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MODELING SUBSARFACE TRANSPORT OF PETROLEUM HYDROCARBONS AND PREDICTING GROUNDWATER CONTAMINATION

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INTRODUCTION: Soil contamination with petroleum hydrocarbons is a major environmental issue which has attracted considerable public attention over the past decades (Peng et al., 2009). Mathematical models can help clarify the fate of petroleum hydrocarbons at various sites and thus provide managers with guidance on monitoring and operation. Therefore, the present study sought to model the subsurface transport of petroleum hydrocarbons in order to predict groundwater contamination status.

MATERIALS AND METHODS: This research applied a previously designed model to predict the concentration of petroleum-based contaminants at different depths of soil. Accordingly, the equations of water flow in soil and flow of contaminants in the environment were solved simultaneously using a finite difference method. The suitable program for this purpose was written in Fortran (Mirbagheri, 2004). A real sample of oil spill was selected based on the report of Isfahan Oil Refinery (Iran). The parameters required by the model, i.e. the percentage of clay, silt, and sand, soil density, saturation, and pH, inlet concentration of the contaminant (mmol/l), diffusivity of the contaminant in liquid (cm^2/day), and constant evaporation rate (/day), were first determined. Considering the refinery's report, the duration of modeling was calculated as 20 days. In the first seven days, the direct influx was at work. Finally, the model computed the concentrations of petroleum-based contaminants at different depths of soil at five-day intervals.

RESULTS AND DISCUSSION: Five days after the spill, the concentration of total petroleum hydrocarbons (TPH) was very low at higher depths and nearly zero at depths $\geq$ 30 centimeters. As time passed, higher inlet concentration and penetration of the contaminant into the lower layers increased its concentration in all layers of soil. Nevertheless, not all layers of soil absorbed the pollution and the process decelerated gradually. Moreover, although TPH could not penetrate into higher depths of soil during the first days, their concentration and penetration depth increased over time. The increased evaporation rate of the contaminant during the course of the study could significantly reduce the transport and penetration of the contaminant at higher depths. However, such an effect was seen merely in top layers of soil and decreased remarkably and approached zero thereafter. The precision and accuracy of the model were proved by comparing its results with the measured values.

Keywords: Oil pollutant, Finite difference, Model, Refinery

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