Comparison of Several RANS Modelling for the Pavia TRIGA Mark II Research Reactor

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SUMMARY

In this study, a detailed analysis of the turbulent regime within the core of the Pavia TRIGA Mark II reactor is performed by means of an in-depth comparison of the RAS (Reynolds-Averaged Simulation) turbulence models implemented in OpenFOAM. Aim of this analysis is to give some important information with respect to the flow regime within the core. The performance of the various models is tested against a LES (Large Eddy Simulation) of the innermost channel.

TURBULENCE MODELLING

Reynolds-Averages Simulation (RAS) models focus on the mean flow and the effect of turbulence on its properties, by resolving only the largest eddies that characterise turbulence and without entering into details about the smallest scales and local effects. Seven models have been tested:

- RMS (Reynold Stress Model) LRR and RSM-SSG
- Standard k-ε, Renormalised k-ε, and Shih-Quadratic k-ε
- k-ω SST and k-ω SST-SAS

For investigation the behaviour of the quantities of interest near the wall, a Low-Reynolds Number (LRN) approach has been chosen. The fluid flow is modelled as Newtonian, incompressible, turbulent, and it is considered in steady state.

NUMERICAL MODEL

The power produced by the fuel elements was taken as input data for each element. For the LRN approach for wall treatment, the use of placeholder wall functions allow the evaluation of the wall distance y+.

CONCLUSIONS

Overall, the k-ω SST model shows the best agreement with the LES simulation, while being less time consuming. This can be explained with its inherent structure, designed to be accurate both for near-wall and free-stream regions. This models offers the best compromise between accuracy and computational requirements, and may be suitable even for a full core simulation.