

Influence of pressure reducing valve on water hammer in drinking water pipeline system

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Abstract. Drinking water in developed settlement is delivered by pipeline network, which is often very large and complex. The pressure in the pipeline system has to be kept in certain limits, which are given in standards. When the pipeline significantly changes the altitude, the pressure has to be reduced, mostly by a pressure reducing valve, which is able to keep constant downstream pressure regardless the upstream pressure for arbitrary flow rate. The pressure reducing valve works well under steady conditions, but it can have a negative influence when working conditions are changing and the system is looking for a new steady state. The paper is focused on numerical simulation of water delivery system with a pressure reducing valve. Model is based on one-dimensional description of unsteady flow and several unsteady scenarios are modelled. A special attention is paid to influence of pressure reducing valve on water hammer propagation.

1. Introduction

A drinking water system, regardless of its size, consists of several key components. The first one is a water source. This may be a reservoir in a high protection zone (typically a dam) or an underground borehole or a rainwater detention facility. This is followed by a water treatment plant, where harmful substances are removed and the colour, taste and smell of the water are modified. A water treatment plant is not always necessary, as there are (especially groundwater) sources of water that are of sufficient quality that no further treatment is necessary.

The water is then transported either by gravity or by pumps to a water tank that compensates an imbalance between supply and consumption. The tank is usually located on an elevated place, which also ensures sufficient pressure in the pipe network, which should be at least 0.25 MPa (the specific value is given in standards and may vary from country to country). This minimum pressure ensures that consumers can freely take water from the pipe system connected to the given water tank. Larger water supply networks may contain multiple water tanks, each supplying water within its own pressure zone.

The pressure in the pipeline system must also not exceed the prescribed value of 0.6 MPa (again depending on the specific country). Of course, there may be pressure in the pipeline outside the limits, but no customer should be connected in such a place. This brings us to the next important element and that is the pressure reducing valve. A pressure reducing valve is an element without an active control that varies its resistance to maintain a prescribed downstream pressure value regardless of the actual flow. No system that is built in a location with a high elevation change can do without a pressure reducing valve.