TEXTE
98/2015

Evaluating Concrete Steps for Advanced Phosphorus Recovery from Relevant Streams as well as for Efficient Phosphorus Utilization

Summary

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Evaluating Concrete Steps for Advanced Phosphorus Recovery from Relevant Streams as well as for Efficient Phosphorus Utilization

Summary

by

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Introduction

In light of the current political developments – the fertilizer ordinance as well as the draft of the sludge ordinance with integrated controls for phosphorus recovery – individual questions will be answered for phosphorus recovery under the UFOPLAN (Environmental Study) project. In addition to stricter limits of the fertilizer regulation for agricultural recycled sewage sludge from 2015, the report discusses withdrawing from land-related utilization of sewage sludge and introducing a requirement for phosphorus recovery (see draft of the sludge ordinance).

Main topics of the report are the potential for saving phosphorus in products and phosphate-containing products as well as the quality of recycled materials and their use as a fertilizer in agriculture or in the fertilizer industry. In addition, it identifies and evaluates methods for P-recovery, presents the costs and energy consumption of the processes and tests possible changes of the waste water treatment plants in terms of facilitating phosphorus recovery. It also focuses on calculating quantity for the development of thermal sludge treatment and the possibility of landfill mining as well as the long-term storage of sewage sludge ashes. Based on a survey of experts, aspects of introducing the recycled materials onto the market were discussed. Furthermore, steps already taken for disposal of sewage sludge and P recovery are presented from abroad. Finally, it examines the possibilities of legally implementing P-recovery processes, including financing and subsidizing P recovery and for the phosphate industry`s obligation to accept recycled materials produced.

Key subject: savings potential of phosphorus

Outside of agriculture, the uses of phosphorus are comparatively insignificant. The highest potential to save it can be found in machine dishwashing detergents. However, here replacing phosphates is far more difficult than doing so for to detergents for washing machines. The substitutes have to be just as effective in the mixture and must not perform worse from an ecological point of view over their entire life cycle. Moreover, the substitutes have to fulfill certain requirements: biodegradability, low toxicity and environmentally acceptable behavior in aquatic systems as well as high rates of elimination in sewage treatment. A saving of phosphorus must not lead to major environmental loads. Basically, this seems to be feasible, while such measures will likely lead to a price increase for dishwasher detergents. The annual savings is 10,000 to 20,000 Mg P/a. The savings potential in food comes next. Here phosphorus in the form of additives can be cut back. However, this requires the assessment by food chemists.

In metalworking, phosphating can be replaced by new procedures which, additionally, have further advantages such as reduced energy consumption and reduced sludge formation. The phosphorus consumption involved is highly uncertain due to a lack of reliable figures and may be up to 7,000 Mg P/a, but it is probably much lower.

In other areas phosphorus cannot be easily substituted or only so by increasing the amounts of other substances. It is advisable to save phosphorus in the afore-mentioned areas to have enough phosphorus available for these purposes in the future.

Key subject: Phosphorus-recovery on wastewater treatment plants

Phosphorus recovery processes are technologies for the recovery of phosphorus from secondary raw materials. The aim is to be able to use the phosphorus directly in agriculture as fertilizer, in the fertilizer or phosphorus industries (Montag et al. 2010). Phosphorus-recovery processes are characterized by extracting pollutants selectively or separating out valuable substances from pollutants. Therefore, the use of sludge in agriculture or the use of (solubilized) sewage sludge ash cannot be evaluated as a phosphorus-recovery process.
In Germany as well, several large-scale and pilot plants for phosphorus recovery are already being operated and tested. The stage of development or the market maturity of the technologies varies greatly. During the last few years, more new process concepts have also been developed, which shows that further innovations in this field can be anticipated. The potential to recover phosphorus from sewage sludge lies in the range of up to 45 to 70 %, for sewage sludge ash up to 90 %, based on the phosphorus contained in the wastewater treatment plant influent. Nevertheless, these values do not take the degree of plant availability of the contained phosphorus into consideration. Under certain boundary conditions, some processes can already be operated economically today.

A consistent system boundary is crucial when the respective costs and energy requirements for the production of phosphorus fertilizers by recycling processes are compared with the production from primary phosphorus sources. The difficulty lies in the big difference of secondary and primary systems, especially due to the interconnection of phosphorus recycling with the complex processes of sewage and sewage sludge treatment. For example, in case of the sludge treatment as an integral part of the recycling process, it has to be credited to the respective process as additional benefit. The burden and costs of the alternative treatment is, therefore, credited to the process as benefit. Likewise, when the ash from sewage sludge treatment is reduced thanks to recycling processes, a “bonus” results as a consequence of the reduced burden upon landfills.

This approach makes it possible to keep the system boundary consistent and tight. The result can be focused on the significant factors. In a subsequent extended system approach, the thermal treatment of the sewage sludge and subsequent disposal is included within the system boundary in order to account for the interactions of sewage sludge treatment and recycling processes.

The restriction on energy and greenhouse gas balances derived from this should not distract from the fact that, in a full life cycle assessment, clear advantages for phosphorus recycling would show up. When all ecological aspects are considered, the higher inputs of cadmium and uranium into soil by the application of primary fertilizers and the environmental effects from open mining of phosphate rock outweigh the higher energy consumption of phosphorus recovery. Reference is made to the results of the project PHOBE (Pinnekamp et al. 2011).

A comparison between the different recovery methods depends on the individual case under consideration and cannot be made on this general basis. In the model a theoretical average sludge is assumed. In particular, the costs of recovery depend very much on the individual case under consideration and can hardly be evaluated on a generalized basis. There may be process-related synergies, whereby resources are saved elsewhere. In addition, large-scale implementation in most cases is still pending. The information provided by the manufacturer, underlying the energy and greenhouse gas balance and costs calculation, thus relates in part to sites in laboratory scale or represents theoretically calculated data. Especially since the investment costs have a strong scale effect, this study does not show process-specific cost information. The reported spans should provide guidance as to which costs can be expected from a widespread introduction of phosphorus recovery processes from an economic point of view.

In view of the energy and greenhouse gas balance with respect to the tight system boundary, the recovery of phosphorus from the wastewater sector is associated with higher burdens than the production of primary phosphorus fertilizer. These higher burdens are, however, assessed as low:

The phosphorus potential in a year incurred in sewage sludge in Germany, with about 82 million population equivalents, amounts to nearly 60,000 Mg of phosphorus. This amount could cover the mineral phosphorus requirement of about 30 million inhabitants in Germany, corresponding to 30 million inhabitants averages (EDW). If this amount of phosphorus were produced via recovery processes, rather than being derived from phosphorus ores by conventional production of primary fertilizers, an additional burden of up to 60,000 EDW would result depending on the process with respect to the greenhouse effect and 80,000 EDW in terms of energy consumption.

In the extended system approach, the normalized results of the greenhouse effect and energy consumption remain two orders of magnitude behind the saved amount of phosphorus. The environmental burdens connected with the recovery of phosphorus are, therefore, relatively small compared to the attainable conservation of phosphorus resources. The recovery process from process water or sludge can be combined with a subsequent co-incineration of sewage sludge in a power or cement plant. The co-incinerated sludge is depleted of phosphorus, the ashes of which are no longer available as phosphorus resource because of the dilution by mixture. Regarding the energy and greenhouse gas balance, such systems have advantages over subsequent mono-incineration and also over the systems that rely on mono-incineration due to recovering phosphorus from ashes. A normalization step on population averages shows, on the one hand, that the differences between the systems are small.

On the other hand, other studies have proven that the normalized differences between mono- and co-incineration regarding mercury emissions are much more relevant, in which the co-incineration performs much worse (Fehrenbach, Reinhardt 2010). Therefore, from the results of this study with respect solely to the greenhouse effect and energy consumption, no conclusion is possible on an ecological prioritization of mono- or co-incineration after phosphorus recovery from process water or sludge.

The calculated cost range for the recovery processes is € 0.40/kg P to 20/kg P, with the € 0.40/kg P depending on the modeling style, which may not be reached in practice. In contrast, the production costs for primary fertilizer range from € 0.60/kg P up to € 2.20/kg P, depending on the degree of processing, and are thus lower.

Co-incineration tends to be assessed as cheaper than mono-incineration. It is, thus, an option for the systems with recovery processes winning phosphorus from process water and sludge. However, the values reported in the literature have large spreads, so no general statement is possible.

If the amount of phosphorus present in the sewage sludge incurring each year in Germany was produced by recovery processes, the annual costs would range from min. € 0.30 to max. € 14 per inhabitant, depending on the recovery process. The € 0.30 may not be reached again in practice. In comparison, a user will pay up to € 1.60 for the same amount of primary phosphorus in the form of rock phosphate and € 0.40 in the form of phosphorus fertilizers.

The thermal treatment of sewage sludge causes annual costs from € 4.30 to 6.40 per capita in case of mono-incineration, and in the range from € 2.70 to 4.00 for co-incineration in a lignite-fired power plant. Adding the phosphorus recovery leads to total costs of min. € 4.30 up to max. € 11.40, depending on the process and combustion. When these economic costs are taken into account, 1/9 up to 1/3 of the phosphorus needs could be met depending on the recovery process.

Overall, therefore, both the energy consumption and additional greenhouse effect and the increase in costs for the individual citizen move to an acceptable level when the phosphorus recovery is implemented in the wastewater sector. In exchange, the resulting savings of phosphorus resources has to be seen as well as the above-mentioned additional environmental benefits.

A fundamental question remains as to how the recycled materials can be processed in the fertilizer industry and whether a direct application of some products is possible. This will determine what credits and revenues for the recyclates can be taken into account. From an ecological perspective, the energy credit for the production burdens of a corresponding amount of primary fertilizer is not critical. Rather, the saving of phosphorus resources is the crucial point here. The use of recyclates should be designed to achieve maximum savings of primary phosphorus resources by the recovered amount of phosphorus effectively. When a recyclate without any phosphorus available to plants is spread on a field, there are no savings of primary phosphorus resources.

According to the data of the DWA sludge elevation conducted in 2003, an enhanced biological phosphorus removal is applied to 6 % (related to population equivalents) of the municipal wastewater treatment plants. Under optimum conditions, the potential for phosphorus recovery from the sludge liquor on these plants is about 1,300 Mg P/a (including efficiency of recovery process). This potential should be used as soon and as extensively as possible as a part of the phosphorus strategy. Therefore, MAP precipitation processes, for example, can be applied, which generate a recyclate having a very high share of phosphorus available to plants.

However, an extensive conversion to Bio-P elimination processes seems to be unrealistic. This is due to the fact that operators often avoid the operational disadvantages of the Bio-P, and/or additional basin volumes are necessary for which surfaces are not available on many wastewater treatment plants.

Key subject: fertilizer and fertilization

The use of phosphorus can be cut back in agriculture mainly by improved fertilizer application. Due to a high P-status in German soils, especially in areas with high animal density, fertilizer reduction and regional redistribution can help to reduce phosphorus consumption.

Recently, main P-savings have been achieved by depletion of soil reservoirs that have accumulated during the last decades by excessive fertilizer use. This lessening, which is around 5 % per year in average for Germany, can be continued for quite a number of years. However, at some point those reserves will be consumed and then more phosphorus will be necessary to balance the phosphorus removed by harvested crops.

Further P-savings are possible by reallocating any regional surplus. A potential of around 20.000 Mg P/a may be reclaimed from areas dense in animals, especially if separation techniques are improved to allow more economic transportation of those phosphorus substrates.

Generally, improving soil conditions will increase P-efficiency. However, as many of those measures (liming, addition of organic substrate, soil structure improvement) are already used, we do not expect a huge hidden potential for saving phosphorus in Germany. Due to the actual trend of intensification in agriculture, there may rather be stable or lower exploitation than increased one.

Means in plant production, e.g. cultivation of leguminosae, have the potential to save some phosphorus in Germany. However, they do not contribute to P-saving if balanced globally.

The phosphorus products selectively generated with phosphorus recovery processes are called recyclates. Sewage sludge and sewage sludge ash are not recyclates in this sense.

P-recyclates should best be employed as a stand-alone fertilizer. Therefore, product quality has to fulfill the requirements demanded by law as well as to reach sufficient plant availability. Besides, for consumer acceptance, fertilizer price, consistency and handling are important. If the aim of stand-alone fertilizer cannot be reached, recyclates could be added to other commercial fertilizers. It has to be ensured, however, that this does not "hide" bad recyclate quality or dilute pollutant concentrations. As a third possibility, recyclates might be treated/digested together with raw phosphate to obtain super- or triple phosphate. With this treatment, elimination of pollutants could be included as well.

To estimate the fertilizer efficiency, analysis of solubility, soil and plant experiments in pot and field are done. Analysis of solubility – as demanded in DüMV – is a first reference to estimate fertilizer efficiency; however, it cannot fully describe the complex situation in a soil with plants.

P-solubility depends on the P-binding form as well as on the bound cation. Primary phosphates ($H_2PO_4^{-}Me^{+}$) are well water soluble, secondary partly and tertiary phosphates are not water soluble. Further factors influencing the solubility are grain size, batch or additional ingredients. The examined recyclates usually did not have a water soluble P-fractions, but they do have different percentages of ammoncitrate soluble phosphate.

Fertilizer efficiency is evaluated in relation to a paralleled mineral fertilizer. Examined recyclates showed different efficiency:

MAP (struvite) is similar / comparable to super- or triple superphosphate and can be classified as an effective P-fertilizer. Less effective recyclates like Mg-Phosphates, Ca-silico-phosphates, Ca-phosphates scored similar to Thomas phosphate. Due to neglecting effectiveness of Al-P- and Fe-P recyclates and raw ash, those cannot be recommended as P-fertilizer. For some fertilizers, the effect depends on the soil pH and may only be valuable in acid soil conditions.

Little is known about pollutants in recyclates. Especially on organic contaminants, published analyses are rarely available.

A considerably large study on ashes from mono incineration by Krüger & Adam (2014) showed that heavy meatal concentrations in ashes can exceed the thresholds listed in the DüMV. In around 2/3 of the examined ashes, one or more metals exceeded the limit. This was especially the case for sewage sludge from industrial origin.

Several thermochemical or wet chemical treatments have been applied to improve quality and to eliminate pollutants. Results of the available studies show that the treatments are able to reduce the metal concentrations. However, quality demands of the DüMV could often, but not always be reached. Levels of Ni and As were surpassed, as well as those for Zn, Cu, and Cd.

When developing strategies to reuse phosphorus, planners need to include waste water treatment itself (not only sludge) into the approach. Options to regain phosphorus by biological treatment or by new sanitary systems may have advantages compared to current Fe-precipitation as high Fe will reduce P-efficiency of a fertilizer.

To estimate the "recycling efficiency," it is not sufficient to balance the total amount of regained phosphorus. The total amount of P in a fertilizer product is not sufficient either, as it is necessary that the plant can take up that phosphorus. Therefore, the plant-available phosphorus has to be the criteria for efficient recycling.

Key subject: incineration, storage und landfill mining

The amounts of phosphorus in sewage sludge which are co-incinerated (coal-fired power plants, cement works, waste incineration plants) are still irretrievably lost. The residues of incineration plants are deposited, for example, in road construction or on landfills and, therefore, cannot be used for phosphorus recovery on account of their being strongly diluted. The amounts of phosphorus are estimated to be approximately 16,900 Mg P/a. To use the phosphorus, it has to be recovered before the sewage sludge is incinerated. To do this, there are several possibilities to recover it from sewage water or digested sludge. According to the current draft of the Sewage Sludge Ordinance (status: April 2014), sewage sludge can only be incinerated if its maximum P-content does not exceed 20 g P/kg DM. A standard P-content of approx. 35 g P/kg DM in sewage sludge would thus mean phosphorus has to be depleted by 45 percent, but the available recovery process from sewage water cannot reduce the P content in sewage sludge to this extent. The Budenheim and Stuttgart process, however, can just reach this depletion level according to the current results of the process optimization.

Based on the distribution of the contaminant levels in agriculturally recycled sewage sludge, we determined what amounts of sewage sludge in the future (from 2015 on) can no longer be recycled due to the tightened limits of the fertilizer ordinance (DüMV). In addition to cadmium, the tightened limits for mercury and PCB could lead to the fact that about one third of the sewage sludge recycled in 2003 can no longer be used in agriculture or landscaping. The other parameters studied are not likely to lead to any significant reduction in recycling. The evaluations from the federal states Mecklenburg-Western Pomerania and North-Rhine Westphalia come to similar conclusions with much more recent data for sludge quality. It is believed that the heavy metal content in the sludge could fall if the indirect discharge is more intensively monitored. On the other hand, the amendment of the fertilizer ordinance may significantly restrict farmers from spreading sewage sludge in the autumn, and they cannot compensate for this amount by increasing its usage in the spring. These aspects could reduce the amount of sewage sludge to be recycled by about 40 %.

Depending on the scenario (30 % and 50 % of the previously agriculturally recycled sewage sludge no longer complies with the limits set by DüMV), the amounts of thermal utilization of sewage sludge would increase by about 234,000 or 390,000 Mg DM/a.

Under the assumption that, along with the introduction of the ban on land-related sewage sludge recycling, a P-recovery cannot be carried out successfully, 90 % of the sewage sludge would have to be incinerated in mono-incineration plants, with co-incineration losing its legal compliance for Class 4 and 5 treatment plants. Class 1 - 3 sewage treatment plants could continue recycling their sewage sludge material or incinerating it (about 10 %). This would mean that, at the presently available mono-incineration capacity of approximately 611,300 Mg DM/a, approximately 1.05 million Mg DM/a would have to be created additionally.

Assuming that P-recovery procedures are implemented at wastewater treatment plants in the future and that sewage sludge can be depleted below the required P-limit, this sludge could be co-incinerated, and the existing capacities for co-incineration could continue to be used. However, this would mean that all Class 5 sewage treatment plants and a portion of the Class 4 would have to be equipped with a P-recovery process.

Since reliable cost estimates are not yet available for the P-recovery methods and the disposal prices of sludge are expected to change significantly in the future, definite statements cannot yet be made on which P-recovery method with which sewage sludge disposal option is the most cost effective method.

Since the phosphorus in sewage sludge ash cannot yet be economically recovered, but is a valuable resource, sewage sludge ash from mono-incineration plants should be stored separately to allow later phosphorus recovery.

The amendment of the German Landfill Ordinance in May 2013 (DepV) enables sewage sludge mono-incineration ashes to be stored in long-term storage facilities. In accordance with the German Landfill Ordinance the separate storage can be permitted if an application is filed to waive the obligation to prove that the subsequent proper and harmless reuse is assured. This exception has to be limited to a maximum of five years and may be extended until 30 June 2023. Based on the current draft of the German Sewage Sludge Ordinance (AbfKlärV) it is expected that the separate long-term storage of non-P-depleted ash from mono-incineration plants will become compulsory after the transitional periods granted.

Long-term storage facilities could be constructed on existing landfill sites or at mono-incineration plants. A minimum capacity of 200,000 m^3 is recommended for a long-term storage facility.

Pursuant to § 23 of the German Landfill Ordinance, the requirements for long-term storage facilities (of Classes 0 – III) equal the ones for landfills. It can be assumed that the requirements of a Class II long-term storage facility have to be applied for most of the sewage sludge ashes. Some sewage sludge ashes may not be stored in a Class II long-term storage facility, whereas some could also be stored in a Class I long-term storage facility.

For a Class II long-term storage facility a bottom liner has to be implemented as a combination seal with two sealing components above the geological barrier, while for a Class I storage facility a bottom liner with one sealing component is sufficient.

Depending on size and filling period the estimated costs for the construction and operation of long-term-storage facilities for sewage sludge ashes amount to between 19 €/Mg ash and 42 €/Mg ash, 0.21 €/kgP to 0.47 €/kgP (at a phosphorus content of 9 %), respectively. The costs to remove the stored ashes cannot be estimated with any certainty at this time.

In practice, since the German Landfill Ordinance limits the storage of sewage sludge ash, potential operators might not invest in the long-term storage of sewage sludge ash as they may have to remove the material before 30 June 2023 and dispose of it at a landfill.

Based on phosphorus concentrations in sewage sludge, the accumulated sludge volumes and the sludge disposal routes, we determined how much phosphorus from sewage sludge and sewage sludge ash has been stored or deposited into landfills over the last 33 years. The total amount of phosphorus deposited from 1979 to 2012 is approximately 335,800 Mg P, of which approximately 293,800 Mg P are present in sewage sludge and 42,000 Mg P in sewage sludge mono-incineration ashes. In the early 80s, the deposited sludge quantities were high (about 55 % landfilling), the P concentrations (10.4 g P/kg DM) in sewage sludge, however, low. At the end of the observation period, the ratio was reversed. The P concentrations in sewage sludge more than doubled (24 g P/kg DM) and the deposited sludge quantity declined completely in the course of implementing the technical guidelines up until 2005. As domestic sales of phosphate fertilizers are approx. 124,000 Mg P/a in the fiscal year 2012/2013, the amount of phosphorus present in landfills could meet the demand for fertilizers for about 2.7 years. It can be assumed that a large part of the sewage sludge and sewage sludge ashes in the period under investigation was deposited together with domestic waste or municipal waste. Depending on the kind of installation, the sludge amount was between 5 to 13 % and from 1 to 3 % of household waste and municipal waste volume, respectively, so that the sludge found in the landfills and in storage was strongly diluted. In addition, one cannot assume, for example in open, public sludge-based composting facilities, that only the open compost itself can be decomposed selectively. Methods and techniques for phosphorus recovery from landfill residues are not currently available, nor is any empirical knowledge. It is also questionable whether domestic waste and municipal solid waste and sewage sludge can be easily separated.

The amounts of phosphorus in storage and landfills are theoretically available, but they cannot yet contribute to conserving resources according to present knowledge.

Key subject: strategies and measures

In addition to Germany, other countries have begun concentrating on a withdrawal from agricultural sludge disposal and on increasing phosphorus recycling. For example, in the Netherlands, agricultural utilization of sewage sludge is no longer possible due to very low pollutant limits, which means all sewage sludge is, thus, incinerated. In Austria, the states of Vienna and Tyrol have already adopted a ban on the agricultural use of sewage sludge as has Switzerland. The canton of Zurich is currently building a sewage sludge mono-incinerator with neighboring sewage sludge ash storage. The sewage sludge ash will be stored for later use, e.g. for P-recovery.

It turns out that methods for phosphorus recovery have been established in individual countries without there being a requirement for it. In Belgium, the NuReSys® method is used in the industry in particular, and in Germany the AirPrex® method is increasingly being established for sewage treatment plants. In the USA and Canada, the Ostara PEARL® methods have been applied exclusively so far.

In Japan, 100 % of sewage sludge is incinerated as is the case in the Netherlands and Switzerland. A recovery is carried out from sewage sludge ash, from waste water and from municipal sewage treatment plants as well as in the industry. In Japan there is currently no established market for the recycled materials recovered; they are either delivered to the fertilizer industry or wholesale market, where they are mixed with other fertilizers and sold as NPK fertilizer. The proceeds cannot, however, cover the cost of P-recovery. The government does not provide support or incentives to finance the investments.

Categorization of phosphoric recyclates as waste or products

The first legal aspect examined was whether phosphoric recyclates made from wastewater, sewage sludge or the ash of such sludge are to be regarded as waste or as products. As the input material of such recyclates must by itself be considered as waste, the legal basis for the determination of this question is paragraph 5, subparagraph 1 KrWG regarding end-of-waste status. Phosphoric recyclates fulfill that provision's requirements of having undergone a recovery operation, use for specific purposes and existence of a market or demand. Whether the further condition laid down in paragraph 5, subparagraph 1, number 3 KrWG is met, which demands that all technical and legal requirements for the purpose in question – i.e. usage of phosphoric recyclates as an input substance for fertilizer production – must be fulfilled, depends on the individual characteristics of the respective recyclate and, thus, cannot be determined in general. The same is true for paragraph 5, subparagraph 1, number 4 KrWG, which aims at excluding waste-specific risks from recyclates. There is also need for further technical examination with regard to such risks, which may be present and which are not governed by the law relevant to the production and use of fertilizers. For these reasons, a final categorization of phosphoric recyclates as waste or as products is not possible at the moment.

Measures to promote recycling of phosphorus

To promote recycling of phosphorus, the creation of a legal obligation for fertilizer producers to purchase phosphoric recyclates, the grant of state aid, the establishment of a new special charge or a system of apportionment as well as making recycling of phosphorus obligatory for producers of sewage sludge are considered as possible legislative measures, which are examined here with respect to their conformity with higher-ranking law.

Obligation to purchase phosphoric recyclates

With respect to constitutional law, an obligation of the fertilizer industry to purchase phosphoric recyclates must be considered as interference with professional freedom. Because of its aim to protect the environment and to save natural resources, such an obligation is nevertheless constitutional as long as the requirements of the principle of proportionality are met. Thus, there are no fundamental concerns against the establishment of such an obligation; it must however be designed in such a way that the burden imposed on fertilizer producers by technical, economic and legal issues resulting from the duty to purchase and use phosphoric recyclates are adequate to the pursued goal.

With respect to European Union Law, an obligation to purchase phosphoric recyclates has to be regarded as a measure having equivalent effect to quantative restrictions on import within the meaning of the so called Dassonville test and, thus, as an interference with free movement of goods. However, this interference can likewise be justified by the need of prudent and rational utilization of natural resources, as expressly established as a goal of European environment policy in the European Treaties, on the condition that conformity with the principle of proportionality is maintained. For this reason, such an obligation would need to be designed as a requirement concerning the manufacturing process of fertilizers (as opposed to a requirement concerning the product itself), in order not to impair the marketability of fertilizers imported to Germany.

State aid supporting recycling of phosphorus

State aid granted for the recycling of phosphorus, including alleviation of charges, is governed by European state aid law. However, assuming the procedural prerequisites are fulfilled, no fundamental concerns against such state aid arise from these provisions. As waste legislation is applied to the recycling of phosphorus, however, state aid in this field must additionally meet the requirements of Article 14 of the Waste Framework Directive, which provides that the costs of waste management – that term includes recycling – shall be borne by the waste producer or the waste holder. If costs resulting from the recycling of phosphorus are taken over by the state, a conflict with the "polluter-pays principle" prescribed by that provision arises. But as the member states are also obliged under the European Treaties to promote high quality recycling; temporary state aid with the purpose of establishing new forms of recycling can nevertheless be considered lawful.

Special charge

To recover costs for measures of phosphorus recycling, the implementation of a so called special charge can be considered. A special charge is different from a tax, which is constitutional if a material goal is pursued and the respective matter is influenced by the charge, if the charge is imposed on a homogenous group, which bears special financial responsibility with respect to the matter involved, and if the revenue is used to the benefit of that group. Operators of wastewater treatment plants can be considered a homogenous group for this purpose. It is doubtful, however, whether this group bears a special responsibility for financing the recycling of phosphorus. Thus legal concerns regarding the implementation of a "phosphorus charge" exist.

System of apportionment

Implementing an apportionment system, which differs from a special charge in that no funds flow to the public budget, is not governed by European state aid law. Such a system would also conform to constitutional requirements if properly designed. In the designing of a levy for wastewater treatment plant operators, it must, however, be observed that funds for promoting recycling of phosphorus are only available if the number of operators who are obliged to pay the levy is greater than the number of operators who receive money from the system of apportionment. Introduction of a requirement for recycling of phosphorus can, thus, render a system of apportionment pointless. This leads to the advice to provide for the levy funding for the transitional period until the entry into force of an obligation for recycling phosphorus.

Obligatory recycling of phosphorus

The obligation of operators of wastewater treatment plants to take measures of phosphorus recycling conforms to European Law. It is already doubtful whether there is even an interference with the free movement of goods because such obligation could at most be a measure having equivalent effect to quantitative restrictions of export, but it would not have the specific effect of restricting patterns of export. Even if there was an interference with the free movement of goods, such an obligation would be justified by its environmental purposes, assuming that proportionality is maintained.