OpenFOAM activities at Chalmers and within the Swedish Water Power Center

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Outline of the presentation:

- Presentation of SVC (the Swedish Water Power Center)
- Presentation of the use of OpenFOAM in the water turbine field, including validation against results from CFX-5 and measurements
- Presentation of other people and activities within SVC using OpenFOAM
- Presentation of other people and activities at Chalmers using OpenFOAM
SVC – Svenskt VattenkraftCentrum  
(Swedish Water Power Center, www.svc.nu)

Two main parts:
- Civil engineering in water power constructions, LTU/KTH
- Turbines and generators, CTH/LTU/UU

‘Turbines and generators’ is divided into four parts:
- Tribology (lubrication of bearings), LTU
- Generators, UU
- Rotor dynamics, LTU
- Fluid dynamics, CTH/LTU

Håkan Nilsson is responsible for CFD and OpenFOAM is the tool

Collaboration partners: Swedish Energy Agency, Hydro Power companies\(^a\) (through Elforsk AB), GE Energy (Sweden) AB, Waplans Mekaniska Verkstad AB, Chalmers, LTU, KTH, Uppsala university. (LTH also involved).

\(^a\)Vattenfall AB Vattenkraft, Fortum Generation AB, Sydkraft Vattenkraft AB, Skellefteå Kraft AB, Graninge Kraft AB, Jämtkraft AB, Sollefteåforsens AB, Karlstads Energi AB, Gävle Energi AB, Öresundskraft AB
OpenFOAM for water turbine applications, and a validation

Financed by SVC (www.svc.nu):
Swedish Energy Agency, ELFORSK, Svenska Kraftnät, a
Chalmers, LTU, KTH, UU

Companies involved: CarlBro, E.ON Vattenkraft Sverige, Fortum Generation, Jämtkraft, Jönköping Energi, Mälarenergi, Skellefteå Kraft, Sollefteåforsens, Statoil Lubricants, Sweco VBB, Sweco Energuide, SweMin, Tekniska Verken i Linköping, Vattenfall Research and Development, Vattenfall Vattenkraft, Waplan, VG Power and Öresundskraft

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Runner tip and hub clearances

(small geometrical scales)
Coupling between flow in different parts of the system
(large geometrical scales)
Special needs for water turbine applications

- Rotating coordinate systems / multiple frames of reference
- Sliding grid / mixing plane / GGI
- Rotational periodic boundaries (conformal / non-conformal)
- Cavitation models / two phase methods
- Fine resolution in large domains (parallel computations)
- Moving mesh (rotor dynamics)
- Unsteady SIMPLE solvers (skew grids)
- ...
Validation of OpenFOAM in the Hölleforsen runner (velocity profiles at cross-sections Ia and Ib)

Squares: measured axial velocity. Triangles: measured tangential velocity. In (a) the colors correspond to two different measurements. In (b) and (c): Blue curve: quasi-steady draft tube, Black curve: runner without hub clearance, Red curve: runner with hub clearance.
Validation of OpenFOAM in the Hölleforsen draft tube (development of engineering quantities in the flow direction)

Quasi-steady draft tube computation

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Vortex rope of the unsteady draft tube computation

Periodicity in time: $\sim 0.48s$ (same as CFX-5)
People and projects within SVC using OpenFOAM

Aurelia Cure (LTH, Co-supervised by Håkan Nilsson, Chalmers)
(soon also Henrik Lindsjö, WAPLANS, Co-supervised by Håkan Nilsson, Chalmers)
Lagrangian particle tracking at the NACA0015 profile
Rising bubbles using the VOF method
Purpose: Cavitation in water turbines
People and projects within SVC using OpenFOAM

**Martin Karlsson**, LTU, Collaborating with Håkan Nilsson, Chalmers

Rotor dynamics - non-axisymmetric inlet b.c., varying rotational velocity and moving runner (deforming mesh)

... and two planned ph.D. projects using OpenFOAM for water turbine applications
People and projects at Chalmers using OpenFOAM

Rickard Benzow, Shipping and Marine Technology, Chalmers
LES of a turning submarine
LES of a propeller in a rotating mesh
People and projects at Chalmers using OpenFOAM

Tobias Persson, Shipping and Marine Technology, Chalmers
Cavitation modelling and LES, cavInterFoam (developed by Niklas Wikström, FOI/Chalmers)
People and projects at Chalmers using OpenFOAM

Rasmus Hemph, Applied Mechanics, Fluid Dynamics, Chalmers
Fluidized beds using Lagrangian Particle Tracking
Column packing using Lagrangian Particle Tracking
People and projects at Chalmers using OpenFOAM

Fabian Peng Kärrholm, Applied Mechanics, Combustion, Chalmers

Cavitation in diesel nozzles
cavitatingFoam (Now available in OpenFOAM 1.4)
People and projects at Chalmers using OpenFOAM

Isabelle Choquet and Margarita Sass-Tisovskaya,
University West Trollhättan,
in collaboration with Håkan Nilsson and Lars Davidson, Chalmers
Welding in OpenFOAM
Thank you for your attention!

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