CEN/SABE ENV Team
ENVironmental monitoring strategy Team

Phosphorus recycling from wastewater treatment processes: available technologies, applicability and standardization needs – Strategic Position Paper

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This Position Paper aims to provide a basis for recommendations to CEN/SABE for CEN/BT further to the conclusions of the CEN/SABE ENV Team (Environmental Monitoring Strategy Team) meeting of 25 March 2015 on "Phosphorus recycling [1]from wastewater treatment processes: available technologies, applicability and standardization needs".

1. Background and introduction

Phosphorus is a non-renewable resource, essential and non-substitutable for fertilizers and animal feeds, and so for food production. Almost all phosphorus raw material used in Europe is imported. (The current import dependency is 92% for Europe [1], [2].) The demand for phosphorus is growing worldwide and the price of raw phosphorus is likely to undergo wide variations and to increase over time.

At the same time, emissions of phosphorus raise major environmental issues, as phosphorus (together with nitrogen) is one of the principal substances contributing to eutrophication and surface water quality failure. These issues mean that there is a need to define a long-term vision for sustainable management of phosphorus (and nutrients more generally) in Europe. Improving phosphorus use, reducing releases to surface waters and developing recycling can deliver improvements in water quality and reduce European dependency on phosphate imports.

Several routes exist today for phosphorus recycling.

Phosphorus coming from livestock manures (already largely recycled internally at farms) and biowaste, sludge containing phosphorus from conventional wastewater treatment and phosphorus recovered from phosphorus removal processes can be recycled as raw material in fertilizer production or to agriculture directly (taking into account the solubility of the P-forms, the soil characteristics, crop requirements and safety obligations). Processing biosolids to organo-mineral fertilizers, including the adjustment of nutrients, is now possible: there are techniques and various projects in this field.

Another route to reuse phosphorus consists of using wastewater or biosolids, directly or after some processing, as a feedstock for production of e.g. algae, fish, energy crops.

[1] In this document, 'recycling' is used as a general term to cover all routes for reuse or material recovery

A range of phosphorus removal and recovery technologies are today available, at different levels of technological readiness, from laboratory testing through to operation of full-scale commercial installations in wastewater treatment plants. These include:

- adsorption: solid phase adsorbents are frequently used in the removal of phosphorus from wastewater treatment to produce fertilizers and soil amendments;
- precipitation / crystallization: precipitation / crystallization technologies are currently in rapid development, they lead in particular to calcium phosphates that are similar to phosphate rocks, or to magnesium ammonium phosphate (struvite) which is a slow release fertilizer;
- ion exchange, adsorption / resorption and various extraction and processing technologies (e.g. using CO_2, steam, acid, chemicals …);
- biological / microbiological processes (only at research level).

The use of biosolids and biomass as renewable energy sources (e.g. by combustion, methanization) will further concentrate the phosphorus in the output stream, thus accentuating opportunities for phosphorus recycling (it is economically "more attractive" to recover concentrated phosphorus from output streams of energy production processes using biosolids / biomass as input, rather than recovering P directly from the input stream). There issignificant potential for phosphorus recovery from biomass combustion ashes (e.g. sewage sludge incineration ash, poultry manure combustion ashes, meat and bone meal ash and others) or for use of these ashes either directly as fertilizers or in fertilizer production, depending on their characteristics.

2. Current challenges

Storage and transport (e.g. the distance from the site of production of the recovered phosphorus, the form in which it is delivered), the needs of farmers as regards the application techniques (e.g. spreading equipment required), public acceptance and cost are important factors that influence the choice from among the different routes for P-recycling.

There are, however, significant challenges to P-recycling.

The legal requirements regarding the presence of contaminants (e.g. metals) in the biomass and in the materials derived from sludge, manure or ashes, differ among European countries.

In spite of the conclusions of recent studies, such as the P-REX project [2], the potential presence of pathogens (salmonella, E-coli), the occurrence of heavy metals, persistent organic pollutants and substances such as pharmaceutical residues, remain issues of emerging concern for consumers, affecting market attitudes.

Although refinements and increasing prices of phosphate rock may result in P-extraction from wastewaters becoming economical in the future, presently no process competes with P market prices for phosphate rock.

In this respect, the main obstacles to phosphorus recycling routes today are:

- the absence of a harmonized European legislative framework;
- the fact that materials derived from sewage sludge, compost and digestate from biowaste are legally considered as waste (absence of end-of-waste criteria);
- the application of Animal By-Products (ABP) Regulations to recovered phosphorus materials resulting from manures, meat and bone meal ash;
- different interpretations of REACH concerning "recovered" products, such as struvite: Art. 2(7)d exempts "recovered substances" from registration (subject to various conditions) with the aim of facilitating recycling but different member states have at present different interpretations;
- the fact that the homologation requirements for fertilizers differ from country to country.

A more supportive and harmonized legal framework for homologation of products at European level is crucial to develop the phosphorus recovery business.

3. State of play and perspectives in European policies for sustainable use of phosphorus

In July 2013 the Commission launched the Consultative Communication on the Sustainable Use of Phosphorus (COM(2013)517) with 11 questions addressed to the public, governmental bodies, NGOs, and all types of stakeholders in order to draw attention to the sustainability of phosphorus use and initiate a debate on the actions needed.

Among the key elements resulting from the consultation [1], not necessarily associated with standardization activities:

- most respondents agree on the need for EU action to face the risk of soil contamination. The use of recycled phosphorus can be an effective way to avoid the introduction of additional cadmium into the environment, but attention should also be paid to other unwanted substances of emerging concern (e.g. hormones, pharmaceutical residues) that could be contained in the recycled materials; proper understanding of limit values, based on scientific evidence, is crucial in order to increase public trust in P-recycling techniques and promote this route to the more efficient use of phosphorus;
- respondents are in favour of measures to improve management in areas of P surplus: such measures would include the monitoring of P flows, measures to reduce phosphorus at source in areas where there is P over-supply (e.g. due to high density of livestock);
- measures to define the fraction of P which can be considered as bioavailable from the different recycling techniques;
- drivers or incentives were called for in order to encourage more phosphorus recovery and release prevention measures accompanied by the definition of quality criteria to ensure quality of the recycled product (and consequent public acceptance).

The Commission will therefore continue debating this issue in order to evaluate the best policy option to ensure the sustainable use of phosphorus within Europe.

In parallel, the Commission (DG GROW) is working to extend the scope of the Fertilizers Regulation to promote safe fertilizing products derived from P-recycling processing. So generic rules will be established for a number of materials derived from waste in the Annexes of the future legislation. Fertilizers which meet the recovery rules and the essential requirements for environmentally safe products will no longer be dealt with as waste (so will fall outside the scope of the Waste Directive). Technical barriers in the market will also be tackled (e.g. products legally placed in one market will be authorized to be placed on the Internal European Market).

End-of-waste criteria have already been proposed for compost and digestates [3]. Other products in the pipeline are struvite, biochar and biomass combustion ashes.

In particular for struvite and for biomass ashes, the European Sustainable Phosphorus Platform (ESPP) has prepared draft outline proposals for “fertilizer criteria for recovered struvite” and for “biomass ashes” [4]. The objective is to move towards a harmonized recognition of struvite and of different biomass ashes as fertilizers in the EU Fertilizer Regulation revision process and for this definitions of what can be sold as “struvite” or “biomass ash fertilizer” are necessary. ESPP has now started work on a similar document for biochars.

4. State of play of standardization activities

The European Technical Committee CEN/TC 308 “Characterization and management of sludge” is working on standards for sludge recycling, recovery, treatment and disposal.

Beside the testing methods for measuring P-content and physico-chemical characteristics of sludge, two documents are of interest:

- the Technical Specification CEN/TS 13714 "*Characterization of sludges — Sludge management in relation to use or disposal*" gives guidance for dealing with the production and control of sludge in relation to inputs and treatment and gives a strategic evaluation of recycling, recovery and disposal options for sludge according to its properties and the availability of outlets;
- the Technical Report CEN/TR 13097 "*Characterization of sludges - Good practice for sludge utilization in agriculture*" describes good practice for the use of sludges in agriculture as a source of plant nutrients, and/or soil improver, and/or alkaline amendment for crop production.

At international level, work is ongoing in ISO/TC (International Technical Committee) 275 "Sludge recovery, recycling, treatment and disposal", including a specific working group on "Inorganics & nutrients recovery".

Regarding standardization activities on fertilizers, existing standards of interest are published and draft standards are under development by CEN/TC 260 "Fertilizers and liming materials" and/or ISO/TC 134 "Fertilizers and soil conditioners".

It is important to stress that the above-mentioned documents are not specifically focused on P-recovery. Moreover, those documents are not sufficiently acknowledged. For example they are not considered in certain Quality Management Systems. As an example, some non-governmental certification systems (e.g. for food) simply ban the use of sewage sludge on the farm instead of defining the appropriate processing and use conditions.

5. Points for consideration for standardization activities

The role of standardization in support of European legislation is to create a level playing field between conventional and innovative materials. Standards (for monitoring, traceability and quality assurance) should allow presumption of conformity of the given material with the defined requirements for a given use (for example: verification of the compliance of fertilizing products with the requirements of the legislation as regards safety, quality and labelling).

In this regard, CEN/SABE ENV has identified the following recommendations for standardization needs.

a. General considerations and recommendations for standardization in the short term:

Recommendation 1

Phosphorus sustainable management is a priority of the European Commission, particularly in the context of the Circular Economy Package.

It is recommended that **CEN/SABE continue its dialogue with the European Commission and other relevant stakeholders** to ensure that the CEN work programme is closely aligned with the Commission's approach to promoting the sustainable use and management of phosphorus and bionutrients.

Recommendation 2

a) CEN/SABE ENV recommends to CEN/SABE that **current standards be mapped and subjected to critical analysis**, in order to identify:

- any standardization documents (national, European, international) that could be used to improve and promote the recycling of phosphorus;

- any obstacles within the existing standards to such recycling;
- any gaps between current provisions and the needs identified (See Recommendation 6).

b) In addition to assessing relevant standardization processes, CEN/SABE ENV recommends that **an inventory of legislative processes, where integration of P-recovery into standards is needed**, should be carried out, to support regulation development or implementation, for example:

- Circular Economy Package, EU Fertilizers Regulation update *(areas of regulation development)*;
- Water and waste policies, Industrial Emissions Directive (BAT for waste treatment, water treatment, incineration, etc.), Food Safety Directive, Ecolabel, EMAS *(areas of regulation implementation)*.

c) Further, CEN/SABE ENV recommends that **an inventory be made of other relevant non-governmental certification schemes,** for example REVAQ schemes operated in Sweden to identify and assess useful content.

Recommendation 3

CEN/SABE ENV recommends to CEN/SABE **the active promotion of any existing documents** that could be used to encourage the recycling of phosphorus, drawing particularly on the following CEN/TCs:
- CEN/TC 165 "Waste water engineering"
- CEN/TC 223 "Soil improvers and growing media"
- CEN/TC 230 “Water quality”
- CEN/TC 260 "Fertilizers and liming materials"
- CEN/TC 308 "Characterization and management of sludge"
- CEN/TC 345 "Characterization of soils"
- CEN/TC 351 “Construction products”
- CEN/TC 444 “Environmental characterization” (provisional title)

Recommendation 4

As part of this systematic review of standards, CEN/SABE ENV wishes to encourage CEN/SABE to persuade the relevant CEN/TCs to look closely at the content of the standards **with a view to possibly including phosphorus recovery issues in the text of the existing documents, where appropriate, also considering sustainable phosphorus management and phosphorus use efficiency, in combination with other nutrients.**

Recommendation 5

CEN/SABE ENV strongly supports **actions to promote the integration of risk assessment and good practices for phosphorus recycling** (including appropriately treated sludge use in agriculture), defined in standards, in certification systems.

This recommendation is aimed at the technical committees identified above.

b. Recommendations for Standardization in the medium/long term:

Recommendation 6

In order to achieve improvement of phosphorus recycling, CEN/SABE ENV recommends to CEN/SABE **to identify where standards should address the following (and how these standards could be developed)**:
- evaluate the bioavailability of phosphorus in the materials from different recycling and recovery processes;

- improve phosphorus management: e.g. methods to monitor P flows, good practices to reduce P input and losses especially in areas of P over-supply (high density of livestock) and in areas where surface waters are eutrophication sensitive;
- assess contaminant levels and possibilities of mitigation throughout the whole process chain, from the input materials to the recycled nutrient materials and soils in order to ensure compliance with limit values set by legislation for chemical contaminants and other quality and safety requirements (regulated contaminants and other substances of emerging concern);
- allow verification of the technical characteristics of the different products (recycled and non- recycled) depending on the end-use to which they are put;
- assess water content and organic content of recycled phosphorus materials (e.g. struvite: existing standards for water and organic content assessment are not applicable);
- ensure interoperability of datasets related to nutrients at both the 'macro' level (national or regional material flow analysis) and at the operational level (e.g. in a sewage works) to support decision-making on nutrients management.

It should be possible, on the basis of the gap analysis, to establish whether the standardization requirements set out above are comprehensively covered by the existing standards and new draft standards of the relevant technical committees, and to identify any extra requirements.

References

[1] Consultative Communication on the Sustainable Use of Phosphorus (COM(2013) 517)

[2] P-REX Policy Brief 2015

[3] JRC End-of-waste criteria for biodegradable waste subjected to biological treatment (compost & digestate): Technical proposals - Final Report - December 2013

[4] ESPP Proposed EU Fertilizer Regulation criteria for recovered struvite transmitted to DG GROW - Version 24 - April 2015