

Developing the Oscillating-Foils Hydrokinetic Turbine

T. Kinsey, G. Dumas, M-A. Campagna, Y. Jean, J. Lemay, O. G. Tremblay
Department of Mechanical Engineering, Laval University, Quebec City (QC), Canada

Numerical Simulations (CFD)

Using high-end Navier-Stokes Computational Fluid Dynamics simulations (CFD) running on supercomputers in order:

To optimize

- geometry
- motion amplitudes
- oscillation frequency
- multiple-foils spatial arrangement

for maximum performance in power extraction.

To identify

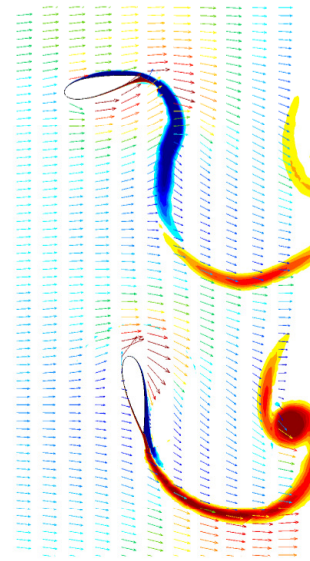
zones of optimal performance in relevant parametric spaces.

To quantify

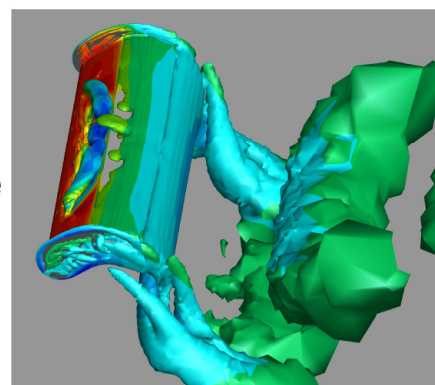
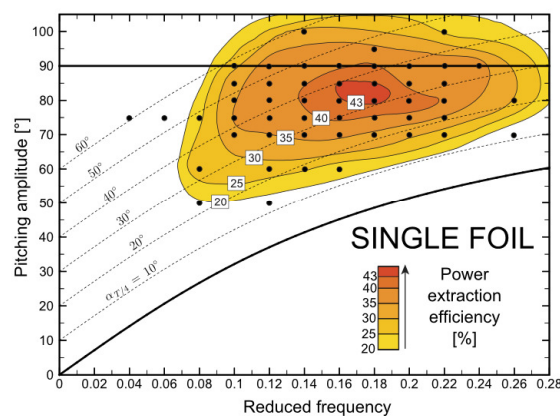
the effect of

- foil aspect ratio (3D)
- flow misalignment
- free-stream turbulence
- free surface proximity

on extracted power.



Velocity vectors and vorticity field around two oscillating hydrofoils in a parallel spatial configuration (2D URANS).



Pressure-colored isosurface of λ_2 vortex criterion around one oscillating hydrofoil (3D URANS).

Prototype Testing

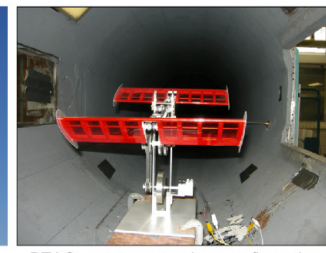
Building small-scale prototypes operating in air or water in order:

To design

efficient and reliable mechanisms for the hydrofoils actuators and the power transmission.



Éolo prototype, parallel configuration, operating in air.



PTAO prototype, tandem configuration, operating in air.

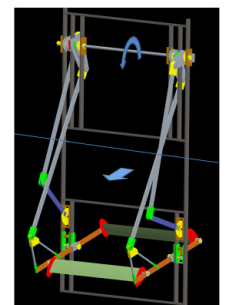


MAO prototype, single foil, operating in water canal.

To measure

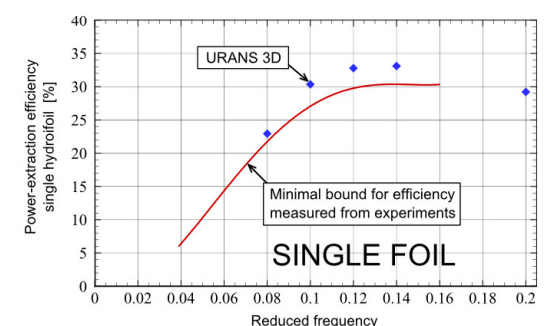
the actual power extracted from a complete turbine with multiple foils

- first-generation HAO prototype (2009): two foils in a tandem configuration



To validate

the results predicted from the numerical simulations (CFD)



Second-generation HAO hydrokinetic turbine

<http://hydrolienne.fsg.ulaval.ca/en>

2-years project (2012-2014) including the design, fabrication, deployment and testing of one turbine unit.

Smoothed-out power output through the use of phase-shifted hydrofoil motions

- makes the turbine self-starting
- facilitates grid integration.

Lean design where the hydrofoils are the only moving parts through the water flow.

Compact and robust mechanisms based on low-pressure water hydraulics.

Funded by Québec's government (MDEIE / PSVT-2) and industry partners (JAMEC, SOVAR, Maria Chapdelaine's CLD and MRC).

