

Assessment of the Predictive Accuracy of Reynolds-Averaged Turbulence Models for a Supply Jet Representative of Vehicle Cabin Air-Conditioning

Kazuki Ito ¹⁾ Masahiro Morishita ²⁾ Kouhei Mutou ²⁾ Takuji Nakashima ¹⁾ Itsuhei Kohri ³⁾
Yoshiichi Ozeki ⁴⁾ Minoru Inoue ⁵⁾ Kazuhiko Matsunaga ⁶⁾ Hidemi Mutsuda ¹⁾

1) Hiroshima University, Graduate School of Advanced Science and Engineering
1-4-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8527, Japan

2) Highly Marelli Japan Corporation
7 Sakae-cho, Sano, Tochigi 327-0816, Japan

3) Tokyo City University
1-28-1 Tamazutsumi, Setagaya-ku, Tokyo 158-8557, Japan

4) AGC Inc.
1-1 Suehiro-cho, Tsurumi-ku, Yokohama, Kanagawa 230-0045, Japan

5) Mazda Motor Corporation
3-1 Sinchi, Fuchu-cho, Aki-gun, Hiroshima 730-8670, Japan

6) Kanagawa Prefectural Junior College for Industrial Technology
2-4-1 Nakao, Asahi-ku, Yokohama, Kanagawa 241-0815, Japan

KEY WORDS: Heat•fluid, Air conditioner, Interior environment, Jet flow, RANS, Turbulent production [D1]

Accurate evaluation of occupant thermal comfort in vehicle cabins requires heat-balance predictions that account for local convective heat-transfer coefficients. This study investigated a rectangular free jet representing an automotive HVAC supply jet, focusing on turbulence development near the potential-core termination. Predictions obtained using the Realizable k - ε model and a Reynolds stress transport model (RSM) were compared with measurements obtained using a high-response multi-hole probe. Fig.1 shows the centerline velocity and turbulent kinetic energy normalized by the reference velocity. Both models overpredicted the potential-core length by 32–41% compared with the measurement and predicted the development of turbulent kinetic energy near the jet center farther downstream than observed.

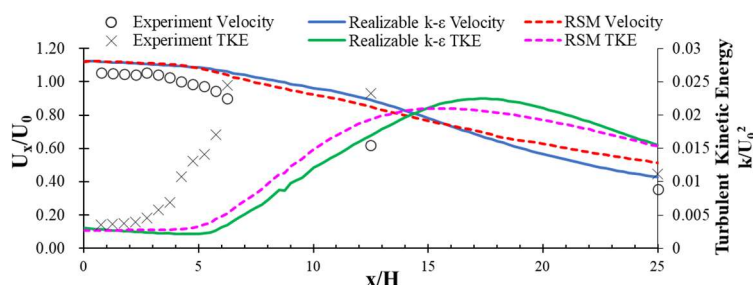


Fig.1 Flow Characteristics along the Jet Centerline

Fig.2 shows distributions of quantities associated with turbulent kinetic energy production along the z -direction at $x/H=5.0$ ($x=200\text{mm}$), near the potential-core termination. Fig.3 shows the modeled turbulent diffusion term. Both models predicted a peak in turbulent kinetic energy near production within the shear layer, whereas the local contribution of the modeled turbulent diffusion term was small near the jet center. The discrepancy between the measurements and CFD predictions may be affected by the modeling of both turbulent transport and diffusion and pressure-strain redistribution.

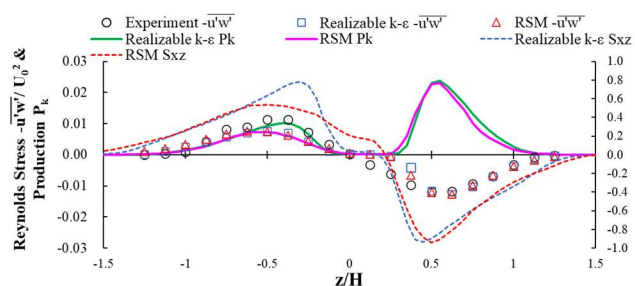


Fig.2 Turbulent Kinetic Energy Production Characteristics

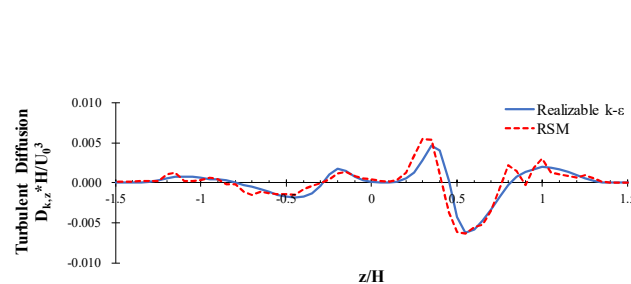


Fig.3 Distribution of the Modeled Turbulent Diffusion Term