NTNU

Faculty of Engineering Science and Technology
Department of Energy and Process Engineering

Thesis title: Pressure oscillations during start and stop of a high head Francis turbine
Name: Anders Tørklep
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Supervisor: Torbjørn Nielsen
Co-supervisor:

Abstract

Start and stop procedures affect pressure oscillations throughout a hydropower plant. A desire to study how pressure oscillations behave during these dynamic conditions was the basis of this report. Instrumentation, experimentation and measurement analysis was conducted on a Francis model turbine in the Waterpower Laboratory at NTNU.

Eight pressure transducers were calibrated and used during the experiments. Two transducers were installed in the draft tube below the turbine. One was placed in the vaneless space between the guide vanes and the impeller vanes. Three pressure transducers on an impeller vane and two transducers located at the inlet were also included in the experiments.

Frequency analysis (PSD) was carried out for all the measurements to explore various pressure oscillations.

Except for the low frequent oscillations (< 30 Hz), definite frequencies repeatedly dominated the frequency domain during start/stop as well as for steady state operation.
The impeller vane oscillation showed an increase in pressure amplitude during guide vane closing. A bigger amplitude increase was registered for BEP than for part load and full load operation.

The guide vane frequency was located in and only in the runner. The amplitude of the guide vane frequency was significant and was located for all studied operational points. The power of this oscillation decreased during guide vane closing.

One specific frequency arose the question of an overtone phenomenon for the water hammer oscillation, a phenomenon, were the fundamental frequency is three times higher than the customary water hammer frequency.