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Numerical Study of Turbulent Flow over Backward-Facing Step with Different Turbulence Models

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Abstract – *Numerical studies are conducted on turbulent incompressible flow over 2D backward-facing step in order to investigate the performance of three different turbulence models (standard k-e, realizable k-e and SST k-ω) in predicting the region of separation and reattachment behind the edge of step. Current solutions of Reynolds number (Re= 13200) and expansion ratio (H: H2=1:3) are compared with experimental measurements. Among the turbulence models, SST k-ω and standard k-e exhibited good agreement with experimental results.*

Keywords: Turbulence model; Turbulent flow; Backward-facing step; Separation; Reattachment

1.0 INTRODUCTION

Flow over a backward-facing step is accounted as a major reason by which recirculation zones are generated and vortices are formed because of the separation flow obtained from the counter pressure gradients in the flow of fluid [4]. The fluid flow over a backward-facing step has become a significant essential subject by which the separation and reattachment processes of turbulent shear layers can be investigated in various practical engineering applications such as internal flow systems (e.g. combustors, diffusers) and flow over airfoils and buildings [1-2]. The two-dimensional (2-D) backward-facing step gives a superior state for investigating the fundamental physical phenomena of separation and reattachment due to its geometrical simplicity [3]. This flow is also considered an important test which can be employed in order to compare between the turbulence models. With the redundancy of data in literature, the flow over a backward facing step is frequently employed as a case of benchmark test for several CFD codes and models related to turbulent flow. A variety of turbulence models such as RANS, LES and DNS have all been employed in order to simulate this flow in 2D domain and 3D as well [5].

Armaly et al. [3], they studied a backward-facing step flows experimentally and numerically. They noticed a variance in the results of length of major recirculation which obtained from the experimental and the numerical work. In addition, they observed a region of secondary flow at the upper wall of channel. Eaton and Johnston [6] investigated the separation of flow back a rearward facing step experimentally. A vortex module was noticed in the layer of free shear as the separating boundary layer was turbulent. Lee and Mateescu [8] conducted an