EXPERIMENTAL AND NUMERICAL STUDY OF TURBULENT BOUNDARY LAYER CHARACTERISTICS ON SINGLE U GROOVED FLAT PLATE

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Abstract

Experiments of flow across a flat plate have been conducted in order to understand the boundary layer characteristics. The general result of those experiments is a decrease of shear force (skin friction force). Yet, the shear force decrease affects the total drag force insignificantly.

This study was done in a subsonic wind tunnel with freestream velocity of 17 m/s. The specimen was a single U-grooved flat plate. Fluid flow velocity was measured horizontally with 2 mm gap, which were four positions before, four positions above, and eight positions after the groove using the total pressure tap. While the vertical position of velocity measurement was done starting at 0.35 mm from the surface and ended when the velocity reached 0.99 freestream velocity. The grooved-wall’s static pressure was measured using pressure taps installed on the groove’s surface. Numerical simulation was carried out using Fluent 6.3.26 with k-ε Realizable turbulent modeling. Post processing is done by extracting data from Fluent 6.3.26 to get the parameters to be analyzed qualitatively.
From this experiment, it is known that the total drag decreased compared to the total drag on the smooth flat plate. The total drag decrease of 0.52% is obtained from the experiment while 6.16% from the numerical simulation. This experiment also verified that the groove located on the flat plate can affect the discontinuity and change the turbulent boundary layer characteristics after a groove, where the value of momentum thickness (θ), disturbance thickness (δ) and displacement thickness (δ*) increased by 3%.

Keywords: turbulent boundary layer, skin friction force, total drag, single U-groove, numerical simulation