EPFL

Proposal for student's semester or Master projects
Autumn semester 2024-2025
EPFL Technology Platform for Hydraulic Machines

Project 1

Title: Parametric study for hydraulic short circuit implementation in pumped storage hydropower plants by CFD numerical simulations

Objective: Perform CFD numerical simulations of a hydropower tailrace interconnection for assessing flow perturbation during hydraulic short circuit operation.

Approach: The student candidate will be expected to set and carry out numerical simulations with CFD software ANSYS (Meshing-Fluent/ICEM, Fluent, CFD-Post). He/she will post-process CFD results, quantify head losses and detect locations of flow vorticity for further investigations. Multiple operating conditions will be simulated to evaluate off-design scenarios that could possibly lead to power losses and instability phenomena.

Tasks:

- Literature review of hydraulic short circuit operation and CFD numerical simulations
- Study of hydropower tailrace bifurcation geometrical properties and understanding of the simulated system.
- Mesh generation and check of grid quality-tests.
- Performance of the numerical simulation in collaboration with the research team.
- Preparation of the post-processing and analysis of part of the data.
- Produce a scientific report

The above list may be modified or extended during the project based on the progress and the results. Number of simulations and scenarios will be adapted for semester projects to be compatible with a full day per week work.

EPFL PTMH project supervision: Dr Elena VAGNONI, Dr Alessandro MORABITO

Project2

Title: Comparative study of Pelton design's performance

Objective: Analyse the performance of a new Pelton runner design in term of efficiency in steady state and fatigue-induced damage during start-up and comparison against an old design.

Approach: The student candidate will perform post-processing of experimental data of a reduced scale model Pelton turbine tested in the laboratory. By analysing the performance in terms of efficiency, bucket vibrations and stresses, the student will assess the advantages of the new design of the Pelton buckets in respect to the previous design of the turbine. Finally, the study of the fatigue-induced damage by leveraging the measured stresses will be tackled to quantify the aging of the machine during the start-up process. For Master project: a last step will consist in modelling the fatigue-induced damage with analytical or regression method and build an optimization framework to minimize the damage during the start-up process of the machine.

Tasks:

- Literature review of Pelton turbines and experimental techniques to study its performance
- Data analysis of efficiency in steady state.
- Data analysis of bucket vibrations and stresses in steady state.
- Data analysis of bucket vibrations and stresses during start-up.
- Study of the fatigue induced damage through Wohler curve method.
- Study of the fatigue induced damage through crack propagation method and comparison with the previous method (for Master project).
- Modelling of the stresses and optimization of the start-up procedure to minimize the damage (for Master project).
- Benefits assessment of the new bucket design.
- Produce a scientific report and discuss the results in an oral presentation.

The above list may be modified or extended during the project based on the progress and the results.

EPFL PTMH project supervision: Dr Elena VAGNONI, Aldo Leonardo ALERCI