Soil Washing with Vegetable oil:
A Greener Solution to Land Availability Problems

***Ee Von Lau**, Suyin Gan, Hoon Kiat Ng*

Department of Chemical and Environmental Engineering
Faculty of Engineering

Introduction to PAH Contamination in Soil

Human activities such as open fires, engine exhaust emissions and manufactured gas plants by-products result in environmental issues primarily soil contamination. In the United States of America, there are an estimated total of 294,000 contaminated sites while in the United Kingdom, up to 100,000 sites have been listed as potentially dangerous due to past and present uses. One of the major contaminants of soil is polycyclic aromatic hydrocarbons (PAHs). Characterised by their high resistance to natural degradation and carcinogenic properties, PAHs are chemical compounds made up of more than two fused benzene rings (C_{12} – C_{24}) in a linear or clustered arrangement.

Traditional soil remediation approaches such as excavation and disposal to landfill or containment measures is no longer a viable option today due to problems with land resources and availability. Therefore, research on soil remediation has been focused heavily on the development of technologies which removes contaminants from soil without disrupting the land ecology to utilise contaminated land.

What is Soil washing?

Soil washing is one of the sustainable technologies at present to remove PAHs from soil. This technique is based on the concept of solid-liquid separation process whereby contaminants in soil dissolve into the wash solution and are subsequently removed from soil. At present, various toxic and costly solvent mixtures (dichloromethane, ethanol, methanol and toluene) are used as the wash solution.

Figure 1: Existing soil washing plants

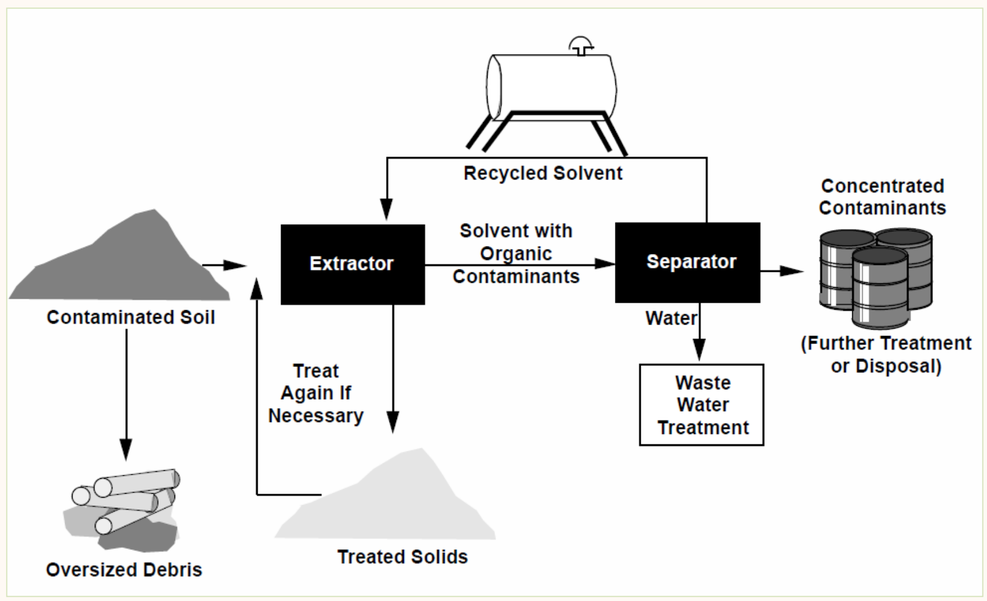


Figure 2: Schematic of soil washing process

Multiple-stage soil washing

In a multiple-stage soil washing process, the contaminated soil is repeatedly washed in the extractor using a limited quantity of fresh solvent at each stage.

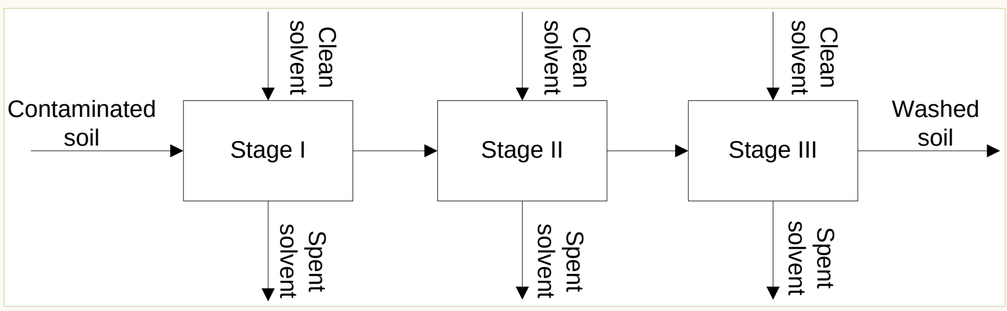


Figure 3: Schematic of multiple-stage soil washing process

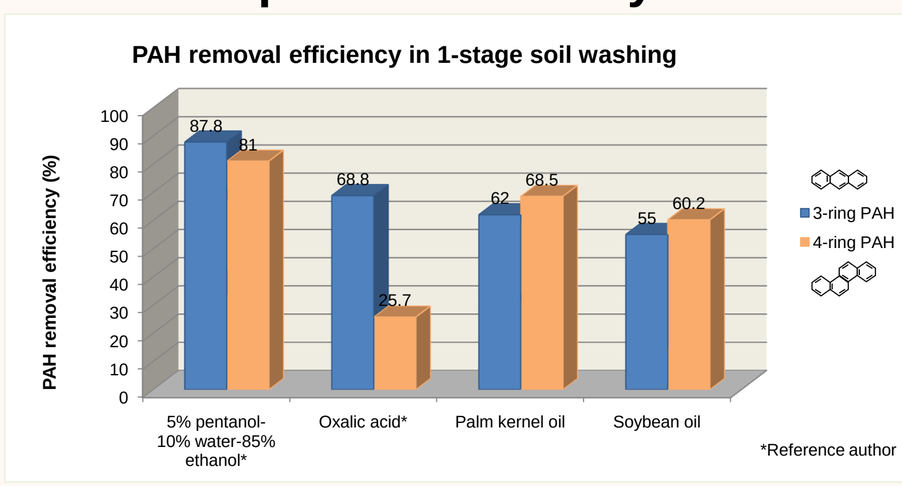
Experimental Study

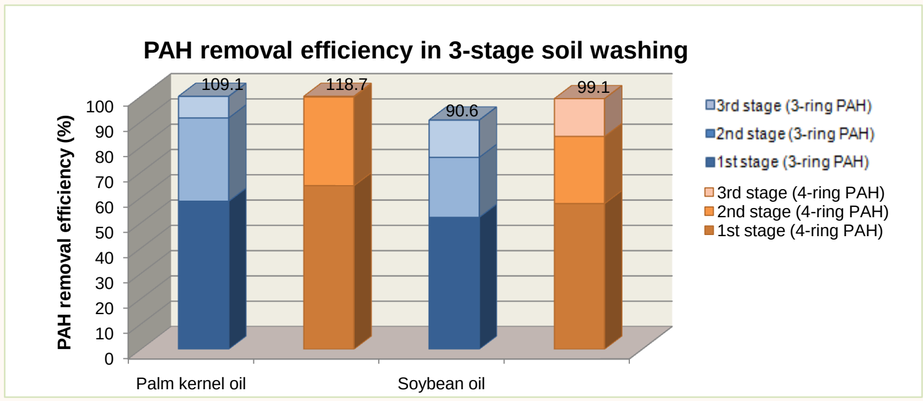
Soil washing was studied in laboratory-scale by placing PAH-contaminated sand/oil slurry in a mechanical shaker, set at a temperature of 30°C. The shaker agitates the sand/oil slurry for 24 hrs.

Figure 4: Sand/oil slurry

Figure 5: Mechanical shaker with temperature-controlled water bath

Results of Experimental Study





Conclusions

This study reveals that vegetable oil (palm kernel and soybean oil) are suitable candidates to replace conventional costly and toxic organic solvents in PAH-contaminated soil washing techniques, with > 90% of total PAH in soil removed in the 3-stage soil washing process.

The increased removal percentage of 4-ring PAH compared to 3-ring PAH is an added advantage since larger molecular weight PAHs are more carcinogenic and less desirable.

Residues of vegetable oil in soil after treatment may act as a growth substrate to soil microorganisms, providing an enhancement in biodegradation of other soil contaminants.