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Aging of NAPLs interfaces in porous media and their effects on mass transfer of organic contaminants

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Release of non-aqueous phase liquids (NAPLs) into natural porous media is a widespread environmental problem, especially at gas works sites, oil processing and wood treatment facilities. Transfer of pollutants across the NAPL-water determines both the extent of groundwater contamination as well as the persistence of residual NAPLs phases in porous media. Previous research has shown that coal tar-, crude oil- and creosote-water interfaces may be subject to “aging” phenomena in aqueous environments. Knowledge of the relationship between aging and mass transfer is an important determinant in risk assessment, remediation effectiveness and research.

Pendant drop tests were performed with various kinds of coal tar and crude oils. We observed aging with all kinds of NAPLs tested so far. All crude oils showed a visible “aging film” after 4-7 days exposure to water (wrinkle formation). Most commercially available coal tars, however, kept their original drop shapes for up to 3 month although a semi-solid interfacial film formed during this time period. Furthermore, there was no visual effect of the aqueous pH on aging except for anthracene oil in basic solution. Acid (pH=3) and basic (pH=12) solutions, however, had a darker colour than neutral solutions indicating pH dependent dissolution and speciation of NAPL constituents.

Dynamic mass transfer experiments were conduced using a continuously stirred flow through reactor (CSFTR) containing a 1:1 ratio of water and a model NAPL (toluene with 12g/L phenanthrene). Aqueous samples were collected, analysed for phenantrene by GC/MS and a mass transfer coefficient of phenantrene was calculated using the analytical solution of a mass balance equation. The values obtained (4 – 12 x 10^{-4} cm/s) are comparable to published data and validated the suitability of the experimen-

tal approach. Further studies will address the potential effects of aqueous and NAPL composition on mass transfer rates.