DHCAE Meso Scale model for filter applications

A new modelling approach is introduced to deal with the formation of a filter cake within the framework of DHCAE's filter solver. Hereby, the filter solver can cover the meso-scale level of filter applications simulation as well.

Particles or parcels are tracked until they hit selected walls or permeable filter elements. The cells adjacent to these patches are filled with these particles, hereby reducing the porosity of the cell.

After reaching a minimum porosity the cell is assumed to be filled completely and the next particles arriving settle in the preceding cell etc.

In an iterative process the filter cake is building up. The tracking itself can be done either with a time efficient local time stepping (LTS) algorithm for long-term view simulations or with PISO controlled transient simulations.

Porosity structure

Pressure loss in the cake

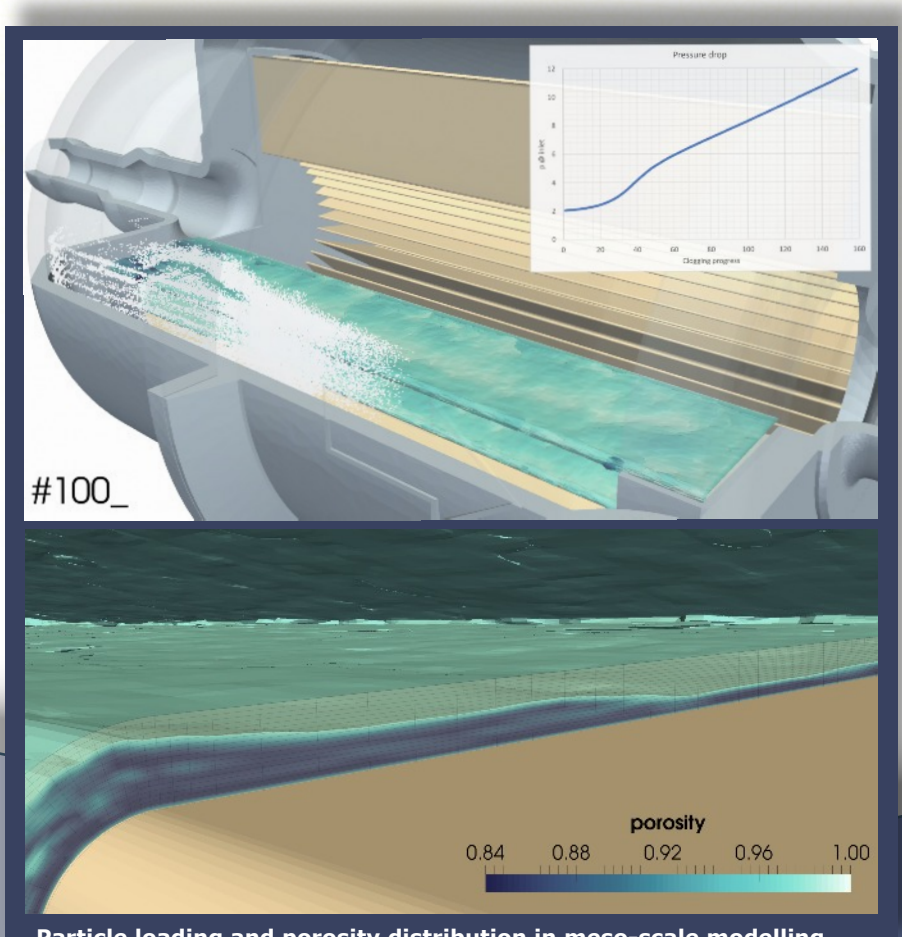
The pressure loss induced by the filter cake is calculated with the Ergun equation according [1]. Each cell can have an individual resistance depending on the local porosity, the particles Sauter mean diameter and an application specific model constant. The user's input into the model is a minimum allowed porosity, resistance parameters for the Ergun equation and the size distribution of the particles.

Pressure loss in the filter media

For the filter media a specific layer can be defined by individual resistance in various formulations,e.g. as Darcy or Forchheimer parameters.

Extension to macro-modelling

The meso scale completes the macro modelling by the capability to investigate local effects at filters caused by particle agglomeration without the need to estimate resistance curves related to flow velocity and particle mass in test facilities. In particular local and regional blockage caused by particles can be considered in form of individual resistance zones.



Particle loading and porosity distribution in meso-scale modelling

CastNet integration

The setup of the meso scale solver is completely integrated into CastNet. A complete GUI based workflow is realized for the case setup.

Templates support the user with an efficient case setup.

The filter can be modelled as 2d element. The boundary layer meshing capabilities in CastNet are used to generate a layered section around the filter for a reliable resistance modelling.

The solving with different particle load cycles is fully automated.

References

[1] Johannes Weber, Numerische Simulation von Transport- und Abscheideprozessen in der Gas-Feststoff- Filtration, 2016.

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