

SCBR MODEL AS A DECISION SUPPORT SYSTEM TOOL FOR MANAGEMENT OF BIOFUELS CONTAMINATED SITES

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ABSTRACT

The worldwide increase in use of biofuels generates a concern in groundwater contamination, creating a demand for computational flow models (CFM) to simulate gasoline and ethanol spills in the subsurface. With fifteen years of experience in studying groundwater contamination by petroleum hydrocarbons and ethanol, Federal University of Santa Catarina, together with Petrobras and ESSS, has developed a numerical model – SCBR (Risk Based Corrective Solution) – to assist in all steps of environmental management of contaminated sites [1], as a decision support system tool. To simulate hydrocarbon petroleum plumes in presence of ethanol, as well the water flow in the subsurface, SCBR uses Boussinesq equation solved numerically to a 2D scenario, considering molecular diffusion, advection, dispersion, sorption, and biodegradation [2]. Among the most used CFM, SCBR stands out because is the only 2D model that includes transport and transformation of contaminants in the subsurface taking in account the cosolvency effect of ethanol. The increase in contaminants concentration in groundwater due to cosolvency effect is calculated according to Equation 1, where S_m is the solubility of the solute in the water-cosolvent mixture, S_w is the solubility in pure water, f is the cosolvent volume fraction in the aqueous phase, and K_{ow} is the octanol-water partition coefficient [3]. To avoid inconsistencies, SCBR uses finite volume method with a structured mesh, which allows the simulation of aquifer heterogeneities, multiple sources, remediation techniques, influence of rivers and lakes in the groundwater flow.

$$\log S_m = \log S_w + f \cdot (0,76 \cdot \log K_{ow} - 0,83)$$

Equation 1

Using SCBR for areas which handle toxic products before a contamination event occurs could be helpful for reducing the response time in case of accidents, and it allows rapid decision making before a plume reaches protected assets. To use SCBR as a decision support system tool it is necessary to have customized SCBR to the contaminated site, in order to obtain a conceptual model, which provides an overall understanding of the area, such as subsurface flow, aquifer properties, and geological soil characterization. The use of biofuels such as ethanol emphasizes the importance of CFM that simulates its effects in case of hydrocarbons petroleum spills, as shown in Figure 1.



Figure 1 – Comparison of simulated plumes of benzene in groundwater due to a gasoline and ethanol spill scenario, considering the cosolvent effect and without presence of ethanol

The legal framework in SCBR is based on Brazilian (as CONAMA 420/09 [4] and CETESB) and international environmental regulations (EPA and ASTM, for instance). With the conceptual model customized, SCBR allows rapid decision making, as it simulates critical scenarios of contaminants flow in groundwater, considering the cosolvency effect in presence of biofuels.

References

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