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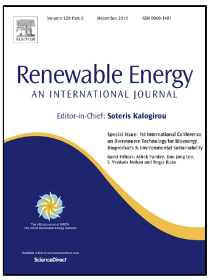

Wave Tracking Method of Hydraulic Transients in Pipe Systems with Pump Shut-Off under Simultaneous Closing of Spherical Valves

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Wave Tracking Method of Hydraulic Transients in Pipe Systems with Pump Shut-Off under Simultaneous Closing of Spherical Valves

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Abstract. The limited wave propagation speed in water permits the propagation of pressure surges in hydraulic transients to be tracked in the time series. This occurs by tracking the primary (*F*) and the reflected (*f*) waves. The *wave tracking method* has been demonstrated to be applicable to highly complex hydraulic systems. The wave propagation induced by passing through a T-junction in the flow complies with the *wave conservation laws* which concern both the wave reflection and the transmission. It has been shown that all computations can be simply implemented in a computation tool like MS Excel. This considerably ensures both the accuracy and the reliability of computations. At a hydraulic system of Pelton turbines, excellent computational results have been achieved. The application to a highly complex hydraulic system with pump shut-off and the simultaneous closing of a spherical valve also showed excellent results, when compared with the field measurements. The key point in the presented computations is to unify the characteristics of the pump and the spherical valve. The entire computation covers the flow rate in the system, the reverse flow through the pump, the pressure response, the deceleration of the rotational speed and the system oscillations.

Keywords: Hydraulic transients; wave tracking method; conservation law; pump; spherical valve; hydraulic characteristics

1. Introduction

Transient flows, for instance, in hydropower stations are encountered at each start and shutdown of fluid machines or by regulating the operating points of the machines like pumps and turbines in the hydraulic system. The worst cases of transient processes, however, are given at load rejection and emergency shutdowns of the machines. Since such hydraulic transients represent highly complex flow dynamics and often lead to rapid pressure rises, cavitation and system instability, the related flow phenomena and pressure rises have, for safety reasons, to be considered already in the early stages of design and constructions. The