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Analysis of One-Way and Two-Way FSI Approaches to Characterise the Flow Regime and the Mechanical Behaviour during Closing Manoeuvring Operation of a Butterfly Valve

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Abstract : Butterfly valves are widely used industrial piping components as on-off and flow controlling devices. The main challenge in the design process of this type of valves is the correct dimensioning to ensure proper mechanical performance as well as to minimise flow losses that affect the efficiency of the system. Butterfly valves are typically dimensioned in a closed position based on mechanical approaches considering uniform hydrostatic pressure, whereas the flow losses are analysed by means of CFD simulations. The main limitation of these approaches is that they do not consider either the influence of the dynamics of the manoeuvring stage or coupled phenomena. Recent works have included the influence of the flow on the mechanical behaviour for different opening angles by means of one-way FSI approach. However, these works consider steady-state flow for the selected angles, not capturing the effect of the transient flow evolution during the manoeuvring stage. Two-way FSI modelling approach could allow overcoming such limitations providing more accurate results. Nevertheless, the use of this technique is limited due to the increase in the computational cost. In the present work, the applicability of FSI one-way and two-way approaches is evaluated for the analysis of butterfly valves, showing that not considering fluid-structure coupling involves not capturing the most critical situation for the valve disc.

Keywords : butterfly valves, fluid-structure interaction, one-way approach, two-way approach
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