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Effect of the Orifice Plate Specifications on Coefficient of Discharge

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Abstract : On the ground that the orifice plate is relatively inexpensive, requires very little maintenance and only calibrated during the occasion of plant turnaround, the orifice plate has turned to be in a real prevalent use in gas industry. Inaccuracy of measurement in the fiscal metering stations may highly be accounted to be the most vital factor for mischarges in the natural gas industry in Libya. A very trivial error in measurement can add up a fast escalating financial burden to the custodian transactions. The unaccounted gas quantity transferred annually via orifice plates in Libya, could be estimated in an extent of multi-million dollars. As the oil and gas wealth is the solely source of income to Libya, every effort is now being exerted to improve the accuracy of existing orifice metering facilities. Discharge coefficient has become pivotal in current researches undertaken in this regard. Hence, increasing the knowledge of the flow field in a typical orifice meter is indispensable. Recently and in a drastic pace, the CFD has become the most time and cost efficient versatile tool for in-depth analysis of fluid mechanics, heat and mass transfer of various industrial applications. Getting deeper into the physical phenomena lied beneath and predicting all relevant parameters and variables with high spatial and temporal resolution have been the greatest weighing pros counting for CFD. In this paper, flow phenomena for air passing through an orifice meter were numerically analyzed with CFD code based modeling, giving important information about the effect of orifice plate specifications on the discharge coefficient for three different tappings locations, i.e., flange tappings, D and D/2 tappings compared with vena contracta tappings. Discharge coefficients were paralleled with discharge coefficients estimated by ISO 5167. The influences of orifice plate bore thickness, orifice plate thickness, beveled angle, perpendicularity and buckling of the orifice plate, were all duly investigated. A case of an orifice meter whose pipe diameter of 2 in, beta ratio of 0.5 and Reynolds number of 91100, was taken as a model. The results highlighted that the discharge coefficients were highly responsive to the variation of plate specifications and under all cases, the discharge coefficients for D and D/2 tappings were very close to that of vena contracta tappings which were believed as an ideal arrangement. Also, in general sense, it was appreciated that the standard equation in ISO 5167, by which the discharge coefficient was calculated, cannot capture the variation of the plate specifications and thus further thorough considerations would be still needed.

Keywords : CFD, discharge coefficients, orifice meter, orifice plate specifications
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