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Compared

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Impinging jet: a transition model does not fix the stagnation region

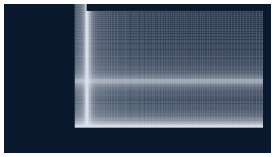
Objective. Predict wall heat transfer under a round turbulent jet impinging on a heated plate, and test whether a transition model recovers the secondary Nusselt peak that fully turbulent RANS misses.

Parameters

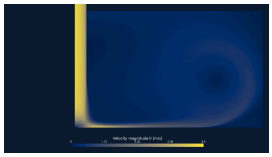
Reynolds number (bulk velocity, nozzle diameter)	23,000
Nozzle-to-plate distance H/D	2
Nozzle diameter D	0.1016 m
Bulk velocity	3.48857 m/s
Fluid	Air: density 1.18816 kg/m^3, viscosity 1.831e-05 Pa s, Prandtl number 0.705
Solver	OpenFOAM v2412, buoyantSimpleFoam with gravity off (forced convection)
Turbulence model	k-omega SST; Langtry-Menter k-omega SST-LM on the identical mesh
Wall treatment	Wall-resolved: plate first cell 20 µm, y+ max 0.23



1 Geometry



2 Mesh

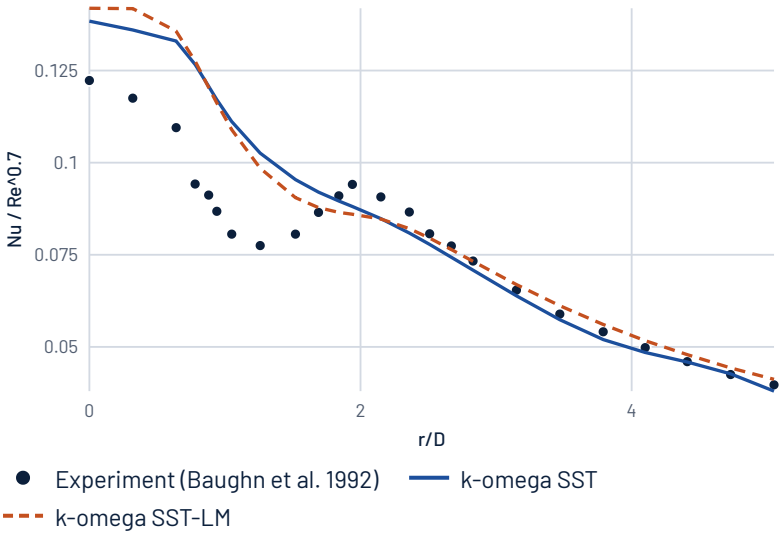


3 Results

Comparison with experiment

Quantity	Experiment	SST	SST, signed	SST-LM	SST-LM, signed
Nu error at stagnation, r/D 0	0.1223	0.1384	**+13 %**	0.1419	+16 %
Nu error at the secondary peak, r/D 1.94	0.0941	0.0881	**−6 % (no peak)**	0.0860	−9 % (no peak)
Nu error in the wall jet, r/D 2.5 and beyond	–	–	**−4.3 to +0.4 %**	–	−1.5 to +4.3 %
Mean |error|, all stations	–	–	**12.3 %**	–	12.2 %

Nu / Re^0.7 against r/D



Verdict

k-omega SST gets the developed wall jet right and over-predicts stagnation heat transfer by +13 %. The transition model gives the same mean error and no secondary peak, so the simpler model stays.

Limits

- Single grid: no numerical uncertainty band.
- Experimental Nu uncertainty is not stated in the source.
- SST ran 4000 iterations against 8000 for SST-LM, so the mean-error tie is unresolved.

1. ERCOFTAC Classic Collection, case 025 (round jet impinging on a flat plate), experimental data CC BY-NC-SA 4.0.
2. Baughn et al. (1992): Nusselt-number data, as distributed with ERCOFTAC case 025.
3. Cooper et al. (1993): single-wire hot-wire mean-velocity profiles, as distributed with ERCOFTAC case 025.

Full page with sources, mesh and numerical accuracy: /cases/impinging-jet/. Every number is checked against its source file.