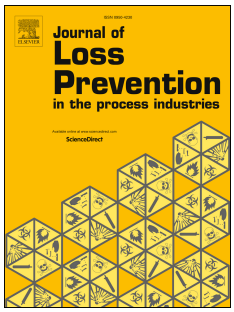

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Reynolds number effects on the performance of safety valves operating with incompressible flows

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Abstract

The goal of the sizing procedure of safety valve operating in liquids is the selection of the valve flow area, taking into account the effect of the viscosity variation by means of a correction factor (K_v) computed on the basis of the flow Reynolds number. In the most commonly applied reference standards (ISO 4126-7, and similarly API 520, part 1), questionable assumptions are often used and this may lead to unpractical solutions or, in a wide range of applications, to untenable paradoxes.

The paper describes a numerical and experimental investigation of the behavior of a 1.5" G 3" safety valve operating in water and oil at different temperatures. Computational results have been obtained using an high-order accurate CFD discontinuous finite element research code. Experimental tests have been carried out on two test rigs: the first one operating with water and a second one with ISOVG46 oil.

The results obtained have shown that whilst the discharge coefficient decreases for increasing values of the fluid viscosity, the force acting on the valve disc may exhibit a non monotonic behavior. Variations in the force exerted by the flow affect the operating performance and lead in some cases to an additional reduction of the valve flowing capacity. The critical evaluation of the results allows to suggest a modification of the sizing procedure proposed by the reference standards.

Keywords:
axisymmetric turbulent incompressible flow, RANS equations, discontinuous Galerkin, oil-water safety relief valves, Reynolds effects on valves discharge capability

Nomenclature

K_d	discharge coefficient (theoretical flow rate to actual flow rate)
K_{dr}	certified derated discharge coefficient of the safety valve ($= 0.9K_d$)
A	orifice area (flow area)

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