Dynamic Load Measurements on a 10 MW Kaplan Runner - Design and Evaluation of a Pressure Measurement System at the Porjus Hydropower Centre

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The construction of hydropower in the beginning of the 20th century played a central role in the development of the mining industry in the northern part of Sweden. Today, hydropower produces almost half of the Swedish electricity. The deregulation of the electricity market has increased the need to regulate the power on the grid. An introduction of renewable energy sources such as wind power will also increase the demand of regulation power. When using hydropower to regulate power, the machines have to be started and stopped more often and sometimes operated on partial load. This means increased stress levels and calls for further characterisation of the dynamical behaviour of hydropower machines.

An ongoing project concerned with full experiments on hydro power machines started 2006 at Luleå University of Technology. 200 sensors installed on different parts of the machine will allow measurements on both rotating and static parts on the full-scale 10 MW U9 unit, at the Porjus Hydro Power Centre, a research and development centre. The aim of the measurements is to determine the characteristics of the rotor system composed of a generator, bearings and a runner. The dynamic loads need to be known to further develop rotordynamic models. In this presentation the measurement system to estimate the hydraulic load on the runner will be discussed.

To determine the hydraulic load 40 miniature piezo-resistive pressure sensors will be mounted on both the pressure and the suction side of one of the six blades of a Kaplan runner. Given the difference in the pressure distribution between the pressure and the suction side the angular resolved and the time dependent forces on the runner exerted by the water can be estimated. The emplacement of the sensors was determined with the help of a CFD-study in order to capture the main gradients.

The mounting of the pressure sensors must be done without changing the shape of the runner. Another requirement is that damaged pressure sensors should easily be replaced without dismantling the runner. To evaluate and further develop a method to mount the sensors on the blade, tests have been done on a laboratory scale. A metal plate has served as runner blade model. Furthermore, tool to calibrate the sensors on site has been developed and tested.