Phosphorus removal

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Introduction

In summer there are a lot of algae in our surface waters. This might seem innocent, but having too much algae is actually harming our environment. Algae blooms, due to the surplus of nutrients in water, can eventually cause oxygen depletion and therefore the death of many other water-species. Furthermore, some of the algae are toxic (such as blue algae).
The reason for this extreme algae growth is the increasing amount of phosphorus in water. This is due to, for example, the waste of fertilizers. Therefore it is important to remove phosphorus from surface water.

There are two types of phosphorus in water:
- Particulate phosphorus; particles “floating” in water
- Soluble phosphorus; dissolved in water

Question

Can we remove particulate and soluble phosphorus from water in order to prevent algae growth, by using sand filtration and iron oxide adsorption?

Method

Phosphorus removal

The set-ups:
- A sand filter, to remove the particulate phosphorus with filtration
- Two adsorption columns filled with iron oxide to remove the soluble phosphorus

Figure 1, 2 & 3: sand filter (left), iron oxide (middle), adsorption column (right)

We collected water from the canals around Wetsus (Leeuwarden, the Netherlands) and took it to the laboratory for our experiments. To imitate the summer conditions, when there are a lot of algae, we added 0.5 mg/L of phosphorus to the initial ±0,2 mg/L.
We let part of the water flow through the sand filter, another part go through the iron oxide columns and a third part go through both the set-ups. With one part we did nothing, to have a reference.

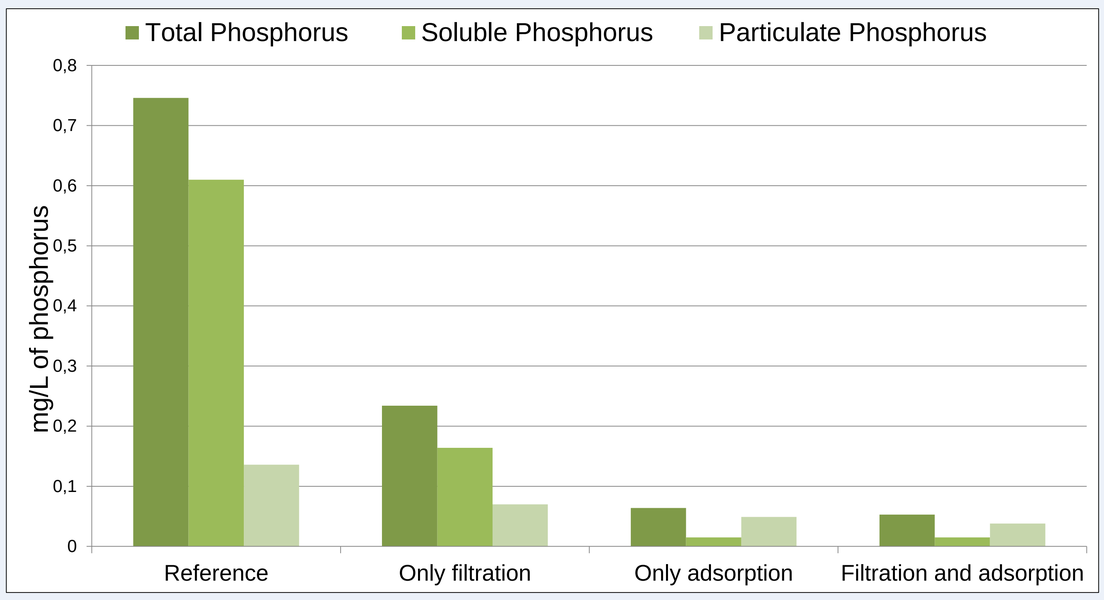
Algae growth

After the experiments, we kept the water in different erlenmeyers under light and stirring to check the algae growth. We added some sediments from the canals as seed for the algae. We have checked the growth by observing and comparing.

Results

Phosphorus removal

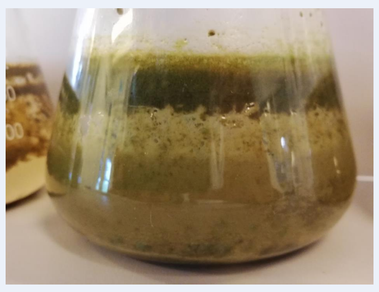
Graph 1 shows a significant drop in the concentration of soluble as well as particulate phosphorus compared to the reference. The most effective method to remove the total amount of phosphorus is by using both adsorption and filtration (93% removal). Elemental analysis with ICP-OES confirmed that our set-up did not pollute the water with other elements (like heavy metals) by using iron oxide.



Graph 1: particulate and soluble phosphorus concentration before and after treatment

Algae growth

We looked at the algae growth by comparing the different erlenmeyers with each other and with the pictures we took the week(s) before. We clearly observed algae growth and a difference between the reference and the treated water. The algae in the treated water did grow, but died sooner than in the reference due to the lack of phosphorus.



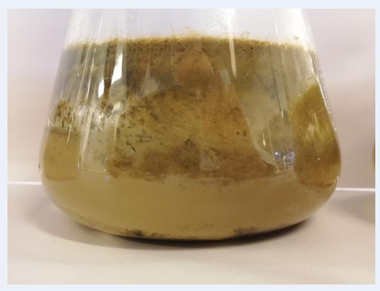


Figure 4 & 5: After 1,5 month, algae are still growing in the reference (left) while they are dead in the filtration and adsorption (right)

Conclusions

- The two step treatment is successful: 93% of the total phosphorus is removed.
- If we remove phosphorus, the algae growth will be stopped in an earlier stage than normal.
- Removing phosphorus from the water from the canal could reduce the algae growth problem during summer.
- By using this method we do not pollute the water in any way.