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Assessment of Hypersaline Outfalls via Computational Fluid Dynamics Simulations: A Case Study of the Gold Coast Desalination Plant Offshore Multiport Brine Diffuser

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Abstract : This study details a three-dimensional field-scale numerical investigation conducted for the Gold Coast Desalination Plant (GCDP) offshore multiport brine diffuser. Quantitative assessment of diffuser performance with regard to trajectory, dilution and mapping of seafloor concentration distributions was conducted for 100% plant operation. The quasi-steady Computational Fluid Dynamics (CFD) simulations were performed using the Reynolds averaged Navier-Stokes equations with a k-ω shear stress transport turbulence closure scheme. The study compliments a field investigation, which measured brine plume characteristics under similar conditions. CFD models used an iterative mesh in a domain with dimensions 400 m long, 200 m wide and an average depth of 24.2 m. Acoustic Doppler current profiler measurements conducted in the companion field study exhibited considerable variability over the water column. The effect of this vertical variability on simulated discharge outcomes was examined. Seafloor slope was also accommodated into the model. Ambient currents varied predominantly in the longshore direction – perpendicular to the diffuser structure. Under these conditions, the alternating port orientation of the GCDP diffuser resulted in simultaneous subjection to co-propagating and counter-propagating ambient regimes. Results from quiescent ambient simulations suggest broad agreement with empirical scaling arguments traditionally employed in design and regulatory assessments. Simulated dynamic ambient regimes showed the influence of ambient crossflow upon jet trajectory, dilution and seafloor concentration is significant. The effect of ambient flow structure and the subsequent influence on jet dynamics is discussed, along with the implications for using these different simulation approaches to inform regulatory decisions.

Keywords : computational fluid dynamics, desalination, field-scale simulation, multiport brine diffuser, negatively buoyant jet
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