S2.3.2 From Resolved Filtration Simulations to Effective Cake Filtration Simulation Parameters

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We simulate cake formation by the following steps: First, a stationary flow through the filter media is computed. Depending on the resolution, it is Stokes-flow or Darcy-Flow. Then, particles are introduced and moved according to the friction with the fluid, inertia and Brownian motion. Filtered particles are deposited on the filter material. Thus later particles experience a different flow field, and can then be caught either by the filter material or the previously deposited particles. In this way, a filter cake forms. The whole process can be simulated using the FilterDict module of the GeoDict software.

Two cases can be distinguished for monodisperse particles that depend on the relation between the particle size and the resolution of the computational grid (voxel size):

1. If the particle diameter is large enough that a particle is resolved by the computational grid, a deposited particle fills several grid cells (voxels), turning them from pore to solid. Thus, the flow through the filter cake can be modeled with the Stokes equations. In this way, the solidity of the cake and flow resistivity of the cake are results of the simulation.

2. If the particle diameter is so small that a particle is not resolved by the computational grid, a deposited particle fills only a fraction of a voxel. Thus, many particles are deposited into a single voxel and form a porous filter cake inside this voxel. Flow can be modeled with the Stokes-Brinkman equations and parameters describing the solidity of the cake and the flow resistivity of the cake are inputs of the simulation.

For poly-disperse particles, the situation is not that simple.

Real test dusts consist of particles with a wide diameter range and both cases are present: the largest particles are resolved by the grid and the smallest ones are not resolved by the grid. Thus, the simulated filter cake consists of solid, porous and empty voxels. The challenge is to assign the porous voxel solidity and resistivity in such a way, that the global solidity and resistivity that result from the distribution of solid, porous and empty voxels and their solidities agrees with the experimentally observed macroscopic cake solidity and cake resistivity.

In this presentation we will present an approach how to choose the local solidity and resistivity from resolved particle filtration simulations such that a given global solidity and flow resistivity of the filter cake is reached. This enables us to simulate cake filtration for any poly-disperse particle size distribution at any resolution. In addition, we set a focus on the verification of the simulation results. The cake formed by partly resolved particle filtration simulations is compared to cake formed by fully resolved particle filtration simulations in terms of local solidity and flow resistivity.