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Review on dynamic and instability phenomena in hydraulic machines

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Abstract

Many utilities, even nowadays, have to live with restrictions of operation in some of their plants due to unresolved problems of hydraulic stability or mechanical vibration. Undesirable levels of pressure pulsation, power swings, vibration and/or noise may occur during operation of hydraulic turbines, storage pumps and related equipment. Sometimes other parts of the plants, such as the generator, penstock, or the building structure are also concerned. In most cases, some hydraulic phenomenon is the root cause. Several quite different kinds of phenomena are possible, a fact which often inhibits proper diagnosis and, as a consequence, successful countermeasures. This situation is less and less acceptable with the increasing demand for high operational flexibility. While the knowledge about unsteady phenomena has been evolving for several decades in a slow multi-disciplinary process still going on it is only documented in an ever-increasing number of scientific papers. To find out the important ones and to sort out those with already outdated theories is too time consuming for engineers who want to do the practical work. To cure this defect, the authors have put together the most important findings of the past and ongoing research in an overview which might serve as textbook for engineers. It is published in cooperation with the Centre for Energy Advancement through Technological Innovation, CEATI's Hydraulic Plant Life Interest Group (HPLIG).

The present article gives an overview of the review highlighting important aspects of assessing pressure pulsations in a water turbine system as well as describing most recent research in the field of pressure pulsations, hydraulic systems stability and flow induced vibration together with the related mechanical issues. Special emphasis is put on current research and discussion related to system models and stability prediction as well as mechanical issues.