

Accepted Manuscript

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PII: S1383-5866(17)31147-4
DOI: <http://dx.doi.org/10.1016/j.seppur.2017.07.066>
Reference: SEPPUR 13923

To appear in: *Separation and Purification Technology*

Received Date: 11 April 2017
Revised Date: 24 July 2017
Accepted Date: 25 July 2017

Please cite this article as: P.P. Falciglia, G. De Guidi, A. Catalfo, G. Finocchiaro, M. Farina, M. Liali, G. Lorenzano, G. Valastro, F.G.A. Vagliasindi, Glycerol-enhanced microwave heating for ultra-rapid effective remediation of marine sediments highly contaminated with hydrocarbons, *Separation and Purification Technology* (2017), doi: <http://dx.doi.org/10.1016/j.seppur.2017.07.066>

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Glycerol-enhanced microwave heating for ultra-rapid effective remediation of marine sediments highly contaminated with hydrocarbons

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Abstract

In this study, a new enhanced MW heating treatment using glycerol was proposed and investigated in the remediation of marine sediments highly contaminated with hydrocarbons. The heating and contaminant removal performance of different treatments using varying glycerol doses were compared. The results showed that the addition of glycerol in sediments largely promoted the MW absorbing performance that corresponded to a large increase in temperature (up to ~120 °C) with a maximum sediment temperature of 342 °C. This allowed much faster contaminant removal kinetic to be obtained. A glycerol dose of 5% led to drastically lowered contaminant residual concentrations of 6454 (R = ~81%), 770 (R = ~98%) and 12 (R > 99%) mg kg⁻¹ after 3, 5 and 10 min, respectively, demonstrating that ~5 min were sufficient to reach the regulatory remediation target. A further dose increase (10%) led to a required time of 3 min (R > 99%), which corresponded to almost half of the MW energy required respect to the unenhanced MW. The main advantage of MW/glycerol treatment is the possibility to obtain a very rapid and effective decontamination process potentially reducing energy costs, also in the case of a very high initial hydrocarbon concentration, without producing additional by-products (respect to MW alone), which in some cases can be toxic. A comparison with other available clean-up alternatives revealed that literature does not report similar rapid and at the same time effective treatments for hydrocarbon-contaminated sediments.

Keywords: Glycerol, kinetic modelling, marine sediments, microwave heating, petrol hydrocarbons, severe contamination.

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