Abstract

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Shape optimization of an orifice meter using the adjoint method and surrogate based optimization

Orifice flow meters are utilized extensively to measure the flow rate thanks to their simple design and relatively lower cost. The main drawback is the high pressure loss with respect to the other obstruction meters. The objective of the present study is to find the optimal shape of an orifice plate that reduces the pressure loss. To reach this goal, the adjoint method was used to reshape the sharp edged orifice plate. Moreover, surrogate based optimization was employed to determine the optimal parameters of interest that control the flow through orifice meter. The optimal shape of the orifice plate using the adjoint method shows 55% reduction in the pressure loss coefficient at a Reynolds number \( Re=1.84 \times 10^4 \). Besides, the effect of ing a downstream ring was investigated. Applying the adjoint method on the orifice plate with downstream ring reduces the pressure loss by 34%. Moreover, the surrogate based optimization was conducted when a ring is used downstream of the orifice plate. Design of experiment (DoE) was conducted on three parameters viz. the distance of the ring behind the orifice, the tip angle of the orifice and the tip angle of the ring. Numerical simulations were carried out to provide the artificial neural network by the necessary training data. The optimum shape reduces the pressure loss by 68%. Keywords: Shape optimization Orifice CFD Adjoint method Surrogate models