Impact of Grid Type on Gas Dispersion Simulation over Underlying Surfaces in Typical Chemical Industrial Parks: Postprint

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Abstract

Mesh constitutes the foundation of computational fluid dynamics (CFD) numerical simulations. To investigate the applicability of different mesh types to gas dispersion simulation in chemical industrial parks, full-scale numerical simulations were performed based on tracer gas (SF6) field release experiments conducted in a typical chemical industrial park. Four mesh types were selected: tetrahedral, polyhedral, hybrid tetrahedral, and hybrid polyhedral. A comparative study of the meshes was conducted in terms of meshing characteristics (cell count, orthogonal quality, aspect ratio) and CFD simulation performance (solution accuracy, fidelity, and computational time). Results demonstrate that regarding meshing characteristics, polyhedral meshes have the lowest cell count (0.6-1.5 million), followed by hybrid polyhedral meshes (0.8-3.3 million); the orthogonal quality of hybrid polyhedral (0.44) and polyhedral (0.41) meshes is significantly superior to that of tetrahedral (0.04) and hybrid tetrahedral (0.02) meshes; hybrid polyhedral meshes exhibit the lowest aspect ratio. In terms of simulation performance, hybrid polyhedral meshes achieve the highest computational accuracy, reaching 10^-4, exhibit the smallest error between simulated and monitored values and the best correlation (0.98), while simulation efficiency (27 min) is significantly higher than that of polyhedral (47 min) and hybrid tetrahedral meshes (112 min). Furthermore, regarding flow field characteristics, the plume width of polyhedral meshes is greater than that of hybrid meshes, and hybrid tetrahedral meshes exhibit the highest average plume concentration.

Full Text

Preamble

The following mathematical expressions are defined:

MATH_{0019}

MATH_{0020}

MATH_{0021}

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MATH_{0026}

MATH_{0027}

MATH_{0028}

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MATH_{0031}

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Section 5

Additional mathematical expressions:

MATH_{0033}

MATH_{0034}

MATH_{0035}

MATH_{0036}

MATH_{0037}

MATH_{0038}

MATH_{0039}

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Note: Figure translations are in progress. See original paper for figures.