3D SPARSE GRID TURBULENCE

Syed M. Usama and Nadeem A. Malik
Department of Mathematics & Statistics, King Fahd University of Petroleum and Minerals, P.O. Box 5046, Dhahran 31261, Saudi Arabia.
Corresponding: nadeem_malik@cantab.net

The new concept of 3D multi-scale sparse grids (3DSG) [1,2] has excited interest in the turbulence community for possible exploitation for enhanced mixing and related applications. In a 3DSG arrangement each generation of length scale of turbulence grid elements is held in its own frame in overall co-planar arrangement as illustrated in Fig. 1. This produces a 'sparse' grid system whereby each generation of grid elements produces turbulent wakes that interacts with the other wakes downstream. A critical motivation here is that the effective blockage ratio in the 3DSG design is significantly lower than in the flat 2D counterpart – typically the blockage ratio could be reduced from say 34% in 2DF down to 17% in the 3DSG. Flat 2D fractal grids (2DF) are known to alter turbulence characteristics downstream of the grid as compared to the regular grids with the same blockage ratio and the same mass inflow rates [3]. The 3DSG possess a much bigger parameter space than 2DF grids because the distance between successive frames can be freely varied, and the effective blockage ratio can also be varied. The main aims of this research are to investigate the turbulence and mixing characteristics of 3DSG and to find possible optimal configurations for enhanced turbulence and mixing. A parametric study of 3DSG for different arrangements and blockage ratios is being carried out using OpenFoam DNS. We will report upon our findings by the time of the conference.

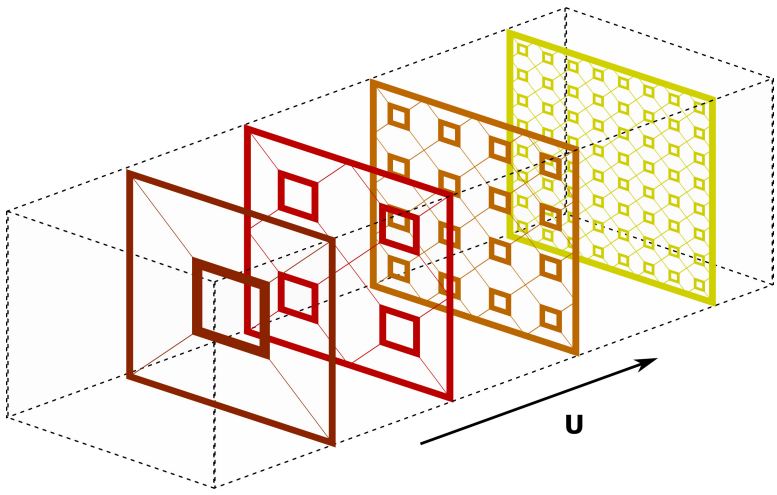

Figure 1. Sketch of a 3D Sparse Multi-Scale Grid Turbulence Generator (3DSGT) placed inside a conduit.

References

[1] N. A. Malik. Sparse 3D Multi-Scale Grid Turbulence Generator. USPTO #14/710,531, Patent (2017).
[2] N. A. Malik. Sparse 3D Multi-Scale Grid Turbulence Generator. EPO # EP 2 965 805 B1, Patent (2017).
[3] S. Laizet, J. C. Vassilicos. DNS of Fractal-Generated Turbulence. Flow Turbulence Combust 87:673705, (2011).