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A New Spin on **Cement**

Simulation broadens understanding of dynamic separators in cement manufacturing.

By Lucas A. Kostetzer and Leonardo P. Rangel, ESSS, Florianopolis, Brazil
Joana B. Souza, Holcim Brazil, Sao Paulo, Brazil

For nearly all products, it can be said that the quality of the raw materials being used in creating those products affects the quality of the final item. In cement production, control of the incoming raw materials influences not only the end product, but also the efficiency of the manufacturing process and its associated costs. If not carefully managed, the size of the solid particles used in creating cement can have a significant effect on efficiency of the cement production line.

The regulation of particle size is handled by two processes in cement production: raw/cement milling, which grinds materials to decrease their size, and dynamic separation, which classifies and partitions particles by size. If particles are smaller than about 90 μm in diameter, the dynamic separator passes them on for further processing. Larger particles, which can have a detrimental effect on thermal and mass exchange during the later manufacturing stages, are returned to the raw milling stage for further grinding.

Holcim is a global supplier of cement, aggregates, concrete and asphalt products and services. To sustain its global positioning, the company has been trying to identify technology gains that can reduce operational costs and increase production efficiency. With the support of ESSS, Holcim Brazil chose to use computational fluid dynamics (CFD), specifically ANSYS CFX software, to analyze the gas–solid flow for one of their first-generation, traditional-design dynamic separators. The main objective of this simulation was to understand the separator performance, using computer modeling to replace expensive and time-consuming trial-and-error testing. This required that the particles' paths be fully simulated and classified as a function of particle diameter. The results of the simulation work were then used to suggest possible improvements in order to increase the separation efficiency.

The dynamic separator looks like a cyclone with adaptable deflectors, that are used to stop the flow of the larger airborne particles that are being swirled in the device. Ideally, the flow pattern in the separator consists of stratified, rotating patterns in which finer particles tend to reside in one area of the device (higher up) and the coarser ones tend to flow to another region (lower in the device).

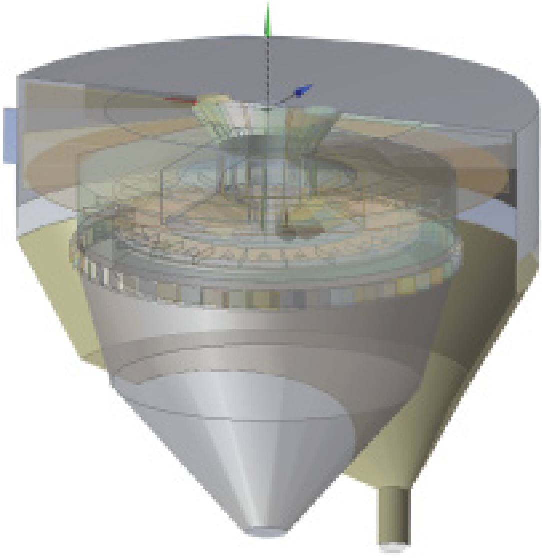
To effectively capture the larger particles and remove them from the flow pattern inside the device, particle classification and deflector positioning occur in strategic locations within the separator where the air velocity is of the same order as the particles' terminal velocities.

Due to the complex geometry involved, a mesh of 2.7 million nodes was generated using ANSYS ICEM CFD meshing software. The mesh was composed of tetrahedral elements with strategically placed prismatic element layers. Simulation of the stationary stage was performed using the ANSYS CFX SST turbulence model for the continuous phase. The dispersed phase was modeled using the Lagrangian approach with one-way coupling to the continuous phase. The dispersion of particles due to turbulence was also accounted for in the simulations, along with the particle drag and weight.

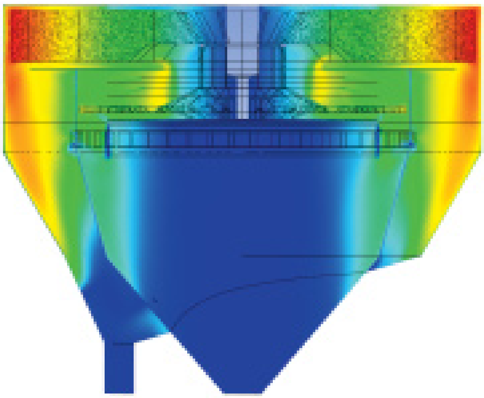
The particles' trajectories, operating pressures and mass flow values observed in the simulation agree with expected values. Particles can be observed as traveling along long trajectories inside the separator, influenced mainly by the blower rotation velocity (approximately 160 rpm) and its diameter (approximately 7 meters). Large recirculation zones have been predicted in places in which, eventually, small particles are retained and experience an increased residence time. While some trajectories of the larger particles appear to indicate that those solids have been dragged into the same current as the small particles, they eventually return to the large particle capture zones.

The CFD results allow Holcim engineers to compare the influence of particle classification on dynamic separator efficiency improvements. With simulation, they are able to gain an understanding of complex flow paths, influenced by changes in internal geometry and operating conditions, that would otherwise only be achieved through extensive trial-and-error testing.

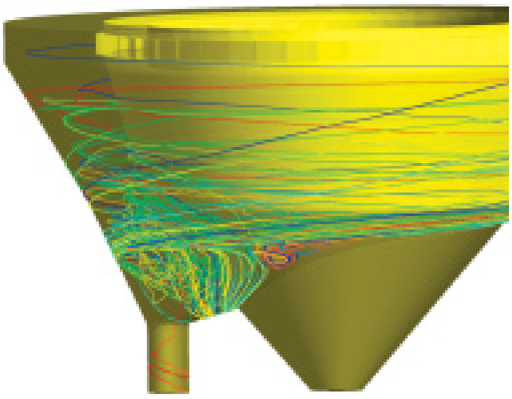
Prior to ANSYS CFX analyses, it had been impossible to understand completely the physical process occurring in the dynamic separator. With ESSS support, Holcim is able to effectively evaluate "what if" scenarios, supplement operators' knowledge and help managers to make decisions regarding costs and benefits of equipment and process modifications. With this methodology in place, Holcim Brazil can evaluate equipment modifications and identify improvements without repeated physical modification of existing equipment, thus reducing the cost of operational testing by approximately 30 percent. ■



The Holcim dynamic separator presented as a 3-D CAD geometry; particles enter through the top of the device and exit through the bottom.



Cross section of a dynamic separator showing contours of velocity. The top section is made up of a rotational bed, while the bottom region is a fixed bed with particle collectors.



Pathlines in a dynamic separator show recirculation zones representing the flow interaction and the residence time.