

Phosphorus

DG ENTR Introduction Paper

1. Introduction

The sustainable use of phosphorus and the recycling of phosphate-based materials as raw materials for fertilisers are subjects under discussion both among the Member States and the European Union.¹ Specific discussions are also focusing on issues like the authorisation of some forms of waste-reuse for the production of fertilisers (e.g. manure and sewage sludge spreading), as well as the usability of such materials in the context of the Fertiliser Regulation (Regulation (EC) No 2003/2003). As this issue is of core competency of the Fertiliser Working Group, it was suggested by Germany, to discuss the main challenges and opportunities and align on the main points. Taking into account that similar discussions are expected with respect to the future revision and its new approach and that the recycling of other waste materials containing plant nutrients is becoming a major topic in the EU, it was considered useful to discuss several aspects at the Fertilisers Working Group on 2nd June.

For this purpose, this paper provides an overview on several aspects of sustainability and recycling of phosphorus, i.e. phosphorus as a critical raw material, the sustainable use of phosphorus, the actual status of recycled phosphorus, the environmental protection requirements, and phosphorus in the context of the bio-economy policy.

2. Phosphorus as a critical raw material

Phosphorus is one of the essential nutrients for plants, animals and humans and is therefore crucial for all life on the planet. In its natural form, phosphorus only exists as phosphate rocks which are – generally spoken – a range of commercially mined phosphorus-bearing minerals. Phosphate rocks are mainly used for the production of fertilisers, but also for the production of detergents and animal feedstock.

Phosphate rock is finite and non-renewable. Bearing this in mind, it should be noted that the growing world population is the main driver of phosphorus consumption as the growing need for food leads to an increased demand for fertilisers based on phosphorus for agricultural use.² The United States Geological Survey (USGS) estimates that the world consumption of phosphorus pentoxide will increase from 42 million tons in 2012 to 45 million tons in 2016.³ However, the use of phosphorus seems to be declining in Western Member States, while it increases in Eastern Member States.⁴

It is estimated that the world resources of phosphate rock are in total 300 billion tons.⁵ 85 to 90% of world's remaining reserves are controlled by only five countries which are Morocco, China, Algeria,

¹ <http://ec.europa.eu/environment/natres/phosphorus.htm>

² Science for Environment Policy, In-Depth Report: Sustainable Phosphorus Use (2013) p.8.

³ To be analysed in a still confidential Commission document, to be shortly released.

⁴ Science for Environment Policy, In-Depth Report: Sustainable Phosphorus Use (2013) p.9.

⁵ Confidential Commission Document, to be shortly released.

Syria and Jordan. China, the U.S. and South Africa keep their mined phosphorus for their own use whereas Morocco and Jordan are the largest exporters. Generally, the EU is almost⁶ dependent on mined phosphorus, and therefore a net importer of natural phosphates. Per year, the EU is importing around 4 million tons of natural calcium phosphates and natural aluminium calcium phosphates, natural and phosphatic chalk unground and ground. Exceptionally, in 2009 only approx. 2 million tons of phosphates were imported, whereas in general a slightly decreasing trend was recorded between 2008 and 2012.⁷

By covering around 33% of all imports into the EU, the main supplier of phosphorus to the EU is Morocco. Other major importers are Algeria, Russia, Israel and Jordan.⁸ Thus, the EU is highly dependent on regions currently subject to political crisis. In Morocco the main phosphate rock mines are state-owned. This of course involves the danger of an unexpected and/or extraordinary price-setting. Furthermore, it is expected that big parts of the supply chain are coming under the control of a single company which means that this company may control the mining, processing and the fertiliser production. China on the other hand imposed a 135% export tariff on phosphates after the 2008 global phosphorus price spike.⁹ Moreover, with regard to the current Ukraine crisis the future of EU's trade relations to Russia is still unclear.¹⁰

Taking into account the need of phosphorus for the whole food production chain, the limited availability as well as Europe's high dependency on import, phosphorus can be considered as a candidate raw material. Currently, phosphorus is among the 54 raw materials that are being assessed in the framework of the revision of the list of critical raw materials. Raw materials are assessed against their economic importance and their supply risk.

A presentation will be made by the colleagues of DG ENTR in charge of the list of critical raw materials during this meeting of the Fertilisers Working Group.

It also explains why several Member States have already taken steps towards the encouragement of a more sustainable use of phosphorus while supporting its recycling. Some forms of reuse such as manure and sewage sludge spreading are even quite common. However, further research into promising techniques and technologies is necessary, existing environmental problems have to be tackled and the creation of an EU fertilising materials market is envisaged via the revision of the Fertilisers Regulation.

3. The sustainable use of phosphorus

⁶ Only Finland has minor reserves.

⁷ Eurostat-Comext Database, CN 2510 1000 and CN 2510 2000 [accessed August 2013].

⁸ Eurostat-Comext Database, CN 2510 1000 and CN 2510 2000 [accessed August 2013].

⁹ Science for Environment Policy, In-Depth Report: Sustainable Phosphorus Use (2013) p.11.

¹⁰ The latest figures from Eurostat-Comext Database (2013) show that Russian exports of ground phosphates are more or less a double of those from Morocco. In unground phosphates, Russian exports are stable and recently increasing whilst Moroccan imports are decreasing.

It is a matter of fact that throughout the whole cycle of the phosphorus use significant quantities are getting currently lost.¹¹ However, there are techniques and technologies which can on the one hand improve the efficiency of its use, and on the other hand facilitate its recovery and recycling. As the prices of mined phosphorus are expected to increase, new alternatives of phosphorus use are becoming more and more economically interesting.

A more sustainable use of phosphorus could be achieved throughout the whole value chain. A first approach can be seen in technology investments as currently a significant share of the total rock are lost from mining, processing, and beneficiation operations. Further losses incur through transportation and handling. A more efficient use and conservation of phosphorus in agriculture could help to improve sustainability. The application of the principle of balanced fertilization, whereby the application of nutrients should not exceed the crop uptake capacity, is key in this respect. Within the EU, several initiatives have already tried to tackle this aim and have led to a reduction of phosphorus losses in agriculture.¹² Nevertheless, at farming level further improvements in the efficient phosphorus use could be enhanced, e.g. through "precision farming" techniques. Moreover, further reductions in the erosion by wind and water as well as an increased crop rotation would help to reduce losses of soil and consequently losses of phosphorus.¹³ Lastly, new techniques and technologies could further increase the efficiency of phosphorus in fertilisers and feedstock, but some of them still require more investigations.

Alongside this, the European Commission (DG Environment) launched a consultation open for contributions from 8 July 2013 to 1 December 2013, on how to use phosphorus in a more sustainable way.¹⁴ The consultation asked, inter alia, how to ensure that reserves are available for future generations, and how to minimise the undesirable side effects the use of phosphorus can have on the environment. The objective was to launch a debate on the sustainable use of phosphorus and to look for ways to enhance resource-efficiency, with a view to creating a "circular economy" of phosphorus.

A summary of the generated reactions will be given from DG Environment on the meeting on 2nd of June.

4. Recycled Phosphorus

¹¹ Consultative Communication on the Sustainable Use of Phosphorus, COM(2013) 517 final, p.9ff.

¹² E.g. the codes of good agricultural practice and action programmes under the Nitrates Directive, agri-environment schemes under the Rural Development policy,... See more examples in the Consultative Communication on the Sustainable Use of Phosphorus, COM(2013) 517 final, p.15.

¹³ Consultative Communication on the Sustainable Use of Phosphorus, COM(2013) 517 final, p.15.

¹⁴ http://ec.europa.eu/environment/consultations/phosphorus_en.htm.

As mentioned before, phosphorus is neither renewable nor recyclable. Beside of a more sustainable use of mined phosphorus, it is feasible to recycle certain materials to make use of secondary phosphorus. Four starting materials are considered of having potential:¹⁵

- manure
- waste water
- animal by-products (e.g. bones)
- food and other green waste (via composting or via ashes)

For 15 out of 22 Member States, the main phosphorus supply to agricultural land is already in the form of recycled phosphorus in manure.¹⁶ However, there is still enough potential to exploit opportunities through improved techniques and technologies (e.g. growing algae on sewage water, burn biomass for energy recovering and recycle the ashes as phosphorus fertiliser, etc.).

Yet, it has to be kept in mind that the use of recycled phosphorus for the production of fertilisers makes only sense if a sufficient level of effectiveness in the production is attained, if the recycled phosphorus is readily available for crops and if the concentration of harmful substances compared to fertiliser based on mined phosphorus does not exceed the maximum limits that DG ENTR is discussing with the Fertilisers Regulation in view of the revision of the Fertilisers Regulation.

It also has to be asked whether or not fertiliser based on mined phosphorus and recycled phosphorus should be treated different with regard to different kind of criteria (e.g. quality, labelling and information). Another main issue is how to ensure a level playing field which takes into account the specificities and different types of products and allows at the same time innovation.

5. Environmental protection requirements

Despite of the fact that phosphorus is a vital mineral, an agricultural over-use of phosphorus in fertilisers can lead to environmental problems. A high concentration of phosphorus in water, which can result especially from losses in areas of intensive agriculture and horticulture, may causes eutrophication of lakes and rivers. Soil quality may also be undermined because of the presence of contaminants. Comparing recycled and mined phosphorus, it has to be kept in mind that both may contain contaminants. Contaminants susceptible to be found in a given product depend on its origin as well as on the production. Fertiliser produced from phosphate rocks may contain heavy metals as for example cadmium.

But also fertilisers produced from recycled phosphorus (e.g. struvite precipitated from wastewater) may contain contaminants, e.g. significant levels of organics or traces of pharmaceuticals and even be re-colonised by microbial pathogens. Current environmental protection requirements (e.g. the Nitrates Directive, the Water Framework Directive, the Urban Waste Water Treatment Directive, the

¹⁵ http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/euromed_presentations/speight_phosphorus_recycling_en.pdf.

¹⁶ No data available for Cyprus, Luxembourg, Bulgaria, Romania and Malta; Consultative Communication on the Sustainable Use of Phosphorus, COM(2013) 517 final, p.16.

actual review of key targets in EU waste legislation, REFIT of the Sewage Sludge Directive, End-of-Waste criteria, etc.) have to be taken into consideration when it comes to recycled phosphorus.

6. Bio-economy policy

Existing EU legislation does not sufficiently encourage a more efficient use of phosphorus nor is it designed with recycled phosphorus as an objective. Hence, further steps have to be taken to foster phosphorus management. The EU is working on an improving market access for some sources of recycled phosphorus, notably through the future revision of the Fertiliser Regulation.

It has to be considered in which way the aims of the bio-economy strategy under Horizon 2020 could be of practical use for recycled phosphorus as building up industrial clusters and fostering research in techniques and technologies are of key importance. Under the perspective of Horizon 2020 as well as under the more and more increasing energy prices, energy-efficiency should be kept in mind.¹⁷

In this regard, a workshop on phosphorus recycling took place on the 6th and 7th of February which was organised by the European Sustainable Phosphorus Platform (ESPP) and Fertilizer Europe. The main objective of this workshop was to inform about the business opportunities in recycling of phosphorus, how the legislative framework can be linked to recycling and about funding opportunities for phosphorus recycling projects. A very similar event was organised more recently by COPA-COGECA on the "making best use of nutrients" which also discussed such issues.

Finally DG ENTR is going to organise with Region Brittany a workshop on the Bio-economy dedicated to the cycling of nutrients from the bio-wastes, among others concerning P-cycling.

7. Conclusion

The security of supply is of main interest as Europe is highly dependent on the import of mined phosphorus. Against this background, a greater self-sufficiency could be generated on the one hand through a more sustainable use of phosphorus, and on the other hand through efficient recycling measures. To reach this aim, several steps have to be taken: Research and innovation in techniques and technology have to be supported whilst trust and market opportunities have to be created. Innovative clusters and business networks have to be established and enhanced along the whole value chain. At the same time, a legal framework has to be set which supports the recycling of phosphorus and ensures simultaneously quality and safety standards.

¹⁷ As an example: In the case of phosphorus recycling from wastewater, chemical-biological treatment cannot only save up to 50% of the energy required compared to biological treatment but also produces more biogas at the same time (response paper by Kemira with regard to the European Commission's consultative communication on the sustainable use of phosphorus (COM(2013) 517 final)).