Thermal enhancement of coal tar pumping in saturated porous media

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PAHs are main constituents of coal tar, which is found on coking plant wastelands. The pumping rate of these DNAPLs is generally low due to its viscous nature and its high residual saturation. The goal of this study is to investigate effects of temperature on coal tar recovery and determine if a thermal enhancement can improve the pumping efficiency.

Coal tars used in this work were sampled from a pilot siteof a former coking plant. In order to understand how thermal remediation would enhance coal tar recovery, we first investigated temperature sensitivity on coal tar properties including density, viscosity, interfacial tension and contact angle with water.Viscosity is affected by temperature and showed a five-fold decrease when coal tar is heated from 10°C to 50°C.Other coal tar parameters, like wettability, were not significantly alteredby temperature changes. The lack of wettability variations due to temperature indicate that coal tar residual saturationshould not be affected by thermal enhancement. However, the decrease in its viscosity shows that coal tar under the water table can be remobilized by heating processes. As a consequence, the recovery rate of coal tar would effectively increase, if a thermally enhanced pumping is used.

We also conducted drainage-imbibition experiments of coal tar – water system in a one-dimensional column to determine the impact of temperature on capillary pressure-saturation curves. A model has been developed to predict coal tar recovery, using COMSOL Multiphysics® in a two-dimensional tank and isothermal conditions. The theoretical results were compared to experimental pumping tests performed in laboratory in a two-dimensional tank to validate the numerical model.

The next step is to perform the experiments in non-isothermal cases and to improve the numerical model bycouplingcoal tar - water flow with transient heat transfers in order to realistically model a thermally enhanced pumping. This is necessary to determine quantitatively how temperature affects the coal tar recovery rate in order to enhance the processes.