Vortrag

Some modelling needs in nuclear natural convection applications and DNS based improvements of RANS models

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Natural and mixed convection is occurring in nuclear reactors in operating and off-normal conditions. Earlier CFD applications show different modelling challenges. One example is the transient after heat removal from a pool type reactor by buoyant convection. Those investigations required finer resolution than could be realised on the available high performance computers. Therefore, very detailed experiments were required for the analysis and to validate the results. In case of failure of the primary system, the afterheat of an PWR could finally be removed from the inner containment shell. The analysis of respective model experiments showed that the combined natural air draft cooling and radiation heat transfer in the containment gap leads to complex velocity and temperature distributions and that it is a problem to separate both effects so that it could be adequately modelled. The long-term heat removal from a molten core was investigated for an early EPR concept. The numerical analysis of simplified model experiments showed, that the water flow above the melt is 3d and highly intermittent, and that the measured heat transfer was strongly governed by experiment-specific local details. So, condensing the physical task for experimental or numerical analysis is a challenge and always needs validation by the other method. And in analysing the early heat removal from inside the molten core material one is faced with serious challenges of turbulence modelling. Features of buoyant flows, which need to be considered in such CFD applications, are their strong anisotropy, the often occurring counter-gradient fluxes of many quantities, and the high accuracy of the temperature field which is required as it governs the source term in the vertical momentum equation. Examples of statistical analyses of Direct Numerical Simulation results are given to assess such modelling problems of RANS for buoyant flows and to deduce suitable models. It is shown that the turbulent Prandtl number concept fails in these flow types, that algebraic heat flux models would be much more adequate, and that even the turbulent k-diffusion term in the standard k-e model has to be extended to include the hidden buoyancy influences and to treat counter-gradient energy fluxes. Such results deduced for RANS may also be used to get improved subgrid scale modelling.

The talk will be delivered in German, the slides will be in English.

Termin: **Mittwoch, 15.06.2011, 09:30 Uhr**
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