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Damping effects and system control due to hydraulic transients in water pipe systems: two-phase flows and compressed air energy storage (CAES) systems

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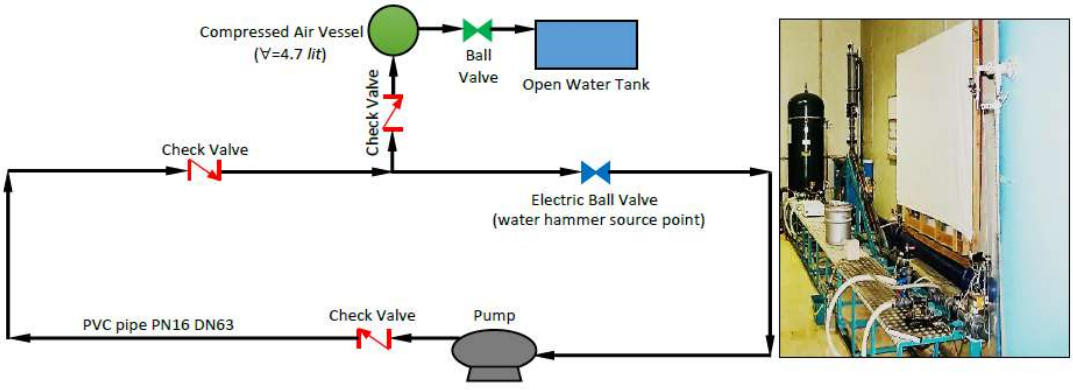
Summary

The main objectives of this research can be stated as: (i) Better understanding of unsteady friction and energy dissipation in turbulent flows; (ii) Establishment of proper 1D, 2D and 3D CFD models to simulate pressure damping in complicated transient conditions; (iii) Understanding the behaviour of air pocket within a CAV under transient conditions; (iv) Using air pocket in a CAV as a protection device to maintain the safety of systems in two-phase transient conditions; and (v) Proposing guidelines for better design of pipe systems. After starting the PhD program, an extensive literature review was performed regarding the pressurized systems and common problems related to entrapped air within a pipe system. After that, a series of experimental tests were fulfilled on an apparatus that was available from previous works with some changes. These tests gave comprehensive perspective towards the problem of having air in the pressurized systems. Using these data, a paper in an ISI journal (Water MDPI) has been pusblished, with the title of "Experimental Study of Air Vessel Behaviour for Energy Storage or System Protection in Water Hammer Events" (http://dx.doi.org/10.3390/w9010063).

Currently, a revision of next experimental apparatus for more progress is ongoing. Also, a collaboration with another PhD student was arranged, from the University of Valencia for studying the entrapped air problem of pressurized systems during emptying process. A paper has been published from that work too under the title of "Experimental and Numerical Analysis of a Water Emptying Pipeline Using Different Air Valves" (http://dx.doi.org/10.3390/w9020098). Two more papers from this collaboration have been submitted in Journal of Hydraulic Engineering, ASCE and Urban Water Journal, Taylor& Francis. Also, this study has been presented in the H2DOC workshop at the EPFL, Lausanne, Switzerland. The plan of experimental apparatus should be accomplished soon at LNEC to do another type of tests regarding air problem in the pressurized systems. More CFD simulations (2D and 3D) must be done and the 1D simulation should start using latest introduced methods to add more progress to fast 1D simulations in two-phase pressurized conditions.

Keywords

Two-phase flow, transient flow, air vessel, water hammer, air-water interface, energy storage, compressed air energy storage system (CAES).



Scheme of experimental apparatus and components.