THERMAL IN-SITU REMEDIATION OF LOW PERMEABLE SOILS

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Summary

To overcome the limitations of the soil vapour extraction, a thermal in-situ technique using local heat sources is developed and optimized which is generating soil temperatures higher than 100°C selectively in the contaminated subsurface.

Introduction

Conventional in-situ remediation techniques (e.g. SVE) are often ineffective for remediation of low volatile contaminants and heterogeneous soils with low permeability which have been contaminated by infiltration of contaminants over years. Due to low volatility of some hydrocarbons and other contaminants, successfull remediation can only be achieved with a thermal treatment technology capable of reaching temperatures higher than 100°C in the subsurface in order to vaporise and subsequently extract these pollutants. There is a necessity to develop and optimize a method which can generate temperatures at the required level selectively in the contaminated soil: local heat sources.

Results and Discussion

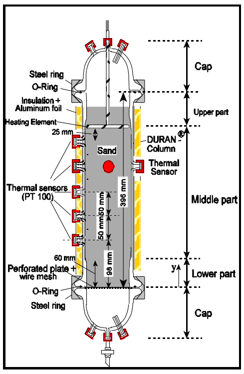

Fig. 1: column setup

The effect of permeability, water saturation and temperature of the heating element on the soil temperatures was studied. One-dimensional column experiments were performed with two homogeneous sand fillings of different permeabilities. coarse and fine sand, each either containing water at residual saturation or dry (Fig. 1). The heating element was shaped as a plate, located at the top of the sand filling and it was regulated such that its temperature remained constant during an experiment. The temperatures in the sand were measured with time by 8 thermocouples located at different levels in the column.

Results and Discussion

The results of one heat transport experiment with coarse sand is shown in Fig. 2. The heating element temperature was maintained at 300°C and the sand contained water at residual saturation.

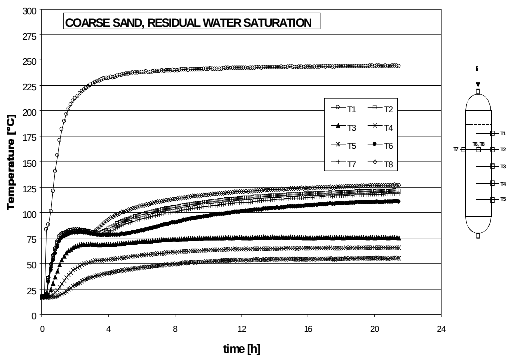

Fig. 2: Heat transport in coarse sand

It can be seen that the increase in temperatures can be divided into two phases (see Fig. 3): in phase I the main heat transfer occurs in the water film due to higher thermal conductivity. The water is vaporised and therefore the saturation decreased the faster the higher the temperatures become such that at the end of phase I the sand is dried completely.

After the region near the heating element is dried, phase II continues. Heat can only be transported by the soil grains themselves. Therefore the energy transport is limited by the low thermal conductivity of the dry sand near the heating element, even though the wet sand at the column bottom could transfer heat at a higher rate.

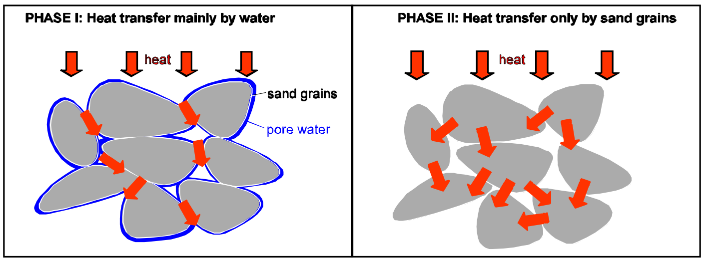

Fig. 3: Two phases of heat transport

Not only heat transfer characteristics are investigated, but also further studies of the physical processes and estimation of remediation efficiency. Numerical simulations are expected to lead to further understanding of the influence of a small change in water saturation, smaller permeability etc. on the heat and contaminant transport.

Literature

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