Phosphorus
a source
for life!

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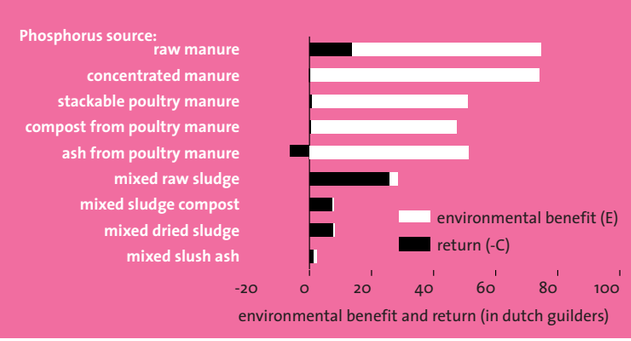


Environmental and financial impacts of using manure and sludge products at Thermphos instead of disposing of them in the present way.

Taking the P out of poo

CE has carried out research into the use of secondary sources of phosphorus, from which it emerges that manure and sewage sludge are the main sources of phosphate residues. Here we look at the findings of the study and the follow-up cycle we have initiated for using manure and sludge.

The research addresses the environmental and financial benefits occurring in the phosphorus chain when manure and sludge (products) would be used at Thermphos. The environmental impacts are expressed in terms of money using the so-called shadow price method. The chart below shows the environmental and financial effects in the chain, considering the following effects:

- *Phosphate ore is partially replaced through other sources of phosphorus.*
- *The current processing of sludge and manure is avoided.*
- *As raw manure and sludge are too wet to be used at Thermphos, they are first dried and incinerated.*

The effects on the process at Thermphos itself are not taken into account.

The conclusions are promising, as all options lead to financial and environmental gain in the chain.

But, as mentioned before, the effects of the processing at Thermphos have not been considered. These will determine wether or not there will be benefits when manure and sludge (products) are used by Thermphos. The most important conclusions of the study are:

- *The use of sludge at Thermphos could be an attractive financial proposition, since it would avoid landfilling and other expensive waste processing methods.*
- *The use of manure at Thermphos could be an attractive environmental proposition, since it would avoid over-fertilization.*

Using manure and sludge at Thermphos, then, could yield significant environmental and financial benefits - but can we really do this?

Manure:

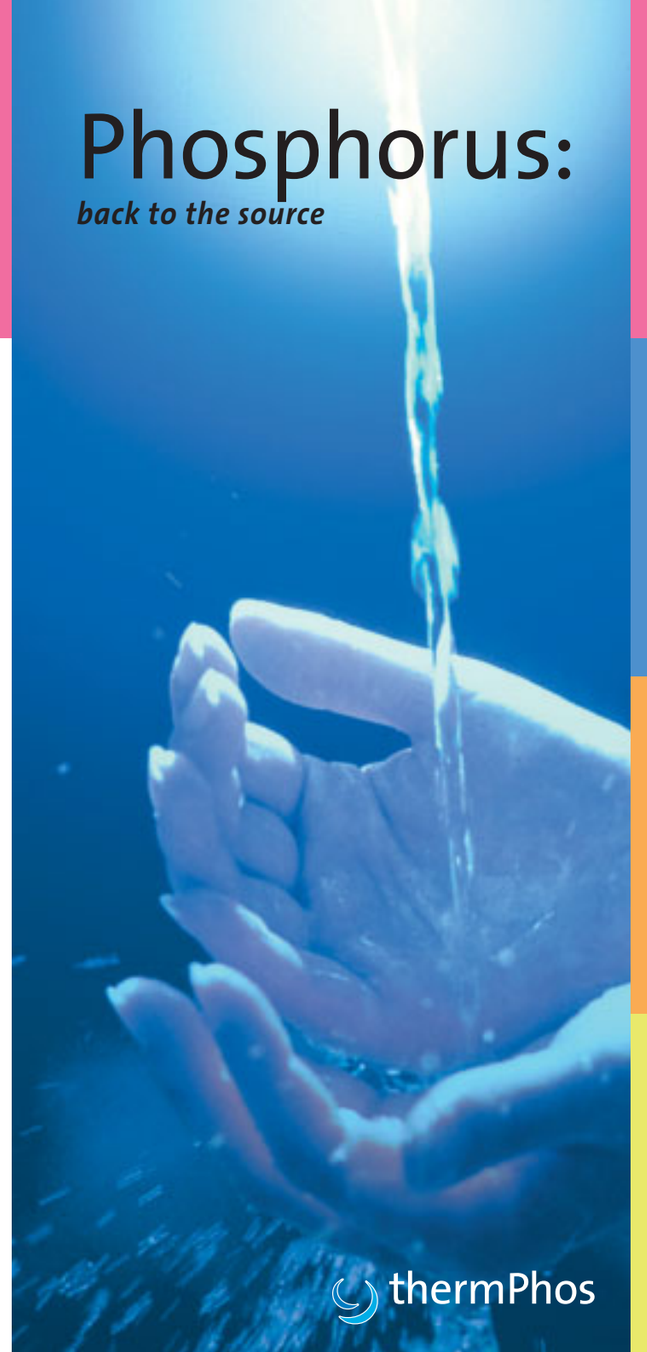
Manure contains low levels of phosphorus (<10%) and a lot of moisture and organic matter, making it difficult to use in our production process (see also the "Thermal production of phosphorus" panel). Drying and incineration solves these three problems at a stroke. This could be done in a new manure gasification plant: trials are currently in progress, and the results are promising. There is a problem here, in that manure is produced at many different farm locations. Therefore the quantity, quality and composition will vary and the collection will require a lot of organization. A group of poultry farmers have formed a co-operative (the Poultry Farmers Sustainable Energy Association-DEP in Dutch) to generate power by incinerating their poultry manure. The government requires them to put the ash produced in the process to good use, and Thermphos can play an important role here. This is not without its problems. Copper and zinc are added to animal feed; these metals get into the manure and thus into the ash. The levels of copper and zinc in the ash are too high for Thermphos to use it as a raw material. Therefore we are talking with the poultry farmers, the animal feed manufacturers and the authorities to see how we can ensure that less of these metals get into the manure without affecting the poultry farmers' operations.

Sludge

Like manure, sewage sludge contains a lot of water and organic matter and not much phosphorus. There are already sludge incineration plants in existence, but here again the ash contains too much copper and zinc from water pipes and gutters. Removing the metals at source at a reasonable cost is thus not a practical proposition in the foreseeable future. The sludge and ash also contain a lot of iron, since sewage is generally treated by adding iron salts, which cause the phosphates to precipitate out of the water. One way of ensuring that metals do not get into the ash would be to extract the metals and the phosphorus from the water at different points in the process. Separate phosphate extraction would have to be done without the use of iron salts. One method would be to use aluminium or calcium salts (aluminium and calcium do not present such a problem to our production process), e.g. in a granule reactor. These treatment techniques are more expensive than those currently used, and sewage treatment facilities would have to be converted. This is probably only financially feasible if they have to be modified for other reasons, so it is only likely to happen in the long term in Holland. Other countries such as Belgium and France, however, still need to convert large numbers of sewage treatment facilities (or build new ones) in order to comply with European regulations: if the right technologies were to be used Thermphos could use the ash from their sludge. The water companies, together with us, are also actively looking for other ways of making phosphates from sewage usable at Thermphos in order to reduce environmental pollution.

Phosphorus:

back to the source



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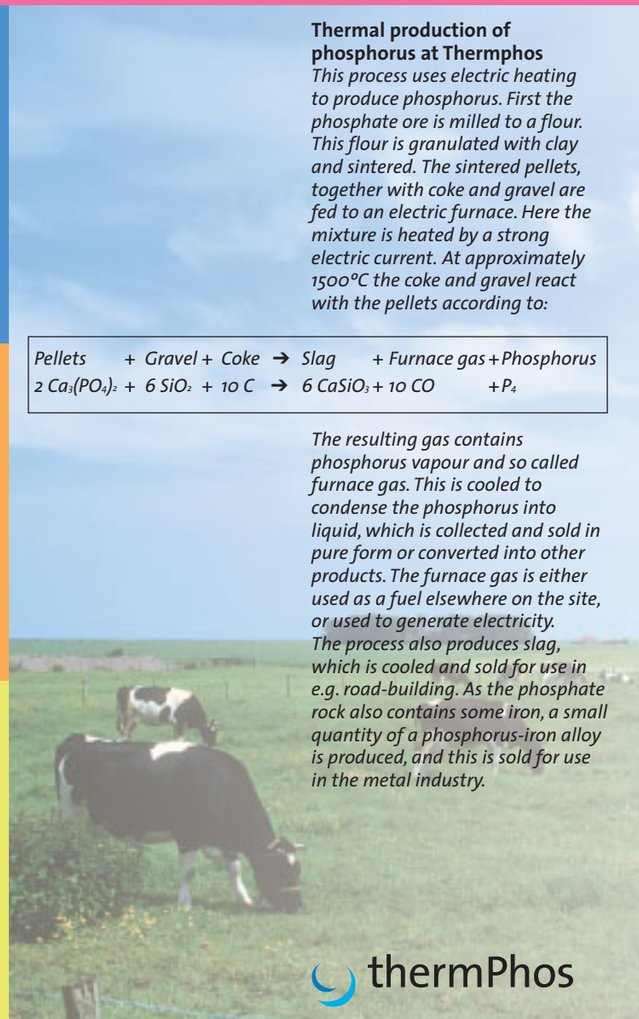
Thermphos takes responsibility for the environment

Thermphos International BV is one of the largest international manufacturers of phosphorus products. A large proportion of our phosphorus is found in consumer products - e.g. soft drinks, detergents and toothpaste - and eventually ends up in the sewers. To reduce pollution of phosphorus products we aim at closing the cycle as far as possible. We believe our position in the phosphorus chain brings about a responsibility for the environmental issues related to the phosphorus cycle. We therefore aim at a 20% substitution of our raw materials by recycled phosphorus.

Can Thermphos help to close the phosphorus cycle?

(and take away the Dutch manure mountain?)



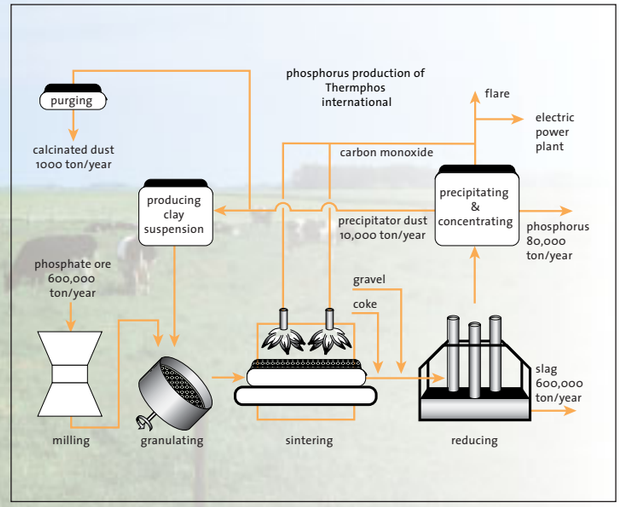
Thermal production of phosphorus at Thermphos

This process uses electric heating to produce phosphorus. First the phosphate ore is milled to a flour. This flour is granulated with clay and sintered. The sintered pellets, together with coke and gravel are fed to an electric furnace. Here the mixture is heated by a strong electric current. At approximately 1500°C the coke and gravel react with the pellets according to:

Pellets	+ Gravel + Coke	→ Slag	+ Furnace gas + Phosphorus
$2\ Ca_3(PO_4)_2$	+ $6\ SiO_2$ + $10\ C$	→ $6\ CaSiO_3$	+ $10\ CO$ + P_4

The resulting gas contains phosphorus vapour and so called furnace gas. This is cooled to condense the phosphorus into liquid, which is collected and sold in pure form or converted into other products. The furnace gas is either used as a fuel elsewhere on the site, or used to generate electricity. The process also produces slag, which is cooled and sold for use in e.g. road-building. As the phosphate rock also contains some iron, a small quantity of a phosphorus-iron alloy is produced, and this is sold for use in the metal industry.

We asked the environmental consultancy CE in Delft to help us formulate an integrated strategic environmental policy, and as part of this we asked them to investigate the possibilities of recycling phosphorus, what environmental benefits this would yield and how much it would cost. CE's survey showed that the phosphate surplus in Holland is found mainly in manure and sewage sludge (see diagram). The ash remaining after incinerating manure and sludge could be used at Thermphos. The survey showed that potential benefits, both environmental and financial, could be large. It sounds great on paper, but is it a practical proposition? Is it technically feasible? We are now looking into whether ash from sewage sludge and/or manure really can be used at Thermphos. Currently the ash contains too much metals that would cause problems in our production process, so we and other actors in the cycle are jointly examining whether we can find a solution.

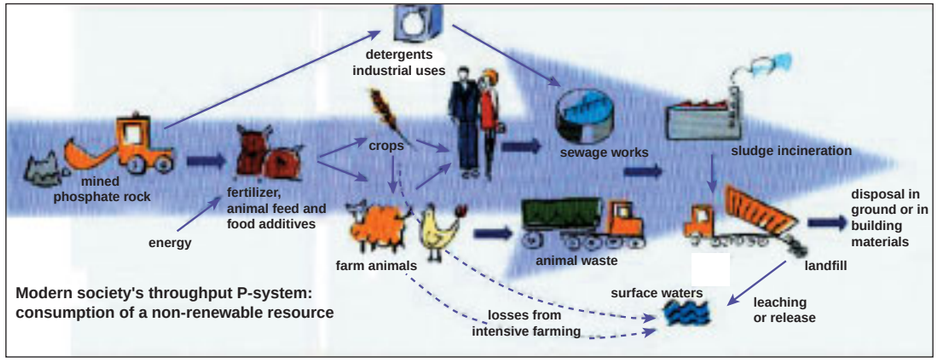


Phosphorus in the environment

Phosphorus is a source of life for all of us, a nutrient without which plants, trees, animals and people cannot survive. As with anything, too much of phosphorus is not good. Some time ago over-fertilization of the land and discharges of untreated effluent resulted in too much nutrients (phosphate amongst others) in the water, which, combined with other factors, resulted in heavy growth of algae. The algae consumed all the oxygen in the water, resulting in decay, unpleasant smells and a sharp deterioration in water quality.

Since then the Dutch government has imposed limits on muck-spreading and the use of phosphate in detergents. Also, treatment plants now remove phosphates from effluent: these end up in sewage sludge, which is currently landfilled. Where the manure is to go now that it cannot be spread on the land is not clear.

The measures have resulted in a manure and sludge mountain in the Netherlands. Using this material at Thermphos would solve the problem at a stroke, if the technical and regulatory barriers are solved!



Modern society's throughput P-system: consumption of a non-renewable resource

Diagram of the phosphorus cycle in Holland

Every year Thermphos produces some 80 million kilograms of phosphorus from 600 million kilograms of phosphate rock. To achieve the target of using 20% recycled phosphorus we would have to use three times the amount of surplus manure produced in the Netherlands, or three times the amount of sewage sludge. If we can solve the technical and regulatory barriers, it would dispose of the Dutch manure and sludge mountain at a stroke. Just using Dutch manure and sludge would mean we would not achieve our target. Importing residues from other countries, however, is problematic because of the strict regulation governing transport of waste over national boundaries. CE has examined this anyway and found that the quantities available in the surroundings (Flanders) are not sufficient, even when added to the Dutch supply, to achieve 20% recycling. Also, transportation would be expensive and it would negate the environmental benefit. We are therefore looking for other sources.

At present one of the main sources of recycled phosphorus is phosphoric acid used by the metal industry: much of this is supplied by Thermphos, and we are already recovering it from the various customers in Holland and other countries in order to reprocess it.

Using waste acids not only yields a significant environmental benefit, it is necessary if we are to achieve our target of using 20% recycled phosphorus. We are therefore keen to use waste acids and phosphates from other plants. Domestic and European regulations designed to combat improper processing of waste do not currently permit this, however, so along with the various authorities we are exploring ways of achieving this within the present regulations. If this turns out to be impossible we shall jointly examine whether the regulations should be amended or even abolished. In other words, we are doing our best to ensure that phosphorus –which we produce for everyone– returns to us at **Thermphos**!

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