Modeling of particle deposition in turbulent flows with Lagrangian module of *Code_Saturne*

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Introduction

Code_Saturne can simulate particle- and droplet-laden flows with a Lagrangian approach.

Standard set-ups can be made by the GUI, for steady or unsteady flows and boundary (particle boundary mass flux or impact number) or volume statistics can be extracted.

Since version 3.0, particle-tracking simulations can be run in **parallel** mode and with **periodic** boundary conditions.

Physical modeling

- Lagrangian stochastic approach

- Near-wall model to take into account coherent structures

- Brownian motion modeling for colloidal particles simulation

- A transport step: hydrodynamic transport of particle toward wall surfaces

- An attachment step: adhesion between particle and surface

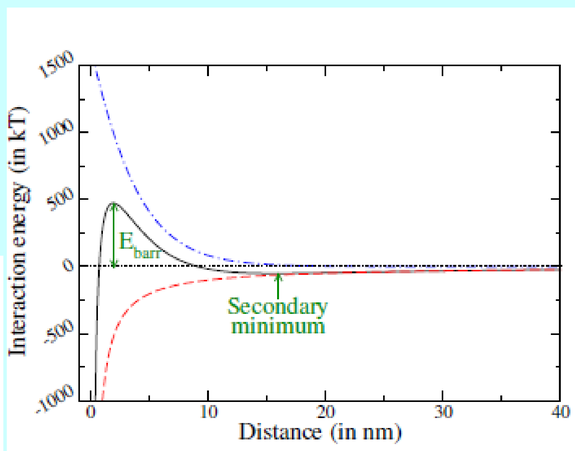
Particle deposition/resuspension modeling

A current axis of research at EDF R&D through the MOFPHET-C2 project

Physico-chemical aspect by the DLVO theory:

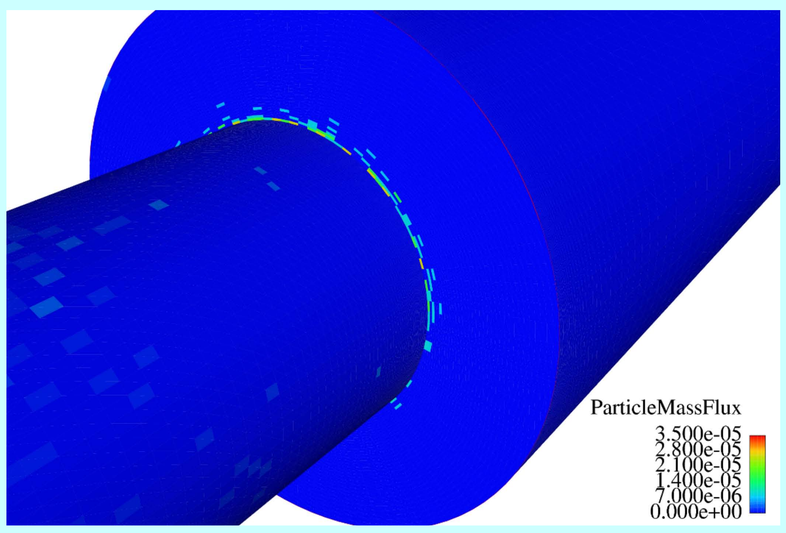
$$F_{DLVO} = F_{vdW} + F_{elec}$$

$$F_{DLVO} = -\frac{\mathcal{A}_H {R_p}^3}{3(2R_p + d)^2 d^2} + 4\pi\varepsilon_w\varepsilon_0\frac{R_p}{\lambda}\varphi_1\varphi_2 e^{-\frac{d}{\lambda}}$$



Approach based on *energetic considerations* :

- $E_{kinetic} \geq E_{barrier}$: deposition occurs
- $E_{kinetic} < E_{barrier}$: particle is reflected from the surface



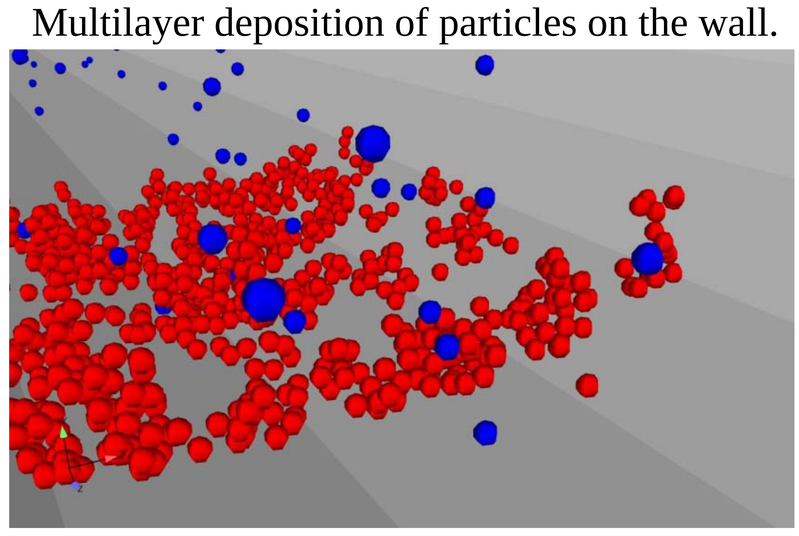
Simulation of the EMILIE experiment (AREVA) devoted to the study of the blocking phenomenon with different materials.

Barrier energy depends on parameters as ionic force, zeta potentials or Hamaker constant.

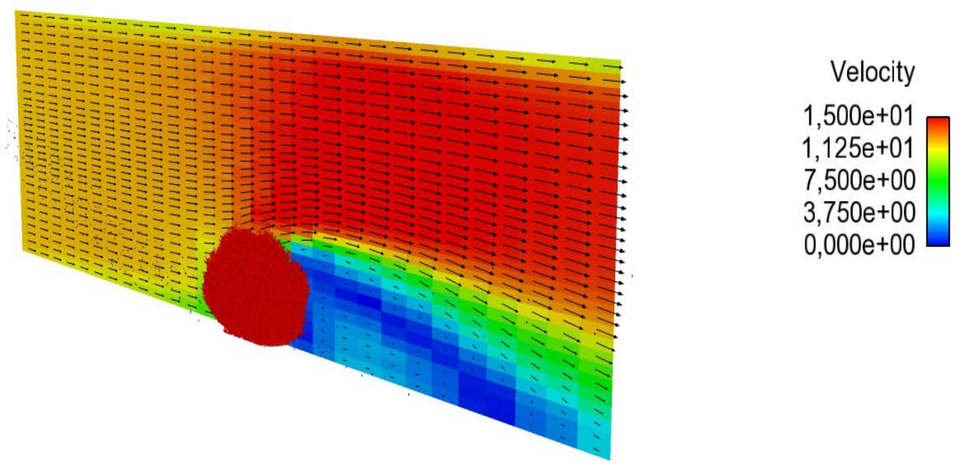
The energy barrier calculation is also possible for a roughness surface with asperities. The roughness tends to decrease the barrier of energy.

Particle clogging (Work in progress)

Multilayer deposition of particles on the wall.



Different morphologies of the deposit (monolayer, dentrites, multilayer) can exist according to the chemical properties of the particles and wall.



The influence of the multilayer deposit on the flow is taken into account by a porous medium approach.

Fluid velocities modified by multilayer deposits are predicted using a head-loss coefficient in the momentum equation.

Forthcoming

Available in an upcoming version of *Code_Saturne*:

- Particle clogging and their influence on the flow

- Thermophoresis force

- Resuspension in multilayer deposit

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