

LAYMAN's REPORT



“LIFEPOSITIVEMgOFGD”

New Desulfurization Technology for SO_x Reduction with Positive Net Environmental Impact Based on MgO Reagents



LIFE15 ENV/GR/000338

Co-funded
by EU's LIFE Programme



GRECIAN MAGNESITE
MINING INDUSTRIAL SHIPPING AND COMMERCIAL SA

I. THE PROJECT

LIFEPOSITIVEMgOFGD project is about the design, construction and operation of a novel air pollution abatement process which reduces the sulphur oxide levels in industrial flue gas emissions.

Project Duration: 1/7/2016 - 31/12/2019

Total project budget: 2,333,817 €

Total eligible project budget: 1,882,818 €

EU/LIFE financial contribution: 1,129,690 €

Website: www.betterlife-withmgo.eu

LIFEPOSITIVEMgOFGD



The process targets a positive net environmental impact: a sustainable energy, water and cost - efficient approach generating higher added value by-products compared to other abatement technologies. The pilot plant is located in the Region of Central Macedonia, Halkidiki, Yerakini Mine Site.

The sole beneficiary is the GRECIAN MAGNESITE, a privately-owned mining and industrial company established in 1959. The company produces and commercializes Caustic Calcined Magnesia, Dead-burned (Sintered) Magnesia, Magnesium Carbonate (Raw Magnesite) and Basic Monolithic Refractories. GRECIAN MAGNESITE ranks among the top magnesia producers and exporters in the world with a very wide spectrum of grades and applications served.

www.grecianmagnesite.com

The environmental problem

Burning of fossil fuels produces flue gases rich in Sulfur Oxides (SO_2 and SO_3 or SO_x) which are emitted in the atmosphere along with other pollutants. SO_x can affect both health and the environment.

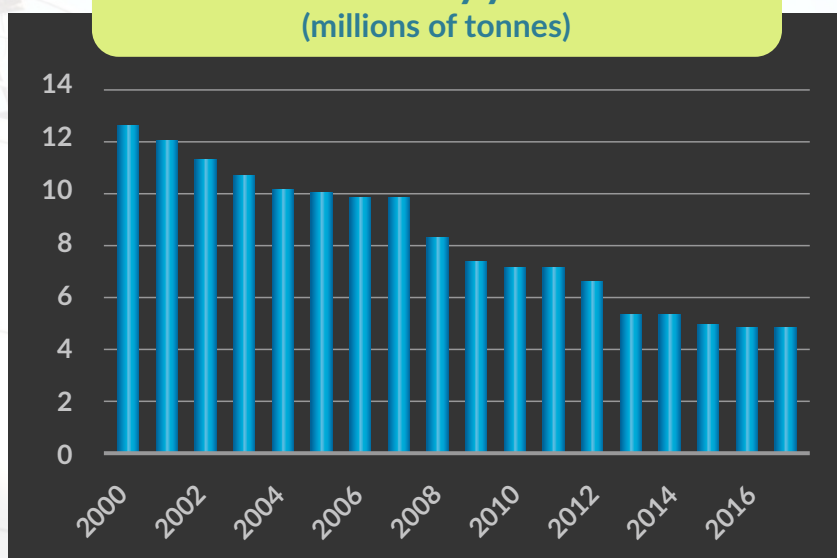
SO_x can harm trees and plants by directly damaging foliage and decreasing growth. Moreover, sulfur oxides can contribute to acid rain which can harm sensitive ecosystems.

Acid Rain Pathway

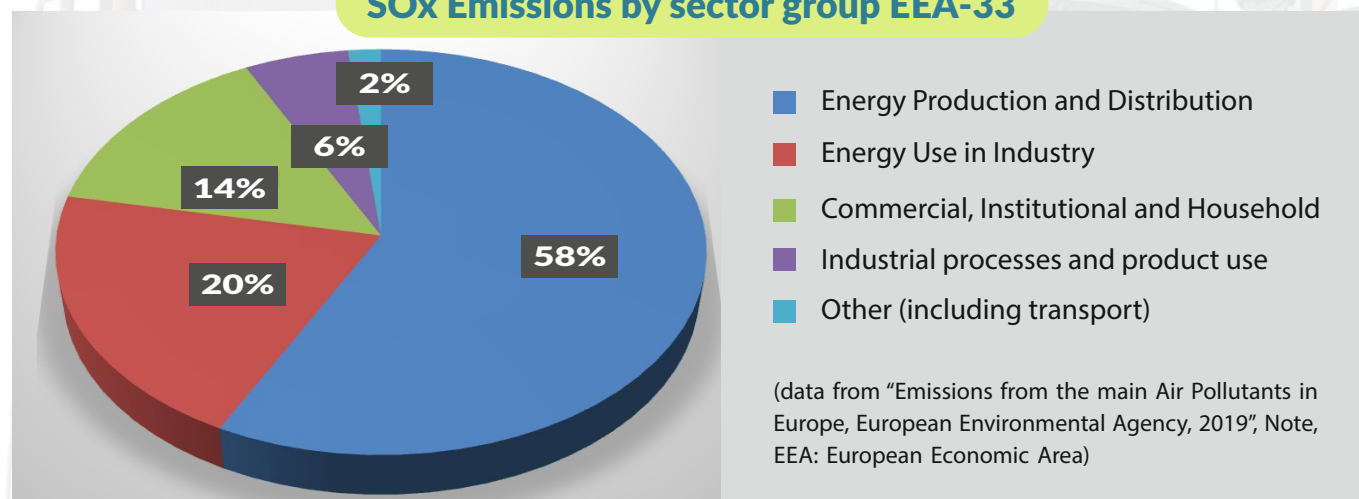


The largest source of SO_x in the atmosphere in Europe are power plants (60% of total emissions in the EEA-33) and the industrial sector (20%), while smaller sources of SO_x emissions include ships, vehicles and the heating of buildings. Emissions have been reduced significantly since the previous century and have been lately stabilizing to about 5.000.000 tonnes per year.

Emissions of SO_x by year in EEA-33
(millions of tonnes)



SO_x Emissions by sector group EEA-33



The idea behind the project

The magnesium oxide (MgO) industrial sector largely utilizes fossil fuels to operate its kilns and in doing so emits flue gases in the atmosphere that contain sulfur oxides (SO_x), among other pollutants. According to EU Legislation, the sector's member industries must implement best available techniques (BAT) described in special reference documents (BREFs) to reduce these emissions below specific limits, typically applying a "flue gas desulfurization" technique using an alkaline chemical. The project objective is to

investigate whether and under which modifications to the existing techniques and equipment, MgO may be used as a sulfur oxide sorbent (a solid material that "captures" SO_x from the gaseous to the solid state), instead of hazardous chemicals such as lime or caustic soda. Furthermore, to study whether resulting solid by-products could potentially be of higher added value and could generate profits or cover part or all of the operating cost of desulfurization, utilizing circular economy principles.

EU relative policy background

EU relative policy background National Emission Ceilings Directive (2001/81/EC) sets pollutant-specific and legally binding emission ceilings for various gaseous pollutants (including SO_x) for each EU Member State. The directive sets specific environmental objectives that address the impacts of acidification and eutrophication on eco-systems, and the harmful effects of ozone on vegetation and human health. In particular it sets 'reduction commitments' applicable from 2020 and from 2030 onwards.

Apart from these generalized environmental objectives, EU closely regulates the emissions of various key industrial activities. One of the

main instruments available is the so called Industrial Emissions Directive (IED, 2010/75/EU), ex IPPC (Industrial Pollution Prevention and Control) directive, and one of its aims is the adoption of the best available techniques (BAT) for pollution control as described in reference documents or BREFs, particular to each industrial sector. The magnesium oxide production industrial sector (where Grecian Magnesite belongs to) is regulated by the IED and the relevant BREF is the so-called Cement-Lime-Magnesia or CLM BREF. The CLM BREF sets an emission limit value of 1.500 mg equivalent SO₂ per normal m³ of flue gases, when the plant is forced to use a dry FGD technique (e.g. in arid areas).

II. PROJECT MAIN OBJECTIVES

The main objective is to demonstrate that a new dry desulfurization technology utilizing magnesium oxide as a sulfur oxide sorbent is a Positive Net Environmental Impact Solution for magnesia industries, especially in those areas where limited water availability renders wet technologies inapplicable. Other objectives include:

- To utilize and/or upgrade at least 90% of the generated solid desulfurization by-product/waste to be used in construction and fertilizer applications
- To demonstrate that a reduced energy consumption by at least 40% is possible compared with wet desulfurization technologies
- To demonstrate that a reduced water consumption by at least 80% is possible compared with wet desulfurization technologies
- To replicate the results to Magnesia sector and transfer them to other relevant European energy intensive combustion industries
- This technique to be adopted as best available technique (BAT) in the related reference document (BREF) of the European Commission for the production of Cement-Lime-Magnesia.

III. PROJECT'S MAIN ACHIEVEMENTS

Design and Construction of the pilot plant

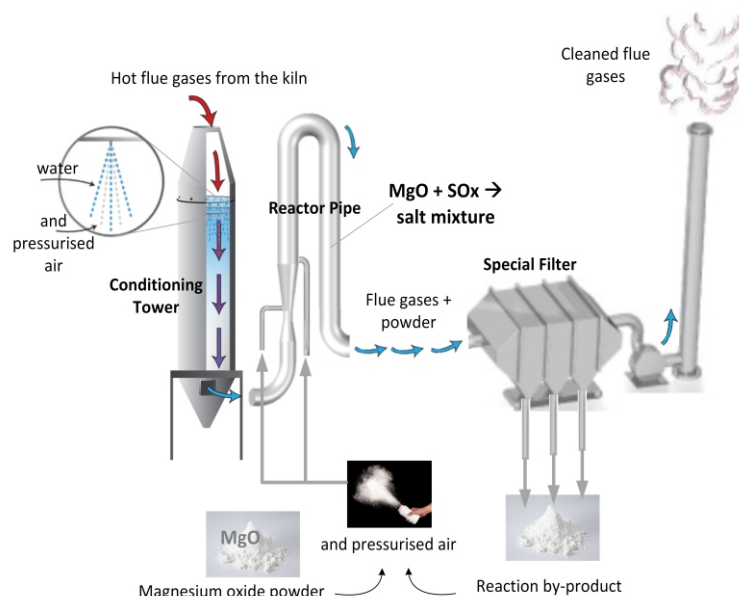
The design and the construction of the plant was conducted by Scheuch GmbH Austria, with the cooperation of Grecian Magnesite's engineers and the Laboratory of Fluid Mechanics and Turbomachinery (LFMT), Mechanical Engineering Department in AUTH's Polytechnic School. LFMT conducted detailed computer simulations based on the principles of the so called "Compu-

tational Fluid Dynamics" or CFD in short, to help design effectively the way the sorbent material (magnesium oxide) is injected into the system.

The scale of the pilot plant is impressive, since it is designed to be fed with all the flue gases coming from one of Grecian Magnesite's kilns in the calcination department of the plant in Yerakini.

Description of the pilot plant

Hot flue gases coming from the calcination department's rotary kilns, containing the SO_x we want to reduce, pass through a "conditioning tower" where water droplets are sprayed in the gases and evaporates. Resulting tower benefits are: a) it lowers the temperature and volume of the flue gases, b) it humidifies them to help the reactions that will follow. The cooler flue gases then pass through a "reactor pipe" which has an upside down U-shape, where they are mixed with the magnesium oxide powder or "sorbent" which is injected in the pipe. MgO partly reacts with SO_x and captures them in the solid state as salts (the by-product now), removing them from the flue gases. This gas/powder mix is then led to a special filter where the solid by-product is separated from the gas which can now, dust free and of lower SO_x, be emitted to the atmosphere from the stack. Part of the by-product is recycled back into the reactor pipe, to participate in the reactions even further. The rest is taken out and stored in a silo.



Production of MgO Sorbent

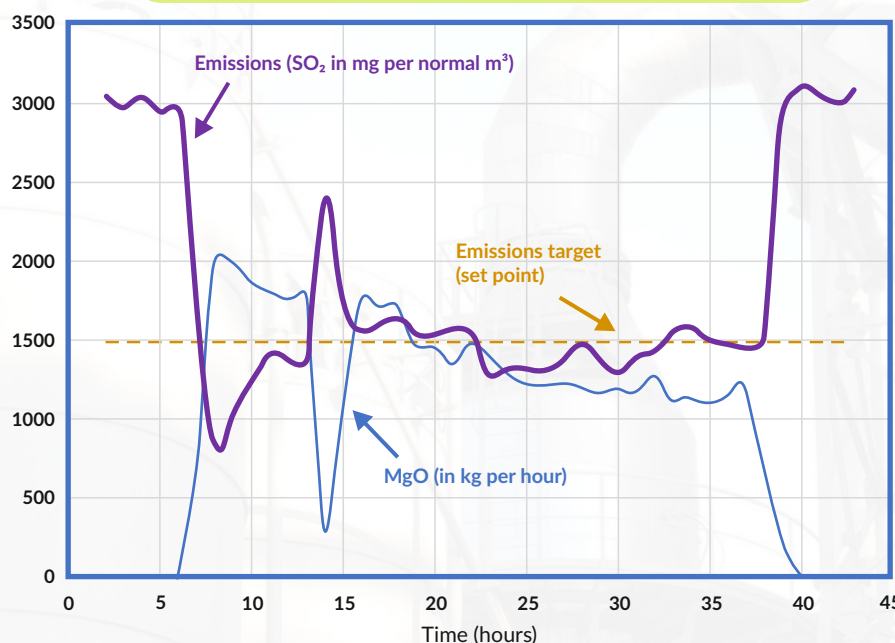


The sorbent required for the pilot plant is produced on-site, as GM takes advantage of old mine stockpiles. This is basically an old waste material, that could however be used as a raw material to produce a lower MgO quality to be used in the plant as sorbent. To get the valuable magnesium carbonate in the pile, GM gets rid of the unwanted minerals also contained therein through a beneficiation process.

Optimisation and Validation

After the installation and initial operation of the pilot plant, there followed a long period of optimization studies, using different sets of operating conditions, different fuel mixtures (which affect the initial SO_x entering the plant) even different sorbents. When optimization was concluded, two long validation periods followed to establish final operation conditions and efficiency. The pilot plant is fully automated, monitored and operated centrally from a control room. The graph above provides an example of emission control by sorbent (MgO) addition: initial emissions of about 3.000 mg/Nm³, with the subsequent addition of sorbent (MgO) in the system fall to 1.500 mg/Nm³. The computer continually checks the emissions and decides whether to increase or decrease the addition rate of the sorbent to reach the pre-defined set point.

Emissions Control by MgO Addition



By-product and its valorization

The pilot plant's by-product is a fine powder and it is a mixture of magnesium oxide and the desulfurization by-products, mainly sulphite and sulphate salts. These characteristics make the by-product valuable for a variety of possible applications such as raw material for magnesium cements in construction products or as raw material for fertilizer production. In particular, Grecian Magnesite has made extensive testing to fully characterize the by-product and its properties and has prepared a comprehensive magnesium cement test report and a report on fertilizer

application tests. The by-product can be used to prepare the magnesium cement that is used in the manufacture of panels and has been initially approved by a major European panel manufacturer, to produce wood-wool coustic panels.

Moreover, part of the generated by-product is valorized on-site, by mixing it with a commercial Grecian Magnesite MgO grade, with favorable results, sold for cement applications such as panels and abrasives. The rest of the by-product is stockpiled for future use.

Quantifying the project

- The pilot plant treats 84.000m³ of fluegases per hour.
- SO_x emissions are reduced by 51%, achieving a value of less than 1.500 mg of equivalent SO₂ per normal m³, which is the current BAT Emission Limit Value.
- Yearly, 520 tonnes of equivalent SO₂ emissions are prevented.
- 80% of the MgO sorbent used comes from the utilization of old mining waste. More than 20.000 tonnes per year waste are utilized.
- The pilot plant consumes 96% less water and 24% less energy than an equivalent FGD plant based on wet desulfurization technology.
- More than 12.000 tonnes of by-product are generated by the pilot plant yearly. The current valorisation rate of 15% of the by-product is estimated to increase to 90% in the After LIFE period.

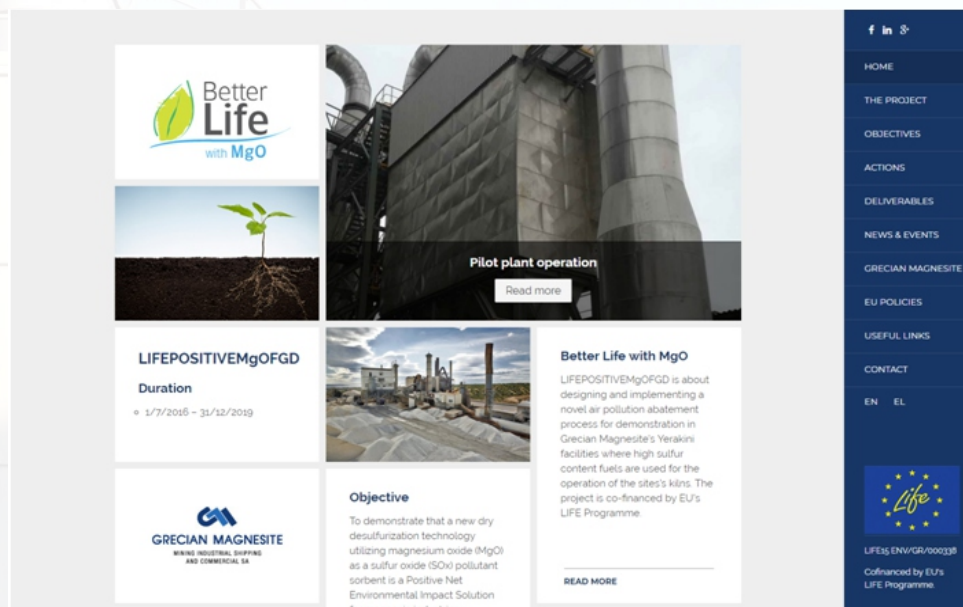
IV. PROJECT'S OUTREACH:

Means and Actions

Website

(data up to 31.12.2019)

- Users: 1.925
- Visits: 7.508
- Countries: 82
- Downloads: 4.564



Organisation of Dissemination and R&T Workshops:

- **October 19th, 2017:** 1st Workshop for the local community, Chamber of Halkidiki, Polygyros (50 participants)
- **March 19th, 2019:** 1st R&T Workshop, Magnesia Producers Assembly, EUROMINES Offices, Brussels (12 participants)
- **March 28th, 2019:** 2nd Project Workshop with major stakeholder participation (67 participants) and a separate R&T session (16 participants), Hellenic Federation of Enterprises Offices, Athens
- **December 17th, 2019:** 3rd Project Workshop presenting the project's results (50 participants), Centre for Research and Technology, Thessaloniki & Pilot Plant Visit



Presentation in Conferences and Events:

- 6th Environmental Conference of Macedonia, June 25-30 2017, Thessaloniki
- 6th International Conference on Environmental Management, Engineering, Planning and Economics, May 5-7, 2017, Thessaloniki
- Greek LIFE Task Force Events: Two (Xanthi & Thessaloniki)

Videos

The main project video can be seen at:

https://www.youtube.com/watch?v=PX0G-0jCEZQ&feature=emb_logo

LIFEPOSITIVEMgOFGD also participated in a Greek Task Force (GLTF) promotional video and can be seen at :

<http://www.lifetaskforce.gr/en/information-material/videos>

or https://www.youtube.com/watch?v=_lqRugA1D-I&t=2m22s

After LIFE

The pilot plant will continue to operate after the project's end, because its role to desulfurise the flue gases of one of the calcination kilns is a priority for Grecian Magnesite in order to reduce SO_x emissions and improve its environmental performance. Efforts will also be made to replicate the technology to one more kiln on the same site. Moreover, finalizing the agreement to supply the by-product for panel manufacture and the continuation of valorization efforts, will generate revenue and increase the long-term sustainability of the project.

Dissemination activities will continue, both with stakeholders and potential customers as

well as presentations in Conferences and Workshops.

Finally, one of the most significant tasks for the After-LIFE period is for the IPPC Bureau to consider the proposed technology as BAT for the next CLM BREF review that is to commence by April 2021. Grecian Magnesite plans to secure participation in the Technical Working Group that will oversee the review process and push for the adoption of the technology. Under moderate estimations, this process is expected to conclude by the end of 2022.

V. CONTACT INFORMATION

<http://www.betterlife-withmgo.eu/en/contact>
info@grecianmagnesite.com



+30 210 7240446 (Athens offices)
+30 23710 51251 (Yerakini Mine)