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Making the world a safer and better place – a plea for more data, validation cases and guidelines for waterhammer simulation

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Engineers tend to overdesign systems when uncertainty exists. Overdesign is an important part of the engineering process, but unnecessary overdesign will only increase the cost of systems without enhancing safety.

An experience between a major pipeline company, their engineering design firm, and the waterhammer simulation software products used by both is described. A disagreement between software package results and ultimately the two companies developed into an issue that could significantly increase costs. More and better validation cases would have helped everyone navigate this situation more quickly, easily and inexpensively. More and better application guidelines may have helped the engineering design firm achieve higher certainty in their recommendations with potentially less overdesign.

Industrial

Unappreciated challenges in applying four quadrant pump data to waterhammer simulation

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Part 1: Fundamentals

The transient analysis of reverse flow and rotation in pumps has evolved over the years into modern four quadrant pump waterhammer simulation. Exact characteristics for a given pump for reverse flow and/or reverse rotation are normally unavailable, and manufacturer curves are often mapped to previously published four quadrant data sets for similar pumps. Assumptions made in this mapping process can cause extreme differences in the simulation. If these assumptions are unaddressed, critically incorrect conclusions about the system's transient behavior may be made, impacting both design and operation. The available choices to the waterhammer analyst and the consequences of those choices are thoroughly detailed in Part 1 of this paper.

Part 2: Application Examples

Transient analysis of reverse flow and rotation in pumps requires the use of four quadrant data. This data is normally unavailable for a given pump, and existing dimensionless four quadrant data is selected based on specific speed. There are different methods for dimensionalizing the four quadrant data, which can result in significant differences in transient predictions. This study examines f our examples with three exhibiting reverse flow. The two most convenient methods of dimensionalizing four quadrant data are used, and significant differences in transient predictions are demonstrated and discussed.

Industrial

Surge transients due to check valve closure in a municipal water pumping station

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The present study highlights the importance of proper check valve selection to mitigate waterhammer and its associated problems. Two different check valves were installed in a pumping station in a municipal water transfer system: a swing check valve and a nozzle check valve. Measurements were taken of pipeline pressures after a pump trip and resulting check valve closure. The field data was compared to predictions from a model using a commercial waterhammer tool. Commonly accepted methods for estimating reverse liquid velocity at check valve closure were utilized. Results were also compared to previous experimental test from other authors. The calibrated model results matched the field data quite well. Comparisons of inferred valve characteristics to previously published results for swing and nozzle valves were not in close agreement for either tested valve.

Industrial

Surge mitigation in a marine fuel oil terminal

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Surge modeling of complex systems such as marine fuel oil terminals requires the use of accurate computer modeling techniques to help insure the best possible response to surge events. Various surge mitigation techniques can be pursued that often require information that manufactures rarely provide and have behavior that is problematic to replicate in a computer model. This paper provides guidance with one such device, the surge relief valve, and offers a case study in how they were used in conjunction with valve stroking to mitigate significant surge events at a terminal in the gulf coast region of the United States.