Solution of Computational Fluid Dynamics Problems on Parallel Computers with Distributed Memory

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There are presented some applications of parallel computers with distributed memory to solving CFD-problems. Two types of flows are predicted. In the first case — multi-phase immiscible incompressible fluid flows in a porous medium. Filtration processes are governed by the 2d Bucley-Leverett model. Explicit as well as implicit methos are used. Simulation of oil extraction by water flooding is considered as an application.

In the second case we deal with compressible gas flows at low Mach number. The procedure of the pressure decomposition into two components iis applied to the quasi gas dynamic system of equations. It allows to avoid singuularities at M —› 0 and M=0.Results for isothermal lid driven cavity are presented.

Numerical simulation of low Mach number compressible flows in horizontal channels with partially heated/cooled walls faces well known difficulties and requires rather correct methods. For the next problem the new QGDS model based on the Enskog eqution for the disribution function was used. The developed approach was applied for modelling of fast contact chemical reactor for heterogeneous methane oxidation in the field of the gravity force.

The first step of the study is concerned with modelling of the gas flow part of the problem. The dynamical processes are characterised by low Mach numbers (0.01-0.1), large Reynolds numbers (500-1000), and strong temperature gradients in the boundary layer. Predictions have been performed in 2D cartesian formulation on the basis of the dimensionless QGDS-equations. The semi-implicit numerical method was used. As to the chemical part: Syngas (the mixture of Hydrogen and Carbon Monoxide) is formed in the course of the surface catalytic reactions. The species formation is described by very stiff system of ordinary differential equations for temperature and species concentrations, characterized by the norm of Jacobian up to 10^{11} . Numerical solution of such systems requires special methods. Several approaches for effective parallel computations are in work.

All desribed problems were solved using multiprocessor Parsytec CC system under MPI communication library. The data partioning principle and the model of message passing were used. The efficiency of parallelization by using explicit as well as implicit schemes was high enough. Test problems predictions showed a good accuracy of developed methods.

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