UNCONVENTIONAL DYNAMIC EFFECTS IN PLASTIC WATER PIPE SYSTEMS

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Research work based on the flow acceleration/deceleration and in mechanical response of the pipe-wall materials is developed in order to better understand the pipe system response under transient conditions for pressurised flows. These effects have been performed by using collect data in transient tests carried out for different pipe system's characteristics (two experimental facilities) and mathematical modelling. Current commercial transient solvers cannot accurately predict the head oscillations in pipes with non-elastic rheological pipe-wall behaviour, such as polyethylene PE, whose application on water supply systems has increased during the last years. Experimental procedures are carried out aiming at the collection of data sets of dynamic effects through pressure time variation and flow velocity fields. The characterization of each phenomenon is presented in order to better understand the pressure wave propagation in terms of, phase and shape. Waterhammer analysis is important in the design of water pipeline systems to select pipe materials, to size wall thickness in order to sustain pressure ratings and to specify surge protection devices. The aim of this research is the presentation of the main dynamic effects in water pipe systems by using physical data collected in two experimental facilities - (i) one developed in the Department of Civil Engineering (DEC) and (ii) in the Department of Mechanical Engineering (DEM), both at Instituto Superior Técnico – IST (Lisbon, Portugal). Comparisons between experimental and computational results using the Method of Characteristics (MOC) enhance some special dissipative effects that can be identified as the main sources of pressure wave and dispersion for any transient conditions.

A well-known problem is the inability to predict the fluid pressure variation along time associated with the pipe velocity fields, in terms of, phase and shape of the pressure waves, during a transient event. In addition, there is a lack of experimental data for new pipe materials (i.e. PE pipes) to support a physical understanding of how the system behaviour influences the dissipation of energy in observed data.

Available commercial codes usually adopts the quasi-stationary hypothesis when calculating the friction factor during transient flow conditions, assuming at each instant and cross section, the equations deduced for uniform steady-state flows are valid. It has been shown that this assumption does not allow for proper prediction of pressure variations between two steady-state flow regimes.

The one-dimensional (1-D) models are the most popular and they are based on a corrective factor to the steady-state friction parameter when a uniform velocity profile is assuming in each pipe section and in each instant. In addition these models have shown to produce good fits to experiments for rigid pipe materials, such as metal and concrete. However, it is fundamental to investigate the physical meaning of this effect, in order to predict the head oscillations in non-elastic materials (in particular PVC, HDPE), whose application for water supply systems has increased a lot during the last years and it is essential for design and diagnosis analysis to detect any type of anomaly.

Keywords: dynamic effects, pipe-wall behaviour, Water pipe systems.

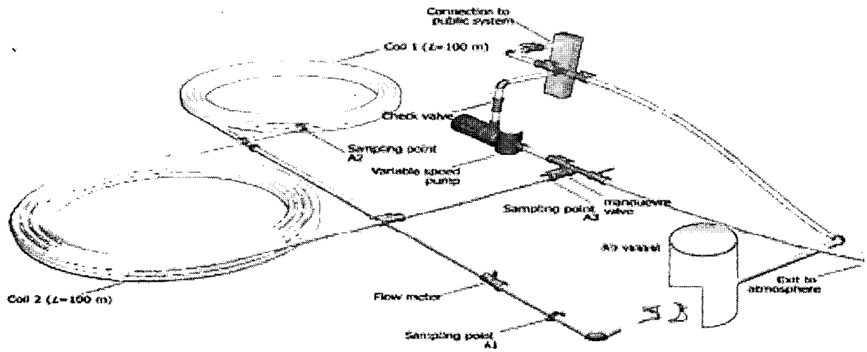

Fig. 1 Scheme of experimental facility 1 with HDPE pipe (L=200 m)

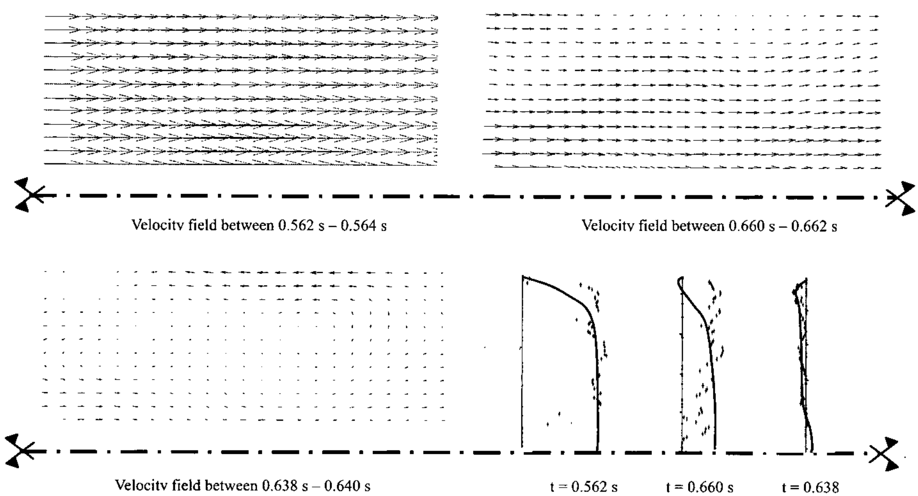

Fig. 2 Velocity fields and profiles for set-up 2 during the up-surge.