

Title: Research on the Effects of Nonsmooth Surfaces on Backward-facing Step Flow

Abstract: To achieve the purpose of backward-facing step flow control, a passive control approach, which consists in introducing nonsmooth structures in solid walls, is applied to the upstream of the backward-facing step. Based on STAR CCM+ software, the standard $k-\varepsilon$ turbulence model was established to simulate flow characteristics of the right angle step, fillet step and nonsmooth fillet step. The introduction of the nonsmooth surface leads to a significant reduction in recirculation region length (17.5%) and a decrease in downstream wall pressure coefficient. According to the analysis of separation point position and turbulent kinetic energy, the delay of separation point and the enhancement of momentum exchange are the main reasons for the success of flow control. Compared with the right angle step, the delay of flow separation of the fillet step leads to a reduction in step expansion ratio (ER), and the existence of the nonsmooth structure enhances the turbulent kinetic energy at the fluid separation points and the momentum mixing at the downstream of the step, thus reducing the reattachment length and the downstream wall pressure coefficient.