Numerical Investigation of Indoor Airflow using a Precursor Inlet Strategy.

Abstract Submitted by

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1 Abstract

The following study presents a OpenFOAM based investigation into the indoor airflow patterns of a classic mixing ventilaition scenario, modeled based on the foundational **Neilsen's case** [1] and modified by adding a precursor channel for more realistic inlet profile. The objective is to validate this case study and predict jet patterns and velocity profile at critical areas wich are essential for indoor ventilation cases. Instead of using codes in blockMesh,a CAD based approach is used by integrating FreeCAD and cfMesh to create the computational domain and mesh.

2 Problem Statement

The objective of this study is to simulate and validate the isothermal airflow described in the standard IEA-Annex 20 Nielsen geometry[1] using OpenFOAM.The results are validated against the experimental data provided by Nielsen with a maximum error of 8.97% from experimental vlues.

Table 1: Summary of Problem Parameters and Numerical Setup

Category	**Parameter**	**Value / Description**
Geometry	Dimensions ($L \times H \times W$)	$9.0m \times 3.0m \times 3.0m$
	Inlet Height (h)	$0.168m$ ($h/H = 0.056$)
	Outlet Height (t)	$0.48m$ ($t/H = 0.16$)
Fluid Properties	Fluid Type	Air (Incompressible, Isothermal)
	Kinematic Viscosity (ν)	$1.5 \times 10^{-5}\, m^2/s$
	Density (ρ)	$1.205\, kg/m^3$
Boundary Conditions	**Inlet**	Fixed Velocity ($U_x = 0.455\, m/s$), Turbulence ($I \approx 4\%$)
	Outlet	Zero Gradient (U), Fixed Pressure ($p = 0$)
	Walls	No-slip ($U = 0$), Standard Wall Functions (k, ϵ, ν_t)
Numerical Setup	Solver	`incompressibleFluid` (OpenFOAM v11)
	Turbulence Model	Standard k-ϵ
	Mesh Type	Hex-dominant Unstructured
	Parallelization	4 Subdomains (Scotch Decomposition)

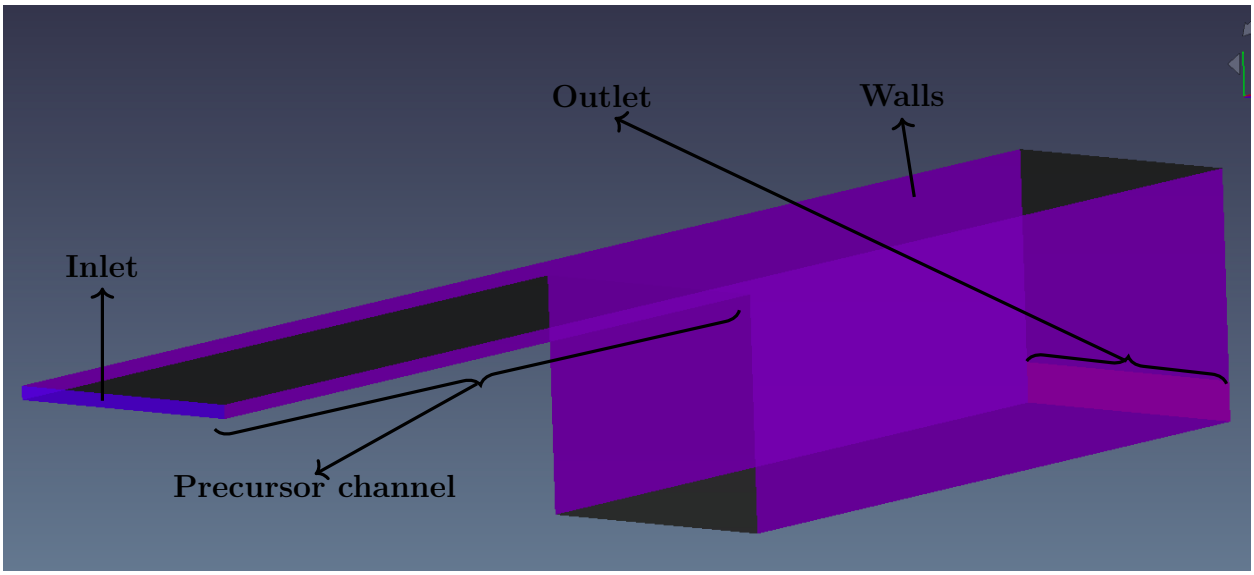

Figure 1: Computational domain showing inlet, outlet, and wall boundaries

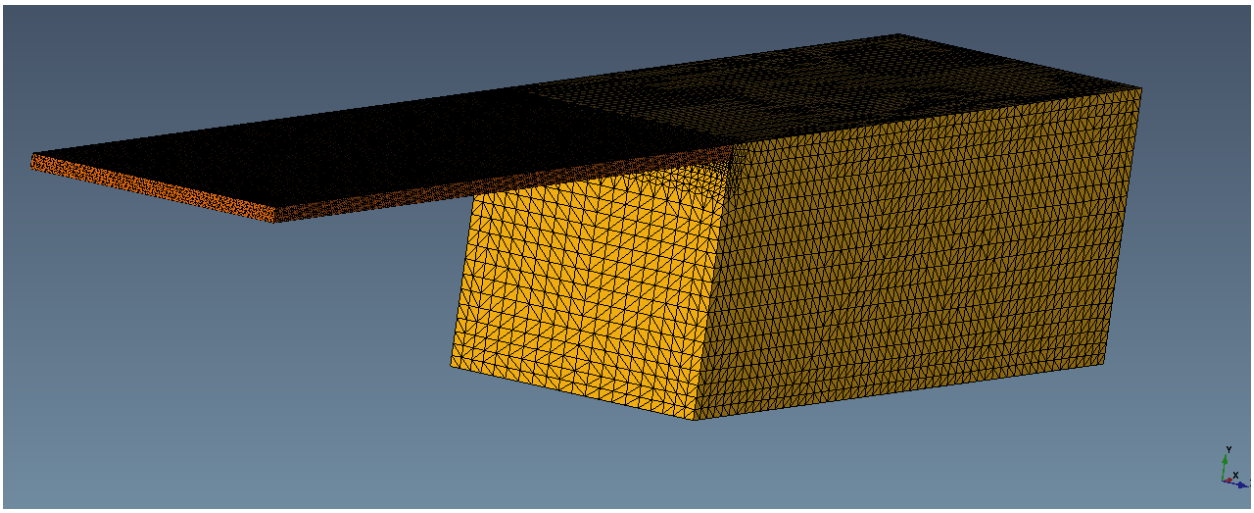

Figure 2: Mesh

References

[1] Peter V Nielsen. *Specification of a Two-Dimensional Test Case*. Tech. rep. R9040. Aalborg University, 1990.