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Application of a hydroxyl-radical-based disinfection system for ballast water

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ABSTRACT:

A hydroxyl radical (•OH) ballast water treatment system (BWTS) was developed and applied to inactivate entrained organisms in a 10,000-ton oceanic ship, where •OH was produced by a strong ionization discharge combined with a water jet cavitation effect. The calculated •OH generation rate was 1373.4 μM min^{-1} in ballast water, which is much higher than that in other advanced oxidative processes such as photocatalysis. As a result, non-indigenous red tide algae were inactivated to meet the ballast water discharge standards (< 10 cells mL^{-1}) of the International Maritime Organization. The ratio of variable fluorescence to maximum fluorescence (F_v/F_m) for algal chlorophyll rapidly decreased to zero within a contact time of only 6 s, indicating complete inactivation of algae. Observation under a scanning electron microscope showed no cellular materials were released by algal cells upon •OH inactivation. A risk assessment of the •OH treatment system was conducted, and the ratios of predicted environmental concentrations to predicted no effect concentrations of all detected disinfection byproducts were less than 1, even at a worst-case oxidant concentration of 2.41 mg L^{-1}. Ship