World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:12, No:04, 2018

3D Numerical Modelling of a Pulsed Pumping Process of a Large Dense Non-Aqueous Phase Liquid Pool: In situ Pilot-Scale Case Study of Hexachlorobutadiene in a Keyed Enclosure

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Abstract : Remediation of dense non-aqueous phase liquids (DNAPLs) represents a challenging issue because of their persistent behaviour in the environment. This pilot-scale study investigates, by means of in situ experiments and numerical modelling, the feasibility of the pulsed pumping process of a large amount of a DNAPL in an alluvial aquifer. The main compound of the DNAPL is hexachlorobutadiene, an emerging organic pollutant. A low-permeability keyed enclosure was built at the location of the DNAPL source zone in order to isolate a finite undisturbed volume of soil, and a 3-month pulsed pumping process was applied inside the enclosure to exclusively extract the DNAPL. The water/DNAPL interface elevation at both the pumping and observation wells and the cumulated pumped volume of DNAPL were also recorded. A total volume of about 20m³ of purely DNAPL was recovered since no water was extracted during the process. The three-dimensional and multiphase flow simulator TMVOC was used, and a conceptual model was elaborated and generated with the pre/post-processing tool mView. Numerical model consisted of 10 layers of variable thickness and 5060 grid cells. Numerical simulations reproduce the pulsed pumping process and show an excellent match between simulated, and field data of DNAPL cumulated pumped volume and a reasonable agreement between modelled and observed data for the evolution of the water/DNAPL interface elevations at the two wells. This study offers a new perspective in remediation since DNAPL pumping system optimisation may be performed where a large amount of DNAPL is encountered.

Keywords : dense non-aqueous phase liquid (DNAPL), hexachlorobutadiene, in situ pulsed pumping, multiphase flow, numerical modelling, porous media
Conference Title : ICCGM 2018 : International Conference on Computational Geosciences and Mathematical Modelling
Conference Location : Venice, Italy
Conference Dates : April 12-13, 2018