Investigation of flow over triangular roughness elements in a cavity

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Studies of flows over various roughness elements and ramps or riblets on the channel wall are concerned with flow resistance reduction, heat transfer intensification and the solution of other challenges related to knowledge and control of fluid dynamics. In this work, pressure losses and flow dynamics are studied experimentally in a cavity formed by two ramps on the channel wall and filled with triangular riblets. The length and amount of riblets are changed from one large to three smaller, occupying the entire cavity length and dividing it into smaller subcavities between riblets. Up to four subcavities, characterised by length-to-depth ratio λ = 8.8–2.8, are formed. Pressure loss regularities and flow structure above such cavity are investigated in a wide range of Re numbers (430–18000) covering laminar, transitional, and turbulent flow regimes. The pressure loss regularities were found depending on the ramps forming the initial plane cavity, while the riblets contribution is minor. However, their influence on the distribution of flow velocity and turbulence parameters is significant. Decreasing subcavities size between riblets, pressure losses increase until the critical size of subcavities is reached. Further reducing subcavities size, the interaction of the main flow and flow in subcavities diminishes, leading to decreased pressure losses. Measured velocity and shear rate profiles reveal dynamics of instabilities above vertices of riblets and their dependence on flow regime and subcavities size.

Our findings are anticipated to serve as a roadmap for passive flow control using riblets in the limited length chambers. Presented results provide a quantitative framework for selecting riblets configurations for developing applications where flow control and pressure losses play a major role.

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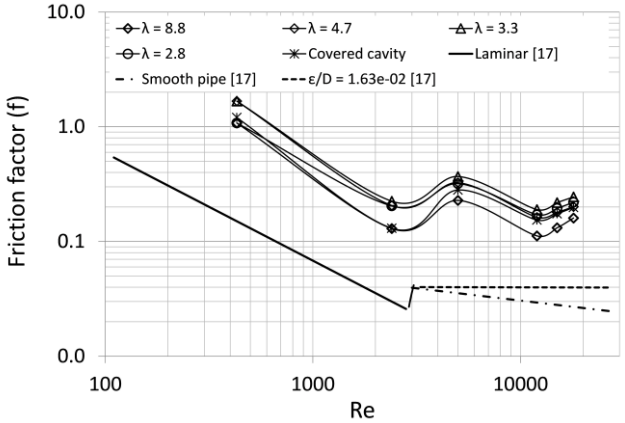

Figure 1. Friction factor dependence on Re for different riblets configurations