Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33554

Evaluating Pc-S relationships for Heterogeneous Subsurface Systems with HYDRUS Modelling and Laboratory Experiments

RABINDRA MAITY[1], DR. PANKAJ KUMAR GUPTA, PHD[2] AND BHAWANA PATHAK[1]

[1]Central University of Gujarat
[2]Indian Institute of Technology Delhi

Abstract

Evaluating Pc-S relationships for Heterogeneous Subsurface Systems with HYDRUS Modelling and Laboratory Experiments

Rabindra Maity[1,2], Pankaj Kumar Gupta[2,3]Bhawana Pathak[1],

[1]School of Environment and Sustainable Development, Central University of Gujarat, 391107, India.

[2]Centre for Rural Development and Technology (CRDT), Indian Institute of Technology (IIT) Delhi, Hauz Khas, New Delhi 110016, India.

[3]Wetland Hydrology Research Laboratory, Faculty of Environment, University of Waterloo, 200 University Ave W, Waterloo, ON N2L3G1, Canada.

*Email: rabindramaity721447@gmail.com, pk3gupta@uwaterloo.ca, bhawana.pathak@cug.ac.in

Characteristically, the capillary pressure (Pc)- saturation(S) relationship is a critical parameter in understanding how fluids, particularly non- aqueous phase liquids (NAPLs) like diesel, kerosene, toluene etc, move through the subsurface. This study focuses on the evaluation of Pc-S relationship across diverse soil types, with a specific emphasis on the distinct hydraulic behaviours found in heterogeneous sub-surface materials such as sand, silt and clay in the Panipat refineries area, India. A series of laboratory column experiments, the development of numerical modelling using HYDRUS- 1D were performed for the targeted soils. HYDRUS was utilized to perform inverse modeling of experimental drainage data, allowing for the estimation of key constitutive parameters. By applying hydraulic models like the van Genuchten and brooks Corey equation, this research explores how variation in porosity and pore- size distribution influences fluid retention and flow. The modeling show that different types of soil process specific air entry pressure and residual saturation points, which are critical factors in the entrapment and mobilization of NAPL.

These findings suggest that standard hydraulic models must be calibrated to account for the heterogeneity found in complex soils to prevent errors in environmental risk assessments. By providing a refined computational approach to calculating (Pc-S) relationships using HYDRUS, this work provides a more reliable basis for developing groundwater remediation strategies and managing oil-contaminated sites.