Pollutant Dispersion Modelling using CFD: A walkthrough of solver development in OpenFOAM

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Abstract

Alarming increase of the hazardous pollutants in the major South Asian cities such as Kathmandu, Delhi, Mumbai, etc risks the life of every individuals there. The situation worsens especially, in the winters rising the air quality index to life-risking situations. A proper scientific study and modelling of the pollutants is necessary in order to properly manage the pollution. A major source in the production of such harmful pollutants are from the vehicles and industries. A computational Fluid Dynamics approach is proposed to model the pollutants using different turbulence models. The primary aim of the study is to develop a turbulent steady state solver for a passive transport of pollutants. The work is validated with the CEDVAL experiment which was conducted at Hamburg University. $k-\epsilon$ model better predicts the dispersion of the pollutant than $k-\omega$ SST turbulence model which over predicts the behaviour.

1 Problem Statement

Modelling of the emissions of the pollutant dispersion from any kind of sources as explained above requires a suitable model development in OpenFOAM. The pollutant such as CO_2,$N0_x$,etc was assumed as a scalar quantity which was being transported through air medium. The scalar was acted as passive field which does not actively reacts or affects the wind flow from farfield. Hence, a passive scalar transport equation was incorporated into the steady state solver simpleFoam. Along with it, a turbulent Schmidt number was added as input which plays significant role in the diffusion of the passive scalar term.

A model which is used to validate the solver is shown in figure 1. An isolated single building with four emission sources assumed as pollutant from the garage is used.

The non-dimensionalization of the co-ordinate axes was implemented as:

$$X = \frac{x}{H}, \qquad Y = \frac{y}{H}, \qquad Z = \frac{z}{H} \tag{1}$$

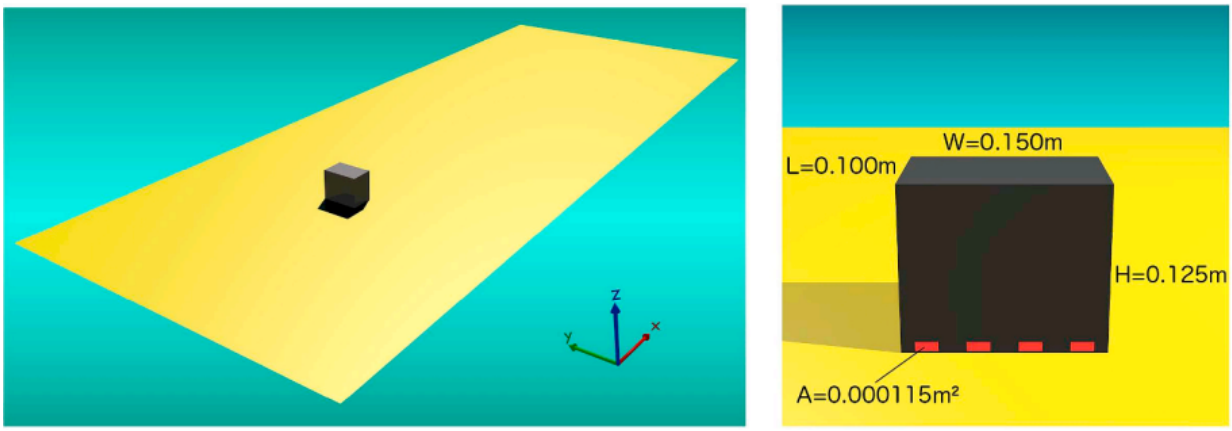

Figure 1: Geometry of CEDVAL A1-5 building (**?**)

Table 1: Dimensions of the configuration (in m)

	Length (x)	Width (y)	Height (z)
Building	0.1	0.15	0.125
Fluid domain	2.15	1	0.66