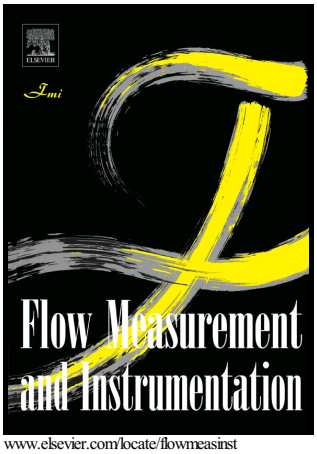

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Monitoring a Francis Turbine Operating Conditions

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Abstract

Francis turbines are designed for a specific set of operating conditions that is particular to each hydropower plant site. It allows this type of turbine to extract as much hydraulic power as possible, as long as they are operating in the right conditions. For this reason, power plant operators must know in advance what are the best conditions for operating their generating units and, naturally, in which exact conditions these units are actually operating. Detailed information about the turbine behavior in any operating condition can be obtained by performing measurements in a reduced scale physical model of the turbine prototype. These tests provide what is known as the turbine hill chart: a two-dimensional graphical representation of the most relevant turbine properties showing, for instance, the power output, the discharge, the efficiency and the cavitation conditions. This paper presents a method to monitor the operating conditions of a Francis turbine by locating it on the hill chart. To do so, it requires the generation of polynomial bi-variate functions based on Hermite polynomials that can calculate the turbine discharge and efficiency from its guide vanes angle and power output. A test case is presented with a turbine prototype of 444 MW of rated power operating through a wide range of operating conditions. The validation is done by comparisons between the measured and estimated values of gross head, leading to similar values.

Keywords: Francis turbine, Operating conditions, Hermite polynomials,

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