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Horizontal insulating barriers as a way to protect groundwater

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Protection of groundwater resources is a key challenge in 21st century. New technologies are crucial in order to prevent pollution not only close to urban settings with highly congested infrastructure, but also in the case of demanding topographical relief. Trenchless Technology of Forming Horizontal insulating Barriers (TFHB) can be considered as emergency and immediate groundwater protection against inflow of pollutants e.g. from hazardous landfill however, so far there is no insulating technology developed and approved, which would not require the displacement of waste.

Trenchless methods seem to be effective, however for the optimum solution the combinations of the numerous factors should be considered, including the materials and the geotechnical aspects.

One of the advantage of the developed TFBH technology in shallow groundwater aquifer is the injection of non-toxic, environmentally friendly modified water solution of sodium silicate. Composition and properties of sodium silicate gels applied, and the complex chemical reactions, leading to hydraulic conductivity reduction, determine the set of additives, which enable hybrid gelation mechanisms.

In TFHB technology, the working fluid (sodium silicate solution) and the gelling agent (carbon dioxide) are injected separately, using one tool, to different zones of the aquifer profile. Carbon dioxide, injected into the saturation zone, is raised by buoyancy forces and reaches the silicate, which was injected at the water table level. This initiates the process of silicate gelation, resulting in the formation of an insulating barrier of expected shape and size. For the technological purposes, the gelation time must be controlled, and the resulting gel must have certain mechanical properties.

The horizontal insulation barrier formed in the aquifer should have excellent insulating properties, durability and relatively small thickness. Moreover, formed barrier has to be environmentally friendly and relatively cheap. In order to apply THFB in real conditions it was necessary to identify important technological and technical parameters, indicate the optimal areas of commercial applicability this technology, as well as to define interactions of injected fluid with aquifer rocks. This clearly outlined the concept of conducted research work.

Geochemical modeling (equilibrium, reaction path and reactive transport) was used to identify potential geochemical effects of the application of the TFHB in sandy aquifers.

Certain petrophysical parameters and mineralogical assemblages of aquifers were addressed, taking into account both low and strongly mineralized groundwater.

The simulations revealed that the TFHB does not have negative impact on the chemistry of rock-water systems considered.

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