Form 2

Technology Information	
Area	(5) Management measures to block groundwater from flowing into the site ５．地下水流入制御の敷地管理
Title	**Solutions for sequestration or treatment of Sr in groundwater (AREVA 5-1)**
Submitted by	AREVA, SUEZ ENVIRONNEMENT and NUVIA

1. Overview of Technologies (features, specification, functions, owners, etc.)

Executive summary :

AREVA is currently developing specific ion exchanger for Sr adsorption. The solution describe thereafter are applied for conventional treatment of groundwater. We propose to use our specific development on Sr sorbent and our nuclear skills in two mastered solutions for groundwater remediation. The first one, applied successfully by SITA REMEDIATION (Suez Environnement Group) is a technology for sequestration of heavy metals pollutant by injection of a permeable reactive barrier. The second one is a treatment solution for groundwater belonging to NUVIA (Soletanche Freyssinet Group), using chemical filters along watertight walls.

First solution :

Injected Permeable Reactive Barrier – microscale Zero Valent Iron - msZVI

Functions:

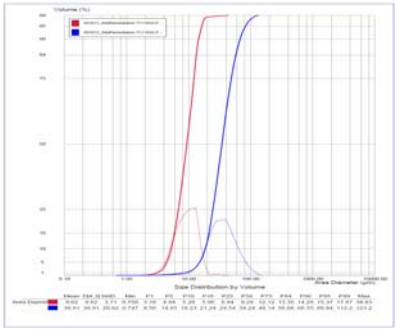
In situ chemical and chemical reduction groundwater treatment. Sequestration of radioactive elements in situ (groundwater treatment).

In anaerobic conditions and sulfate reduction, precipitation of heavy metals occurs.

Summary Description:

This technology consists in microscale zero valent iron injection. The particles of iron react with sulfate in groundwater to form sulfur S^{2-} and ferric oxyhydroxide (FeOOH). The main reactions are :

- Precipitation of stable components of sulfur-metals
- Adsorption on FeOOH surface



Microscale ZVI spécifications:

Biocatalyser F - microscale ZVI,

2 particle sizes are available for grouting application :

F15 (< 15µm) and F80 (< 80 µm)

Injection Specifications

➔ In low depths or in case of low permeability aquifers, soil mixing is possible (trench cutters, pilling machines), but this technology creates a very poor geotechnical soil.

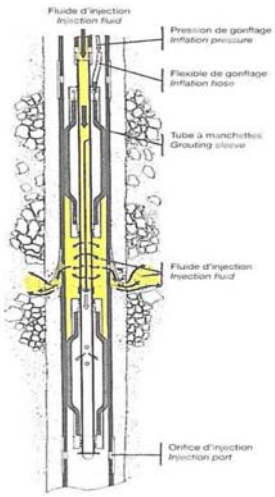
➔ In high depths or in case of high permeability aquifers (permeability $>10^{-4}$ $m.s^{-1}$), direct injection is possible.

- Sleeve-pipe sealing and hydraulic grouting

Sealing with bentonite-cement slurry

Hydraulic grouting press and equipment

- injection (equipment reuse or precise injection) : 1 sleeve each 33 cm & double packer



Examples of simple and double packers

AREVA will bring its long experience in the nuclear domain for :

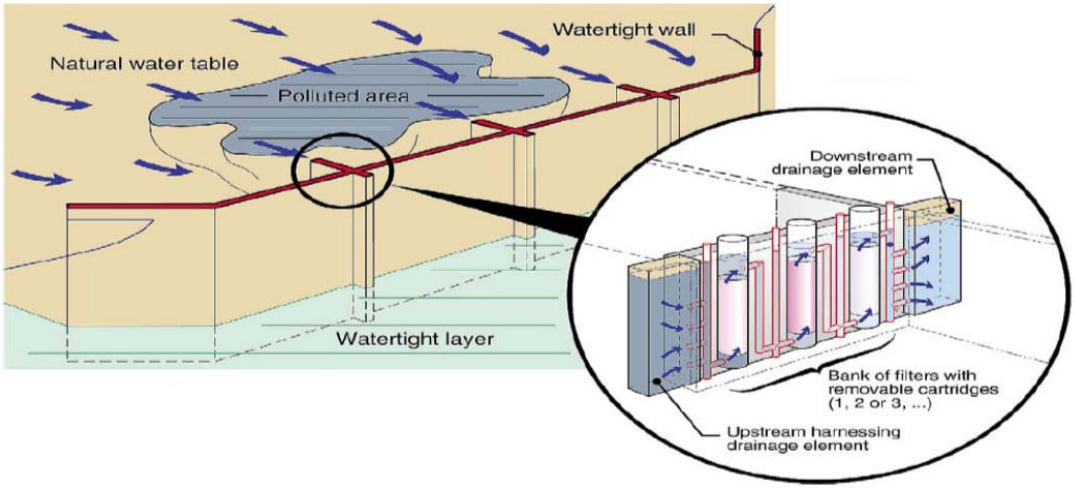
- The qualification of the process on Sr sequestration with active test of the solution in nuclear laboratory, lab and pilot scale, prototype and nuclearization,
- Looking for alternative chemical species for Sr sequestration (apatite for example)

Second Solution :

Groundwater treatment on high selective ion exchange materials in columns

Functions :

This solution of treatment for groundwater pollution is described in the diagram below :



The main elements are :

- Watertight walls including drainage and filters equipments,
- Treatment of the groundwater is realized with classical sorbents in removable cartridge.

Implementation of the groundwater treatment solution in conventional industry

AREVA is currently working on different columns technologies for reversible treatments (sorbent extraction or elution) or direct final storage solutions. Underground in line columns used in this solution will be removable and will include specific radioprotection. In parallel, new ion exchange inorganic materials (powder, grain or felt forms) are in development phases for Sr adsorption. The selection between the columns technologies and sorbents will be done from the data coming from the understanding of the groundwater flow (flow rates, RN and chemical species concentrations,…)

2. Notes (Please provide following information if possible.)

Technology readiness level (including cases of application, not limited to nuclear industry, timeline for application):

- The Injected Permeable Reactive Barrier – msZVI solution has more than 20 years of experience in the application of chlorinated solvents for groundwater remediation (chemical reduction). More details on http://battelle.org/media/battelle-conferences/chlorcon
- The treatment solution with permeable reactive barrier is currently used in conventional industry for groundwater pollution treatment.
- Sr sorbents exist or are currently in development. They have to be tested with the groundwater characteristics.

Challenges:

- Effect and performance of the presented technologies and sorbents on different radionuclides (can be developed and tested in AREVA inactive and active laboratories),
- Lifespan of ms-ZVI in salt water or high sulfate water contents,
- Development a specific selective sorbent for Sr in salt and sulfate water contents with an attractive economic point of view,
- Nuclearization of the ground water treatment solution in the Sr case.

Other (referential information on patent if any):