LIFE

POLYPHOS ACID

Production of Polyphosphoric Acid using an innovative system based on the phosphoric acid wet process

PRAYON

LAYMAN'S REPORT

February 2018

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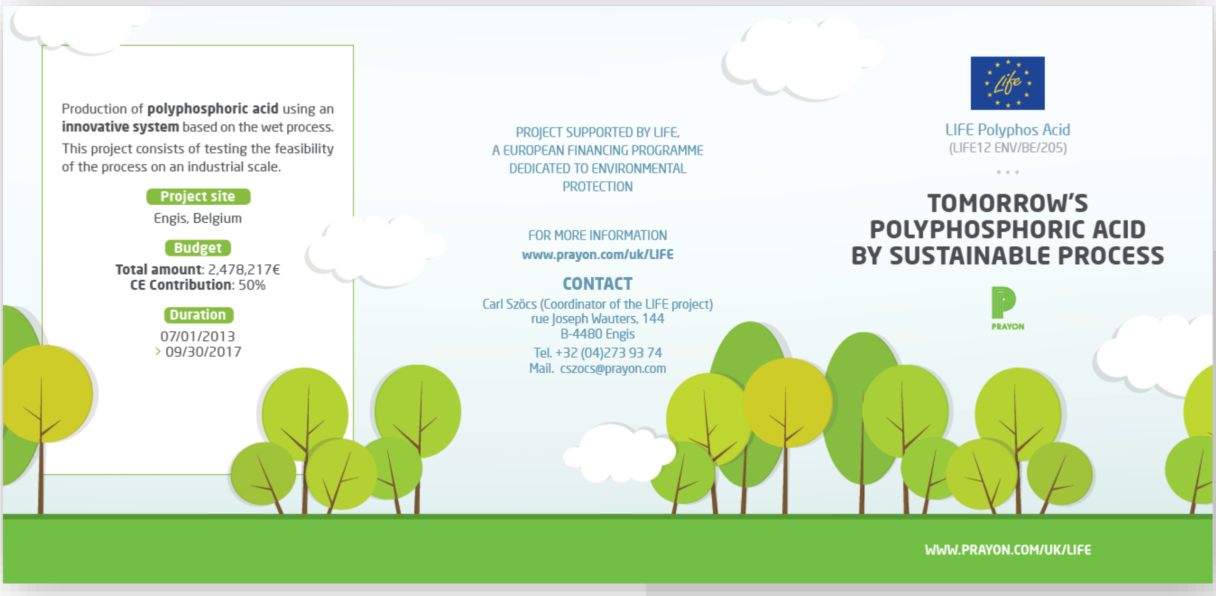
LIFE Polyphos Acid factsheet



LIFE Polyphos Acid is co-financed by LIFE+, the financial instrument for the environment of the European Commission (LIFE12 ENV/BE/000205)

Duration: 2013-2017

Budget: 2,5 Million Euro

Goal: the aim of the LIFE Polyphos Acid project is to offer a solution to the reduction of the carbon footprint and to the non-valorised wastes in the context of the polyphosphoric acid production.

Project demonstration site: Engis, Belgium

Project website:

http://www.prayon.com/en/our-activities/innovations/Life-polyphos-acid.php

1. Summary of project scope and objectives

1.1. Project scope

With a share of more than 30% of the total industrial energy use worldwide (including feedstocks), the chemical and petrochemical sector is by far the largest energy user in industry. The sector is faced with the challenge of saving energy primarily for economic and environmental reasons (OECD/IEA report, 2009). According to the European Environmental Agency (EEA), the European chemicals industry, including pharmaceuticals, emitted a total of 147.4 million tonnes of CO_2 equivalent in 2009.

The UK Environmental Agency has identified priority environmental issues in the chemical sector, considering each phase of the chemical life-cycle (Sector plan for the chemical industry, UK Environmental Agency, 2005). The table below clearly illustrates the overall Environmental problems to be tackled by the sector.

Table 1: UK analysis of environmental issues and priorities

		Raw materials acquisition	Raw materials processing	Product manu-facture	Product use	Product end of life	Overall sectoral importance
Agency topics	A better quality of life	x	x	x	x	x	High
	An enhanced environment for wildlife	x	x	x	x	x	High
	Cleaner air for everyone	x	x	x	x	x	High
	Improved and protected inland and coastal waters	x	x	x	x	x	High
	Restored, protected land with healthy soils	x	x	x	x	x	High
	A greener business world	x	x	x	x	x	High
	Wiser, sustainable use of natural resources	x	x	x	x	x	High
	Limiting and adapting to climate change	x	x	x	x	x	High
	Reducing flood risk						
Overall sectoral importance		High	High	High	High	High	High

The Phosphate industry obviously falls within the scope of the above analysis, and the LIFE Polyphos Acid project should offer, once validated, a solution to the reduction of the carbon footprint and to the non-valorised wastes in the context of the Polyphosphoric Acid production.

The increasing production of polyphosphoric acid is linked to the growing demand from several sectors (pharmaceutical, cosmetics, petrochemical, road construction - asphalt-, textile industry, water treatment industry, fertilizers, etc.). In 2009, its worldwide production reached more than 50 Kt (kilotons), representing a 4.2% y-o-y market growth (source: PRAYON). More than 60% (31.91 kT) of this production is achieved via the thermal process, which is the less environmentally-friendly process, as well as the less efficient one.

The LIFE Polyphos Acid is not only a technical demonstrator, it is evidence that more can be done in terms of energy consumption (meaning also reduction of greenhouse gas emissions), compactness of equipment and valorisation of waste.

1.2. Objectives

Currently, the most popular process used for the production of polyphosphoric acid is the thermal process. It is easier to implement but involves high energy consumption.

The project aims at producing highly purified polyphosphoric acid (85% P_2O_5) via an innovative wet process. This process is less polluting and more energy-efficient, but more complex so not widely used yet.

The LIFE Polyphos Acid project aims to offer a complete solution that not only complies with the existing standards but goes well beyond.

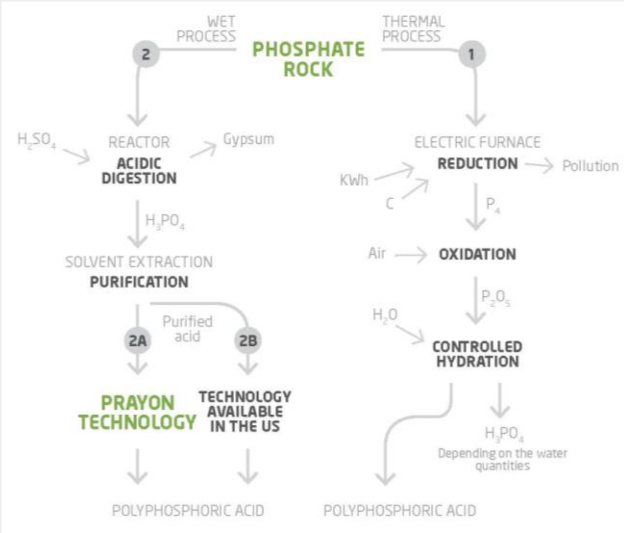


Figure 1: Comparison of the different processes

With this patent-pending process, Prayon aims firstly at reducing the carbon footprint of the production of polyphosphoric acid:

- by decreasing the energy consumption;
- by using a much more compact system than the Best Available Technologies (BAT).

As such, this project will have a very positive effect on the environment in general, and on the climate change in particular.

2. Description of the techniques / methodology implemented and results achieved

Figure 2: Picture of the demonstrator

2.1. Project activities

During the project, the team developed and built, at the Prayon site in Engis, a demonstrator consisting of a flame chamber (the 1st subsystem and the main innovative element), a mass and energy recovery unit (2nd critical subsystem), and finally gas treatment equipment.

Some activities were delayed mainly due to the difficulty of designing the flame chamber in a relatively new material and it took several more months to complete the studies. PRAYON has come to define a global scheme of operation of the material and energy recuperator within the demonstrator.

Figure 3: Assembly of the flame chamber

The flame chamber was installed in February 2016. The five test campaigns carried out since 2014 validated and closed the activities related to the control and installation of the flame chamber. The start of operations, tests and adjustments was then started in March 2016. The major risk is the breakage of silicon carbide elements that require up to 6 months of manufacturing time. Particular attention was therefore paid during the first test campaign, which led to the following conclusions:

- good sealing and excellent thermal insulation of the flame chamber,
- very good quality of the polyphosphoric acid produced.

The first months of 2017 were devoted to ordering the latest components and instruments needed for installation. The summer of 2017 allowed the assembly of the recuperator, the gas washer as well as the numerous pipes, piping materials, power supplies and instrumentation related to it to finalize the construction of the prototype.

At the same time, related surveillance activities continued their course to ensure the proper implementation of the pilot and the achievement of technical, environmental and socio-economic objectives.

2.2. Expected results / obtained results

The expected outcome of the LIFE Polyphos Acid project was the development and the validation of an innovative process for the production of polyphosphoric acid based on the phosphoric acid wet process with the following expected results:

- Reduction of the carbon footprint with a decrease in CO_2 emissions of 54% as well as a reduction in energy consumption.
- Reduction of the materials necessary to set up the process: reduction in terms of volume of the installation could be up to 80%, and the reduction in terms of mass could be up to 50%.

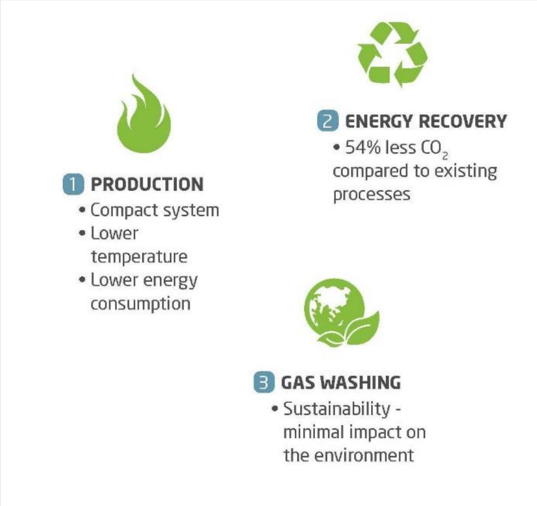


Figure 4: The three steps of the process

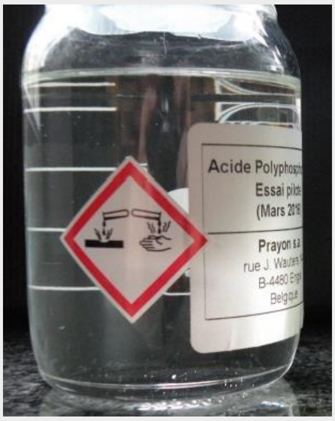


Figure 5: Sample produced on the prototype

The Life Project and the development of the demonstrator allowed the validation of a certain number of hypotheses emitted at the starting point:

- The demonstrator allowed us to produce a polyphosphoric acid of high quality and high purity, making the new process highly attractive compared to the existing one.
- The choice of materials used, despite the difficulties encountered in identifying reliable suppliers, proved to be a good choice (resistance, low product contamination, energy consumption, etc.).
- The compact system that was implemented has many advantages both in terms of reproducibility and investment required as well as expected maintenance costs making it highly competitive.

3. Assessment of the benefit and impact

3.1. Socio-Economic impact

Based on the available market data and the experience gained during the tests, both on the R&D pilot and with the LIFE demonstrator (without. however, taking into account the mobilization of the numerous stakeholders for its installation), PRAYON has developed and refined the draft of a business plan as part of the post-demonstrator industrial phase planning.

If operational and market conditions allow, PRAYON plans to build a plant with more capacity (it is currently about several thousand tons per year). In this case, the current version of the Business Plan provides for an investment of approximately 10 million euros and the direct creation of 15 new jobs.

Figure 6: Visit of the Demonstrator

3.2. Environmental impact

The primary goal of PRAYON was first to reduce the carbon footprint of polyphosphoric acid production.

The aim pursued was also a more sustainable management of the water used.

As such, this project aims to have a positive effect on the environment in general and on climate change in particular.

The evaluation was formalized through the monitoring of gas consumption on the datasheets and the calculation of direct production yields without material recovery. The decision to favor material recovery in relation to the energy balance has influenced the result of this monitoring of the energy aspects but without having any impact on the organization and intensity of this monitoring itself.

The design of the recuperator and the cooling loop allowed the optimization of the pilot at the energy level.

Monitoring and evaluation of material recovery

This follow-up has been put in place since the firts tests on the R&D pilot. The calculation of the direct yields of polyphosphoric acid production in the single flame chamber of the R&D pilot or the LIFE demonstrator (of the order of 50% P_2O_5 in both cases, that is to say, as much material collected as temporarily lost at gas level) has only underscored, if necessary, the importance of the recuperator in its role of recovery of material.

All the data fueled the design of the recuperator, the cooling loop and the gas treatment system to the point of prioritizing, where possible, material recovery.

The last test campaign, following the installation of the recuperator and the gas treatment system, showed a huge improvement in the recovery of material since 98% of the P_2O_5 introduced were recovered (60% in the form of acid polyphosphoric at the foot of the combustion chamber and 38% in the form of phosphoric acid at the bottom of the recuperator).

As the demister planned at the exit of the recuperator had not been placed in the latter during this test campaign, we can expect an ever higher valuation of materials during the tests scheduled for mid-2018 on this industrial pilot.

Environmental Impact Monitoring – Life Cycle Assessment (LCA)

This monitoring was started in January 2015 at the level of the definition of the objective and the identification of the necessary data.

The simulations carried out following the last tests allow us to consider that the environmental objectives pursued within the framework of the project, particularly in terms of reducing the carbon footprint compared to other existing processes, have been achieved.

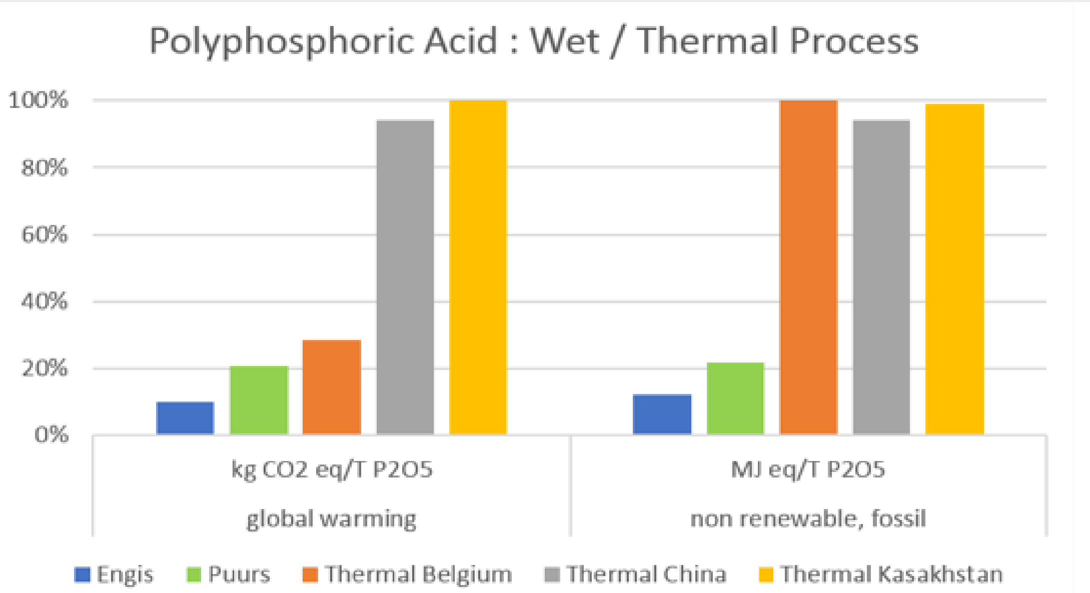


Figure 7: LCA on CO_2 and non-renewable energy

Perspectives after the end of the project

The action continued at the end of 2017 by updating the LCA for the phosphoric acid feeding the demonstrator and will continue by analyzing the data collected at the LIFE demonstrator level in future test campaigns so as to quantify definitively the different positive environmental effects achieved.

4. Transferability of project's results

We have sought to obtain some polyphosphoric acids available on the market for the purpose of objective comparison of the quality of the acid produced on the LIFE Polyphos Acid demonstrator. At this stage, we can already say:

- that our production, from a phosphoric acid produced by the wet process, shows levels of impurities lower than those encountered in of the process by thermal ways (traces of antimony and, especially, of arsenic);
- that the LIFE Polyphos Acid demonstrator allows, in its current configuration, to get rid of the sulphates contained in the acid fed;
- that the most troublesome impurity present in our polyphosphoric acid are the result of the corrosion of the R&D pilot elements that have not yet been replaced (nickel and chromium) and are therefore destined to decrease;
- that even the iron content of our acid is quite comparable to others polyphosphoric acid produced by thermal ways.

Replication has been found to be possible on a large scale, especially in countries where the thermal process is still widely used (Asian countries in particular) and where PRAYON's technology for the production of phosphoric acid is already in place (in more than 140 plants in 30 countries, more than 50% of phosphoric acid production worldwide). The benefits to the environment and the economy should be able to facilitate the adoption of this innovative system by the legislator and allow the acceleration of the deployment of technology and thus generate a virtuous circle.

Figure 8: Fields of application

Main EU policies targeted:

- Energy Efficiency: Energy Efficiency Directive (2012) sets the framework for measures to promote energy efficiency across the EU and help the EU reduce its energy consumption by 20%.
- Reduction of greenhouse gas emissions: 2030 Climate Framework for reducing greenhouse gases in the period until 2030 to continue the trajectory toward a low-carbon economy in the period beyond 2020.
- Waste management: Waste Directive 2008/98/EC requiring Member States to establish waste prevention programs. The Waste Framework Directive has evolved over the last 30 years through a series of environmental action plans and a framework of legislation that aims to reduce negative environmental and health impacts and create an energy and resource-efficient economy.

Expected Long term results

In the longer term, PRAYON has great ambitions for the polyphosphoric acid production process that it has developed.

In addition to the construction of an industrial facility on one of its sites, for the sale of polyphosphoric acid in large quantities (several thousand tons), PRAYON also plans to commercialize this innovative patented technology through the sale of licenses to economic actors who would be interested in replacing their current process of polyphosphoric acid or who would like to introduce a new one in their production process.

Information Board implemented at the entrance to the premises

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