Discussion on "Experimental parametric equation for the prediction of valve coefficient (Cv) for choke valve trims" by Andrew Grace and Patrick Frawley

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The prediction of the behaviour flow coefficient, Cv, of a control valve is an interesting topic and the performance optimization of the fluid flow control is a topical theme in industrial fluid-dynamics applications. The paper proposes a design method wherein the valve internal geometry parameters are interpolated from experimental data. In the paper is reported that: "the proposed non-dimensional ratio is derived from the restrictive geometry of an orifice plate and the non-dimensional geometry ratio used therein".

In the attempt to apply the methodology presented to our experimental data, we noticed some dimensional errors and inconsistencies on the equations presented. The valve coefficient Cv, as reported in the paper, or the flow coefficient, as reported by the international standard, is erroneously reported as dimensionless. The results reported in the paper are different for the different valve dimensions (Figs. 13–15). A proper dimensionless parameter should provide a representation where the valve dimension does not significantly affect the parametric solution. On the other hand it is easy to check from equation (24) that Cv is dimensional.

Moreover, the definition of Cv equation (24) contains other inconsistencies: a) the coefficient 2 should be erased; b) the parameter ρ_2 is not defined and if it represents the downstream density, as the notations suggest, we do not understand why the Authors referred Cv to the downstream density condition; c) there is a typographical error in the reporting of pressure jump which should probably be (P1−P2). The inconsistency reported at point a) probably comes from equation (1) in which the coefficient 2 in the second square root should be erased, and from equation (3) which is substantially correct but the coefficient 2 formally should be in the first square root and not in the second. Equation (4) maintains the same problem as equation (3), it is substantially correct, but only because the coefficient 2 has been omitted in the definition of Cm.

These inconsistencies make the results presented not usable. We found a tricky problem when we tried to compare the method proposed with our experimental data. Our data are referred to a 2″ choke valve with cage and sleeve trim mechanism, which present a Cv behaviour qualitatively similar to those proposed in the paper. The different trim mechanism could potentially extend the application range of the model proposed in the paper. On the other hand, we are not sure about the equations used by the Authors and, without geometrical and fluid-dynamic details on the experimental test, we are not able to check the results. We need confirmation by the Authors of the equations actually used in calculations.

Authors' response

We thank the discussers for their interest in our paper.

The term "dimensionless" was not meant to imply that Cv is not affected by the geometry of the valve under investigation or that it is a dimensionless number. A dimensionless quantity is one without an associated physical dimension or unit of measure. For example, Reynolds number is a dimensionless number but is affected by geometrical factors including length.

The discussers are correct in that P3 should be P2 in equation (24) and that Cm should incorporate the coefficient 2, as it represents constants and geometry factors. Equation (24) where Cv is represented of a similar factor should also combine the geometry factors and constants and the coefficient 2 should not appear here.

However, the errors in the equation do not affect the determination of the parametric equations. These equations are derived from the experimental testing per the IEC standard. The other

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referenced equations (1), (2), (3) & (24) are used to demonstrate how Cv is derived and what it represents in terms of the valve geometry. This knowledge is used to create a non-dimensional value of α. The equations commented on above (which has the coefficient 2, in them incorrectly) are used to determine required Cv, not rated Cv which is an inherent in the valve geometry. The rated Cv is determined using the experimental method and α as described.