

Source-to-Hood Alignment Effects on Ammonia Dispersion and Capture Performance in an Engine-Room Test Bed

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Abstract

Ammonia is a promising carbon-free marine fuel, but accidental leakage in enclosed engine rooms can generate persistent toxic clouds and severe breathing-zone exposure. Conventional ventilation assessment based only on nominal exhaust capacity or air-change rate may not adequately represent hood capture performance, particularly when the leak jet is not aligned with the suction region. In this study, eighteen transient three-dimensional CFD simulations were conducted for a full-scale ammonia engine-room test bed by varying leak location, hood type, and hood height. The results show that source-to-hood alignment strongly controls early plume capture and long-term residual contamination. The well aligned IE-T3-H6 case achieved a removal efficiency of 98.77% with only 0.05 kg NH₃ remaining at 180 s, whereas the poorly aligned VALVE-T3-H6 case achieved only 38.30% removal and retained 2.51 kg NH₃. In the worst case, the 30 ppm toxic cloud expanded to nearly the full compartment volume, and the breathing-zone average concentration remained above 30 ppm until approximately 913.5 s. These findings demonstrate that hood ventilation performance should be evaluated using toxic cloud volume, breathing-zone exposure, residual mass, and capture delay even under an identical exhaust-flow basis.

Keywords

Ammonia Dispersion, Ventilation Hood Efficiency, Computational Fluid Dynamic, Toxic Cloud Evolution, Breathing-zone Exposure, Toxic in the Engine Room

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