Mechanical Engineering

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

2010 Departmental Seminar

Thursday 22 July 2010
3.00 pm
Mechanical Engineering Seminar Room – E547

Adapting simplified propeller turbines to higher specific speeds: CFD studies

Adam Fuller, Ph.D.-cand. UC

Abstract:

Several observations have been made which help to explain the under-performance of a Giddens microhydro propeller turbine in terms of efficiency and specific speed, and have lead to some suggestions for moving forward. Through CFD analysis of individual components and whole turbines, and velocity measurements within volutes, observations pertaining to each component which address these shortcomings are:

Draft tube The turbine torque may be small enough that designing for axial inlet flow and swirling outlet flow is not only acceptable, but beneficial to draft tube pressure recovery and overall turbine efficiency, contrary to the accepted practice of designing for negligible exit swirl. The head loss due to the swirl leaving the runner would be traded with a decrease in losses in an axial-flow volute. This modification could be exploited to simplify volute construction.

Runner Existing flat-bladed runners for lower specific speeds have achieved efficiencies of 70% despite operating with nearly twice the inlet swirl velocity than designed for, suggesting a stalled leading edge may be a loss mechanism of only secondary importance, but that efficiency gains may nonetheless be made by designing the runner leading edge to more closely match the actual velocity distribution.

Volute Single tangential inlet volutes are not suitable for the weak swirl needed to attain a high specific speed. Reducing volute inlet swirl either with a diffuser to reduce the velocity or by decreasing the inlet offset excessively, is fraught with loss and uncertainty. Furthermore, assuming the volute itself is torque free may be invalid, especially in those two cases. A new design is needed to avoid the clogging issues of guide vanes and provide a predictable outlet velocity distribution.

These points form the skeleton of an adapted simplified propeller turbine design. Along with several key runner and volute design changes, these could potentially reduce the complexity of the volute, and meet a target of 70% turbine efficiency and a specific speed of 650, making lower-head sites practical to develop. The paper will expand on these points, with preliminary CFD results of an adapted turbine.

All are welcome!