Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Simulation of Explosion Hazards in Powder Flows

Holger Grosshans

Motivation

- Ignitions and explosions in the chemical and process industry can occur when combustible powders are handled
- Dust deposits and tribolelectricity can cause smoldering fires and spark discharges
- A wide range of simulation tools is on the market but none with the focus on explosion protection

⇒ We develop pafiX and distribute it on our group's website

Goals of the tool for the user:

- User friendly experience, focus on explosion protection, removal of non-relevant features
- Productive tool to provide fast results
- Constant improvement through research activities

Goals of the tool for research:

- Clearly structured code enables fast understanding and easy implementation of new features
- Study of fundamental physical processes

Mathematical model and methods

Electrohydrodynamics solver:

- Navier-Stokes equations for the fluid
- Gauss's law for the electric field
- Newtonian law for the particles

Relevant for explosion protection:

- The condenser model for particle charging [1]
- Model of non-uniform particle charging
- Formation of deposits and agglomerations

Exemplary results

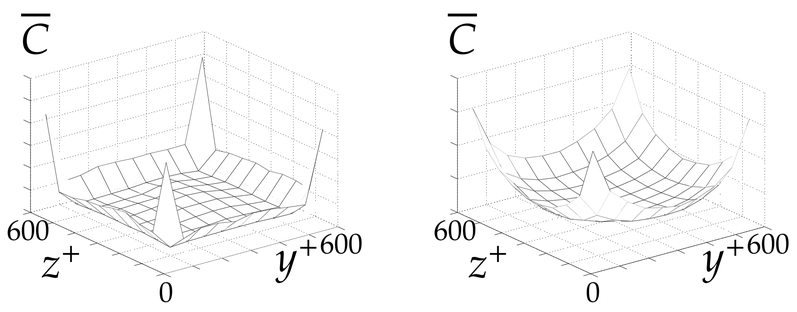

Fig. 1: Concentration of uncharged (left) and charged particles (right) in a square duct [2].

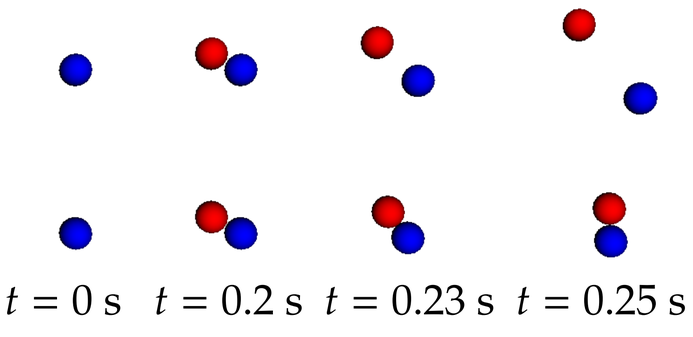

Fig. 2: Colliding particles, without (top) and with (bottom) van der Waals forces.

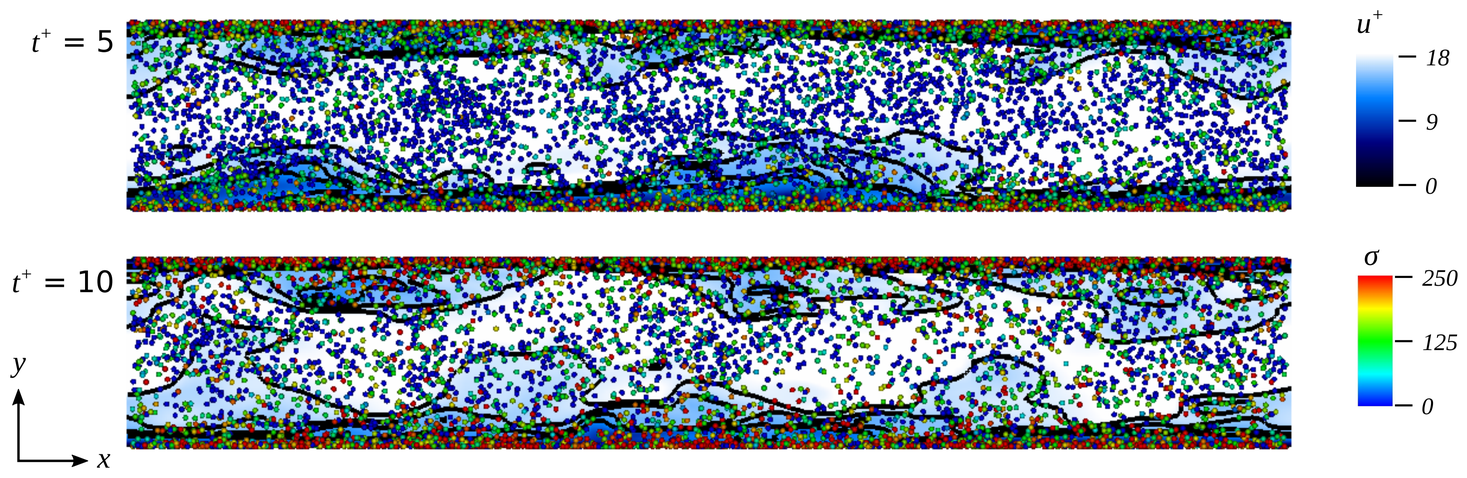

Fig. 3: Triboelectric particle charging in a channel flow [3].

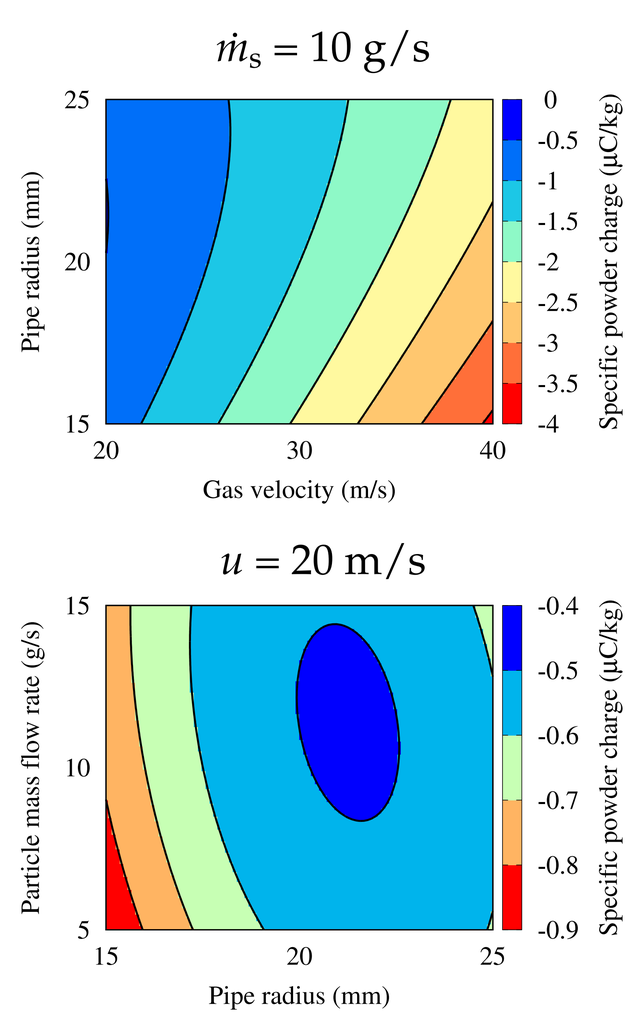

Fig. 4: Powder charge after transport in a circular pipe [4].

Perspectives

- pafiX requires constant updates and improvements
- Reducing the computational time, more complex geometries and other features
- Possible open source distribution

References

[1] Soo SL (1971). In *Topics in Current Aerosol Research*, 71–73. Pergamon Press.
[2] Grosshans H (2018). Phys. Fluids, 30(8):083303.
[3] Grosshans H and Papalexandris MV (2017). J. Fluid Mech., 818:465.
[4] Grosshans H and Papalexandris MV (2016). J. Loss Prev. Process Ind., 43:83.

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Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

Holger Grosshans
3.5 Explosion Protection in Energy Technology
3.51 Analysis and Simulation in Explosion Protection

Bundesallee 100
38116 Braunschweig
Telefon: +49 531 592-3510
Fax: +49-531-592-693510
E-Mail: holger.grosshans@ptb.de
www.ptb.de