Selection and Testing of Surfactants for Enhanced In Situ Alkaline Hydrolysis (S-ISAH) of Pesticide DNAPL

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Selection and Testing of Surfactants for Enhanced *In Situ* Alkaline Hydrolysis (S-ISAH) of Pesticide DNAPL

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Background

Groyne 42 is a 20,000 m² former chemical dump site in Denmark contaminated with 200-300 tons of organophosphorous pesticides (OPPs). The majority of contaminant mass is present as sorbed phase and residual DNAPL. The NorthPestClean project was established to determine the effectiveness of using *in situ* alkaline hydrolysis to treat the DNAPL (Fig. 1).

A primary challenge is *in situ* mixing, establishing sufficient contact between hydroxide and DNAPL.

Scope of study

To test surfactants as a method for enhancing the solubility of OPPs and the rate of *in situ* alkaline hydrolysis and select a commercially available formulation for pilot scale site tests.

Initial selection

Previous work has identified non-ionic surfactants as the best performing type increasing OPP solubility.

Ten candidate surfactants was identified based upon the following criteria:

- stability under alkaline conditions (pH of 12 or higher)
- acceptability for *in situ* use – not toxic to the environment
- readily biodegradable in the environment
- limited foaming

Screening

Ten candidate surfactants was identified based upon the following criteria:

- Previous formulation performance
- Rate of increase in OPP solubility
- Effectiveness of using the surfactant for hydrolysis of OPPs
- Toxicity to aquatic organisms
- Cost of surfactant

A list of ten candidate surfactants was identified. Further studies were performed to select the best OPP solubilizer.

**Fig. 1: The alkaline hydrolysis of OPPs.**

**Fig. 2: Screening of ten surfactants at pH 13 after 7 days with a 10:1 surfactant:DNAPL volumetric ratio.**

**Fig. 3: The contaminated soil/surfactant water ratio used in this test was 4 g/mL. No extra DNAPL was added.**

**Fig. 4: Results of batch tests with soil of four alcohol ethoxylates after 7 days of reaction at pH 13.**

**Conclusion**

Ecosurf EH-9 was best at increasing OPP solubility in the presence of soil due to higher soil adsorption of the other ethoxylates. Highest OPP removal from the soil was obtained with Rhodasurf CET25 (64%) and Ecosurf EH-9 (63%) compared to 40% of the reference alkaline tap water. Ecosurf EH-9 has higher biodegradability and lower costs.

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