FLUID STRUCTURE INTERACTIONS RESEARCH GROUP

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DESIGN AND DEVELOPMENT OF COST EFFECTIVE SURFACE MOUNTED WATER TURBINES FOR RURAL ELECTRICITY PRODUCTION

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Motivation & Aim

➢ There is a strong requirement globally for electricity generation derived from relatively low-power renewable resources such as mountain streams and low gradient rivers.

➢ Governmental and global targets for reduction in carbon emissions, environmental impacts and the capability of serving the ever increasing demand of power requirements in the shortest time are driving forces for small/low head hydro power generation.

➢This project intends to design and develop cost effective design of engineered low head hydro turbines capable of utilizing 2-10 meter of water head and power output 2 to 15 kW.

➢Cluster layout of LHH turbines not only can contribute to improve living standard of rural and distant population can also be connected to main grids for other purposes.

➢10,000 LHH feasible sites in UK

➢Small-scale hydro power is the key source for further hydro development. Optimization of existing recourses for power harnessing has made application of low head hydro power a choice for water treatment plants, water and waste water networks

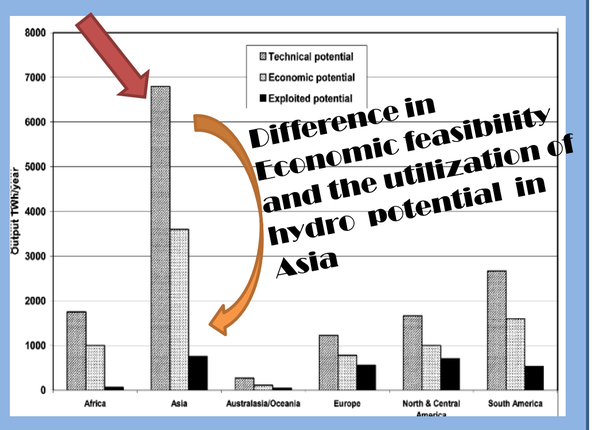


Fig.1 global technical/feasible hydro potential [1]

Computational Fluid Dynamics application to LHH turbines work

The modern design, analysis and manufacturing techniques can contribute to investigate hydro potential as low as 1 meter head and a power output of 200 Watts

CAD/CAM based automated design and analysis process for LHH applications is opted for real cost effective LHH designs.

Application of Computational fluid dynamic techniques particular to LHH turbine operational range of parameters to evaluate

➢ Complex 3-D flow visualization

➢Component behaviour characterisation

➢Design optimization

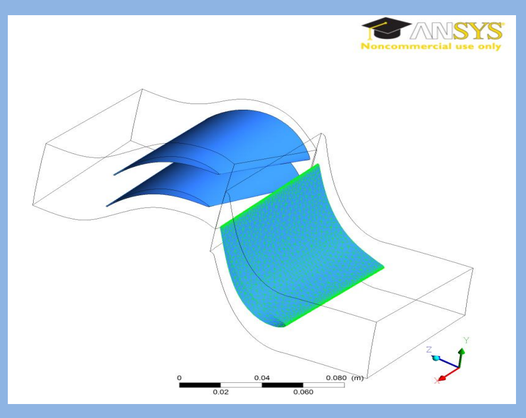


Fig.4 Section model of a three –dimensional rotor-stator combination

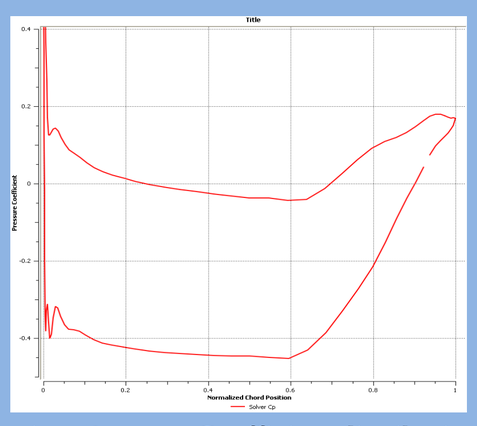


Fig.5 Pressure Coefficient distribution around NACA 0012

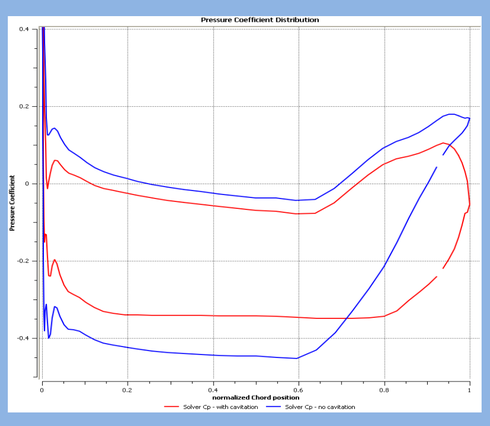


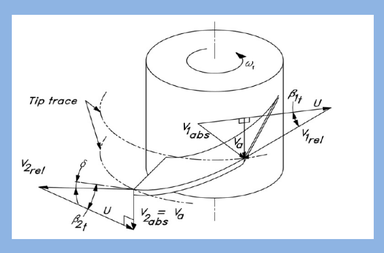
Fig.6 Cavitations behaviour approximation of NACA 0012 profile

➢ Current Design and development status in LHH

For LHH turbines there is no cost effective and hydro dynamically balanced design available capable of serving low head operating conditions.

Conventional LHH turbine designs are experimental designs and mostly tuned as per site specific conditions instead of hydrodynamic designs.

Design criteria for current LHH turbine are based on minimum cost/unit power instead of max deliverable power. Recently developed four models of axial ,radial and mixed flow turbines are compared for their performance[2]



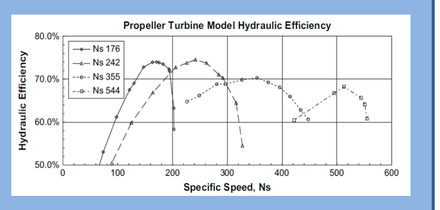


Fig.2 Conventional Axial and mixed flow runner prototype models and performance comparison[2]

The drawback of this approach results in undue design simplifications, non-feasibility of theoretically feasible hydro potentials along with below average performance of design models. These designs appear to be over constrained by simplicity and economic constrains rather unconstrained as stated mostly

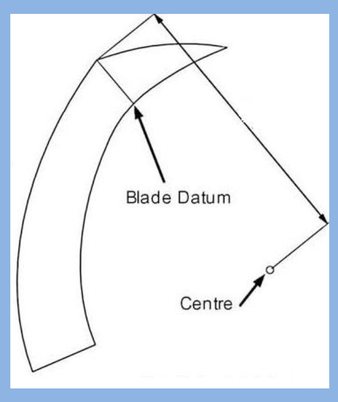


Fig.3 Blade profile (flat plate) used for reference turbines compared above

Project Targets

To build up an automated design process for CFD and CAM assisted LHH turbine design future work will be focused on following tasks

- Benchmarking of different hydrofoils for a range of flow conditions
- Hydrodynamic runner design
- Steady/unsteady turbulent flow computations for reference turbines
- Prototype testing and modifications
- Overall performance characteristics for reference model and design of hydro dynamically balanced rotor.

References

[1] International Journal of Hydropower and Dams: World Atlas. Sutton: Aquamedia Publications, 2000.
[2] Radial- and mixed-flow turbines for low head micro hydro systems K.V. Alexander

Acknowledgement

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