SYSTEMIC Living Lab conversations:
P recovery: Re-P-eat

10/12/2020 16:00h CET – 16:45h CET – TEAMS online meeting

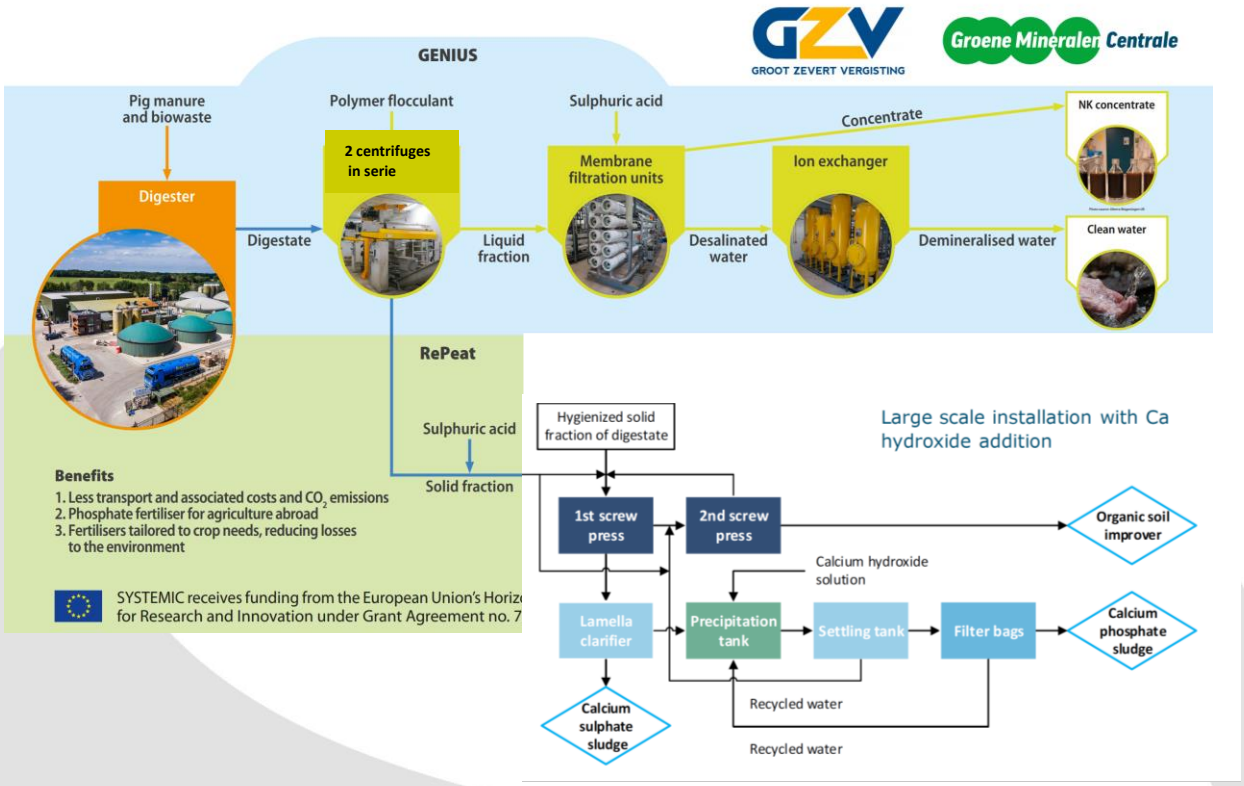
Moderator: Marieke Verbeke (VCM, SYSTEMIC project)

Extra information inserted in this summary after the discussion.

Expert Panel:

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)

General description of the technology



Biogas Plant in Finland

Peat mining in Finland causes environmental problems, so here an alternative for peat, like the P depleted organic matter could really have value.

Is the Re-P-eat system currently treating all the digestate at Groot Zevert?

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Program for Research and Innovation under Grant Agreement no. 730400 (www.systemicproject.eu).*

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)
The digestate is separated first and the liquid fraction is completely treated in the GENIUS system(Nijhuis Industries) (see Living Lab discussion: membrane technologies and RO).
The system works on the solid fraction, and is currently only working for 6 hours a day, for testing purposes. Technically it is designed to treat all the solid fraction (16.000 tons/year) on full scale. However, this upgrading of treatment capacity will depend on the revenues we get from the P depleted organic matter and the recovered calcium phosphate.
So, only if these revenues would drop, because for example political decisions like reduction of the livestock in the NL, the cost for the nutrient recovery technology would increase.

Is there a technology provider selling the Re-P-eat system developed by Wageningen university?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)
Yes, Nijhuis Industries.

Ludwig Herman, Proman, ESPP (AT)
Is the intellectual property of the system Wageningen or Nijhuis? Is it patented?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)
It is partly patented, combined by Wageningen and Nijhuis. They are both the owners of the intellectual property.

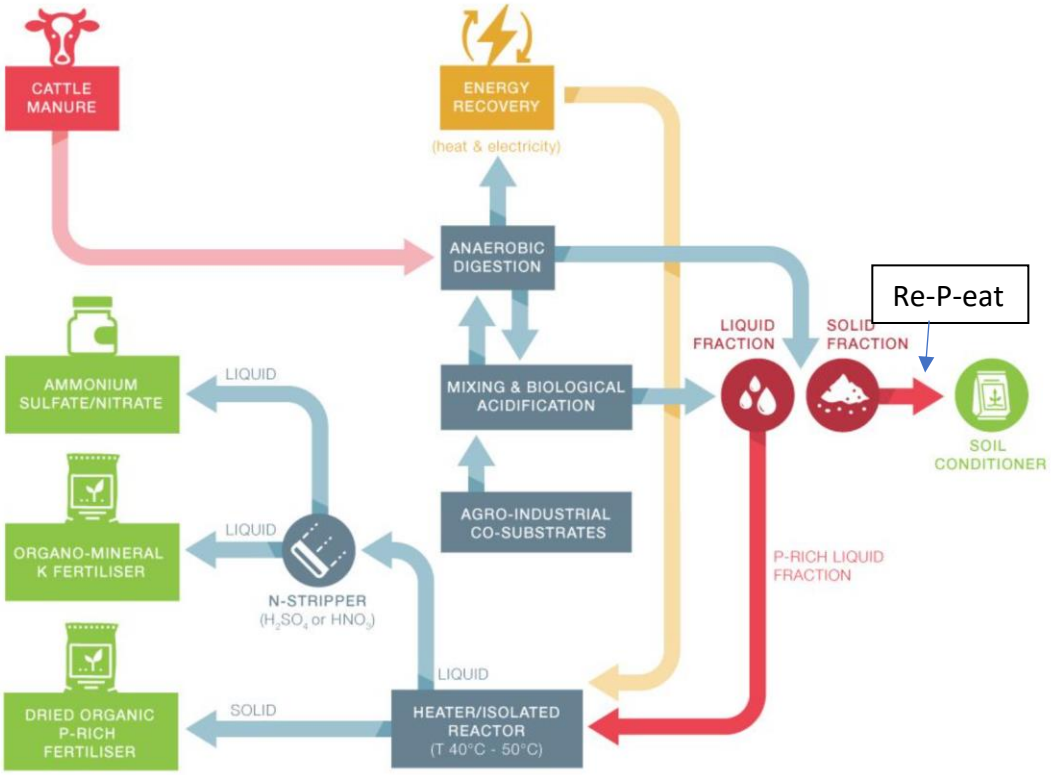
Is the system also technically and economically feasible on farm scale?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)
The most economical way is to collect it at large scale. In the Fertimanure project (fertimanure.eu) we will try to do it on a dairy farm (Prinsen Dairy Company), there a stripper is implemented for the liquid fraction and we will also try to implement a small scale P recovery (Re-P-eat).However, it will be a slightly different system, which would be less complex and less expensive (operational costs). We will try to use biological acidification as an alternative to acid addition. Also, sulfur is becoming an issue if we would use sulphuric acid. We will try to dilute it by adding extra water.

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Program for Research and Innovation under Grant Agreement no. 730400 (www.systemicproject.eu).*

SYSTEMIC
Circular solutions for biowaste

ON-FARM EXPERIMENTAL PILOT IN THE NETHERLANDS



www.fertimanure.eu

Which experiments did you do to dewater the calcium phosphate?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)

We are currently working with a lamella separator followed by 2 screw presses.
We have tried also centrifuges and membrane filtration.
In Germany (Benas) they use a chamber filter press to dewater the solution of ammonium sulphate for the suspended calcium carbonate. That seems to work there and we would like to try it to dewater our Calcium phosphate sludge.
For details see (Regelink et al. 2019) and (Schoumans et al. 2017)

Did you test any chemicals for extraction of the CaP?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)

No we don't want to add chemicals (flocculants).
We tested 5 or 6 different organic acids for the release of P from the solid fraction: citric acid, butyric acid. But there is an issue with smell, especially with butyric acid.
And you need much more to reduce the pH. These acids can be very cheap, but you will need a lot. By doing this you will also start to increase the volume of your product.
For details see (Regelink et al. 2019)

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Program for Research and Innovation under Grant Agreement no. 730400 (www.systemicproject.eu).*

Are the 2 centrifuges in series necessary to obtain a solid fraction with the right quality for P recovery?

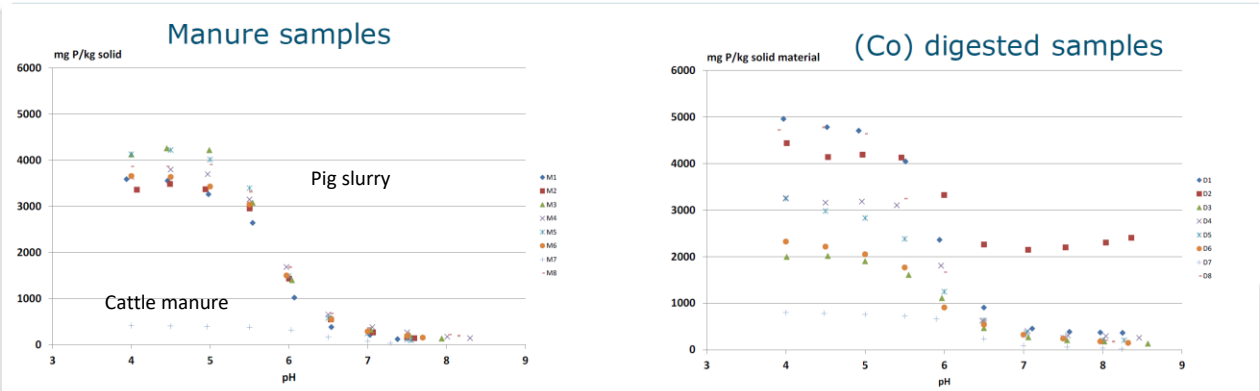
Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)
No, not for the Re-P-eat cascade. They are necessary for the GENIUS cascade (micro filtration +RO)
The 2 centrifuges are not necessary for the quality of the solid fraction.

Are the 2 screw presses in series necessary?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)
Yes, because the organic matter is twice treated with acid, before going to each screw press. The second one is more a cleaning, with less acid to get the remaining phosphorus in the liquid fraction.

Does the amount of acid you need to add depend on the type of digestate and the buffer capacity of the digestate?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)
It's quite simple, you have to experiment first to see how much acid (or mEq of H+) you need to reduce the pH of your digestate to a certain value (i.e. check the buffer capacity).
And then you can calculate the amount of acid you would need for a full scale installation and if it would be profitable.
But for the most manure samples it did not vary a lot (see left graph) for digestate it could (see right graph).



Release of phosphate by reducing the pH (lab)
(mg P per kg fresh solid material)

For details see (Schoumans et al. 2017)

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Program for Research and Innovation under Grant Agreement no. 730400 (www.systemicproject.eu).*

Why is the liquid fraction of the second screw press recycled back to the first screw press?

Oscar Schoumans, Wageningen University & Research, Coordinator SYSTEMIC project (NL)

After you have added acid before the first screw press, the P in the solid fraction will become soluble in the liquid fraction and the separation creates a solid fraction lower in phosphate, but not completely depleted. Therefore we acidify again (less acid) and send it through the second screw press. The P enriched liquid fraction from this separation will go back to the first screw press, so all the phosphates go with the liquid fraction to the lamella separator, $Ca(OH)_2$ addition and precipitation tank and settling tank.

After CaP has settled in the settling tank, the remaining solution has a higher pH and can still contain a little bit CaP. This is send back to the second screw press to 'clean' the organic matter instead of using tap water.

If you would put it in the first screw press, the high pH of the recycled solution would cause that a higher amount of acid would be required to solubilize the phosphate.

Is it a large installation? Surface area needed?

Arjan Prinsen, Groot Zevert vergisting (NL)

For 16.000ton per year, you need (all tanks, separators and reactor vessels included) 200m².

How much time is needed for an operator to follow up on this installation?

Arjan Prinsen, Groot Zevert vergisting (NL)

We still need to finetune and optimize the system. This is currently the biggest challenge.

The phosphorus separation (Re-P-eat) works technically fine. We only need 3 hours monitoring per day.

3 hours per day include monitoring if the installation runs well, checking if there is enough Ca(OH)2, checking the levels of the tanks, fixing small issues or disturbances. Mostly monitoring because the installation runs automatically.

However, it is difficult to keep control of the costs. To recover the P depleted organic matter (peat replacement) you need a lot of water to 'clean' it, which costs if you don't have recycled water available from somewhere else. *(Partly recycled from the following steps as described in the question above).* Also getting the phosphate in the right form *(dried calcium phosphate crystals with low organic matter)* is also a challenge.

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Program for Research and Innovation under Grant Agreement no. 730400 (www.systemicproject.eu).*

Are there issues with scaling and fouling?

Arjan Prinsen, Groot Zevert vergisting (NL)

We are currently working with calcium hydroxide to precipitate the phosphorus. Here we have no issues at all with scaling or fouling.
We want to start precipitating struvite and here we expect more of these issues.

Read more about the RePeat system implemented at Demo Plant Groot Zevert Vergisting on https://systemicproject.eu/downloads/ →Project Deliverables
D 1.20 Update from the demonstration plants (construction, monitoring, demonstration activities) (2020)
D 1.8 Updated factsheets of the demonstration plants (2020)
D 2.2 SYSTEMIC Business Case Evaluation Report (2019)
D 2.4 Final report on the development and application of economic key performance indicators (KPIs) (2020)
D 3.2 Final report on schemes and scenario's for nutrient recovery and Reuse (update 2021)

Regelink, Inge, Phillip Ehlert, Geo Smit, Sjoerd Everlo, Arjan Prinsen, and Oscar Schoumans. 2019. *Phosphorus Recovery from Co-Digested Pig Slurry Development of the RePeat Process*.
Schoumans, O. F., P. A. I. Ehlert, I. C. Regelink, J. A. Nelemans, I. G. A. M. Noij, W. van Tintelen, and W. H. Rulkens. 2017. *Chemical Phosphorus Recovery from Animal Manure and Digestate*.

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Program for Research and Innovation under Grant Agreement no. 730400 (www.systemicproject.eu).*