mollierSolver

Phase transitions in open source CFD

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Why Fluid dynamic simulations of many environmental phenomena and industrial applications are directly related to phase change: from prediction of *microclimate* in urban areas, to optimisation of *drying processes*, to elimination of unwanted condensation in *car headlights* and *printing processes*. Only strongly integrated CFD-simulations uniting latent heat of phase change, heat conduction in solids, radiation and bouyancy into one solver can produce physically correct results over a wide range of input parameters for these complex, transient phenomena.

How Rheologic created a novel solver implementing phase transitions in the gas-phase and on surfaces including condensation, evaporation and (re)sublimation for arbitrary substances for use within OpenFOAM® called **mollierSolver**. Conjugate heat transfer, radiation and compressible, turbulent flow are included in the solver.

Results The solver was validated against an experiment: under rigorously monitored conditions moist air was condensed on a cooled mirror. The temperature changes in the mirror were monitored to track the condensed mass of water on the surface of the mirror. Half way through the experimental run the inlet flow was reverted to dry air which evaporated the liquid film on the surface. The experimental setup was duplicated in a simulation and the results compared - see figure 2 and videos on our homepage: *www.rheologic.net*

Outlook The solver works with arbitrary pure substances, modeling all relevant thermodynamic effects including conjugate heat transfer and radiation. Future work will include modeling of morphological effects on surfaces like forming of droplets, build-up and melting of ice and refinement of the related kinetic effects.
Rheologic is planing to team up with research partners to get reliable input data for evapotranspiration rates of different types of vegetation and soils depending on temperature, relative humidity and radiation parameters. **mollierSolver** is our basis for future simulations and assessments of urban microclimate.

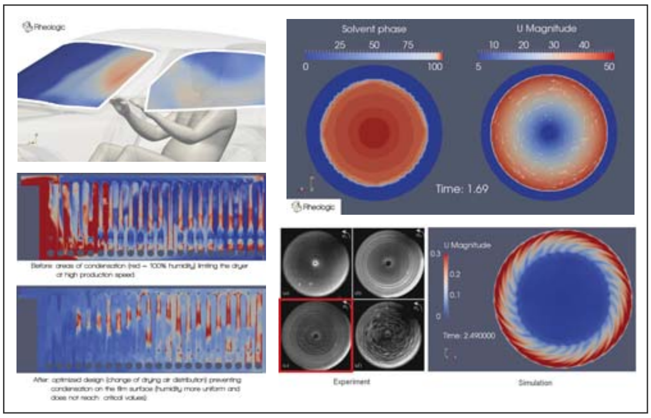

Fig.1: Application examples - **mollierSolver**
CCW from top left: windshield defogging, optimisation of industrial dryer, flow patterns and drying of photoresist in a spin-coating device

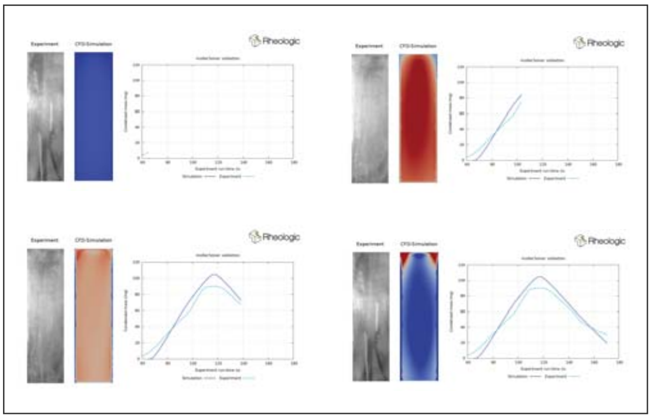

Fig.2: Reality check - comparison of experiment and CFD-simulation
Simulation run-time: 10 hours for 560k cells at 1.5 m/s air speed

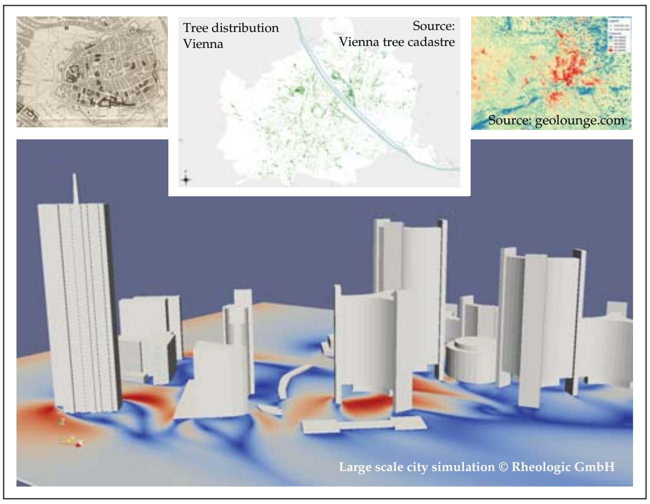

Fig.3: Future development - simulation of urban microclimate

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