

**Synopsis**  
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## **Numerical Simulation of a Steady Plane Wall Jet Using OpenFOAM: Validation Against Published RANS Models**

This research migration project aims to simulate the steady two-dimensional (2D) plane wall jet problem using the open-source CFD platform **OpenFOAM**, and validate the simulation results against the benchmark study by (Yan *et al.*, 2018), originally carried out using ANSYS FLUENT 14.5. The validation focuses specifically on replicating the results shown in Figure 3 of (Yan *et al.*, 2018), which compares mean streamwise velocity and turbulent kinetic energy (TKE) profiles across different grid resolutions.

The simulation was developed using OpenFOAM v7, employing the steady-state incompressible solver `simpleFoam`. The turbulence closure selected was the standard  $k-\epsilon$  model, as specified in the `turbulenceProperties` file under the Reynolds-Averaged Navier–Stokes (RANS) framework. A structured mesh was generated and refined near the wall to ensure sufficient resolution in the viscous sublayer, with validation carried out using intermediate mesh resolution.

The configuration includes:

- **Solver:** `simpleFoam`
- **Turbulence Model:**  $k - \epsilon$  (RANS)
- **Numerical schemes:** bounded Gauss linearUpwind for convective terms, Gauss linear corrected for Laplacian terms
- **Solver algorithms:** SIMPLE algorithm with residual control and relaxation factors tuned for pressure and turbulence fields
- **Boundary conditions:** Uniform velocity inlet and pressure outlet consistent with the experimental configuration in the reference study

Simulation results at  $x = 20b$  were extracted and compared against the benchmark profiles from Figure 3 in the original paper. The OpenFOAM results showed strong agreement in both velocity and TKE distributions for the intermediate mesh, validating the fidelity of the setup. This exercise successfully demonstrates the capability of OpenFOAM to replicate published RANS-based turbulence modeling outcomes and serves as a foundational step for future migration to higher-fidelity models like Reynolds Stress Models (RSM) or Large Eddy Simulation (LES).

**Reference:**

[1] Yan, Z. *et al.* (2018) 'Evaluation of RANS and LES turbulence models for simulating a steady 2-D plane wall jet', *Engineering Computations*, 35(1), pp. 211–234. Available at: <https://doi.org/10.1108/EC-11-2016-0397>.