# Process, Arrangement and Plant for the clean-up of waters contaminated by chlorinated solvents, nitrates and sulfates.

### **KEYWORDS**

- REMEDIATION OF CONTAMINATED SITES
- CHLORINATED SOLVENTS
- NITRATE
- □ SULPHATE
- GROUNDWATER CIRCULATION WELLS
- □ IN SITU TECHNOLOGIES
- POLY-HYDROXYBUTYRATE

## AREA

ENERGY & ENVIRONMENT

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Patent Type Patent for invention.

#### **Co-Ownership**

Sapienza University of Rome 50%, IEG Technologie GMBH 25%, Sersys Ambiente 25%.

#### Inventors

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#### Industrial & Commercial Reference

The patent describes a process for the remediation of chlorinated solvents, nitrates and sulphates contaminated groundwater.

#### **Time to Market**

The process has been largely tested at a pilot scale and it is already adopted for the full scale industrial application.

#### Availability

Cession, Licensing, Research, Development, Experimentation, Collaboration, Start-up and Spin-off.



Fig. 1 Shaft connection detail - treatment unit.



Fig. 2 Positioning of treatment unit and connection with recirculating well.

## Abstract

The patent describes a novel chemicalphysical-biotechnological process for chlorinated solvent, nitrate and sulphate contaminated groundwater remediation. The process uses polyhydroxyalkanoate as a fermentable carbon source for the in situ stimulation of the biological degradation of contaminants. By using groundwater circulation wells, the distribution of reagents and the action onto the less reachable aquifer portions is enhanced with respect to the traditional systems. The process, already largely tested at the pilot scale, allows a significant acceleration of the remediation without the depletion of water resources and reduced waste generation.

#### **Publications**

- Pierro L., Papini M.P. et al. "Polyhydroxyalkanoate as a slow-release carbon source for in situ bioremediation of contaminated aquifers: From laboratory investigation to pilot-scale testing in the field". New Biotechnology, 37, pp. 60-68, 2017.
- Papini M.P., Majone E., Pierro L. et al. "First pilot test on the integration of GCW (groundwater circulation well) with ENA (enhanced natural attenuation) for chlorinated solvents source remediation". Chemical Engineering Transactions, 49, pp. 91-96, 2016.



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## Process, Arrangement and Plant for the clean-up of waters contaminated by chlorinated solvents, nitrates and sulfates.

## **Technical Description**

The patent describes a process for the in situ remediation of groundwater contaminated by chlorinated solvents, nitrates and sulphates without spoiling water resource.

The process is carried out by extracting contaminated water by means of a groundwater circulating well (GCW) and transferring it to an external treatment unit comprising a reactor containing the fermentable polymer and one with zerovalent iron for the removal of the extracted contaminants.

The fermentation products are re-injected through the GCW and the ammendants are efficiently distributed to stimulate the natural biological activity for the contaminant degradation directly in the aquifer.

The process allows to significantly accelerate the remediation especially at complex sites.

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Fig. 3 Detail of outdoor treatment unit.

#### **Technologies & Advantages**

field of the groundwater In contamination, chlorinated compounds are certainly recognized among the most dangerous contaminants because they are highly toxic, their presence is very widespread, they are persistent substances, often occurring as residual non-aqueous liquid form (DNAPL) and consequently may be present in groundwater at high concentrations for a long time. Typically, reclamation occurs in such cases through the socalled Pump & Treat systems, where contaminated water is extracted from the ground, treated in an external system and discharged into a different surface body. The patented process allows to significantly accelerate the reclamation time by directly acting on the contamination source without spoiling of the water resource and by stimulating degradation processes directly into the contaminated area. This is due to the simultaneous action induced by the recirculating wells along with the distribution of organic carbon on the ground and the removal of the extracted contaminants by zerovalent iron. The modular structure of the process allows it to be adapted to sources of different size and to reach areas hardly accessible to traditional systems.

#### Applications

The remediation of contaminated sites is one of the most important environmental emergencies in Italy and Europe where 3.5 million potentially contaminated sites are estimated, of which approximately 500,000 are likely to be remediated.

In Italy, there are 39 National Priority Sites whose reclamation is considered to be of great environmental importance and about 15,000 sites affected by less contamination that will need to be potentially recovered at around  $\in$  25-30 billion in the next 15 years.

Considering the significant presence of chlorinated solvents in contaminated sites, the potential patent application is particularly extensive and the process could significantly contribute to the recovery of abandoned industrial areas.



Fig. 4 Installation of unit of treatment.



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