Newsletter

№ 7 / December 2020

Life ALCHEMIA

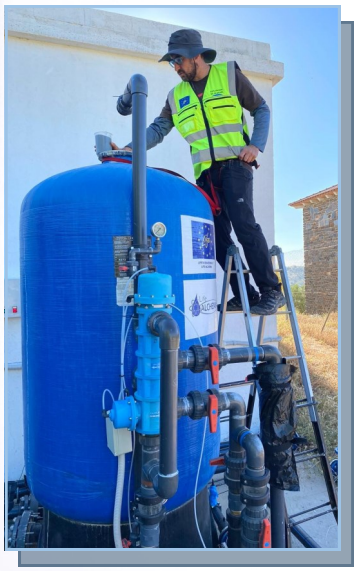
With the contribution of the LIFE Programme of the European Union

LIFE16 ENV/ES/000437

ACTIONS COMPLETED

THE PILOT PLANTS OF THE PROVINCE OF ALMERIA AGAIN IN OPERATION

After the three pilot plants in the province of Almería were stopped due to the state of alarm by Covid-19, technicians from the **Diputación de Almería** and **CIESOL** managed to resume the operation of the pilot plants again. Carrying out previously, maintenance and cleaning operations of the filters. As well as some modifications of the operating conditions.



END OF OPERATION OF THE VIIMSI PILOT PLANT (ESTONIA)

Last September the Viimsi pilot plant completed operating tasks after two years in operation.

The **University of Tartu** and **Tallin University of Technology** are carrying out the analysis of all the results obtained. A preview of these results:

- Elimination of Radium isotopes around 90%.
- Radionuclide accumulation rates in the filters much lower than in the filters of the system that is currently operating in the Viimsi ETAP.

The main results obtained will be published on the project website.

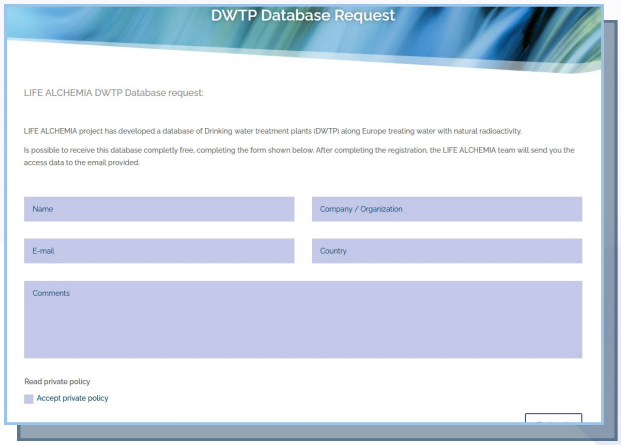
ACTIONS COMPLETED

DATABASE OF EROPEAN DWTP$_S$ TREATING WATER WITH NATURAL RADIOACTIVITY

The updating of the database developed in the framework of the project is being finalized.

The database has information from 12 European countries.

To Access the database, it is necessay to **request access** to the LIFE ALCHEMIA team through a short form available on the project website.



READ MORE

EXTENDING THE DATE OF COMPLETION OF THE PROJECT

EASME has accepted a 9 month extension of the project end date, scheduled for December 2020. The **new project end date** is September 2021.

ACTIONS COMPLETED-DISSEMINATION

IX RESEARCH IN EXPERIMENTAL SCIENCES SYMPOSIUM

Our partners from **CIESOL-UAL** and Diputación of Almería participated in the poster session of the IX Research in experimental sciences Symposium which was held online the last November.

Two posters were presented in the section dedicated to biotechnology and industrial bioprocesses.

Removal of iron and uranium in groundwaters through catalytic filter beds of iron oxide and magnesium oxide

M. Guadalupe Pinna-Hernández [1]*, José Luis Casas López[1], Isabel Rodríguez Ruano [2] and F. Javier Martínez Rodríguez [2]

*e-mail:gpinnahernandez@ual.es

[1] Solar Energy Research Centre (CIESOL), Joint Centre University of Almería-CIEMAT, Almería, 04120, Spain

[2] Provincial Government of Almería, Calle Navarro Rodrigo 17, 04001 Almería, Spain

Introduction

The LIFE ALCHEMIA project (LIFE16 ENV/ES/000437) faces one of the current challenges in the treatment of water for human consumption, such as the presence of natural radioactivity.

This is an environmental problem that cannot be solved at source, since it is generated by the dilution of minerals rich in radioactive isotopes in groundwater, mainly by the Uranium (U), Radium (Ra) and Thorium (Th) decay series.

Therefore, new systems capable of providing a sustainable elimination of radioactivity from the point of view of environmental and economic sustainability are needed.

The objective of the LIFE ALCHEMIA (LIFE16 ENV/ES/000437) project is to demonstrate the technical and economical viability of sustainable technologies using catalytic filter beds to remove the natural radioactivity in groundwater and thus be able to be used subsequently for urban uses, always ensuring compliance with the legislation in force.

The filtering bed materials in pilot plants are manganese oxide coated zeolites, but there are other materials that could be considered (iron oxide and manganese oxide) and which are analyzed in this work.

Image 1. Catalitics material (zeolites coated manganese oxide)

Objective

The objective of this work is the study of the filtering and adsorption process of two different catalytic materials composed of magnesium oxide (80%), CaO (10%) and metal-free elements (10%), the first one, and iron oxide (iron oxide minerals, FeO(OH)) the second one, to reduce natural radioactivity and possible cation interferences in groundwater from two different locations.

Materials, methods and tests

Lab-scale discontinuous tests (**Table 1**) were carried out with iron oxide and magnesium oxide materials, considering two different water locations to be treated. In the case of magnesium oxide, two particle sizes were used (2-5 and 5-8 mm).

During the tests, in situ measurements (**Image 2**) of pH, redox potential, conductivity, turbidity and gamma radiation were carried out. Samples were taken during each test every 0, 6 and 20 minutes, to be able to measure values of cations and anions by ion chromatography, and iron and uranium by ICP-M

	Particle diameter (mm)	Location	Nº tests
Magnesium oxide	5-8	1	6
		2	6
	2-5	1	3
		2	3
Iron oxide	Solid granules (0.5-2)	1	3
		2	3

Table 1. Experimental plan

Image 2. Measurement equipments

Image 3. Tests with magnesium oxide material

Image 4.Iron oxide materials (A) and magnesium oxide material (B)

Results and conclusions

The tests with magnesium oxide materials were carried out with two particle diameters (2-5 mm and 5-8 mm) and two different water extraction points. The best results were obtained with particles of 2-5 mm diameter (**Figure 1.A**) with good percentages of reduction of uranium (74.60%) and iron (99.46%) in location 1 (water rich in anions and cations). The best reduction percentages of uranium (93.13%) were obtained with the magnesium oxide material and the water from location 2 (**Figure 1.B**). It is important to remark that the uranium present in the raw water type 2 (43 mg / L) is higher than in type 1 (13 mg / L).

Regarding the results obtained with the iron oxide material, have been satisfactory in water 1 (**Figure 2.A**) with a 39.18 and 94.94% reduction in uranium and iron. For water 2 (**Figure 2.B**), uranium reduction percentages of 50.30% and 75.36% of iron were obtained.

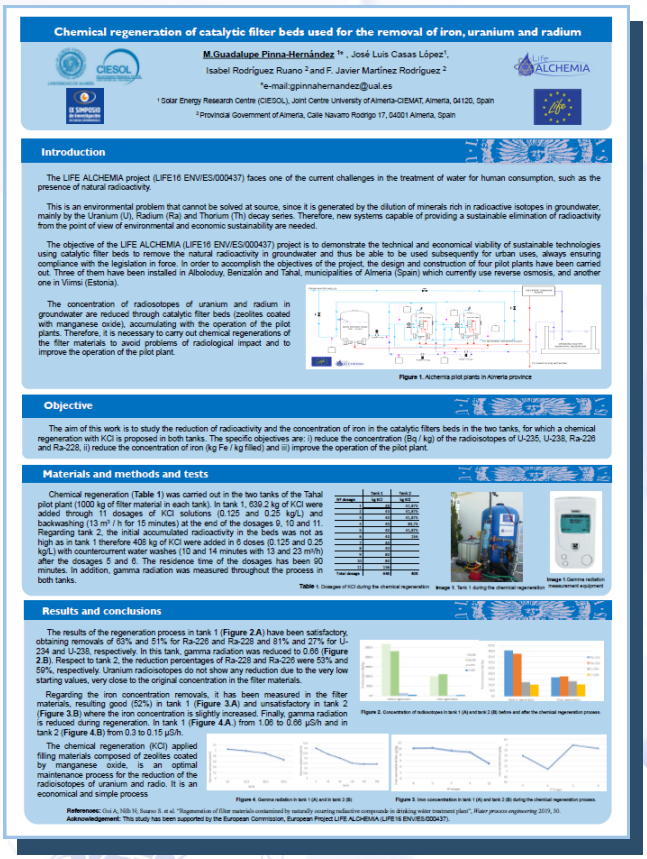
The best results for reducing iron and uranium have been obtained with the magnesium oxide material with a particle diameter of 2-5 mm, nevertheless, due to the liberation of magnesium cations, subsequent treatment to reduce the concentration of these ions is needed.

Figure 1. Removal of iron and uranium during the tests carried out with the magnesium oxide material (2-5 mm) in water 1 (A) and in water 2 (B)

Figure 2. Removal of iron and uranium during the tests carried out with the iron oxide material in water 1 (A) and in water 2 (B)

References: Mohamed Soliman Nagar, Abdou Ali Abdou * and Reda Abdel shaheed Ghazala, "Removal of Radium from Uranium effluent by Manganese Oxide coated Modified bentonite. Mediterranean Journal of Chemistry 2018, 7(2), 105-114.

Acknowledgement: This study has been supported by the European Commission, European Project LIFE ALCHEMIA (LIFE16 ENV/ES/000437).



Chemical regeneration of catalytic filter beds used for the removal of iron, uranium and radium

M.Guadalupe Pinna-Hernández [1]*, José Luis Casas López[1], Isabel Rodríguez Ruano [2] and F. Javier Martínez Rodríguez [2]

*e-mail:gpinnahernandez@ual.es

[1] Solar Energy Research Centre (CIESOL), Joint Centre University of Almería-CIEMAT, Almería, 04120, Spain

[2] Provincial Government of Almería, Calle Navarro Rodrigo 17, 04001 Almería, Spain

Introduction

The LIFE ALCHEMIA project (LIFE16 ENV/ES/000437) faces one of the current challenges in the treatment of water for human consumption, such as the presence of natural radioactivity.

This is an environmental problem that cannot be solved at source, since it is generated by the dilution of minerals rich in radioactive isotopes in groundwater, mainly by the Uranium (U), Radium (Ra) and Thorium (Th) decay series. Therefore, new systems capable of providing a sustainable elimination of radioactivity from the point of view of environmental and economic sustainability are needed.

The objective of the LIFE ALCHEMIA (LIFE16 ENV/ES/000437) project is to demonstrate the technical and economical viability of sustainable technologies using catalytic filter beds to remove the natural radioactivity in groundwater and thus be able to be used subsequently for urban uses, always ensuring compliance with the legislation in force. In order to accomplish the objectives of the project, the design and construction of four pilot plants have been carried out. Three of them have been installed in Alboloduy, Benizalón and Tahal, municipalities of Almería (Spain) which currently use reverse osmosis, and another one in Viimsi (Estonia).

The concentration of radioisotopes of uranium and radium in groundwater are reduced through catalytic filter beds (zeolites coated with manganese oxide), accumulating with the operation of the pilot plants. Therefore, it is necessary to carry out chemical regenerations of the filter materials to avoid problems of radiological impact and to improve the operation of the pilot plant.

Figure 1. Alchemia pilot plants in Almería province

Objective

The aim of this work is to study the reduction of radioactivity and the concentration of iron in the catalytic filters beds in the two tanks, for which a chemical regeneration with KCl is proposed in both tanks. The specific objectives are: i) reduce the concentration (Bq / kg) of the radioisotopes of U-235, U-238, Ra-226 and Ra-228, ii) reduce the concentration of iron (kg Fe / kg filled) and iii) improve the operation of the pilot plant.

Materials and methods and tests

Chemical regeneration (**Table 1**) was carried out in the two tanks of the Tahal pilot plant (1000 kg of filter material in each tank). In tank 1, 639.2 kg of KCl were added through 11 dosages of KCl solutions (0.125 and 0.25 kg/L) and backwashing (13 m^3 / h for 15 minutes) at the end of the dosages 9, 10 and 11. Regarding tank 2, the initial accumulated radioactivity in the beds was not as high as in tank 1 therefore 408 kg of KCl were added in 6 doses (0.125 and 0.25 kg/L) with countercurrent water washes (10 and 14 minutes with 13 and 23 m³/h) after the dosages 5 and 6. The residence time of the dosages has been 90 minutes. In addition, gamma radiation was measured throughout the process in both tanks.

Table 1. Dosages of KCl during the chemical regeneration

Image 1. Tank 1 during the chemical regeneration

Image 1.Gamma radiation measurement equipment

Results and conclusions

The results of the regeneration process in tank 1 (**Figure 2.A**) have been satisfactory, obtaining removals of 63% and 51% for Ra-226 and Ra-228 and 81% and 27% for U-234 and U-238, respectively. In this tank, gamma radiation was reduced to 0.66 (**Figure 2.B**). Respect to tank 2, the reduction percentages of Ra-228 and Ra-226 were 53% and 59%, respectively. Uranium radioisotopes do not show any reduction due to the very low starting values, very close to the original concentration in the filter materials.

Regarding the iron concentration removals, it has been measured in the filter materials, resulting good (52%) in tank 1 (**Figure 3.A**) and unsatisfactory in tank 2 (**Figure 3.B**) where the iron concentration is slightly increased. Finally, gamma radiation is reduced during regeneration. In tank 1 (**Figure 4.A**.) from 1.06 to 0.66 µSi/h and in tank 2 (**Figure 4.B**) from 0.3 to 0.15 µSi/h.

The chemical regeneration (KCl) applied filling materials composed of zeolites coated by manganese oxide, is an optimal maintenance process for the reduction of the radioisotopes of uranium and radio. It is an economical and simple process

Figure 2. Concentration of radioisotopes in tank 1 (A) and tank 2 (B) before and after the chemical regeneration process.

Figure 4. Gamma radiation in tank 1 (A) and in tank 2 (B)

Figure 3. Iron concentration in tank 1 (A) and tank 2 (B) during the chemical regeneration process.

References: Gui A, Nils N, Soares S. et al. "Regeneration of filter materials contamined by naturally occuring radioactive compounds in drinking water treatment plant", *Water process engineering* 2019, 30.

Acknowledgement: This study has been supported by the European Commission, European Project LIFE ALCHEMIA (LIFE16 ENV/ES/000437).

READ MORE

NEXT ACTIONS

- **REPLICATION STUDIES of ALCHEMIA technology.**
- **2nd project promotional VIDEO** with the main results.
- **MONITORING** of the environmental **INDICATORS** and the socio-economic impact of the project.
- **4th MONITORING MEETING** with **NEEMO.**
- **EVENTS:**

Seminar of the Almeria pilot plants. June 2021. Almería (Spain).

Follow us though: **www.lifealchemia.eu**

@lifealchemia

www.facebook.com/Lifealchemia

Life ALCHEMIA

CENTRO TECNOLÓGICO CARTIF

DIPUTACIÓN DE ALMERÍA

TALLINN UNIVERSITY OF TECHNOLOGY

VIIMSI VESI

UNIVERSIDAD DE ALMERÍA

CIESOL
SOLAR ENERGY RESEARCH CENTER
JOINT CENTER UAL - PSA CIEMAT

UNIVERSITY OF TARTU
1632

www.lifealchemia.eu

LIFE16 ENV/ES/000437

With the contribution of the LIFE Programme of the European Union