In situ biological treatment of nitrate-polluted groundwater for drinking water production

LIFE12 ENV/ES/000651

insitrate.ctm.com.es

I. Jubany[1], M. Calderer[1], J. Espí[1], F. Clarens[1], E. Vilanova[2], J. Font-Capo[2], J. Molinero[2], B. Medina[2], R. Grau[3], E. Pintó[3], M. Rovira[1]

[1]Fundació CTM Centre Tecnològic. Plaça Ciència, 2. 08243-Manresa (Spain), irene.jubany@ctm.com.es
[2]Amphos 21 Consulting S.L. Ps. Garcia i Faria, 49. 08019-Barcelona (Spain)
[3]Catalana de Perforacions. P.I. Sta Anna, 4.2. 08251-Santpedor (Spain)

INTRODUCTION AND OBJECTIVES

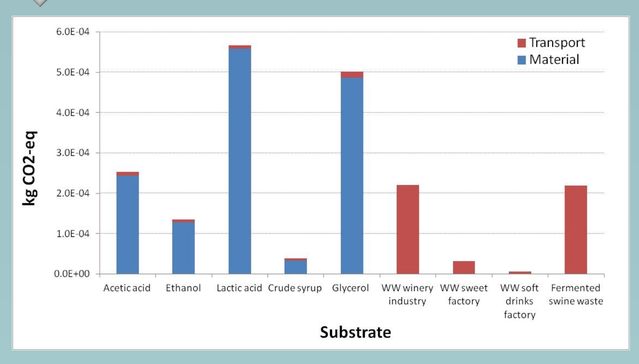
The LIFE+ InSiTrate project aims to demonstrate the potential of an in-situ biological treatment technology for tackling groundwater pollution from nitrates. The technology will be used to restore groundwater quality and to improve the safety of drinking water in wells, especially for small communities that do not have access to other freshwater sources.

Within the project an in-situ bioremediation strategy will be implemented at Sant Andreu de Llavaneres (Catalonia, Spain). The selected implementation site is a representative aquifer of the Catalan coastal area with averaged nitrate concentrations of 80 mg/L in the last years. Within this work, the proper design of the in-situ bioremedation strategy is presented. First, the optimal organic substrate for enhance biological removal of nitrate was selected taking into account environmental, economic and technical criteria. Secondly, a numerical model considering the site hydrogeology was developed to define the configuration of the in-situ denitrification plant.

ORGANIC SUBSTRATE SELECTION

23 potential organic substrates identified
(8 commercial products, 3 by-products, 12 wastes)

Life Cycle Assessment (LCA)
&
Life Cycle Cost Analysis
(LCC)



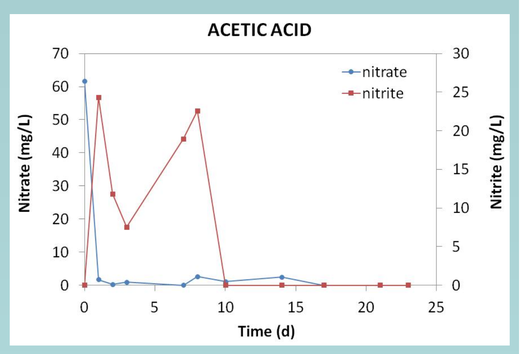
5 substrates for technical evaluation at lab scale:
molasses, acetic acid, glycerol, glucose, WW from fruit juice factory

COLUMN EXPERIMENTS

Temperature: 20ºC

Feed: groundwater +
29 mg/L organic carbon

Flow: 7 mL/h



SUBSTRATE	TECHNICAL PERFORMANCE AT LAB SCALE
Molasses	Good denitrification efficiency
Glucose	Decrease denitrification efficiency with time
Glycerol	Incomplete glycerol biodegradability
WW from fruit juice factory	Good denitrification efficiency
Acetic acid	Good denitrification efficiency

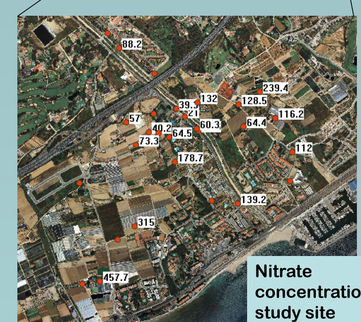
Acetic acid selected for in-situ pilot denitrification tests

DENITRIFICATION PLANT CONFIGURATION

Site characterization:

- Hydrological study (pumping and tracer tests)
- Piezometric maps
- Nitrate monitoring
- Construction of a prospection well

Prospection well



Nitrate concentration at the study site

NUMERICAL MODEL

Geochemical + hydrodynamic (Comsol multiphysics + PhreeqC)

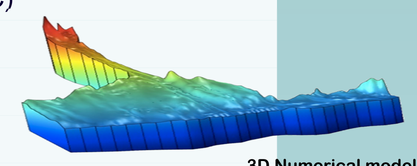
3D: between -50 y 156 masl

Dimensions: 4535 x 2720 m (3,8 km²)

Mesh: 3.500.000 tetrahedra

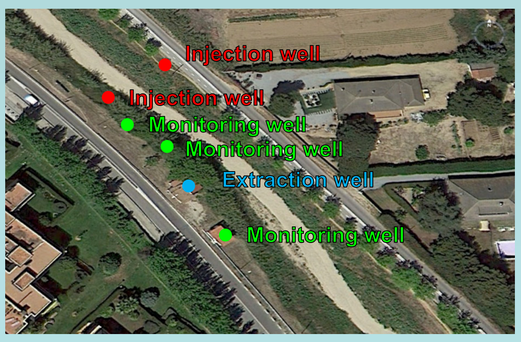
The model simulates quaternary coastal materials from slope and valley bottom

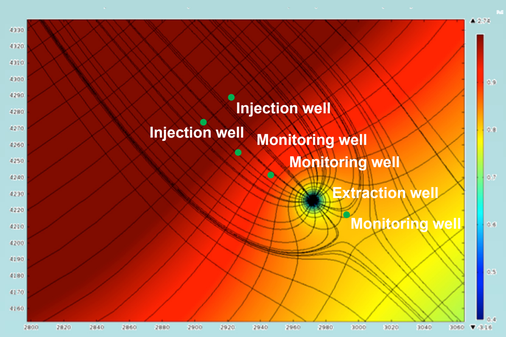
2 K zones: alluvial from the stream (2.25 m/d) and the rest of the model (17 m/d)



3D Numerical model

In-situ remediation strategy at the study site





Hydrological model and wells position

CONCLUSIONS

✓ Acetic acid was selected for in situ denitrification at the study site taking into account environmental, economic and technical criteria.

✓ Site characterization was conducted to properly feed numerical model

✓ A 3D numerical model was developed considering the reactive transport of contaminants

✓ The model was used to define the bioremediation strategy at the study site

The research leading to these results has received funding from the European Community's Life + Programme under grant agreement **LIFE12 ENV/ES/000651**