Events

ESPC5 – register now online or for Lleida: 8-10 October

The 5th European Sustainable Phosphorus Conference, 8-10 October 2024, online and Lleida Spain, has already over 200 registrants. Online registration enables participation in all plenary sessions and selected parallel sessions with access to live streaming and to the session questions and discussions ('chat'), as well as speaker and registrant profiles and contact via the conference networking app (Swapcard, as for other ESPP events). Lleida participants can also participate in site visits to industrial nutrient recycling and digestate processing (Fertilizantes del Ebro and Bioenergia d'Almenar). Join us for this unique networking, industry, policy and science event worldwide.

Deadline for on-site (Lleida) registration is 29th September. *Online registration remains open.*

Updated programme, online and Lleida registration, site visit details: https://www.phosphorusplatform.eu/espc5

Regulatory status of algae grown using wastewater, wastes or ABPs, 13th November 2024

Brussels and online, Wed. 13th November 14h00 – 18h30, legal status of boimass produced in wastewater treatment or with waste gas, manure or food waste inputs, and valorisation in fertilisers, feeds and industry. Presentation and discussion of legal analysis prepared for ESPP by Barry Love, Environmental Law Chambers, with the European Commission, user industries, algae production and processing experts, EU and national policy makers.

Brussels and online, Wed. 13th November 14h – 18h, information and registration www.phosphorusplatform.eu/legalworkshop

Phosphorus use and recycling in intensive livestock: March 2025

Can intensive livestock be more phosphorus efficient than extensive or organic farming ? Looking at P flows, P efficiency in feed, P-recycling, best nutrient management practices. UNEP uPcycle workshop, organised by BETA Technology Centre (University of Vic), with ESPP, hosted by Cooperl (the Brittany pig farm cooperative) and Roullier (feed and fertilisers). In Saint Malo and Lamballe, near Rennes, Brittany, France, 4-7 March 2025 (tbc). With site visits to the Saint Malo Minerallium (chemistry of minerals and phosphates), Roullier fertiliser and feed production and research, Cooperl experimental livestock technology research farm and Cooperl's manure and animal by-product reprocessing to energy and organic fertilisers. This

workshop will be limited to 60 participants, with representatives of livestock farmers organisations, meat and dairy processers and distribution, animal feed industries, with selected experts from science and from P recycling.

If you would be interested to participate or present, please contact laia.llenas@uvic.cat

ASLO P-sustainability session

Deadline for submission: 21st October 2024. As part of the major ASLO Aquatic Sciences Meeting, **26-31 March 2025, session on phosphorus in marine and freshwaters**. Presentations can cover phosphorus aquatic biology, eutrophication, impacts of climate change on phosphorus loading, phosphorus management in agriculture, food systems and diet, phosphorus policies and regulation.

ASLO 2025 Aquatic Sciences Meeting, 26-31 March 2025, Charlotte, North Carolina, USA, session 5539 "Taking the pulse of phosphorus sustainability: challenges and solutions across the freshwater to marine continuum", led by James Elser & Eric McLamore https://www.aslo.org/charlotte-2025/

Nutrients in aquaculture and fisheries – June 2025

ESPP workshop, with partners in Norway and UNEP uPcycle, on nutrient management in aquaculture feed, seafood processing and fish sludge valorisation, Norway & online, 17-19 June 2025 (tbc), covering nutrient flows, environmental best practice, phosphorus recycling, regulatory challenges. The workshop will contribute to the United Nations (UNEP) project uPcycle, leading to a UNEP white paper on phosphorus sustainability in aquaculture. Workshop in Norway with possible online connected meetings in Brussels, Chile. Site visits: state-of-the-art aquaculture, fish sludge processing installations.

If you would potentially contribute, please email indications of your organisation's areas of interest, competence, possible content of presentation, to info@phosphorusplatform.eu

Photo: trout in Montenegro fish farm, BuhaM WikiCommons https://commons.wikimedia.org/wiki/User:BuhaM

EU policies

CSRD reporting requirements include circularity and Critical Raw Materials

Large companies and listed SMEs must now publish reports on environmental and social risks, impacts and actions. Information must cover resource use and circular economy, waste and Critical Raw Materials. The EU Corporate Sustainability Reporting Directive (CSRD) 2022/2464, which entered into force on 5th January 2024, concerns all companies > 250 employees or turnover > 50 M€, listed SMEs (except micro-companies) and non-EU companies with an EU branch with turnover > 150 M€. The CSRD extends obligatory company non-financial reporting to "double materiality": that is both the company's impacts on the environment and on sustainability issues and repercussions of these issues on the company itself (social and environmental risks). The Directive is implemented through ESRS (European Sustainability Reporting Standards): twelve standards covering (2) general requirements and disclosures, (5) environment (climate, pollution, water, biodiversity – ecosystems, resources – circularity) and (4) social. These are now detailed in the Commission implementing regulation 2023/2772 (July 2023). Under ESRS E5 "Resource use and circular economy", companies must describe their resource inflows in particular Critical Raw Materials (E5-5 §30) and waste in particular food waste, biomass, non-metallic minerals and Critical Raw Materials (E5-4 §38), as well as how company actions impact resource efficiency, in particular Critical Raw Materials (E5-2 §20a). The implementing regulation specifically refers to "nutrient recycling" in the definition of Circular Economy (ESR E5 – 'Objective' §3).

Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 … as regards sustainability reporting standards https://eur-lex.europa.eu/eli/reg_del/2023/2772/oj

EU Corporate Sustainability Reporting Directive (CSRD) 2022/2464: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022L2464

EU Future of Agriculture report

"Strategic Dialogue" report, which will shape the new European Commission's "Vision for Agriculture and Food", recommends improving nutrient management, reduction and decarbonisation of mineral fertilisers, organic farming. The 110-page final report of the President of the European Commission Ursula von der Leyen received today the final report of the Strategic Dialogue on the Future of EU Agriculture, launched in January 2024, includes 10 pages of political principles and 50 pages of recommendations. The more digestible Executive Summary (6 pages) specifies ten "guiding political principles" and 14 recommendations. The guiding principles refer to 10 = food security and 4 = geopolitical security, to sustainability (linked to 6 = economics, 7 = markets, 8 = innovation and technology) and to 9 = "balanced diets that are healthier and more sustainable"). Recommendations include promoting sustainability and reduced GHG emissions (2, 3, 5, 6, 7, 8, and in particular sustainable

livestock 9) and changing diets (6). Recommendation 7 includes "*to reduce external inputs as mineral fertilisers and pesticides, improve nutrient management, advance in the decarbonization of mineral fertilizers … to support organic production as well as agroecological farming practices*". In the detailed recommendations text, a section on nutrient management (in §2.2.2 pages 61-62 calls for the (announced but not yet published) EU Integrated Nutrient Management Plan (INMAP) to be centred on improving nutrient efficiency and circularity, safe recycling of nutrients, decarbonisation of fertilisers and EU strategic autonomy. The report underlines the need for collaboration and partnership between governments, research and industry in the circular economy (page 20: "*the circular economy extends far beyond nutrient cycles and geographical collaborations and involves all partners as equals*"). Nutrient management is also recognised as important in recommendations 3.1.1 "Nonet land" (soil health and land take), 3.2.1 water resilience and 3.2.2 crop breeding.

European Commission press release IP/24/4528 , 4th September 2024 https://ec.europa.eu/commission/presscorner/detail/en/ip_24_4528

Final report "Strategic Dialogue on the Future of EU Agriculture A shared prospect for farming and food in Europe", September 2024 https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_24_4528/IP_24_4528_EN.pdf

ESPP input to Ecodesign preparatory study

ESPP has submitted comments to the European Commission (DG GROW) regarding the "Ecodesign preparatory study for product specific measures on scarce, environmentally relevant and critical raw materials and on recycled content". Phosphorus (as P_4), which is on the EU Critical Raw Materials list (CRM), was only briefly mentioned in the preparatory study (draft 11/6/2024), despite its importance for the five product categories identified for further study: fridges, imaging equipment, personal computers, washing machines and electrical motors. The CRM "Phosphorus" (in the specific P4 form) is in fact critical for fire safety through flame retardants, electronic chip production, and potentially semiconductor doping. ESPP urged for a thorough investigation of phosphorus's relevance in the next phase of the study and offered to assist in gathering additional information. The Ecodesign for Sustainable Products Regulation (ESPR) entered into force on 18 July 2024 and replaced the Ecodesign Directive (2009/125/EC), enabling introduction of Ecodesign criteria for a broader range of products and defining obligatory requirements for the most energy and greenhouse-gas-intensive products.

"Ecodesign preparatory study for product specific measures on scarce, environmentally relevant and critical raw materials and on recycled content" Interim Study Report, Ecodesign for Sustainable Products Regulation: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1781&qid=1719580391746

EU Fertilising Products Regulation (FPR)

Microorganisms for "biostimulants" to improve crop nutrient processes

Study launched for the European Commission (DG GROW) on microorganisms for possible authorisation under the EU FPR (CMC7) to propose an assessment methodology, screen proposals and assess microorganisms/processes. Proposals assessed will be those submitted to the EU survey of 2022 (see ESPP eNews n°69). The study has been contracted to AIT (Austrian Institute of Technology). The published 'inception report' (30 pages) presents the study approach, work plan and timeline. It further includes a first draft methodology indicating data requirements and decision criteria for microorganism taxonomic description, health and safety risks and for agronomic efficiency. The latter will be assessed against the four functions specified in PFC6 of the EU FPR, that is improving nutrient use efficiency, abiotic stress tolerance, crop quality or availability of nutrients in soil or rhizosphere. This will rely on the guidance and standards published or being developed by other organisations to substantiate efficacy claims of biostimulants, in particular the 2023 CEN standards: CEN/TS 17700-1:2022 Plant biostimulants - Claims - Part 1: General principles; CEN/TS 17700-2:2022 Plant biostimulants – Claims - Part 2: Nutrient use efficiency resulting from the use of a plant biostimulant; CEN/TS 17700-3:2022 Plant biostimulants – Claims - Part 3: Tolerance to abiotic stress resulting from the use of a plant biostimulant; CEN/TS 17700-4:2022 Plant biostimulants - Claims - Part 4: Determination of quality traits resulting from the use of a plant biostimulant; CEN/TS 17700-5:2022 Plant biostimulants - Claims - Part 5: Determination of availability of confined nutrients in the soil or rhizosphere.

"Technical studies to support the inclusion of new materials and microorganisms under the Fertilising Products Regulation, Lot 1 microorganisms & processes", Inception report, 21st march 2024, AIT, LINK.

Two EU harmonised standards for fertilising products

The European Commission has published in the Official Journal the first two references of harmonised standards, developed by CEN, to implement the EU Fertilising Products Regulation (FPR): EN 17816:2023 Liming materials – Determination of physical and chemical properties and specific contaminants and EN 17817:2023 Fertilizers, liming materials and inhibitors - Determination of the quantity (declared by mass or volume).

Commission Implementing Decision (EU) 2024/2387 referencing two harmonised standards for EU fertilising products, Official Journal 10th September 2024 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AL_202402387

European Commission mandate to CEN (n° M564) listing harmonised standards to be developed to support the EU FPR C(2020) 612, amended by C(2022) 47 and C(2023) 8288 https://ec.europa.eu/growth/tools-databases/enorm/mandate/564_en

Nutrient recycling technology catalogue

Update and new entries for Catalogue of Nutrient Recovery Technologies

ESPP has updated the Catalogue of Nutrient Recovery Technologies summarising processes for recovery of nutrients from sewage, manure or other sources. Recently added processes include Charlene (RE-CORD), Sinfert, SusPhos, Pyreg, and Stiesdahl Skyclean. Additionally, the catalogue has transitioned from a PDF file to an interactive web-based system, enabling users to directly access detailed information about each technology. The catalogue has also expanded its scope to include nitrogen (N) and potassium (K) recovery, with new filtering options available to search by type of recovery, operation, or input material.

The catalogue is open for the addition of new technologies. To be included, technologies should be operational or demonstrated at full-scale or pilot scale and should recover any of the nutrients: phosphorus, nitrogen, potassium, and/or micro-nutrients. Required information includes details about the technology supplier (website, contact information), input materials (e.g., sewage sludge, ash, manure), output products (nutrient content, organic carbon content, and other characteristics), process description (including the management of contaminants), current operating status (including the number and capacity of operational plants, pilot capacities, and duration of continuous operation), and photos of operational installations.

To include further technologies in the Catalogue: *send information to catalogue@phosphorusplatform.eu*

ESPP Catalogue of Nutrient Recovery Technologies: http://www.phosphorusplatform.eu/p-recovery-technology-inventory

Nutrient circularity in livestock and aquaculture

ESPP – UNEP uPcycle workshops: aquaculture, intensive livestock

ESPP with UNEP uPcycle and other partners, will organise workshops on nutrient management and phosphorus recycling in intensive livestock (4-7 March 2025 tbc) and aquaculture and fisheries (17-19 June 2025 tbc). See above.

To present or participate, contact info@phosphorusplatform.eu

Animal feed industry calls for circularity

Livestock feed industry federations have called for a "Feed Circularity Roadmap" and for discussions with regulators to identify possibilities to improve use of secondary materials in animal feeds whilst ensuring safety and quality. A joint letter signed by seven organisations and sent to the European Commission and to national food safety agencies, calls for dialogue to address regulatory restrictions to use of certain recycled materials in animal feed, in order to improve livestock circularity and reduce dependency on natural resources, soya import, deforestation pressures. The letter responds to a report by the EU Heads of national Food Safety Agencies (HoA) "Towards sustainable food systems - Reflections by Heads of Food Safety Agencies" (Sept. 2023, not online). The industry federations joint letter calls for public publication and discussion of this HoA report and dialogue to develop 'Feed Circularity Roadmap' identifying regulatory blockages to circularity in animal feed systems based on the examples indicated in the HoA report and other cases proposed by feed industry sectors.

Joint letter from industry federations to the European Commission (DG SANTE) and to the HoA (EU Heads of national Food Safety Agencies), 18th September 2024. Signed by European Fishmeal and Fish Oil Producers, European Former Foodstuff Processors Association, European Fat Processors and Renderers Association ESPP, EuropeanPetFood, FEFAC, European Feed Manufacturers Federation, International Platform of Insects for Food and Feed www.phosphorusplatform.eu/regulatory

SAFOSO final report on Cat1 animal by-product ash

Risk appraisal of Cat1 ABP ash (incinerated to EU standards) finds no evidence of BSE risk. The EU had only 4 (total) cases of classical BSE 2014-2019 and none 2019-2023. Use of the ash as fertiliser in the UK has not shown BSE cases. The UK Government (when the UK was still in the EU), authorised use of Cat1 ash as fertiliser subject to End-of-Waste requirements (Environment Agency 2012) and some 70 000 t/y of ash has been used as fertiliser since then. Portugal has also authorised use of Cat1 ash (2 000 + t/y) as fertiliser, but in forestry only. In neither case has an increase in BSE incidence resulted, despite use starting in the UK when BSE levels were higher than in the EU today. Considering different EU-authorised rendering processes upstream of disposal by incineration or power-station combustion, under the conditions required by the EU Animal By-Product and Industrial Emissions Directives, the report estimates that risk reduction to ash is between 30 000 – 100 000 and 10 million - 30 million depending on the rendering method. Taking a "worst case" scenario of five BSE cows in a single batch, this concludes that residual batch BSE infectivity [(Bo)ID50/kg-ash] is estimated to be 5.5 - 16.4 x 10^{-8} (rendering ABP Method 1) or x 10^{-5} (no risk reduction considered for other rendering methods). The risk appraisal was carried out for ESPP by animal health consultancy experts SAFOSO Switzerland. ESPP has transmitted the SAFOSO report, and the 50+ studies and documents referenced in it, to EFSA (European Food Safety Agency) to input to their current assessment of prion risk

European Commission (DG SANTE) has requested from EFSA (European Food Safety Agency) requested by the European Commission in April 2024 (conclusions expected by April 2025). EFPRA (European Fat Processors and Renderers Association) estimates that Cat1 ABP ash in Europe contains maybe 1 – 3 % of phosphorus used in mineral fertilisers (this does not include P in Cat1 material currently going to cement kilns).

European Commission DG SANTE "Request for a scientific opinion on the presence of biological and chemical hazards in ash from Category 1 material after incineration, co-incineration, and combustion", Ares(2024)2805627 - 17/04/2024, EFSA reference EFSA-Q-2024-00278, Mandate number M-2023-00166 https://open.efsa.europa.eu/question/EFSA-Q-2024-00278

The above is ESPP's simplified summary of the SAFOSO report. Please refer to the full report for conclusions and details.

"Risk appraisal of use of Category 1 animal by-products ash as fertiliser", SAFOSO for ESPP, September 2024
www.phosphorusplatform.eu/regulatory

EU funding for aquaculture sludge nutrient recycling

AquaPhoenix EU Horizon project will receive 10 million € to develop and implement technology to transform and recycle "fish sludge" from aquaculture in Hardangerfjord Norway, in particular with phosphorus recycling. Fish sludge is a mixture of uneaten fish feed and fish faeces and can damage freshwater or marine environments. The project is led by NORCE with 30 partners including ESPP member EasyMining (Ragn-Sells), Framo and five fish farming companies are taking part in the four-year project: Eide Fjordbruk, Erko Seafood, Lingalaks, Tombre Fish Farms, and Bremnes Seashore, all located near Rosendal, Norway. The Åland Fish Farmers' Association, Finland, is also a partner, interested in experience transfer to the eutrophication sensitive Baltic. The Hadangerfjord, Norway, produces some 100 000 tonnes of farmed salmon annually. Other trials by Lerøy Seafood suggest that around 60% of fish sludge can be collected below net cage aquaculture in fjords.

"Fish farming project in Hardangerfjord awarded over 10 million euro in grants", Ragn-Sells, 14th August 2024 https://www.ragnsells.com/about-us/press-media/articles/hardangerfjord/

"120 million NOK for unique EU project on sludge collection in Hardangerfjorden"", NORCE 12th August 2024
https://www.norceresearch.no/en/news/120-millioner-kroner-til-unikt-eu-prosjekt-for-slamoppsamling-i-hardangerfjorden

"Net pen collection system trapped 60% of sludge", Fishfarmingexpert, 22nd April 2022 https://www.fishfarmingexpert.com/leroy-seafood-lift-up-morenot-aquaculture/net-pen-collection-system-trapped-60-of-sludge/1288746

Sewage-recovered phosphate from Germany to animal feed in Canada

Gelsenwasser Germany, Friesen Group Canada and EasyMining will recover calcium phosphates from sewage sludge incineration ash in Germany use in livestock nutrition in North America. The EU animal feed regulations pose regulatory obstacles to use of sewage-recovered phosphates in animal nutrition, irrespective of the quality and safety of such secondary phosphates. Canada and the USA do not have such regulatory barriers. High-quality calcium phosphates will be recovered from sewage sludge incineration ash in Schkopau, near Leipzig, Germany, from Gelsenwasser's wastewater treatment plants. Gelsenwasser is a German utilities company, established in 1887 in the Ruhr region, and with today 6 billion € turnover in water and energy activities. Friesen Group is family-owned medium sized Canada and US supplier of animal feed, breeding and other livestock services. EasyMining, part of the Ragn-Sells group (ESPP member) has developed the Ash2Phos process to recover high-quality calcium phosphorus from biosolids or other organic waste ashes, recovering over 90% of the phosphorus from the ash.

"European recycled phosphorus can be exported to Canada", 21st November 2023
https://newsroom.easymining.com/posts/pressreleases/european-recycled-phosphorus-can-be-exported

"Green Light for a new phosphorus recovery Plant to address global resource needs", 10th September 2024
https://newsroom.easymining.com/posts/pressreleases/green-light-for-a-new-phosphorus-recovery-pla

Consultation: UN FAO draft document on livestock in the circular bioeconomy

Consultation open to 27th September on 230 page draft from the United Nations FAO (LEAP TAG 'Circular Bioeconomy Approaches'). ESPP notes that the document provides extensive literature references but no "guidelines" or practice recommendations, and no useful numbers on circularity potential. The draft document covers indicators of Nutrient Use Efficiency circularity, LCA and food systems modelling; plant by-product and animal by-product based animal feed potentials; manure and food waste management; public policies; food safety; planetary boundaries, one-health and other analysis frameworks. The document provides a high-level view, with many academic references and some industry information, and many examples, but not actionable technical or policy recommendations. Many numbers are given on different current recycling routes in the livestock sector, suggesting that there is already today a high level of circularity (in particular of use of animal and plant by-products), but there are scarcely any numbers for estimates of possible improvements in circularity through proposed practices (compared to current practice). The FAO document notes that "*livestock can play a crucial role in the circular bioeconomy by recycling resources that are not part of the primary food basket, through diverse contributions in areas such as food production, utilization of plant-based products, residual management, nutrient cycling, soil health and renewable energy generation …. vital role in nutrient cycling and soil health*", referring to Van Zanten et al. 2019 (biophysical concept of circularity). The report notes that livestock circularity can be measured using different indicators (e.g. Partial Nutrient Balance, Nutrient Use Efficiency, Gross Nutrient Surplus, Nutrient Recycling Index …) where each one emphasises a different metric.

Circularity of feed can, for example, be assessed as regards energy value, protein content or phosphorus cycling. Manure management is discussed: collection, storage, treatment and processing, including recovery of energy and processing to fertilisers. Quantities of manure generated worldwide and per continent are indicated.

Public consultation is open to 27th September. ESPP made input to the public consultation on the document welcoming the collection of information as a reference documents, regretting the absence of clear "Guidance" in the document (despite its title) and suggesting that it should be reformulated to separate clear and actionable recommendations for practice, and noting the need for numbers to estimate the potential for improvement of circularity compared to current existing recycling and valorisation practices.

"Guidelines on the role of livestock in circular bioeconomy systems", draft, UN FAO (United Nations, Food and Agriculture Organisation, LEAP Livestock Environmental Assessment and Performance, TAG Technical Advisory Group), https://www.fao.org/partnerships/leap/news-and-events/news/detail/en/c/1708905/

***Open for public input to 27th September 2024**: https://www.fao.org/partnerships/leap/resources/public-review/en/*

ESPP input submitted 13/9/2024: www.phosphorusplatform.eu/regulatory

Marine advisory councils call on fishery and aquaculture circularity

Identified obstacles to blue economy recycling include the exclusion of aquaculture sludge from the EU fertilisers and the Animal By-Products regulations . The seven-page policy paper from NSAC (North Sea Advisory Council), MAC (Marine Advisory Council), AAC (Aquaculture Advisory Council) and CCRUP (Consultative Council for Ultraperipheric Regions) follows the Circular Blue Economy event (January 2024, see ESPP eNews n°84). It identifies sustainability concerns (health, ecosystems, fisheries) for fishery and aquaculture waste and by-product recycling, opportunities and economic benefits, consumer attitudes and current regulatory and policy objectives. It is noted that today, 40% of fish meal used in aquaculture feed originates from marine fishery leftovers and that there is a need to reduce this reliance by increasing use of other vegetable or animal by-products. The advisory councils specifically identify as regulatory obstacles the current exclusion of fish sludge (aquaculture wastewaters) from the EU Fertilising Products Regulation and the status of fishery and aquaculture derived materials under the Animal By-Products Regulation. The councils consider that "*There is a need to revisit the 2009 Animal By-Product Regulation to align with the principles of the circular economy and food sustainability, without compromising safety standards in the current landscape. The new version should categorise fish excreta as manure and make them suitable for use as fertiliser*." The AAC already called for farmed fish effluent to be classified as an Animal By-Product in 2022. They also note the obstacles posed by "*the necessary co-existence of animal by-product materials processed within the same establishment. Such integration is pivotal for enhancing industry efficiency and making the best value of raw materials. Certain fishery products, and in particular cut offs from the processing industry, could be classified as animal by-products, and once declared animal by-product, such raw materials cannot be upgraded and processed for food markets. Mixing different raw materials, approved for food or for feed, is not permitted either*." More flexibility in regulation is needed, whilst continuing to ensure health and safety. The councils underline the need to enable use of aquaculture and fishery wastes in Organic Farming.

"Joint-AC Advice on valorisation of fisheries and aquaculture by-products", 3 September 2024, https://www.nsrac.org/wp-content/uploads/2024/09/12-2324-Joint-AC-Advice-on-Valorisation-of-fisheries-and-aquaculture-byproducts.pdf

Research and innovation

Lab testing of P_4 synthesis from phosphoric acid

A lab-scale reactor (32 mm diameter, 1.2m high, acid input 0.01 ml/minute, 1 hour runs) was tested for production of white phosphorus (P_4) from phosphoric acid using carbon reducing agent electrically heated to 900 - 1000 °C. No data is provided as to whether this would be more energy efficient than current P_4 furnaces using coke and electric heating and operating at >1500°C. ESPP notes that energy is economised in that calcium is separated from phosphate upstream of the process (production of the phosphoric acid, by the 'wet acid' route, using sulphuric acid which has zero energy footprint because it is a by-product of oil refineries) but on the other hand very considerable energy will be consumed to evaporate water (85% phosphoric acid is 85% H_3PO_4 so in effect 38% water: 15% as water and 13% in the H_3PO_4). The phosphoric acid (85% concentration) was dripped from the top of the reactor tube onto a 20 – 50 cm bed of coke or activated carbon bed. The phosphoric acid is thermally decomposed into P_2O_5 and H_2O gases at the top of the bed held at 1000℃. The generated gases are reduced in the carbon bed into CO, H_2, and P_4 gases. Some of the P_4 was condensed in the lower, cooler layers of the bed and trickled down through the silica filter reactor base into a water bath, some came off as gas which was reacted in water bath. A difficulty identified is that because there is no silica input (from phosphate rock or ash), no slag is produced (an energy consumption benefit), whereas the molten slag in conventional furnaces removes impurities from the system. Some impurities are however retained in the carbon reactor bed. No data is given concerning carryover of phosphoric acid with the offgas. Other challenges to address are removal from the reactor of the ash from reacted coke, and collection of solid white phosphorus (rather than reaction to phosphoric acid in a water bath). ESPP notes that it is likely that phosphine PH_3 will be released: this could pose operational challenges, or could be a commercial opportunity (phosphine is a precursor for organophosphorus

chemistry). ESPP considers that these lab tests show that P_4 production from phosphoric acid is technically possible, but that energy analysis is needed to assess whether this offers significant benefits compared to a conventional P_4 furnace (using phosphate rock or secondary ash as input), solutions must to be found to remove contaminants and inerts from the reactor (calcium, silica) given that there is no slag outflow, more work is needed on carryover of phosphoric acid and phosphine, and that scale-up will require addressing corrosion throughout the system (hot acid, corrosive offgases …). Based on these first tests, Tohoku University is now conducting experiments with acid input 0.6 litres/hour.

"White phosphorus production by a carbothermic reduction of upcycled crude phosphoric acid", H. Yu et al., Resources Conservation & Recycling 211, 2024, 107868, DOI.

Groundwater is a significant source of phosphorus to Oneida Lake, USA

Total groundwater P concentrations reached high values (up to 100 mg/l), with inorganic P representing c. 10% of total P, elevating lake P concentrations at the shore sediment–water interface and in the overlying water column. The role of groundwater leakage in P loading dynamics was evaluated along the shoreline of Oneida Lake (New York, USA), a shallow mesotrophic 207 km^2 lake. Two studies were conducted focusing on different scales along the lake: the first during summer 2017 and 2018, with sampling stations installed along 800 m of the southern basin shoreline; the second during summer 2020, sampling 10 representative sites around the entire shoreline. Groundwater leakage volume was measured and used with total P (TP, unfiltered samples) and Soluble Reactive Phosphorus (SRP, filtered sample) data of pore and lake water samples to estimate P loads. Groundwater SRP concentrations and loads, although low, were constant throughout each summer season (c. 0.2 mg/L in 2017-18, 0.1 mg/L in 2020), indicating a consistent input of readily available P to the littoral environment, while TP concentrations were significantly higher than SRP (c. 2.0 mg/L in 2017-18, 25.0 mg/L in 2020), and widely variable across time and space (up to c.100 mg/L in 2020). Local and regional precipitation were positively correlated with flow rates and P fluxes. Sampling sites adjacent to residential areas exhibited higher P concentrations, possibly due to septic systems or garden fertiliser use. High TP loads also occurred adjacent to forested landscapes, possibly because of dissolved organic compounds leaching from the forest soils. In the study, SRP concentrations averaged less than 10% of TP, indicating that dissolved organic P, likely available for biological consumption, was the predominant fraction entering the lake via groundwater seepage (TP samples showed little to no particulate fraction). Therefore, even though the P entering the lake through groundwater seepage (3% of annual water inflow into the lake) is a small fraction of the total P loading to the lake, it may have an important impact due to its high bioavailability.

"Groundwater inputs could be a significant but often overlooked source of phosphorus in lake ecosystems", M. Sol Lisboa et al., Scientific reports 14, 2024, 16269, DOI

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