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Fluid viscous device modelling by fractional derivatives

Gusella, V., **Terenzi, G.**
Institute of Energetics, Faculty of Engineering, University of Perugia, Strada S. Lucia Canetola, 06125 Perugia, Italy

Abstract

In the paper, a fractional derivative Kelvin-Voigt model describing the dynamic behavior of a special class of fluid viscous dampers, is presented. First of all, in order to verify their mechanical properties, two devices were tested the former behaving as a pure damper (PD device), whereas the latter as an elastic-damping device (ED device). For both, quasi-static and dynamic tests were carried out under imposed displacement control. Secondarily, in order to describe their cyclical behavior, a model composed by an elastic and a damping element connected in parallel was defined. The elastic force was assumed as a linear function of the displacement whereas the damping one was expressed by a fractional derivative of the displacement. By setting an appropriate numerical algorithm, the model parameters (fractional derivative order, damping coefficient and elastic stiffness) were identified by experimental results. The estimated values allowed to outline the main parameter properties on which depend both the elastic as well as the damping behavior of the considered devices.