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Modeling Oil Droplet Dynamics in Offshore Produced Water: A Population Balance Approach

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Abstract:

Produced water, the largest waste stream from offshore oil production, often contains residual oil droplets with harmful chemicals, posing risks to marine ecosystems. Given the daily discharge of over 250 million barrels globally, understanding oil droplet behaviour is essential for environmental protection and regulatory compliance.

This study presents a population balance model that integrates physical and chemical dynamics using a modified Smoluchowsky equation to account for buoyancy, diffusion, and agglomeration. The model uniquely incorporates the effects of production chemicals on droplet coalescence and dynamics, addressing complexities often overlooked in prior models.

Using the method of lines, we numerically solved the equations to simulate droplet behaviour, offering insights into chemical interactions that affect transport in marine environments. The model has practical applications for the offshore oil industry, aiding in risk assessments and optimizing water treatment to minimize environmental impacts.