PACE Research Report

Institution

University of the Fraser Valley

Principal Researcher

David Fenske
Noham Weinberg

Research Field

Agriculture and Land Use

Student Involvement

Heather Wiebe
Ashley Epp
Melissa Prachnau
Whitney Wong

Partners & Collaborators

Gentech Developments Ltd
Randy Brown, President

Funding Sources

NSERC Engage grant

Project Location

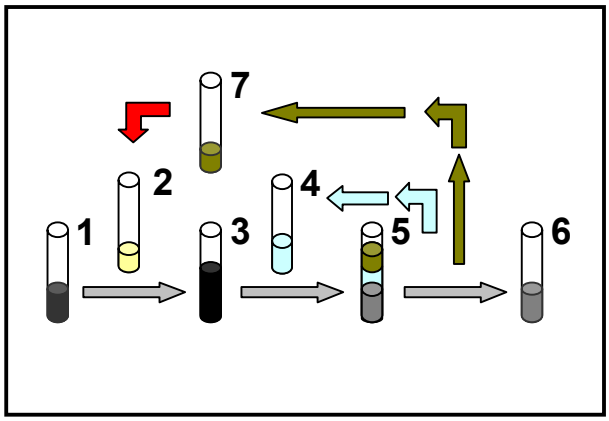
Chemistry Department, UFV

Soil remediation with eco-friendly solvents

Soil and solvent recovery from petroleum contaminants

The environmentally friendly solvent developed by an Abbotsford company was proven to be a highly efficient alternative to toxic halogenated solvents. The objective of this student-driven project was to develop a cost-effective way of removing petroleum contaminants from the solvent in order to extend its lifetime and improve its economic viability.

Many soil contaminants, such as pesticides, antibiotics, and petroleum products are hydrophobic and tend to remain in soil for extended periods of time. They can be removed by non-polar solvents, but the majority of these are either potential contaminants themselves, or pose a health threat to workers. Vegetable oils, which are also hydrophobic, mix with hydrocarbons in any proportion. They are biodegradable and thus represent an environmentally friendly alternative to synthetic solvents or surfactant materials for use in soil remediation and wildlife rescue operations.



The soil remediation process utilizing a vegetable oil solvent can be illustrated by the schematic shown on the left. Contaminated soil **1** is treated with solvent **2** to form mixture **3.** After the process of extraction is complete, water **4** is added to the mixture to separate contaminant-containing solvent (top layer of **5**) from remediated soil (bottom layer of **5**). Three layers of **5** are then easily separated into recovered water **4**, clean soil **6**, and contaminant-containing solvent **7.** Recovered water and the solvent can be reused in the next cycles. Periodically, the vegetable oil solvent will need to be put through a recovery process aimed at eliminating petroleum contaminants (red arrow). The efficiency of use of such solvents crucially depends on availability of a simple and inexpensive process for their recovery. The objective of this project was therefore to develop an economical approach towards recovering the vegetable oil solvent from the petroleum contaminants, and obtaining the contaminants in isolated form.

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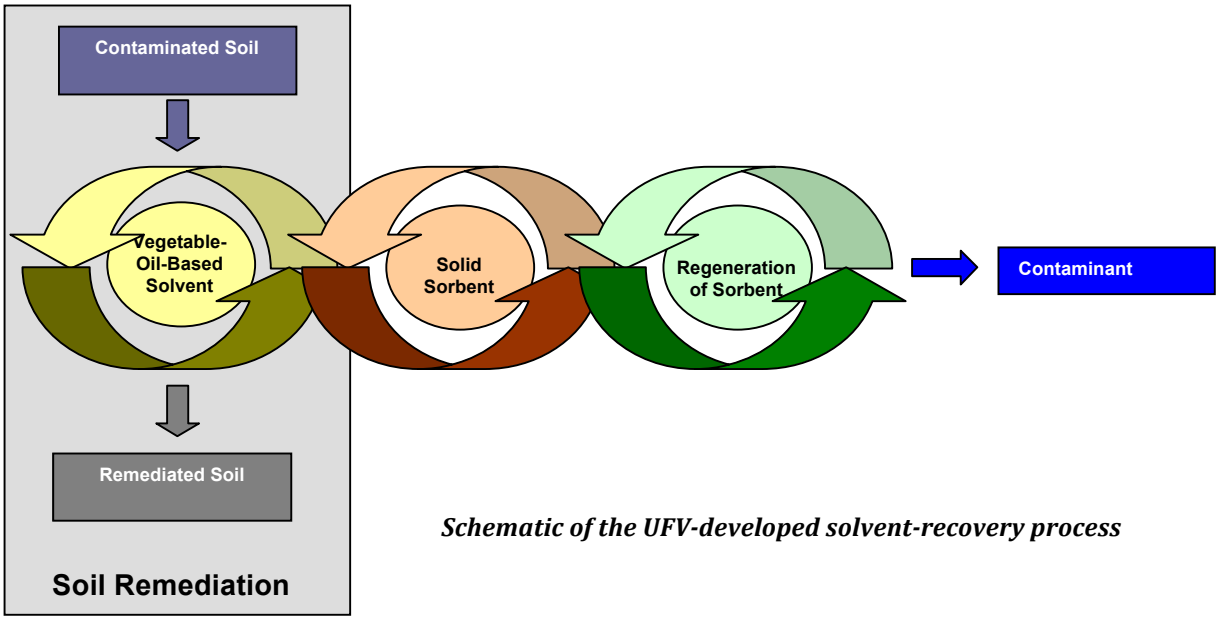
The experiments were designed and performed by a research team of four UFV undergraduate students – Heather Wiebe (project leader), Ashley Epp, Melissa Prachnau, and Whitney Wong, working under the supervision of Drs. David Fenske and Noham Weinberg. The project was supported by an NSERC Engage grant, and was conducted in partnership with Gentech Development Ltd., Abbotsford (Randy Brown, PresidentA schematic of the overall process including soil remediation and solvent recovery is shown below.



Schematic of the UFV-developed solvent-recovery process

In the first cycle, vegetable oil solvent is used to extract petroleum hydrocarbons from soil. In the second cycle, the contaminated solvent is treated with a sorbent (activated charcoal or molecular sieves), which extracts the contaminant and regenerates the solvent. In the third cycle, the sorbent is regenerated either by its treatment with a volatile organic solvent (activated charcoal) or through thermal recovery (molecular sieves). Both activated charcoal and molecular sieves proved efficient in extracting hydrocarbon contaminants from vegetable oil solvent. The efficiency of extraction was controlled by ultra-violet spectroscopy and high performance liquid chromatography. It has also been found that molecular sieves could be effectively regenerated by thermal treatment, since the sieves are thermally stable; whereas the hydrocarbon contaminant would either ignite or pyrolize/evaporate. When sieves were recovered by burning, a black, charcoal-like residue was deposited on their surface, which reduced their efficiency in the subsequent extraction cycles by 50%. However, when sieves were recovered by heating without ignition, their efficiency was restored to 100%. Since molecular sieves are inexpensive and can potentially be regenerated an unlimited number of times, they offer a simple and cost-efficient solution to the problem of regeneration of vegetable-oil-based environmentally friendly solvents.

Ignition of contaminated molecular sieves

For her leadership and a crucial contribution to the project, Heather Wiebe received a UFV Industry Liaison Award for Outstanding Undergraduate Research. She is currently a Ph. D. student at SFU. Ashley Epp and Melissa Prachnau are currently studying medicine at UBC.

Fresh sieves (left) and sieves regenerated by burning (right)