

ANALYSIS OF POLLUTANT DISPERSION IN A STREET CANYON OF ASTANA

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Introduction. Due to the steadily rising number of vehicles, atmospheric air pollution has become one of the evident problems in main cities around the world. Astana, the capital city of Kazakhstan, is not an exception with its current expansion and economic growth. In order to avoid the hazardous consequences of automobile and industry pollution onto the residents' health of Astana, it is important to analyze and monitor the conditions of atmospheric air in the city. The main objective of this research project is to simulate and analyze the dispersion of vehicle pollutants (CO) at the crossroad of Zhenis and Bogenbay streets using Computational Fluid Dynamics (CFD) tools based on SolidWorks-EFD numerical platform. This particular place for the study is selected because of its relatively heavy traffic load and its close location to many residential buildings.

Methodology. In this study, the computational model of the Bogenbay and Zhenis streets crossroad is generated via CAD (Fig.1) and discretized along with governing equations, which include: energy, Reynolds-Averaged Navier-Stokes (RANS) equations, mass conservation, along with ideal gas equation of state, conservation of species and the 2-equation enhanced k-s turbulence closure model. The latter is the combination of the classical k-s model and Launder-Spalding wall function approach (SolidWorks Flow Simulation Technical Paper, 2013). The numerical platform (SolidWorks-EFD 2014) provided a multifunctional CFD tool that uses the finite volume method and a 2nd order upwind spatial scheme to produce accurate results for every single point of the domain under examination. Local wind data for the four seasons and the characteristics of pollutant CO gas are used as input data. The computational domain is set, boundary conditions are selected, and the mesh is discretized according to the prescriptions learned from previous works in similar applications.

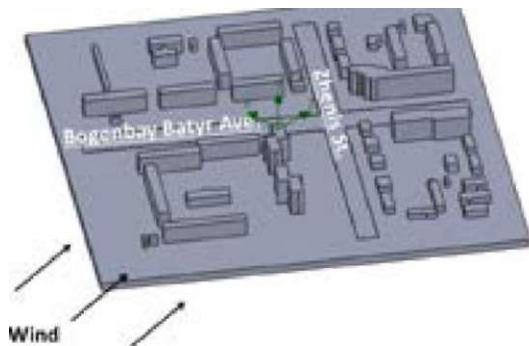


Fig. 1. Street Canyon physical model

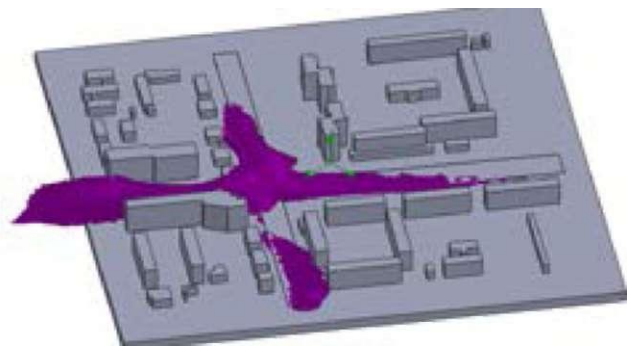


Fig.2. Isosurface of CO mass fraction in Summer

Results and Discussion. The computation of wind velocity distribution and pollutant concentration (see Fig. 2) are obtained for the four seasons of the year. It was learnt that the results of the pollutant concentration are within the allowed norm, which is, according to US Federal Highway Administration, 35 ppm for 1 hour or 9 ppm for 8 hours. The maximum of 11.2 ppm is reached in summer period, due to the slowest winds. As it was expected, the buildings do not cause obstacles and no hazardous "gas stagnation" places were observed.

Concluding remarks. Maximum calculated CO concentration does not cause any long-term effects to an arbitrary pedestrian, driver, or even inhabitants of nearby apartments. Only in case of long exposure, the gas emissions might have a lethal influence. However, further research is recommended to validate in-situ the most critical results in order to assess the actual accuracy of the numerical tool and gain confidence from local authorities in the use of this tool to plan the city future expansion.