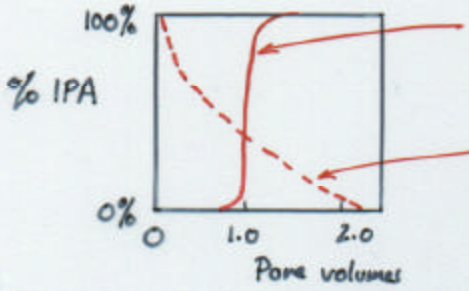
4.2 Cosolvent Washing

Hydrophilic organic compounds { alcohols, esters, ketones } — solubility enhancement, reduces surface tension



Isopropanol displ. Naptha M = 0.27 (Stable)
Creates miscible plug

Naptha displ. IPA M = 3.69 (1/.27) (Unstable)

Emulsion plug

Miscible interface — Immiscible interface

Field Implementation

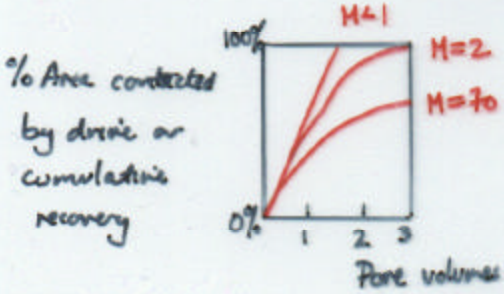
1. Slug injection of cosolvent + 2. Injection of driving fluid (water)
Consider stability of each front with M < 1

M may change as slug is attenuated { adsorbed to grains, expanded at front

No known field application — TCE pilot study @ R.S. Kerr Lab (EPA)

Level of Demonstration

Petroleum industry — 1-D column experiments
2-D radial experiments M < 1 ok } homogeneous



← Heterogeneous models (Habermann, 1960; Blackwell, 1959)

Boyd and Farley (1992) $H_2O \rightarrow IPA \rightarrow TCE$ 1-d column of glass beads.

$v = 18$ ft/day

Upflow, downflow and horizontal sweeps

Downflow most effective (front stable) with action of gravity

Experiments with 16% wt clays.

Small slug sizes gives poorer TCE recovery due to fines mobilization and clogging.

Applied to 2ppm PCB contaminated soils (lab) 2g/kg organic matter

Ethanol water solutions

PCB displ. effectiveness of 85–98% using ethanol–water of 47%–76%

Applicability / Limitations

- Solubility enhancement of hydrophobic hydrocarbons in soils well documented since 1980s.
- Interfacial instability ($M > 1$) for large differences in viscosity (5–200cp) causes deterioration of slug.
- May add alkali agents, surfactants, polymers, to improve M.
- Heterogeneities largely influence behavior
- Special well construction materials may be needed. Stainless steel.
- May result in desiccation for clays due to cosolvent reaction.

Cost and Availability

Used in petroleum industry

No widespread use for NAPLs in envt. but shows promise.

Density considerations (cosolvents are light) may make cosolvents applicable for LNAPLs rather than DNAPLs.

Heterogeneity is major issue.

No cost information.