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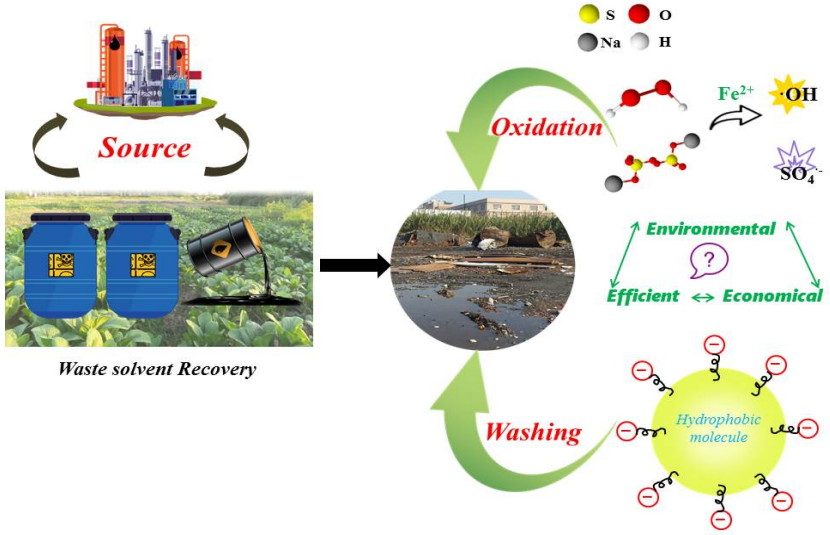
A comparative study of methods for remediation of diesel-contaminated soil

Key words:
total petroleum hydrocarbon;
chemical oxidation;
soil washing;
environmental risk;
soil remediation



BACKGROUND

- Confronted with several types of TPH-polluted soils, chemical oxidation, chemical washing, thermal desorption, bioventing, and other combined technologies have been put into practice.

- Taking the real-world application of different techniques into account, classical remediation methods, such as chemical oxidation and chemical washing, are frequently more welcome based on successful precedents.

- For oxidation method, Fenton/Fenton-like techniques and the increasingly prevalent activated persulfate oxidation technique have exhibited a benign remediation potential to eliminate diesel; water, anionic and non-ionic surfactants are common eluents for TPH-polluted soil.

- The extensive occurrence of soil pollution caused by TPH and its relevant derivatives has attracted attempts to seek or establish efficient, economical, and green remediation strategies to restore polluted sites.
- The object of this study was collected from waste solvent recovery-polluted sites.

METHOD

Treatment method	Influence factor	Fixed conditions
Fenton-like oxidation	Fe^{2+}:H_2O_2 molar ratio (1:10, 1:50, 1:100, 1:500)	Citric acid: 0.24 mmol g^{-1} H_2O_2: 6 mmol g^{-1} Treatment time: 5 d
Activated persulfate oxidation	Fe^{2+}:$Na_2S_2O_8$ molar ratio (1:10, 1:50, 1:100, 1:500)	$Na_2S_2O_8$: 2 mmol g^{-1} Treatment time: 5 d
DI water washing	Washing time (15, 45, 75 min)	Water volume (50 mL) Soil-to-liquid ratio (1:5/1:10/1:20)
	Soil- to-liquid ratio (1:5, 1:10, 1:20)	Water volume (50 mL) Washing time (15, 45, 75 min)
SDBS/Tween 80 washing	Washing agent concentration (2, 3, 4, 5 g L^{-1})	Soil-to-liquid ratio (1:20) Washing time (15, 30, 60, 90 min)
	Washing time (15, 30, 60, 90 min)	Soil-to-liquid ratio (1:20) Washing agent concentration (2, 3, 4, 5 g L^{-1})
	Soil-to-liquid ratio (1:10, 1:20, 1:25)	Washing time (60 min) Washing agent concentration (2, 3, 4, 5 g L^{-1})
Mixed agent washing	SDBS: Tween 80 ratio (1:4, 2:3, 1:1, 3:2, 4:1)	Total agent concentration (5 g L^{-1})

METHOD

ENVIRONMENTAL FRIENDLINESS ASSESSMENT

Literature investigation

COST ESTIMATION

Calculation based on local prices

RESULTS

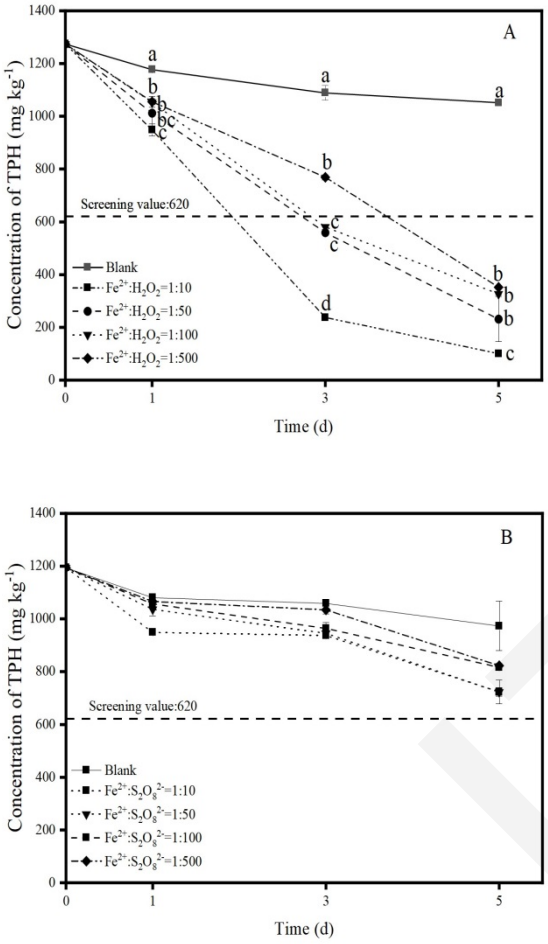


Fig. 1 Residual concentrations of TPH in spiked soil with chemical oxidation (A: effects of the Fe^{2+} to H_2O_2 molar ratio in Fenton-like oxidation; B: effects of the Fe^{2+} to persulfate molar ratio in activated persulfate oxidation). Different letters noted for the same time point in panel A represent a significant difference.

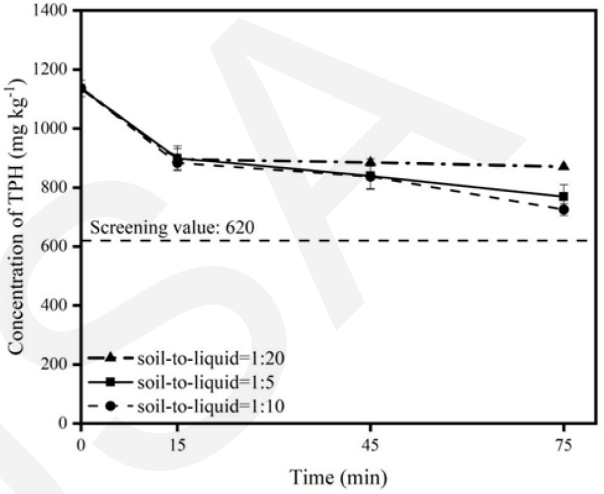


Fig. 2 Effects of the soil-to-liquid ratio and washing time on the removal of TPH from spiked soil by DI water washing.

RESULTS

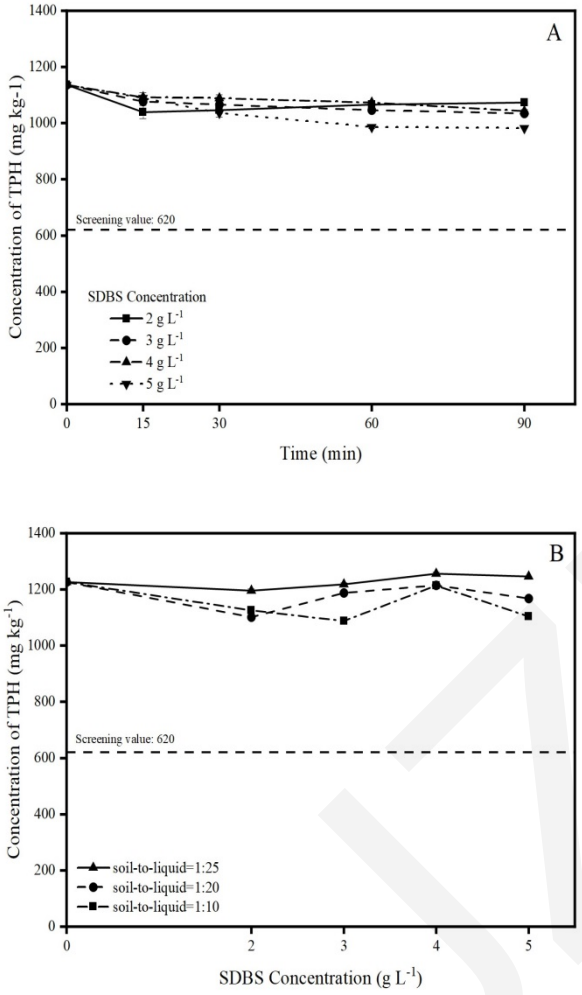


Fig. 3 A: effects of the washing agent concentration and washing time on the removal of TPH from spiked soil by SDBS washing; B: effects of the washing agent concentration and soil-to-liquid ratio on the removal of TPH in spiked soil by SDBS washing.

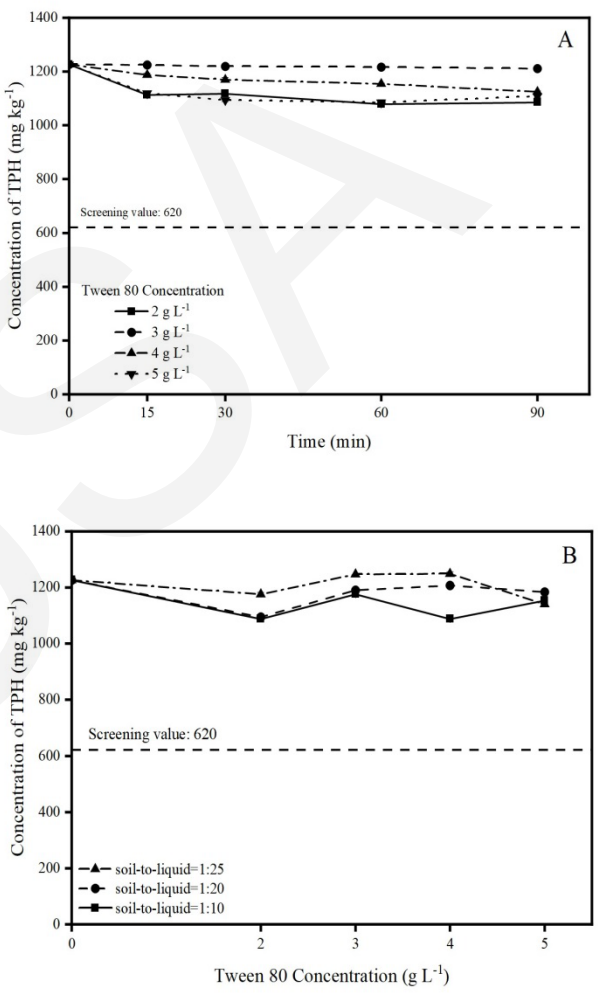


Fig. 4 A: effects of the washing agent concentration and washing time on the removal of TPH from spiked soil by Tween 80 washing; B: effects of the washing agent concentration and soil-to-liquid ratio on the removal of TPH from spiked soil by Tween 80 washing.

CONCLUSION

- Chemical oxidation tests found a drastic reaction generated by the Fenton-like process and a relatively mild and tardive process led by activated persulfate oxidation. Accordingly, the optimal oxidation treatment condition was a Fe^{2+}:H_2O_2 molar ratio=1:10.

- DI water washing was the most effective method for TPH removal.

- Only Fenton-like process could achieve the remediation goal based on the screening value, and DI water washing would be a better alternative for low-level TPH pollution (<916 mg kg^{-1}).

- Water washing (24.30 \$ t^{-1}) was considered as the best choice for polluted site remediation on account of its high efficiency as well as its environmental and economic superiority.

- The study provided a basic diesel-contaminated soil remediation pattern, and further study should be concentrated on seeking a balance between engineering, nature, and society.