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> Recovery of phosphorus from waste water treatment plants

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> Summary

The present study provides an overall perspective on technologies for the recovery of phosphorus from waste water treatment plants and the opportunities they offer. It differs from previous work in that it not only provides technical process details, but also – and particularly – highlights the status of development, probable availability, and economic viability of the processes, providing the reader with an aid in decision-making.

It becomes readily apparent that the conservation and careful use of phosphorus has now become a matter of worldwide concern that has given rise to numerous research activities. Many of these have now left the laboratory stage and are on offer commercially; even if at an early stage that does not permit final assessment.

As the study shows, procedures for the recovery of phosphorus have been brought to the stage of industrial maturity in all 5 continents. Further processes are now at a more-or-less advanced stage of development. The driving forces behind these have proved to be: operational problems in plants with high biological phosphorus elimination (Bio-P) that are very difficult to manage; and also political initiatives, especially in Sweden and Germany.

In the first chapter, the reader is provided with an introduction to the essential functions of the element phosphorus in living cells, the conditions for the degradation and preparation of mineral phosphate ores and the high potential of secondary raw materials for sustainable cyclic production.

The description of processes for waste water treatment that follows, and a review on possible points of application are given to provide an understanding of the processes for phosphorus recovery, and to facilitate the assessment of the recovery processes described. Not least, the recycling processes are applied at 4 different points in the process chain of waste water treatment: (a) the main flow section of the treatment plant, (b) in a concentrated secondary flow section following sludge dewatering, (c) in the wet or fermenting sludge, (d) in the ash from sludge incineration. This section makes it clear that every point of application has its advantages and disadvantages, and that therefore no one process technology can claim to be the “ideal” solution. Considering that the technologies for phosphorus recovery have only just crossed the threshold from the research institute to the pilot stage, there certainly exists a technological potential that can be exploited under favourable social and political conditions.

To judge by the number of plants in continuous operation in waste water treatment plants, the Japanese Unitika Group can be said to be the market leader. In Japan, 3 “Phosnix“ plants are in operation, and these offer not only a clearly marketable process technology, but also a scheme for marketing the MAP crystals, which are supplied to

the Japanese fertiliser industry, where they are further processed to organic/mineral fertilisers for special cultures.

The following companies, which each have one plant in operation, follow in positions two to five: ASH DEC in Austria, DHV in the Netherlands, Ostara in Canada, and Seaborne in Germany. Whilst the DHV Crystalactor® has been in operation since 1994, the installations of the other companies are still at the pilot stage. Whereas in Japan the economic viability of processes is not equally prominent as in the rest of the world, and the calcium phosphate produced in the Crystalactor® plant cannot be marketed at an economic price, the commercial viability of all these processes cannot at present be ascertained.

The ASH DEC pilot plant has by far the greatest throughput, with a daily production of 7 tonnes of phosphate fertiliser – a greater production than that of all other plants taken together.

Whilst Unitika, Ostara and ASH DEC offer a comprehensive scheme comprising process technology and fertiliser marketing, DHV and Seaborne are limited at present to the sale and installation of plant, so that their offer is not quite so attractive to potential buyers.

Where the recovery potential is concerned, ASH DEC and Seaborne lead the field. These alone can recover the phosphorus eliminated in the waste water treatment plant completely, whereas the other processes must be content with recovery rates of 45–50 %. The quantitative recovery of phosphorus with ASH DEC makes necessary the thermal utilisation of the sludges in monovalent incineration plants.

Apart from ASH DEC, all the leading manufacturers follow the principle of phosphorus recovery in the waste water treatment plant, i.e. fully decentralised. The principle adopted by ASH DEC is also relatively decentralised, the preferred location of installations being near to the sludge incineration plant. The decentralized approach incurs the economic disadvantage of lower process throughput, which weakens their competitive position with respect to the fertiliser industry, which is concentrated at only a few places.

The MAP crystallization processes of Unitika, Ostara and DHV have the advantage that a marketable product is produced directly in the reactor. The Seaborne and ASH DEC products require one or more finishing stages before they can be sold as fertilisers. Regardless of this, Ostara alone exploits this advantage in that the granulate is sold directly as Crystal Green®. ASH DEC itself makes provision for this with PhosKraft®, either in its own or in third-party installations. Unitika and DHV leave the finishing stages to the fertiliser or phosphorus industries.

Market developments will show whether, and to what extent, marketable fertilisers can be produced from mutually finished MAP crystals and products from sludges and sludge ashes. Should both process approaches prove successful, the question will arise as to the combination necessary for the achievement of maximum recycling quotas.

From an ecological standpoint, as it can neither be assumed that MAP crystallization will be installed in all Bio-P waste water treatment plants, nor that all sludges will be utilized in monovalent incineration plants, further intensified coordination and cooperation are desirable.

Alongside the processes whose manufacturers are even today asserting the economic viability of processes for the recovery of phosphorus from waste water with more-or-less continuous operation, there are those processes that are likewise at the pilot stage, but which have not yet achieved market maturity.

In this connection the AirPrex process of the *Berliner Wasserbetriebe*, the process used in the Treviso waste water treatment plant, the Rem Nut® process and the Nishihara crystallization reactor should be mentioned, each of which could reach this development stage in the near future. Notwithstanding this, the Treviso waste water treatment plant and the Rem Nut® process still have the disadvantage of not disposing of a commercially active process promoter.

Whether or not those processes that fulfil both the requirement regarding a commercially active process promoter and practical testing in a pilot plant, but owing to lack of economic viability, or due to process problems, have not yet achieved continuous operation, will again come to prominence, remains doubtful.

In fact, it seems more probable that one of the processes that are at present still at the university stage could be successful. For this, not solely technical and economic feasibility but also the readiness of companies to invest, and the political conditions, will be decisive.

In view of the discussion in recent weeks and months of the importance of the prevailing social and political conditions in achieving an economy that serves humanity, this also – and particularly – applies to the development and viability of processes for phosphorus recovery. These processes will enable Europe and other communities with only few raw materials to become less dependent on potentially unreliable sources of supply and make a significant contribution to the conservation of limited resources.