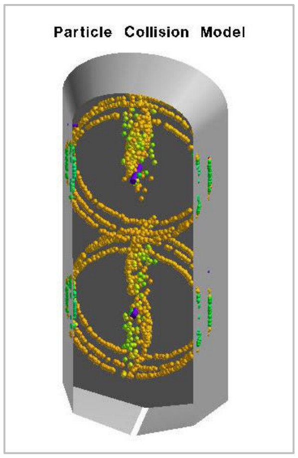
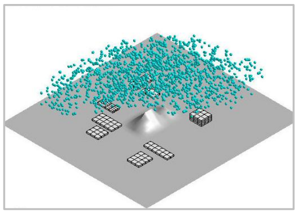


CAESIM provides a Lagrangian approach (two-phase particle tracking method) that allows for the calculation of the fluid-particle interaction between a dispersed phase and continuous fluid, effectively modeling the following combinations of particulate and continuous phase applications:

- Liquid particles in a gas continuous phase
- Solid particles in a gas continuous phase
- Liquid particles in a liquid continuous phase
- Solid particles in a liquid continuous phase
- Gas bubble in a liquid continuous phase

The simulation of particulate two-phase flow is of special interest to many scientific and engineering research disciplines. Examples include the design of power-generating devices such as internal combustion engines and liquid/solid rocket engines, pollution control, nozzle design, filter design, etc. In each of these applications the two-way coupling of transportation of momentum, heat, and mass between continuous phase and particulate phase plays an important role in the nature of these flows.

Lagrangian Methodology

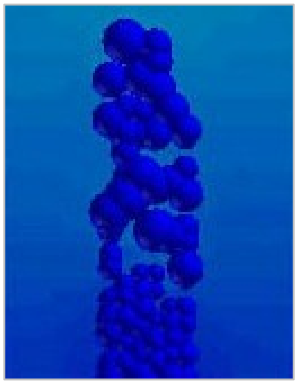


Simulating two-phase flows that involve particle tracking requires the Lagrangian methodology because of its accuracy in calculating fluid-particle interaction between a dispersed phase and a continuous fluid. To track the particles in a realistic manner, the Lagrangian methodology directly models the physics of particle behavior in conjunction with the flow field. It treats the particles as discrete entities in the flow field and calculates their relative trajectories. It then simultaneously describes, and consequently solves, the continuous phase using an Eulerian approach.

$$\frac{\pi}{6}d_p^3\rho_p\frac{dv_i}{dt}=\frac{\pi}{8}d_p^2\rho C_D\,|\,v_i-u_i\,|\,(v_i-u_i)\frac{\pi}{6}d_p^3\frac{\partial p}{\partial x_i}+\frac{\pi}{12}d_p^3\rho\left(\frac{du_i}{dt}-\frac{dv_i}{dt}\right)+\frac{3}{2}d_p^2\sqrt{\pi\rho\mu}\int_{t_0}^{t}d\tau\frac{\frac{du_i}{d\tau}-\frac{dv_i}{d\tau}}{\sqrt{t-\tau}}+\frac{\pi}{6}d_p^3\rho_pF_{bi}$$

The Lagrangian methodology couples the solution of the dispersed phase to the continuous phase by representing the dispersed phase as a finite number of computational particles. Then, the mass, momentum, and heat exchanges are computed between the two phases. The Eulerian phase takes the exchanged amounts and adds them to the source term of the governing equations to quantify the effects of the dispersed phase. The particulate phase takes the exchanged amounts and calculates the particle characteristics (velocities and positions). Interactions between particles and particles with wall are modeled as well.

Switch-on physical models



Sophisticated physical models are available which can describe specific particle behavior observed in nature, such as particle evaporation, particle breakup, particle combustion, and turbulent particle dispersion. Particle collision can also be taken into account based on particles colliding with other particles and/or particles colliding with surface boundaries or blockages or blockages, including parameters for representing the effects of sticking and bouncing. The addition of these switch-on physical models allows for a more accurate description of the complex interactions between particulate phase and continuous phase.