International Journal of Technology 10(2): 280-289
ISSN 2086-9614

CFD INVESTIGATION OF FLOW OVER A BACKWARD-FACING STEP USING AN RNG *k-ε* TURBULENCE MODEL

Steven Darmawan[1*], Harto Tanujaya[1]

[1]*Faculty of Engineering, Universitas Tarumanagara,, Jl. Letjen S. Parman No. 1, Jakarta 11440, Indonesia*

(Received: October 2017 / Revised: December 2018 / Accepted: March 2019)

ABSTRACT

Backward-facing step (BFS) is a benchmarked geometry for visualizing recirculation flow and validating turbulence models. Nowadays, numerical analysis with the CFD method has became more popular and has stimulated research involving CFD without avoiding the experimental method. In this paper, flow over a BFS was numerically investigated with an RNG *k-ε* turbulence model to predict recirculating flow. BFS geometry refers to the geometry proposed by Kasagi & Matsunaga; it is three-dimensional, with inlet Re = 5.540. The paper aims to investigate the performance of the RNG *k-ε* turbulence model over a BFS. Two important parameters were analayzed: the performance of the RNG *k-ε* on the recirculation zone and on the reattachment length. Recirculation flow is presented by the x-velocity for Y = 17.4 mm and Y = 34.9 mm. In these Y-section, the RNG *k-ε* is compared to the STD *k-ε* and both models show the recirculation flow occurred from X = 0 mm to about X = 200 mm. The following results were obtained. The RNG *k-ε* predicted a slightly higher x-velocity component than that predicted by the STD *k-ε*. This result shows that the RNG *k-ε* turbulence model is suitable for predicting recirculation flow on the BFS. The reattachment length was measured by non-dimensional X/h to the x-velocity component with the RNG *k-ε* turbulence model. The analyzed data were taken from X/h = 4.5 to X/h = 10, on the x-velocity component from Y = 17.4 mm. The reattachment point was achieved at X/h = 7.22, close to that achieved by Kasagi & Matsunaga of X/h = 6.51.

Keywords: Backward-facing step; CFD; Reattachment point; Recirculation flow; RNG *k-ε* turbulence model

1. INTRODUCTION

Backward-facing step (BFS) is the one of the most powerful geometries for visualizing flow, validating the performance of turbulence model on recirculating flow (Thangam & Speziale, 1991; Thangam, 1991). Generally, there are two main specific flows in a BFS considered as a benchmarking geometry: the recirculating flow after the expansion zone and the reattachment point reaching near to the outlet zone. The recirculated and swirling flow occurs in many engineering applications well-presented by BFS geometry. This type of flow can be useful or harmful, depending on the application; examples include recirculation flow in electronic devices; recirculation flow in aerodynamics fields; flow around buildings in architectural applications; flow in combustion chambers; and the disadvantage of swirling flow at pipe bends (Mouza et al., 2005; Rouizi et al., 2009; Gautier & Aider, 2014; Ramšak, 2015; Saha & Nandi, 2017;