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Electrokinetic remediation of contaminants of emergent concern in clay soil: Effect of operating parameters ☆

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Highlights

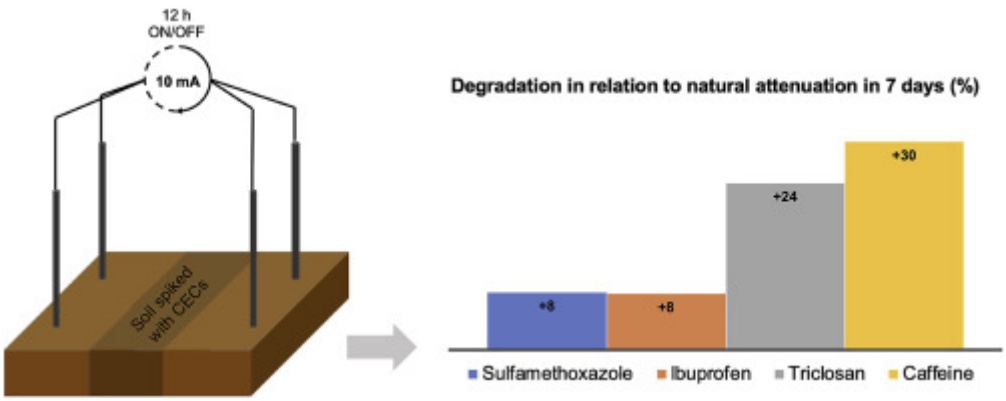
- EK-assisted remediation accelerated the decay of most CECs present in clay soils.
- Application of a unidirectional current stimulated the removal of biodegradable CECs.
- Caffeine decay with or without a constant current was negligible.
- Efficient caffeine removal was achieved under a unidirectional current with a 12 h void period.

- The design of an EK remediation strategy should target the least biodegradable contaminant.

Abstract

The potential of electrokinetic (EK) remediation to remove from soils one particular group of contaminants - contaminants of emergent concern (CECs), remains largely overlooked. The present study aimed to evaluate the efficiency of the EK process for the remediation of an agricultural clay soil containing CECs. The soil was spiked with four CECs - sulfamethoxazole, ibuprofen, triclosan and caffeine - and their status (*i.e.* residual amounts and spatial distribution) evaluated at the seventh day of EK treatment at a defined current intensity, directionality and duration of void period. The characterization of the soil physicochemical properties was also undertaken. The results showed similar degradation trends in all applied EK strategies, which were suchlike to that of the natural attenuation (biotic control): sulfamethoxazole > ibuprofen ≥ triclosan ≥ caffeine. The removal of the CECs was higher under a 10 mA constant current application than in the natural attenuation (up to 2.8 times higher; from 13 to 85%). Caffeine was the exception with its best removal efficiency being achieved when the ON/OFF switch mode with a void period duration of 12 h was used (36%). The use of electro-polarization reversal mode did not favour the remediation. The soil pH variations resulting from EK application were determinant for triclosan remediation, which increased with soil pH increase. The only EK condition that promoted the removal of all CECs was the ON/OFF switch mode of 12 h (removals between 36 and 72%), in which only minor physicochemical disturbances of the soil were observed. This is in accordance with a potential application of EK *in-situ*. The last is reinforced by the low estimated electrical cost of the best EK technology - 2.33 €/m^3 for the 7 days. Overall the EK remediation processes are a promising technology to stimulate *in situ* the removal of CECs from agricultural soils.

Graphical abstract



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Keywords

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