6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

On the implementation of RANS solver with LRN k-omega turbulence model based on isogeometric analysis

Bohumír Bastl*, Marek Brandner*, Jiří Egermaier*, Hana Horníková*, Kristýna Michálková* and Eva Turnerová*

* New Technologies for the Information Society (NTIS)
Faculty of Applied Sciences, University of West Bohemia
Univerzitní 8, 201 00 Plzeň, Czech Republic

Keywords: *turbulent flow, RANS, isogeometric analysis, algebraic flux correction*

The Navier-Stokes equations are the basis for computational modeling of the flow of an incompressible Newtonian fluid. The fluid flow behaviour is very complex and depends on the Reynolds number Re, which depends on viscosity ν, geometry and fluid velocity. The Navier-Stokes equations can be used to directly simulate turbulent flows. But the number of grid points in spatial discretization must be proportional to $Re^{9/4}$ and the time step has to be sufficiently small to resolve the movement of the fastest fluctuations, otherwise the simulation becomes unstable. Then the direct numerical simulation based on solving Navier-Stokes equations becomes impossible as the Reynolds number increases and some kind of turbulence modelling is necessary.

In this contribution, we focus on incompressible fluid flow simulation based on RANS equations with LRN (Low Reynolds Number) variant of the two-equation k-omega model. The numerical model is based on Isogeometric Analysis (IgA) which is a recently developed approach based B-spline/NURBS objects and sharing a lot of features and approaches with the well-known Finite Element Method. In general, it is necessary to consider the computational domain to be composed of several B-spline/NURBS objects, the so-called patches, which have to be consequently joined in the solver into one computational domain in a conforming or non-conforming way.

Similarly to other approaches, numerical solutions based on IgA-approach to convection dominated flow problems or problems including steep gradients in the domain suffer from spurious oscillations. Therefore, the algebraic flux correction (AFC) stabilization is applied to avoid non-physical behaviour. Our solver is implemented in an open-source C++ library G+Smo and its functionality will be demonstrated on several examples.

REFERENCES

[1] T.J.R. Hughes, J.A. Cottrell, Y. Bazilevs, *Isogeometric analysis: CAD, finite elements, NURBS, exact geometry and mesh refinement.* Computer Methods in Applied Mechanics nad Engineering 194 (3941) 4135 - 4195, 2005.

[2] D.C. Wilcox, *Formulation of the $k-\omega$ Turbulence Model Revisited.* AIAA Journal 46 2823 - 2838, 2008.