COMING CLOSER TO CLOSING THE PHOSPHORUS CYCLE – HOW BACTERIA COULD BE THE SOLUTION TO THE COMING FOOD CRISIS

Researchers at Lund University are currently developing a technique that will help ensure food safety by optimising the use of a certain type of bacteria.

In comparison to the oil industry and the talk of "peak oil", people have recently began referring to "peak phosphorus". This is alarming as phosphorus is a nutrient - important for growth and vital for all life. Being a nutrient, phosphorus is also one of the main components of fertilizers. And here is the problem: we are about to run out of mineral phosphorus, and if we do, there will be no more mineral fertilizers. This means that the world's food production is under threat and we could face a huge food crisis. To make matters worse, once the phosphorus reaches the oceans, it is difficult to recover. We therefore need to find a way to catch the phosphorus, to recover it, and close the nutrient cycle before it is lost at sea.

But don't fret, there are ways to solve this problem.

The solution

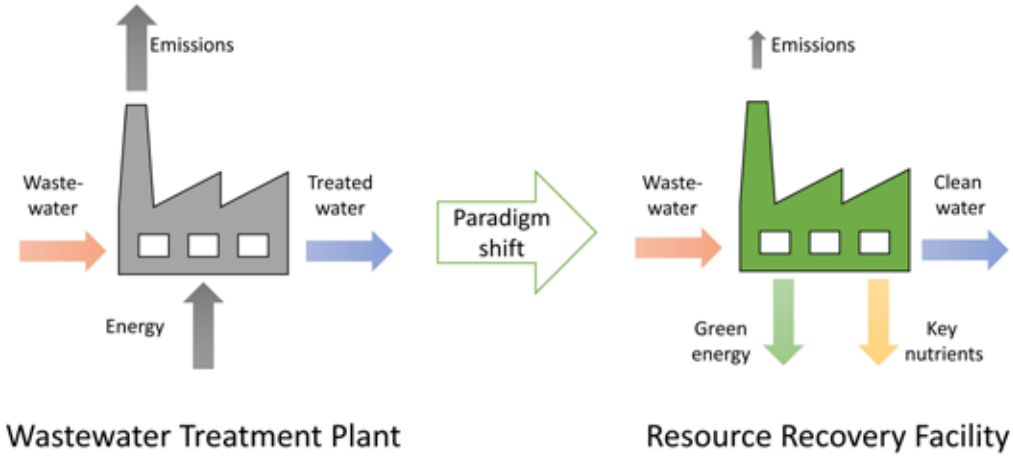
One possibility is to target one of the main routes for phosphorus to the environment: wastewater treatment plants. Our waste is full of phosphorus and a lot would be won if this phosphorus could be recovered from the wastewater and reused on the farmlands. Currently, researchers are developing a technical solution that would allow us to do just that. The technique is based on the use of certain bacteria that can take up and store more phosphorus than other bacteria. Once these bacteria have taken up the phosphorus, they are removed with the waste sludge. In Sweden, this sludge is further treated and then often used as a fertilizer. Lately though, there have been concerns that the increasing amounts of pollutants such as heavy metals and pharmaceutical residues that enter the treatment plants also end up in the sludge. Needless to say, this is not wanted on our farmlands.

We therefore want to produce something that contains phosphorus from wastewater yet does not contain pollutants. Luckily, this something already exists. It is called *struvite*. The technique is quite new in full-scale facilities – and as such, promising yet not entirely problem-free – but exists in some places around the world. In Denmark for example, phosphorus has been recovered in the shape of struvite at some wastewater treatment plants for a few years now. In Sweden, there are plans on implementing this technique for the first time in the construction of a brand-new wastewater treatment plant in Lidköping.

Our contribution

A problem in taking the technique to the next level is how we can produce enough struvite. To solve this, we need to make sure that the entire treatment process is efficient. Several different stages in a wastewater treatment plant are related to phosphorus removal and all of them are interconnected. This means that if one setting is changed in one treatment step, it could affect the performance in the other steps. At the Department of Chemical Engineering at Lund University, we are currently looking into how to optimise both the design and the operation of these processes. We are looking at the big picture, but also more in detail on the different treatment processes.

One such detail is that the bacteria used in the process need energy in the form of carbon in order to take up phosphorus. And not any carbon. Easily degradable carbon. The problem: this is expensive, at least when talking about the volumes required at a treatment plant. The solution: produce it on-site. That's right. The expensive carbon structures can be produced at the plant using the left-over waste



Graphic describing the current shift in mindset from the notion that wastewater is waste and needs to be discarded at treatment plants, to the idea that these instead are production facilities where resources can be recovered.

in a process called *hydrolysis*. This is a win-win situation as the amount of waste to be disposed of decreases simultaneously as the bacteria get their much-desired carbon. At Lund University, we have recently begun with experiments relating to this hydrolysis process. The aim is to find out what mixture of carbon would be the best for the bacteria and if we can run the hydrolysis process so to create this mixture.

Waste evolution

In this way, we hope to be able to make the phosphorus recovery process more efficient. This endeavour is part of an ongoing, international paradigm shift towards a system of closed loops and a circular economy. In the footsteps of the paradigm shift, wastewater professionals around the globe are changing their mindsets: It's not waste unless you waste it – instead recover, reuse and recycle it! This has led to a change in how we see and refer to wastewater treatment plants. Instead of a name that contains the term "waste", a new popular name has entered the world stage: *Resource Recovery Facility*. The treatment plants are no longer a place where waste ends up, energy is needed, and emissions are let out into air and water. Now they are becoming production facilities for clean water, green energy and key nutrients.

We believe that this paradigm shift is necessary if we want to continue to feed the people of the world. To recycle nutrients is so important, and to do this, we need to make more efficient use of our bacteria. By improving the existing techniques, for example the hydrolysis process and struvite production, we will be one step closer to closing the phosphorus cycle and saving the world.

Sofia Högstrand is a PhD student at the Department of Chemical Engineering at Lund University. Her research topic is the biological removal and recovery of phosphorus. She is also working in the LIWE LIFE-project in which a completely new wastewater treatment plant is going to be built in Lidköping municipality. More information about the project can be found at www.angensarv.se