Numerical Investigation of the Influence of a Guide Wall in a Fish-Friendly Weir

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Research project **Wachstumskern Flussstrom Plus**

- Six projects focused on energy conversion using free-stream water power plants with low ecological impact
- Projects: small-scale hydro power plants, fish monitoring, valuation and certification, development of technical components...

Source: (16.09.2016)
right:
Numerical Investigation of the Influence of a Guide Wall in a Fish-Friendly Weir

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Project: Fish-Friendly Weir

• Numerical investigation of various geometrical parameters
  - Without & with turbine
  - Guide wall
  - Turbine clearance, number of blades ...
• Volume of fluid (VOF) method – 2 phase multiphase simulations (water & air)
• Unsteady, Reynolds- Averaged Navier- Stokes (RANS)
Inlet channel

Vortex pool

Turbine

Source: (14.09.2016)
http://www.efre-thueringen.de/mam/efre/projekte/fittosize__800_0_17eef5a697bf84f34be94f2cd383410f_1311_abbildung_04.jpg
Outlet and outlet channel

Source: https://www.google.de/search?q=fisch+freundliches+wehr&client=firefox-b-ab&source=lnms&tbm=isch&sa=X&ved=0ahUKEwj1hO6a4brUAhWLK1AKHdzdBiQQ_AUICigB&biw=1252&bih=574&dpr=1.09#imgrc=RY7PYF0AhZ9TcM: (13.06.2017)
Simulation Settings

• Simulation software: Star- CCM+ V11
• Multiphase simulations (water & air)
• Settings:
  1. 850 l/s, max. velocity at the inlet: 1.08 m/s
  2. k- omega- SST turbulence model
  3. Mass- flow inlet boundary condition

without turbine:
• ~1 mio. Cells
• HPC- Cluster: 48 cores
• Adaptive timestep & mesh

with turbine:
• ~4 mio. Cells
• HPC- Cluster: 128 cores
Guide wall

• Without guide wall
• 6 different lengths of the guide wall
  (0.25 m to 1.5 m)
Vortex depth

→ shallower and flatter vortices
Vortex position

→ fluctuation of ~3 % in each direction
Influence of the guide wall on the velocities

→ shifting of the velocity distribution
Adaptation of the turbine speed

- Guide wall length: 0.5 m, volume flow rate: 850 l/s

→ acceptable difference in power
Conclusion – usage of a guide wall

• Benefits regarding the requirements of fish passage
• Turbine velocity must be adapted to maintain power
Conclusion – usage of CFD

• Complementary to experiments

• Allows:
  • Insight into the flow
  • Analysis of influence of geometrical parameters
  • Estimation of the compliance of fish passage requirements
  • Identification of potential for improvement

• Opportunity to guide and optimize fish experiments (?)

• But: long computational times, high computational resources
Thank you for your attention!

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Physical Time: 14.730 (s)

Velocity: Magnitude (m/s)
Physical Time: 9.850 (s)

Velocity (m/s)
Physical Time: 14.730 (s)
Physical Time: 14.730 (s)

Velocity above 2 m/s
**Physical Time:** 14.730 (s)

**Velocity:** Magnitude (m/s)