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Modelling of heat and mass transfer during in-situ microwave thermal treatment of polluted soils

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Traditional *ex-situ* soil remediation methods need high excavation and transportation costs and cause disturbance to the environment. New *in-situ* techniques are to be developed to reduce this cost while maintaining good remediation efficiency. Microwave heating remediation has been proved to be a high performance technique for the remediation of organic contaminated soils. Contrary to conventional Thermal Conduction Heating technique, the moisture plays an important role in the absorption of microwave and in the distribution of heat [1,3]. The simplicity, moderate cost, flexibility, short processing time [1], and efficiency for a large number of soil contaminants [2] can be cited as the advantages of the microwave heating remediation. The main objective of this study is to validate these benefits using a comprehensive comparison between microwave and conventional heating technique obtained in the same thermo-physical conditions.

A numerical model has been developed, using COMSOL Multiphysics[®], taking into account the coupled phenomena of electromagnetic heating, heat and mass transfers with phases changes in porous media. The model was used to simulate the remediation of a soil column contaminated with diesel fuel using microwave and electrical resistance energy, respectively. The simulation results show that for the same soil water content and energy consumption, heat transfer is faster for microwave heating compared to classical heat conduction case. The model will be then validated against ongoing experimental results. Eventually, the model will be used to simulate real cases remediation in order to improve the efficiency of the treatment processes, using parametrical study.

[1] P.P. Falciglia, A. Bonifacio, and F.G.A. Vagliasindi, Oil Gas Res 2: 110 (2016).

[2] R.A. Abramovitch, L. ChangQing, E. Hicks, and J. Sinard, Chemosphere 53 (2003).

[3] Y.C. Chien, J. Hazard. Mater., Journal of Hazardous Materials 199– 200 (2012).