Numerical modelling of vortex shedding and dispersion from an oil tank

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The focus of the study is to analyse fluid flow and gas dispersion over oil tanks placed in the Rotterdam harbour area, and therefore to estimate the total amount of oil/gas leaking from the tanks. Full-scale measurement is prohibitively expensive and might be inaccurate. For example, it is a big issue whether it is appropriate to estimate the total flux by measuring velocities and concentration at a few stations in the downstream. Some wind tunnel experiments have been conducted in EnFlo, University of Surrey (Robins & Hayden, 2012), which provides a baseline validation. In this study, the computational fluid dynamics technology was adopted and the numerical results were validated against the wind tunnel measurements. It was confirmed again that a proper inflow condition (Xie & Castro 2008) is crucial for such flows and dispersion. It was found that the concentration in the near field was sensitive to the location of the source, whereas in the far field it was not. The mean concentration profiles in the spanwise and vertical directions were in Gaussian distribution shape in the far field region. We fitted the mean concentration distribution on the spanwise - vertical plane into a 2-D Gaussian distribution in the far field. Also a simple expression of mean velocity was obtained by using the numerical data. Finally the total flux was estimated based on the approximated 2-D Gaussian distribution, which was in reasonable agreement with the total flux specified at the sources. This may suggest that it is possible to estimate the total concentration flux by measuring velocities and concentration at a limited number of stations in the downstream. However, further work is required to confirm this, e.g. for a group of tanks.

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References

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