Chemical-Physical combined treatment of TPH contaminated marine sediments by using potassium ferrate

Marco Capodici[a], Daniele Di Trapani[a], Federica De Marines[a], Gaetano Di Bella[b], Riccardo Campo[b], Manuela Russo Tiesi[a], Giovanni Vinti[a], Gaspare Viviani[a]

[a] Dipartimento di Ingegneria, Università degli Studi di Palermo, Palermo, Italia
[b] Facoltà di Ingegneria e Architettura, Università di Enna "Kore", Enna, Italia

E-mail: marco.capodici@unipa.it

Total Petroleum Hydrocarbons (TPH) contaminated marine sediments treating represents a challenge as the solids composition as well as pollutants content strongly vary depending on the contamination of the source area. Among contaminants recovered in marine sediments, TPH frequently represents the main pollutant affecting port areas sediments [1]. Due to poor solubility of TPH in water such substances results persistent in the solid matrix as well as recalcitrant to conventional treatment process.

Conventional sediment washing treatments involve a double-stage process to remove TPH from marine sediments: a preliminary solubilization step by using surfactants in order to favor the enrichment of liquid phase in TPH content [2 – 3], and a further treatment step of the liquid phase by using chemical oxidant.

In order to overcome such conventional treatment scheme, the removal efficiency of a single stage treatment process was assessed in treating real marine sediments.

In details, real marine sediments derived from Augusta bay (Italy) with an initial TPH content measured close to 5000 mg/Kgss, were treated in stirred slurry reactors.

Experimental activities were carried out creating a slurry blend 1:5 mass on mass ratio. Chemicals used in order to remove TPH from the solid phase were Sodium Dodecyl Benzensulphonate (SDBS) and Potassium Ferrate. SDBS was used as surfactant to promote TPH solubilization while potassium ferrate (Fe(VI)) was used as oxidant. It is worth noticing that in this experimentation SDBS and Fe(VI) were simultaneously spiked in the slurry reactor thus allowing the one stage treatment. Furthermore it is useful highlighting that potassium ferrate is commonly used in drinking water treatments facilities due to the double effect of Fe(VI) that acting as oxidant leads to byproduct (Fe(III)) production that can act also as coagulants. Surfactant and oxidant combined efficiency was assessed varying the dosage of each chemicals in order to optimize the process. Experimental results showed a 50% TPH removal from solid phase by dosing 1.5% of Fe(VI) and 0.2% of SDBS.

References:

[1] M.Russo Tiesi et al., Role of mixed surfactants for hydrocarbons removal from real marine sediments: Removal efficiency and residual phytotoxicity after sediment washing treatment.Journal of Environmental Chemical Engineering 13 (2025) 119873

[2] F. De Marines, et al Remediation of a diesel contaminated soil by means of anionic and non-ionic surfactants: effect on soil phosphorus availability and vicia faba L. Growth. Sci. Total Environ. 958 (2025) 17799.

[3] D. Di Trapani et al, Surfactant-enhanced mobilization of hydrocarbons from soil: comparison between anionic and nonionic surfactants in terms of remediation efficiency and residual phytotoxicity. Process Saf. Environ. Prot. 180 (2023) 1–9.

Acknowledgement

This study was carried out within the RETURN Extended Partnership and received funding from the European Union Next-GenerationEU (National Recovery and Resilience Plan – NRRP, Mission 4, Component 2, Investment 1.3 – D.D. 1243 2/8/2022, PE0000005)