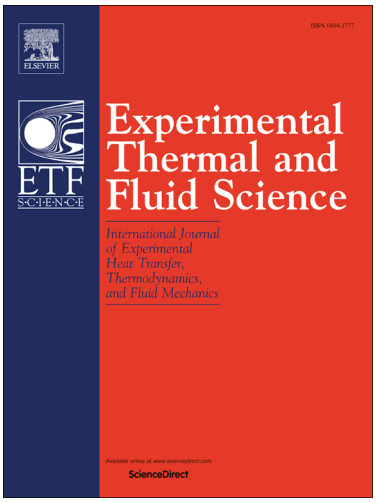

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A comparative study of natural and ventilated supercavitation across two closed-wall water tunnel facilities

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Abstract:

Despite half a century of experimental investigation into both natural and ventilated supercavitation, there are still significant discrepancies among the results, in terms of supercavity geometry and ventilation demand, etc., under approximately similar conditions from different water tunnel facilities. To understand the influences of the flow facilities on the supercavitation experiments, a systematic comparison is conducted using the results from two closed-wall water tunnels, i.e. the Saint Anthony Falls high-speed water tunnel and the Chuangnam National University Closed Tunnel. For both ventilated and natural supercavitation, the experimental conditions from the two facilities are designed to match over a wide range of Froude number and blockage ratio, etc. For the ventilated supercavitation, the cavitation number for generating a ventilated supercavity and the hysteresis process for sustaining a supercavity show a proper match across the two facilities while holding the Froude number and blockage ratio constant. However, the ventilation demand to form a supercavity shows a noteworthy difference across the facilities even under the same Froude number and blockage ratio. Such a difference in the ventilation requirement is attributed to the mismatch of Reynolds number, the detailed geometry of the cavitator models as well as the test section which influences the pressure distribution along the span of the supercavity. Similarly, for natural supercavitation, both facilities yield a similar vaporous cavitation number for the supercavity formation under the same Froude number and blockage ratio, as well as similar choking behavior, i.e. cavitation number stays constant despite the decrease of test section pressure once a natural supercavity forms. The theoretical analysis of the choking phenomenon explains the trend of cavitation number under choking and its