THE 5TH ASIAN COMPUTATIONAL FLUID DYNAMICS
BUSAN, KOREA, OCTOBER 27~30, 2003

Direct Numerical Simulation of Channel Flow with Transpired Wall

Y. Na [1]

1. Multidisciplinary Aerospace System Design Team,
Department of Mechanical Engineering, Konkuk University,
Kwangjin-gu, Hwayang-dong, 1, Seoul 143-701, Korea, yangna@konkuk.ac.kr

Corresponding author ***Y. Na***

Abstract

The present work investigates turbulent velocity and temperature fields subject to strong wall injection in a channel using a Direct Numerical Simulation technique. A simplified model problem of the internal flows inside the hybrid rocket motors where a regression process at the wall is idealized by the wall blowing has been considered to gain a better understanding of how the near-wall turbulent structures are modified. Since the near-wall state of turbulence is likely to be modified due to the effect of wall blowing and the mean flow dynamics differ significantly from those in typical non-transpired channel flows, caution needs to be made when the RANS type calculations are to be performed. The present work is mainly motivated by the need for the data of turbulent flows with strong wall-injection to understand the physical process in the near-wall region and to support the turbulence and LES modeling developments.

As the strength of wall blowing increases, the flow experiences stronger streamwsie acceleration or inhomogeneity and this prevents from using the periodic boundary condition in this direction. Both the wall shear and friction temperature decrease significantly but the turbulence intensities, turbulent heat flux, r.m.s. temperature fluctuations and Reynolds shear stress increase rapidly as the flow moves downstream and this is thought to result from the shear instability induced by wall injection. Also, turbulent viscosity and turbulent diffusivity grow rapidly. Thus, the effect of wall-blowing modifies the state of turbulence significantly and more sophisticated turbulence modeling is required to predict this type of flows accurately.

Keyword: *Turbulent Flow, Wall Injection, Direct Numerical Simulation, Passive scalar, Turbulent viscosity*

Paper No. : 1-2A-2