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Numerical analysis of fate and transport of leaked heat exchanger fluids in borehole

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The ground source heat pump (GSHP) systems need to be evaluated in terms of potential risk on groundwater contamination due to the leakage of heat exchanger fluids. The antifreeze fluid is widely used as heat exchanger fluid for the closed GSHP system with ethylene glycol and propylene glycol. Although the toxicity of these fluids is low, the fluid leakage from the tube can deteriorate groundwater quality. As increasing in the installation of GSHP, the risk of ground and groundwater contamination becomes higher. The objective of this study was therefore to predict the fate and transport of leaked heat exchanger fluid around the borehole.

HYDRUS software was used in this study to simulate the fluids transport, which was based on the numerical solution of Richards equation for variably saturated water flow in porous media and advection-dispersion equations for solute transport in the liquid phase. The analysis domain was 10 m $*$ 10 m $*$ 50 m with 10 geological layers to mimic the GSHP system installed at the study site in Tokyo University of Agriculture and Technology. Hydrological and thermal properties obtained from borehole core samples were assigned to each layer. Several different leaking scenarios were simulated in this study. This study demonstrated that fate and transport of leaked heat exchanger fluids can be simulated by HYDRUS. This allows the users of GSHP to assess the potential risk of contaminating surrounding ground and groundwater.

Keywords: ground source heat pump, solute transport, potential risk of contaminating