2nd PhytoSUDOE Stakeholder Workshop
Tuesday 17th April 2018

Main Auditorium
Escola Superior de Biotecnologia, Universidade Católica Portuguesa

REMEDIATION TECHNIQUES: LANDFARMING WITH PLANTS, NANOPARTICLES AND CHEMICAL STABILIZATION

Albert SABANÈS. GEOAMBIENT – SERFIM GROUPE
Numbers in 2017

2,000 Employees

Annual turnover of 320 M€

Principal activity sectors:
- Environment
- Public works
- Industrial
- ICT

29 companies in 45 locations
Numbers in 2017

160 Employees

30 M€

8 Offices
(France, Spain & Tunisia)
INTERVENTS ON

- Soil and groundwater remediation
- Decontamination & asbestos removal
- Hazardous waste management
- Global management of non-hazardous waste landfills

AND PROVIDES

- An R+D cell and a test laboratory
- A design and construction center of treatment units
- Emergency action service
OUR CERTIFICATIONS

8 CERTIFICATIONS

IN FRANCE

ISO 9001
ISO 14001
MASE
QUALIBAT 1552
LNE SITES & SOLS POLLUES DOMAINE B
LNE SITES & SOLS POLLUES DOMAINE C

IN SPAIN

UNE EN ISO 17020
EC SOL Inspection
TRADEMARKS

- Bacteau®
- Roseaulix®
- Nanéau®
- Hybréau®
- Phytosol®
- Stabilisol®
- Facilab®
- Sécurisite®
- Chimexpert®
NEWS IN 2018
Acquisition of H20 TECHS, a company specializing in the treatment of industrial effluents and leachates.

Current & Future Projects:

- Management of industrial effluents from the YARA site - Le Havre
- Treatment of landfill leachates on Orange sites, St Etienne sur Chalaronne, Aix en Provence, ...
The process $\text{H}_2\text{Otechs}$

The result of an 18-year experiment, the H2Otechs process is based on an osmosis filtration technique that uses semi-permeable membranes that allow the passage of water while stopping salts but also organic fillers.

A solution for your effluents ...

Leachates, industrial water, the H2Otechs process makes it possible to answer all of your treatment problems including a study of reuse of treated water on site.

A tailor-made study ...

SERFIM DECONTAMIN. assists you completely from the characterization of your effluent to the on-site treatment.

An adapted on-site treatment ...

Simple to implement: mobile processing container.

From service delivery to the sale of units, all solutions are studied.

Laboratory / Field Pilot

Treatment container
Polluted soil treatment platforms and valorization in the cement industry

In 2018 we are working to operate in 3 different sites in NE, center and SE of France
2013-2018: **SILPHES** (DNAPL / dissolved - chlorinated solvents / INOVYN Tavaux site) - 3.5 M € (INOVYN, BRGM, CNRS / University, ...)
- Closure in progress / consolidation innovations SERPOL and partners (optimized DNAPL extraction / HYBREAU / Phytoscreening)

2015-2018: **3D FOAM** (blocking foam - chlorinated solvents) - 0.8 M € (RENAULT, IPB Bordeaux)
- Patent filing in progress ...

2016-2021: **BIOXYVAL** (HAP / ISCO Ferrates / ARCELOR MITTAL site) - € 5.5 million (GISFI, EODD, TAW, ...)
- In progress, CIFRE thesis

2017-2020: **FAMOUS** (TCB lindane / Foam blocking, sparging and vectorization reagents / Site SOLVAY Pont de Claix) - 1.3 M € (SOLVAY, IPB Bordeaux, UTINAM)
- In progress....
REMEDIATION TECHNIQUES: LANDFARMING WITH PLANTS, NANOPARTICLES AND CHEMICAL STABILIZATION
LANDFARMING WITH PLANTS

THE PLANTS DECONTAMINATING ENGINES FOR HYDROCARBONS

INNOVATIONS:
BIOLOGICAL TREATMENT AND ECONOMIC EFFICIENCY

Transforms non-hazardous waste to inert
Application by agricultural techniques on biopiles and landfarming
Effective in large or small surfaces and granular or cohesive soils
LANDFARMING WITH PLANTS

- It is an in situ/on-site process developed by the R&D department of Serfim Decontamination.
- The R&D project allowed selecting the most favorable and resistant plant to grow in contaminated soils, as well as selecting different bacteria depending on the type of contaminant.
- BIO Technique: To favor the development of the roots of plants and the development of hydrocarbon degrading bacteria.
- Applications: With or without landfarming - With or without bacteria, specially in big areas.
Landfarming with plants in Le Pontet (France)

- Initial phase for delimitation and excavation of contaminated soils.
- Initial concentrations of TPH ($C_6 - C_{40}$):
  - Maximum of 20,000 ppm (mg/kg)
  - Medium of 5,000 ppm
- Objective: Less than 2,000 ppm

- Landfarming preparation according to the available surface and batch treatment with a similar degree of contamination.
- Extension of seeds, nutrients and bacteria, according to these concentrations.
Initially 90% was non-hazardous waste
Round 5,000 m² contaminated area
Over 40,000 m³ successfully treated (Less than 500 ppm)
Lots of 100-150 m³ with monitoring every 3 months
Between 40 and 60 €/m³ treated
THE POWER OF NANOTECHNOLOGY FOR THE ENVIRONMENT

INNOVATIONS: EXTREME EFFICIENCY

Good results in chlorinated solvents and metals in high concentrations
Easy application of the nanoparticles in the focus or in the plume
High influence radius thanks to the polymer coating
NANOPARTICLES

Groundwater remediation in Prodem, Cornebarrieu.

Injection of Fe (0) nanoparticles in interface zone
NANOPARTICLES

- Chemical factory in activity
- Pollution plume at the property boundary
- Geology:
  - 0-2 m of fill
  - 2-5 m of sand and gravel
- Freatic level: about 3 m deep
- Permeability: 2 m / day
- TCE: from 0.5 to 8 mg / L
- Chrome VI: from 0.5 to 37 mg / L

Previous studies in our laboratory and at the site conclude that the injection should be done in the focus area, in 2 phases separate for a minimum of 6 months.

- First phase of intense action and wait for the response of the medium.
- Second stage of timely action in areas of high remaining concentrations.
- Injection in the piezometers of the focus area with a specific injection unit.
- Low pressure injections with concentration of Fe (0) nanoparticles between 1.8 and 2.1 g / L.
- Low flow injections, prolonged for several days. Hydraulic tests necessary to determine optimal injection flow.
- Periodic control of: pH, redox potential, O2, nitrates, sulfates, TCE and Cr VI.
Nano-Fe (0) propagation distance between 2.7 and 4.9 m, negligible mobility after dispersion.
Highly electronegative redox potential (up to -700 mV) for 4 months => representative of the reactive and reductive character of the nano-Fe (0)
Reduction of 89% to 98% of TCE levels without vinyl chloride+DCE production.
Total reduction of chromium VI.
No rebound effect so far.
ADDITIVES FOR BLOCKING CHEMICALLY CONTAMINANTS

INNOVATIONS: VALORIZATION AND ECONOMIC EFFICIENCY

Transforms hazardous waste to inert
Variety of additives, including mixtures and byproducts
Application by agricultural techniques - In situ / On site
Precise dosage and adjusted to concentrations - Specific machine
Environmental rehabilitation of an industrial site in Malgrat de Mar (BARCELONA)

Chemical stabilization of pyrites ashes charged with metals

- SEVESO factory in activity in on plot of 5 ha (+ 100 employees)
- Mediterranean sea at 50 m
- Downtown at 300 m
- From 1952 to 1968, production of sulphuric acid from pyrite
- Geology: sands over 10 m
- Groundwater 3 m depth
SOIL STABILIZATION

- Pyrites ashes stored on 2 ha
- 0.8 m medium thickness, up to 2.5 m at certain points
- Maximum concentrations in soils:
  \[ \text{As} = 14,000 \quad \text{Pb} = 38,000 \text{ mg/kg} \]
  Other metals: Cd-Zn-Hg
- Metal leaching by rainwater
  Concentration \( \text{As/Pb} \) up to 10,000 \( \mu \text{g/l} \)

Monitoring and control for HSE and quality validations

<table>
<thead>
<tr>
<th>Metal</th>
<th>Remaining soil (mg/kg)</th>
<th>Leaching (( \mu \text{g/l} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>94</td>
<td>60</td>
</tr>
<tr>
<td>Pb</td>
<td>4700</td>
<td>150</td>
</tr>
</tbody>
</table>
SOIL STABILIZATION

- Tractability testing at lab and on site
- Geotechnical study to implementation of pilings
- Excavation and sorting for extension before stabilizing
- Laboratory facility on site for treatment control
- Dust management
- Establishment of a waterproof three-layer covering
SOIL STABILIZATION

- Excavation / classification of pyrites ash
- Extension (500 to 1000 m³)
- Zoning and initial characterization
- Stabilization No. 1 with pre-set dosage
- New characterization
- Stabilization No. 2 if necessary with specific dosage
- Characterization for final validation
Initially 90% was hazardous waste
Finally 50% is inert + 50% is non-hazardous waste
16,500 m³ pyrite ash treated with 100% validated
250 tons of byproduct valued as additive
More than 300 m³ valued at the work.
470 tons of various waste recycled
12 month and under 1 M€ for soil stabilization
THANK YOU VERY MUCH FOR YOUR ATTENTION

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