

Onboard pressure measurement in high head Francis prototype runners

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Abstract

The empirical scale-up relations from model to prototype values for efficiency measurements for hydro turbines are well described. There is a desire to develop a similar scale-up possibility for pressure pulsation levels in Francis turbines. Alongside the refurbishment project on Statkrafts Tokke hydro power plant in Telemark, Norway, the existing prototype Francis runner, both the model and the prototype of the new designed runner and a new model runner with splitter blades was made accessible for onboard pressure measurements. The model with splitter blades was designed at NTNU. The original prototype runner was designed and manufactured by Kværner, with splitter blades. The replacement prototype and its model were designed and manufactured by ANDRITZ HYDRO, formerly Andritz VA Tech Hydro.

To be able to perform onboard measurements on the original prototype and the replacement prototype, a logging system needed to be designed. Simultaneous high frequency measurement of several channels was the key feature. To reduce the extent of permanent alteration of the turbine components, telemetry was rejected and onboard storage was a chosen feature. The logging unit was installed in the runner cone.

To fully exploit the potential of the developed logging chain on the prototype replacement runner, it was decided to simultaneously measure both strain and pressure on the runner blade outlet, and pressure at the inlet pressure side of one blade. The authors installed three Quartz pressure sensors lowered into the pressure side of the blade inlet, six miniature bridge based pressure transducers at the blade outlet (three on the pressure side and three on the suction side), and 16 strain gauges on both pressure and suction side of the outlet of the blades. In addition, there were installed pressure sensors in stationary parts such as draft tube cone and lower cover surface.

The test on the replacement runner was performed in February 2009 on Tokke Unit 3, as a cooperation between ANDRITZ, NTNU and Statkraft. The test on the original runner was performed in October 2008. This test failed, and was going to be repeated during the summer of 2010.

An overview of the logging chain used for the Tokke Unit 3 replacement runner prototype will be presented in this paper, along with some preliminary results from the analysis of the pressure and strain measurements (presented in relative values due to confidentiality).