PRACE Industrial Seminar 2013
Emerging Application: **ViscoSolve**

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CAPACITIES

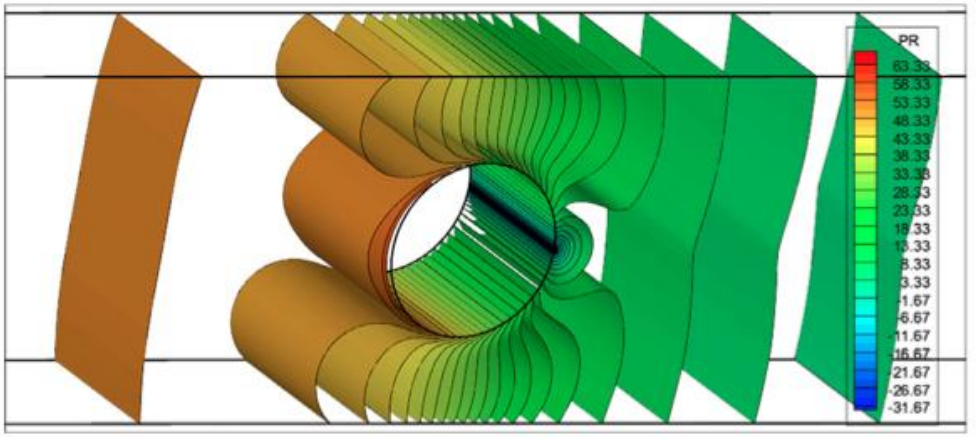
e-infrastructure

Overview

- Emerging Application: ViscoSolve
- ViscoSolve for Industries
- ViscoSolve so far, and future
- Where are we?

Emerging Application: **ViscoSolve**

- A non-Newtonian flow solver,
- A stable unstructured finite volume method for parallel large-scale viscoelastic fluid flow calculations,
- The code uses the open-source libraries PETSc and MPI for parallel computation,
- Written in FORTRAN90,
- By Dr. Mehmet Sahin (Astronautical Engineering Department, Faculty of Aeronautics and Astronautics, ITU)



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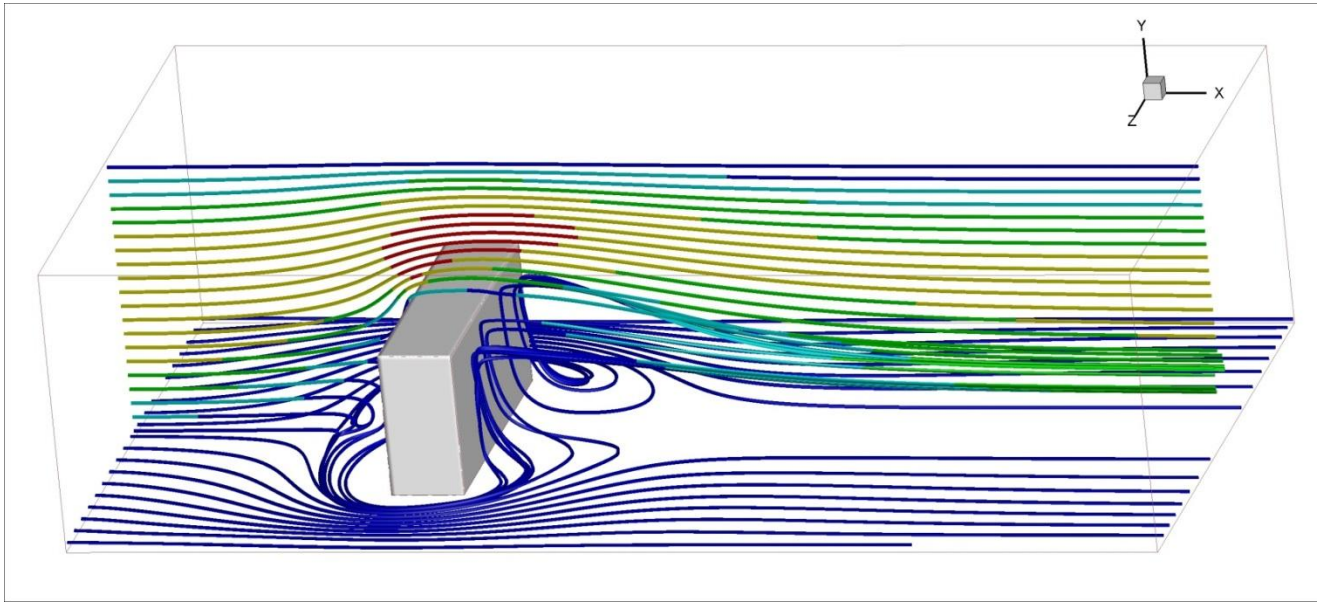
Emerging Application: **ViscoSolve**

- Theoretical approach was developed by Dr. Sahin,
- The first version of the code was tested for basic shapes, and preliminary results published
- To be applied to complex problems, as required by industry, the code needed some optimizations to improve performance and scalability



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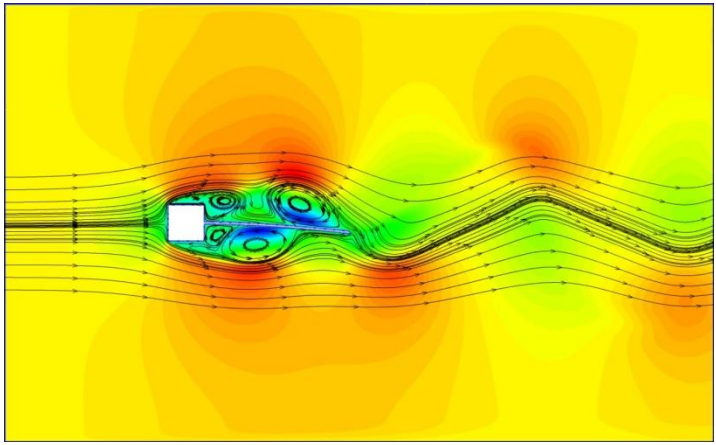
ViscoSolve for Industries

- The code is suited to design and model polymer products
- Industrial Interests
  - Polymer industry,
  - Household appliances industry.



- Helpful to define and optimize the shape of the products before production,
- Useful to predict the output quality constraint depends on the operating conditions,
- The code can increase the processing and production speed.

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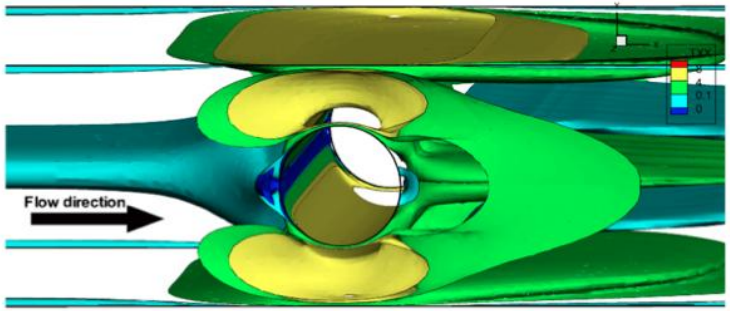
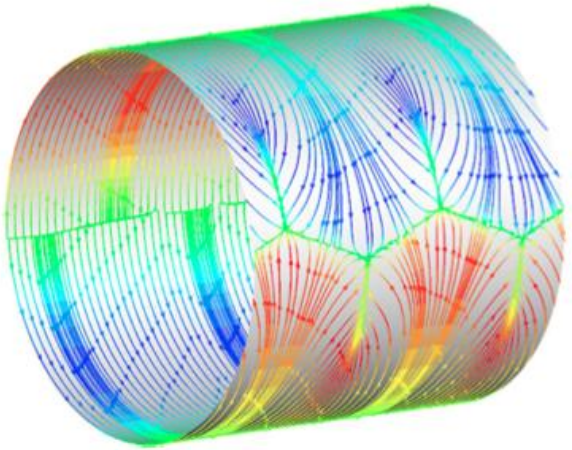
ViscoSolve vs OpenFOAM

- ViscoSolve
  - Uses numerical methods are based on the unstructured finite volume method.
  - The velocity vector components are defined at the element face midpoints meanwhile the pressure and the extra stress tensor components are defined at the element centroids, as in the OpenFOAM.
  - **The main advantage** of the present approach is that it leads to a stable numerical algorithm and **does not require any ad-hoc stabilization techniques**.
  - The continuity equation **is satisfied at the machine precision.**



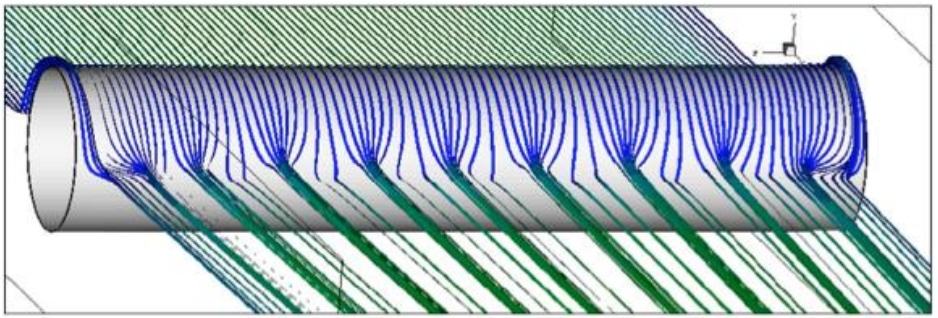
ViscoSolve vs OpenFOAM

- ViscoSolve
  - ViscoSolve algorithm uses a two-level non-nested multigrid preconditioned FGMRES(m) algorithm for the solution of the coupled Stokes system.
  - The Stokes solver is setup only once at the beginning of the code since the Stokes system is a linear system (not like the Navier-Stokes).
  - The Stokes solver requires time only for the iterative solution part during the iterations.
  - OpenFOAM decouples the Stokes system and uses an algebraic multigrid solver for the pressure Poisson equation.



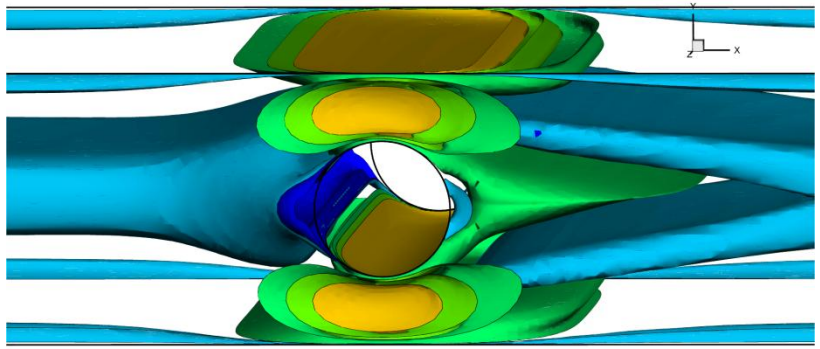
ViscoSolve vs OpenFOAM

- At high Weissenberg number flows, called the log-conformation is used for the solver can handle very sharp stress gradients and diverge.
- The current version of the ViscoSolve is limited to hexahedral unstructured meshes due to solution accuracy and efficiency.
- On the other hand, OpenFoam can handle more complex elements including polyhedral meshes.



ViscoSolve so far, and future

- Getting expression of interest from Arcelik A.S.
  - One of the biggest household appliance companies of Turkey



- Multi thread mesh partition algorithm will be developed and implemented to the code,
- Mesh data and global reference values of each thread will be written in datafiles,
- Doing scaling and profiling tests for larger number of processors such as 256 or 512.,
- Evaluation of the code for optimization and implementation to the cluster. Testing and simulating for new shapes requested by interested industries.

Where are we?

Milestone	Description	PMs needed	Deadline
1	Kickoff and exchange of information between Dr. Sahin and UHeM Team	0,5	Dec 2012
2	Specification of the tests cases	0,5	Dec 2012
3	Porting and installation of ViscoSolve on the cluster environment	1	Jan 2013
4	Benchmarking and profiling of ViscoSolve on linux cluster.	1	Jan 2013
5	Optimization of ViscoSolve on unstructured meshes	2	Feb 2013
6	Developing multi thread mesh partition algorithm for parallel I/O.	3	Feb 2013
7	New tests requested by industries	1	May 2013
8	Analysis of the new performances	0,5	May 2013
9	Final report and prospects	0,5	June 2013
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References

- M. Sahin, A Stable Unstructured Finite Volume Method for Parallel Large-Scale Viscoelastic Fluid Flow Calculations. Journal of non-Newtonian Fluid Mechanics, 166:779-791, (2011).
- M. Sahin, Parallel Large-Scale Numerical Simulation of Purely-Elastic Instabilities Behind a Confined Circular Cylinder in a Rectangular Channel. Journal of non-Newtonian Fluid Mechanics, 195:46-56, (2013).