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## Particulate modeling in Simcenter STAR-CCM+

Ensure performance, save energy and increase efficiency for particulate flow systems in the chemical and process industry with lagrangian and discrete element method (DEM)

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### Benefits

- Simulate realistic particle shapes
- Accurate, fast modeling of particle motion and contact
- Single license for resolving coupled flow and particle physics
- Reduce expensive experimentation and testing

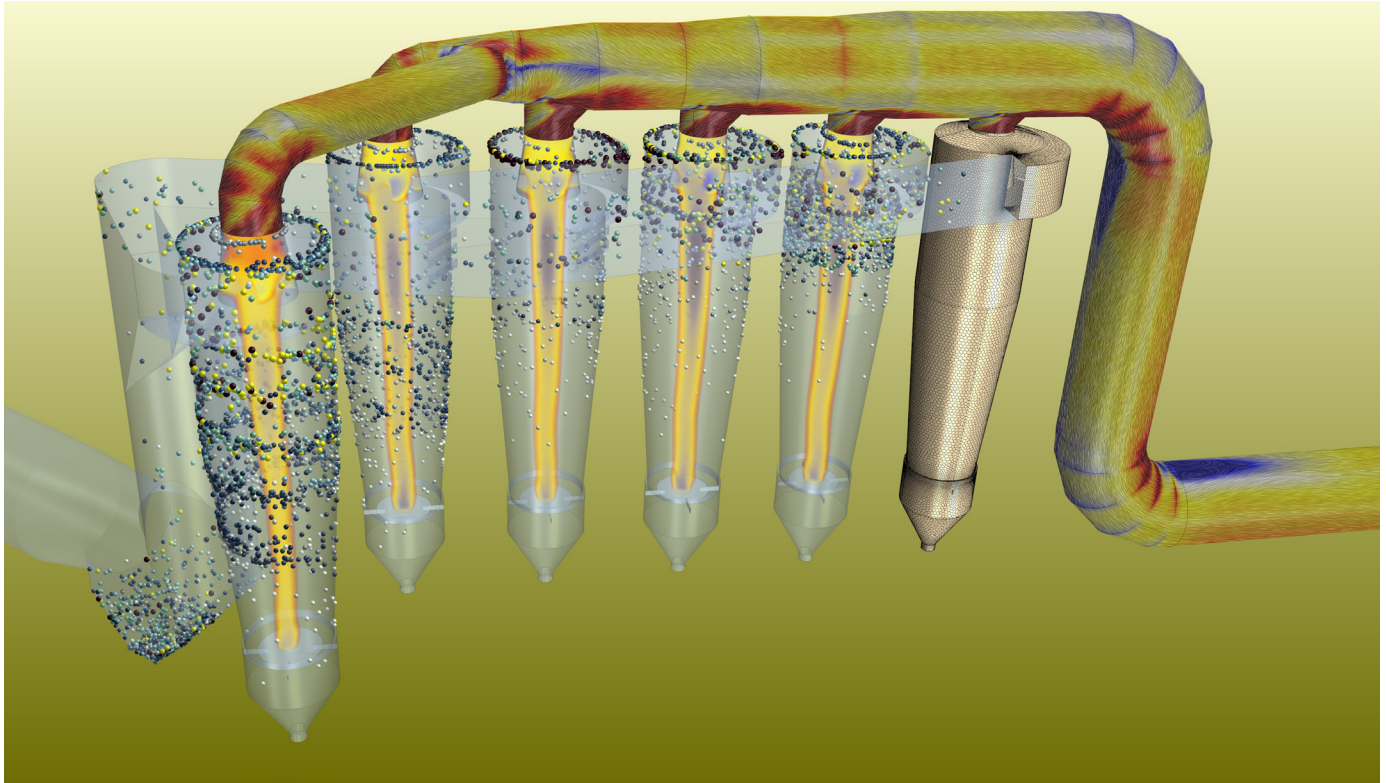
### Features

- Fully coupled with fluid flow simulation
- Non-spherical particles of varying sizes
- Single integrated environment for particle and flow physics
- Compatibility with other physics models
- First CAE code to have full integration

Particle flows are very common in the chemical, process and mineral processing industry. Pneumatic conveyors, hoppers, chutes, cyclones, belt conveyors, electrostatic precipitators, etc. are used in the industry for various processing operations. They usually involve flow of particles together with a carrier fluid where the intricate dynamics of the interaction of the two phases is governed by momentum and energy transfer between the phases. Erosion, abrasion, wetting, cohesion and various other phenomenon define the performance and energy usage of these equipment. Understanding the particulate behavior during the design phase is key to improving such processing operations.

*“PSRI finds that Simcenter STAR-CCM+, with its unique coupled DEM capabilities, is an invaluable tool for bridging fundamental ideas, observations and concepts into applied technology.”*

Dr. Ray Cocco, President, PSRI

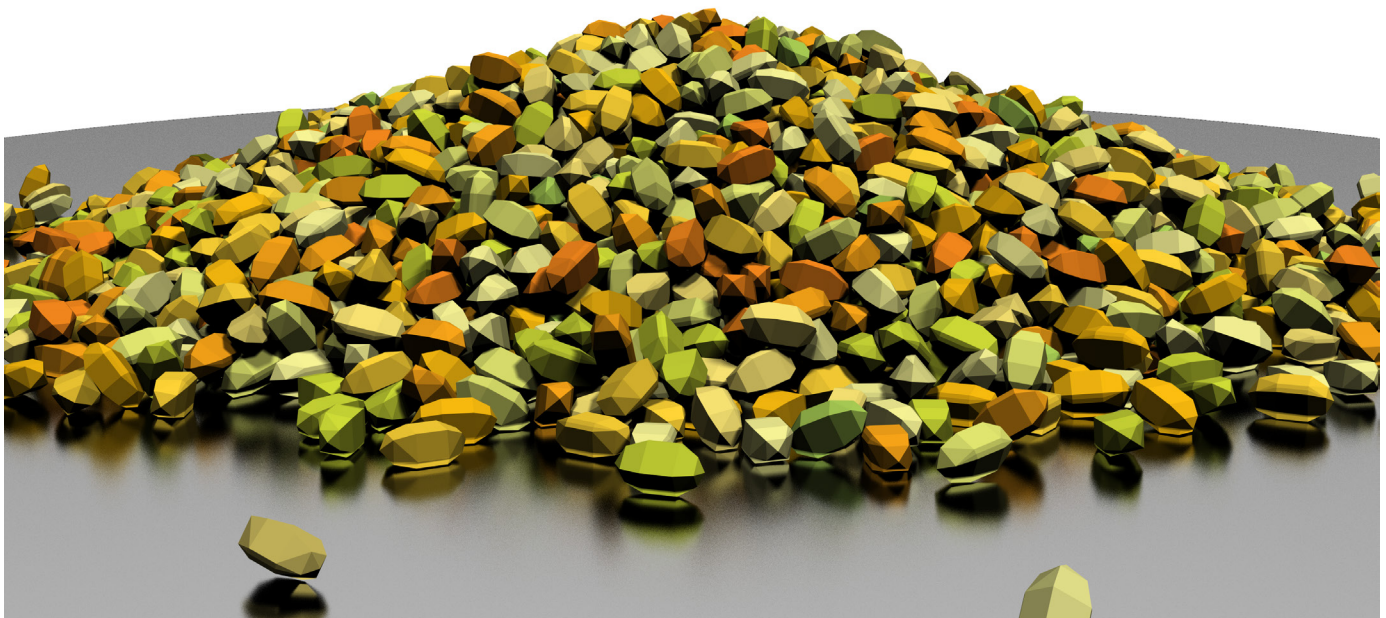


Cyclone separator simulation in Simcenter STAR-CCM+.

#### Model key particle physics

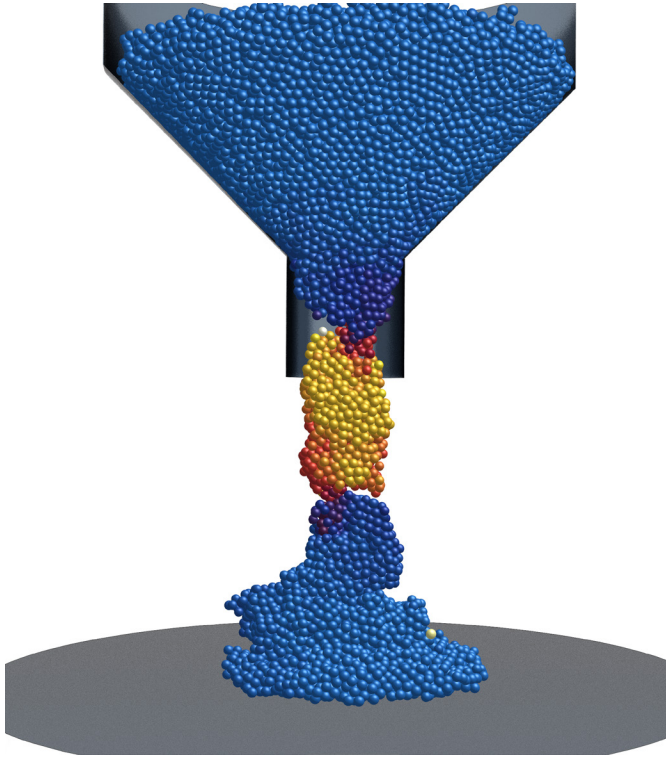
**Lagrangian (discrete) particle model (LMP)** provides an effective means of modeling particle movements in equipment. Erosion of safety valves due to impingement of particles or droplets can be examined. Separation efficiency of particles in cyclone separators can be determined together with pressure drops across the unit. Coupled with the built-in heat and mass transfer models, the combustion of solid particles can be simulated.

**Discrete element model (DEM)** can be used to model granular flow of particles. Each particle is treated as a discrete body in the Lagrangian framework. Particle shape import from CAD is possible. The flow of particles is fully coupled with the fluid flow. Good scalability is achieved in parallel computation for large problems. DEM method finds applications in hoppers, forage blowers, chutes as well as coating and granulation in pharmaceutical and food industry.



Pile of polygonal DEM particles in Simcenter STAR-CCM+.



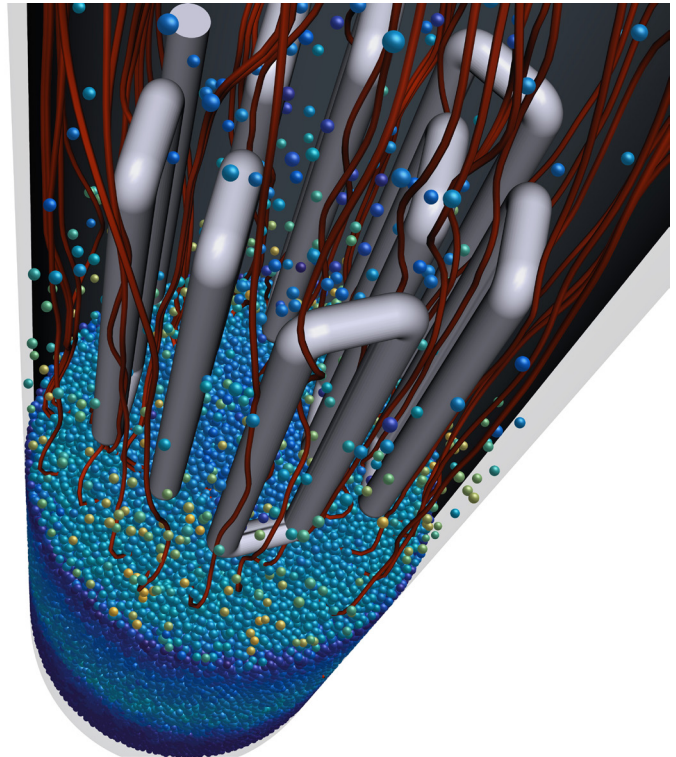


Cohesion model to simulate sticky particle flows.

The unique capability of DEM coupled to CFD in Simcenter STAR-CCM+™ is a key enabler to simulate particulate flows and gain an understanding of the drag and contact behavior of the particles. Particulate flow simulations can help explore designs digitally, troubleshoot industrial problems and carry out scale-up studies. Simcenter STAR-CCM+ allows to include complex physics such as reaction, transfer of mass, cohesion and adhesion of particles and customization of particle contact models.

#### Effect of particle size distribution

Fluidized beds are common in many industries, notably chemical processing and energy. Not only the design of these beds, but also their operation can be a challenging task due to the complexity of processes and limited ability for

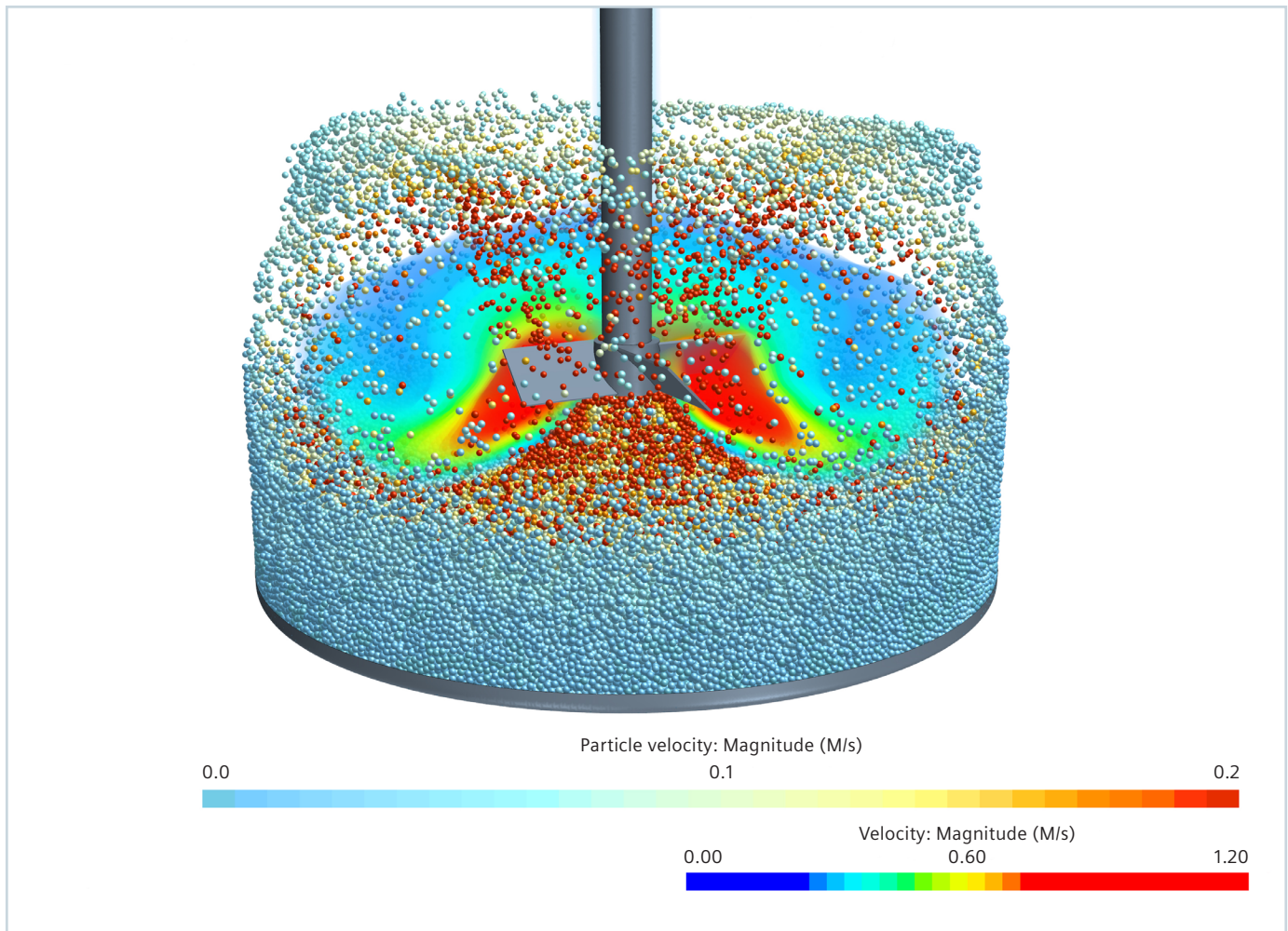


Fluidized bed with tube bundle simulated in Simcenter STAR-CCM+.

direct measurements within the bed. Numerical simulation of fluidization can reveal many behavioral aspects of a fluidized beds.

Particle size distribution is known to be important to the behavior of fluidized bed reactors. For example, moderate increase in amount of smaller size particles can lead to better performance, while excessive content of fine particles can amplify the role of inter-particle forces and decrease reactor performance.

Simcenter STAR-CCM+ facilitates large-scale parallel simulations of fluidized beds with DEM fully coupled to fluid flow. Simulations predict model performance upfront and help identify and avoid problems like segregation and choking.



Simulation of particle mixing at 300 rpm.

### Design space exploration

Solid – liquid mixing in high viscosity liquid with high solids concentration is a challenging problem due to the solid-solid and solid-liquid phase interactions. Just suspension speed ( $N_{js}$ ), suspension height ( $H_s$ ) and the power consumption can vary not only with the material properties but also with the design of tank and impellers. Simcenter STAR-CCM+ allows a single integrated approach rather than a co-simulation approach with 2 different codes for CFD and DEM. The integrated Design Manager allows running parametric sweeps quickly to explore the effect of rpm (rotation speed) on the suspension.

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