

A 3D Numerical Environmental Modeling Approach For Assessing Transport of Spilled Oil in Porous Beach Conditions under a Meso-Scale Tank Design

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Abstract : Shorelines are vulnerable to significant environmental impacts from oil spills. Stranded oil can cause potential short- to long-term detrimental effects along beaches that include injuries to the ecosystem, socio-economic and cultural resources. In this study, a three-dimensional (3D) numerical modeling approach is developed to evaluate the fate and transport of spilled oil for hypothetical oiled shoreline cases under various combinations of beach geomorphology and environmental conditions. The developed model estimates the spatial and temporal distribution of spilled oil for the various test conditions, using the finite volume method and considering the physical transport (dispersion and advection), sinks, and sorption processes. The model includes a user-friendly interface for data input on variables such as beach properties, environmental conditions, and physical-chemical properties of spilled oil. An experimental mesoscale tank design was used to test the developed model for dissolved petroleum hydrocarbon within shorelines. The simulated results for effects of different sediment substrates, oil types, and shoreline features for the transport of spilled oil are comparable to those obtained with a commercially available model. Results show that the properties of substrates and the oil removal by shoreline effects have significant impacts on oil transport in the beach area. Sensitivity analysis, through the application of the one-step-at-a-time method (OAT), for the 3D model identified hydraulic conductivity as the most sensitive parameter. The 3D numerical model allows users to examine the behavior of oil on and within beaches, assess potential environmental impacts, and provide technical support for decisions related to shoreline clean-up operations.

Keywords : dissolved petroleum hydrocarbons, environmental multimedia model, finite volume method, sensitivity analysis, total petroleum hydrocarbons

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