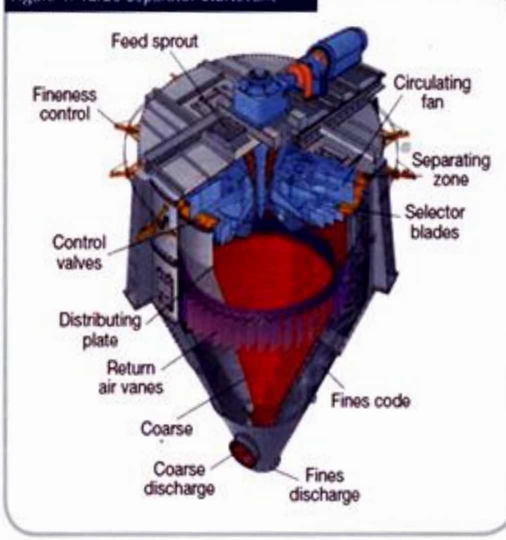
CEMI – Process Technology and Engineering report on the various generations of separator design and how improved models have enabled cement producers to reduce their energy costs while advancing product quality. Furthermore, the latest development to dynamic separators has just been launched – the OptSep and is detailed in this article.

Every day modern industries are subjected to greater challenges to supply the market demand and product quality, environmental laws, competition with foreign markets etc. This is especially true of the cement industry, where there is a particular demand for higher product quality and reduced operating losses. Furthermore, this industry is one of the most energy intensive and the largest part of production costs are associated with energy inputs. Therefore, one of the most common targets for cement manufacturers has been to reduce energy and material consumption to achieve the required product quality. To achieve these targets, cement producers must keep abreast of new automation and control techniques.

Grinding circuits are large consumers of electricity. In a cement plant the costs associated with energy represent 15 per cent of the total production expenses, 12 per cent of which derive from grinding operations. In addition, milling circuits are closely linked with the quality of the cement particle size. Therefore, the grinding section should be viewed as one of the main areas for potential optimisation[1].

Figure 1: Turbo Separator Sturtevant



In the milling process, it is ideal for particles of feeding size to be removed from the grinding circuit as soon as the required size is reached. Thus, energy is only used on oversized particles[2]. Consequently, no energy is wasted on particles that are already the specified size and no coarse particles will be present in the product. The best way to approach the ideal situation is by the use of a classifier, so the particles that leave the mill will return to it if they are larger than required, while the finer particles will go into making the product.

Figure 2: second generation – cyclone separator

The dynamic classifier commands a prominent position in cement grinding circuits and various industrial minerals[3] which can be attributed to its improved cost-benefit ratio compared to other classifiers.

Classification is basically a separation carried out in the chamber where particles are suspended and dispersed in the air[4]. The following forces act upon particles in the classifier[5]:

- gravity
- centrifugal acceleration
- drag force of the separating air.

The different types of equipment are always designed to achieve a specific set of results, which must be capable of performing to requirements and dealing with the differing motions of fine and coarser particles.

From these basic concepts, dynamic separators have been developed and can be classified into three generations:

- first generation – turbo separator
- second generation – cyclone separator
- third generation – cage type separator.

Evolution of dynamic classifiers

Each separator differs by the evolution of internal and external devices to increase separation efficiency. The first generation is basically a turbo separator, as shown in Figure 1. The material entering through the feeding trough is subjected to a centrifugal force due to rotation of the distributor plate and fan that propel particles towards the upward air flow. Due to gravity the coarse particles fall and are collected in the coarse cone. Fine particles, however, are captured and entrained by an upward flow produced by a fan (fixed blades). During this secondary separation, the remaining coarse particles are not able to follow the air flow while bypassing the (adjustable) moving vanes, falling too, into the coarse cone discharge.

Figure 3: third generation – cage type separator

Figure 4: installation schema of OptSep

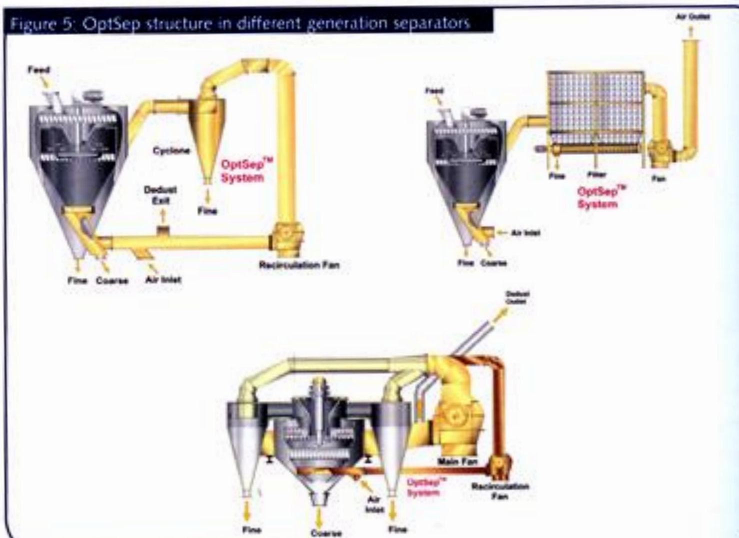


Figure 5: OptSep structure in different generation separators

Second generation classifiers are characterised by the coupling of cyclone separators, as shown in Figure 2. The principle idea behind the evolution of this equipment was the storage of the fines, inadequately precipitated in the separator's precipitation chamber, in a separate precipitation chamber. Cyclones are employed for this solution. Effective precipitations in the range of 90-97 per cent can be achieved in this system where the classifier is fitted with an external fan[5].

The third generation has a different zone of separation in the form of a cage, as shown in Figure 3. Feed material enters the separator through the chutes, above the classifying zone, and the top of the rotor serves to disperse the feed. The feed forms a cylindrical curtain of material. As it falls toward the rejects hopper, it is subjected to the high velocity air leaving the guide vanes. The material spirals as it travels through the classifying zone due to the initial spin imparted by the rotor as it is distributed and the swirl produced by the airflow. The airflow leaves the guide vanes almost tangentially to the outside of the rotor. The rotor thus increases the swirl of the air in the classifying zone. A variable speed drive operates the rotor and adjusting the speed determines the amount of swirl in the classifying zone and therefore the size of the separated particles.

Summarising, the region of separation in the first generation separator is the zone of separation between the distributor plate and the blades. In the second generation the main region remains between the distributor plate and the blades, but there are more regions where fines are recovered. But in the third generation, separation occurs around the rotor cage. The specific load is respectively from 1.5 to 3.6t/hm^2, from 8 to 11t/hm^2 and from 10 to 12t/hm^2.

OptSep system – the present situation

The OptSep is a system developed by CEMI for optimisation of the dynamic separator, enabling higher efficiency of any generation of grinding circuit.

The assembly of Optsep contains gears specifically developed to promote injection of an additional airflow output within the separator at precise locations to increase capacity and efficiency of grinding circuits. The main component of the system is a scroll with regulating blades used for air entrance (see Figure 5). The applications are shown in Figure 6.

For the process balance, an air outflow gear is installed, interconnected in the

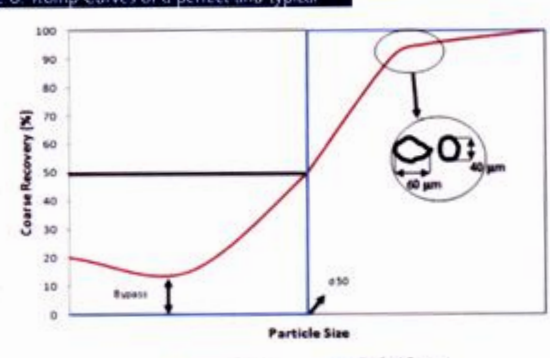


Figure 6: Tromp Curves of a perfect and typical

Table 1: average gains achieved with OptSep

First generation (%)	Second generation (%)	Third generation (%)
15	10	5

Figure 7: first generation separators Tromp Curve

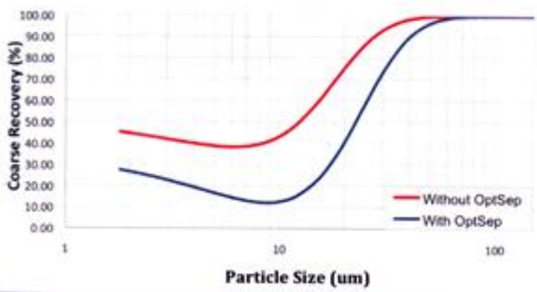


Figure 8: second generation separators Tromp Curve

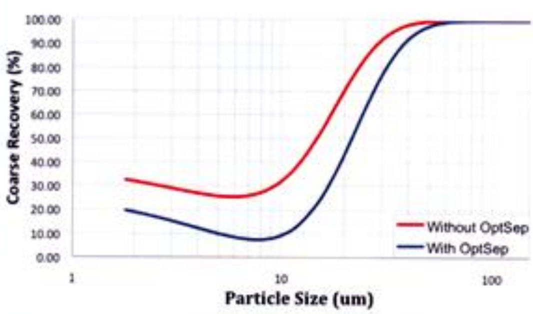
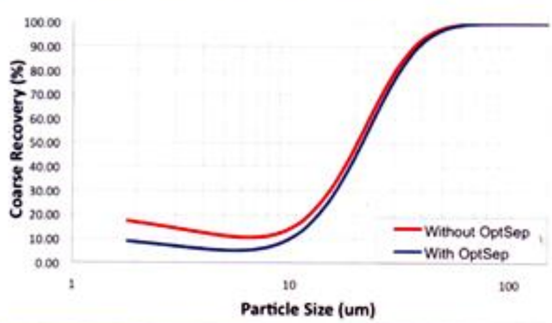


Figure 9: third generation separators Tromp Curve



circuit ventilation system. This can be arranged in several ways, according to the circuit and type of the existing dynamic separator. The ventilation system is made of a filter and a fan, but can have a cyclone that makes the precipitation of pneumatically carried material to ease the solid amount on the filter bag (or electrostatic precipitator). The products of the filter and cyclone are added to the final product coming from the dynamic separator.

The outcomes reached with OptSep can change according to the characteristics and performance of the pre-existing grinding circuit. The results are shown in Table 1.

The most important tool to compare the dynamic classifiers' performance is the Tromp Curve. It is a plot of the selectivity of a separation process for all size of particles[4].

Figure 6 shows two Tromp Curves, where the blue line represents an ideal situation, which all particles are spherical; and the red line represents typical curve whose shape is affected by the imperfection of the particles' shape[1].

In Figure 7, it's possible to see the Tromp Curve of the single separators and the effect of the 'reclassification' yielded. That also happens in Figures 8 and 9, as we can see the major gain is related to the first generation separator. Although there has been improvement in the development through generations of dynamic separators it is still necessary a coarse reclassification to decrease the bypass of fines. This is easily reached using the OptSep.

The future outlook

The incorporation of internal devices has increased the efficiency of the classifiers, but the increase in its use may introduce interference in the internal flow causing loss of efficiency. That is why OptSep represents an advancement in the optimisation of dynamic separation, providing significant capacity gains for the entire circuit. Investment is around 10 per cent of the price to replace the dynamic separator for a new one.

Considering the various evolutions of dynamic separation, the future alternative to increasing efficiency is the use of classifications in series.

Another aspect is the use of image analysers to generate high-resolution grain size data of the fluxes of the separator, such as the Tromp Curve. Additionally, dynamic simulation technology can be useful in assessing the potential of this type of process. With the introduction of a phenomenological model it would be possible to calibrate a simulator and to receive dynamically measured parameters, like a 'soft sensor' and it will also help to control the process.

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