LAGRANGIAN PREDICTION OF DISPERSE GAS–PARTICLE FLOW IN CYCLONE SEPARATORS

Th. Frank, E. Wassen, Q. Yu

Abstract

Disperse multiphase flows are very common for processes in mechanical and thermal process technology (e.g. gas–particle or gas–droplet flows, coal combustion, pneumatical conveying, erosion phenomena). Processes for the separation of solid particles from gases or fluids and for the classification and particle size analysis are an important field of interest in process technology.

The paper deals with a 3–dimensional Lagrangian approach for the prediction of disperse multiphase flows. The underlying numerical algorithm is based on the PSI–cell approach, where trajectories of a large number of particles are calculated from the equations of motion of the disperse phase.

The time–averaged equations of fluid motion are solved by the program package FAN–3D developed by Perić and Lilek and modified for gas-particle flow calculations by the authors. The most fundamental features of FAN–3D are :

- use of non–orthogonal, boundary fitted, numerical grids with arbitrary hexahedral control volumes,
- use of block structured numerical grids for optimum geometrical approximation of complex flow domains and for parallelization purposes;
- finite volume solution approach of SIMPLE kind with colocated variable arrangement; Cartesian vector and tensor components.

The disperse phase is treated by the Lagrangian approach where a large number of particle trajectories is calculated throughout the flow domain. For the formulation of particles equations of motion a small density ratio ρ_F/ρ_P is assumed. So the drag force, the lift force due to shear in the fluid flow (Saffman force), the gravitational and added mass force are taken into account [1, 2].

The 3–dimensional Lagrangian approach was applied to the gas–particle flow in standard cyclone separators. Due to the complex geometry of the cyclones a numerical grid with 42 different grid blocks and about 250.000 control volumes was designed for the numerical calculations of the gas–particle flow. The numerical predictions were compared with experimental results for pressure loss and precipitation rates published by König [3]. The investigations for the precipitation of quartz particles were carried out for a series of four geometrically similiar cyclone separators for different gas inlet velocities. Numerical results were found in very good agreement with the experimental data.

References

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