P filterbox for drainage water

Location

Country: Belgium
City: Anzegem
Coordinates: 50.84572, 3.49098

Figure 1. Driving route to site Anzegem

Problem description

P concentrations in the drainage water are too high (on average 0.47 mg TP/l and 0.37 mg DRP/l) to meet the EU standard in the receiving surface water. The basic concept to reduce these P losses is installing a filter box containing a P sorbing material (PSM) at the end of the drainage tubes. This forces the water through the filter material and allows the removal of P from it before entering the ditch (Figure 2).

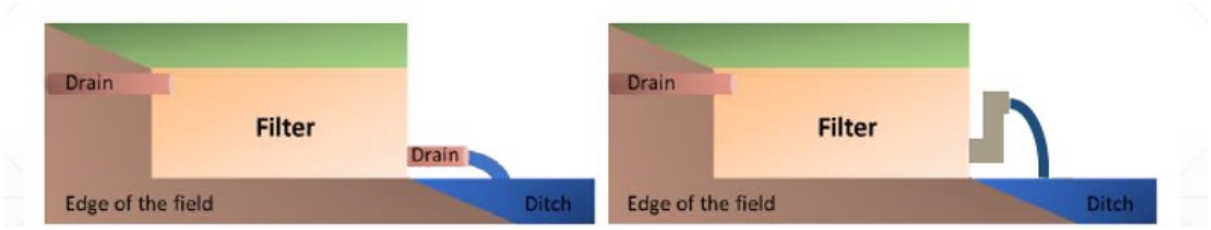

Figure 2. Schematic overview of the installation of P filters in the field

Filter description

Season of 2017-2018 (custom-made filter)

One cylindric custom-made filter ton was installed in December 2017 (Figure 3) filled with iron coated sand (ICS). Filter materials were filled a layer of no more than 20 cm (approximately 32 l). A layer of wire mesh of 0.75 mm was placed on the bottom to stop big particles. Water enters the filter directly from the top of the ton and the height difference between the outlet tube and the top was 5 cm.

Season of 2018-2019 (custom-made filter with renewed ICS)

The same filter ton was used for season 2018-2019 but the ICS was renewed as there was a lot of sediment/soil/algae in the filter. The filter box was cleaned and refilled with fresh sieved ICS.

Season of 2019-2020, 2020-2021, and 2021-2022 (prototype filter)

The new prototype filter (cylindric shape, Figure 4) was installed in December 2019 with sieved filter materials (ICS>2mm). A layer of 24 cm with approximately 35 l of ICS was filled in the filters. The prototype from season 2019-2020 was kept until March 2022 to check the long-term performance of the filter. From January 2021, overflow was observed and the filter was gradually clogged by sediment as shown in Figure 4, not only at the bottom but also at the top of the filter.

Photo filter

Figure 3. the custom-made filter ton in the season of 2017-2018 and 2018-2019.

Figure 4. Prototype installed in the season of 2019-2020, 2020-2021, and 2021-2022.

Results (through the different seasons)

Season of 2017-2018 (custom-made filter)

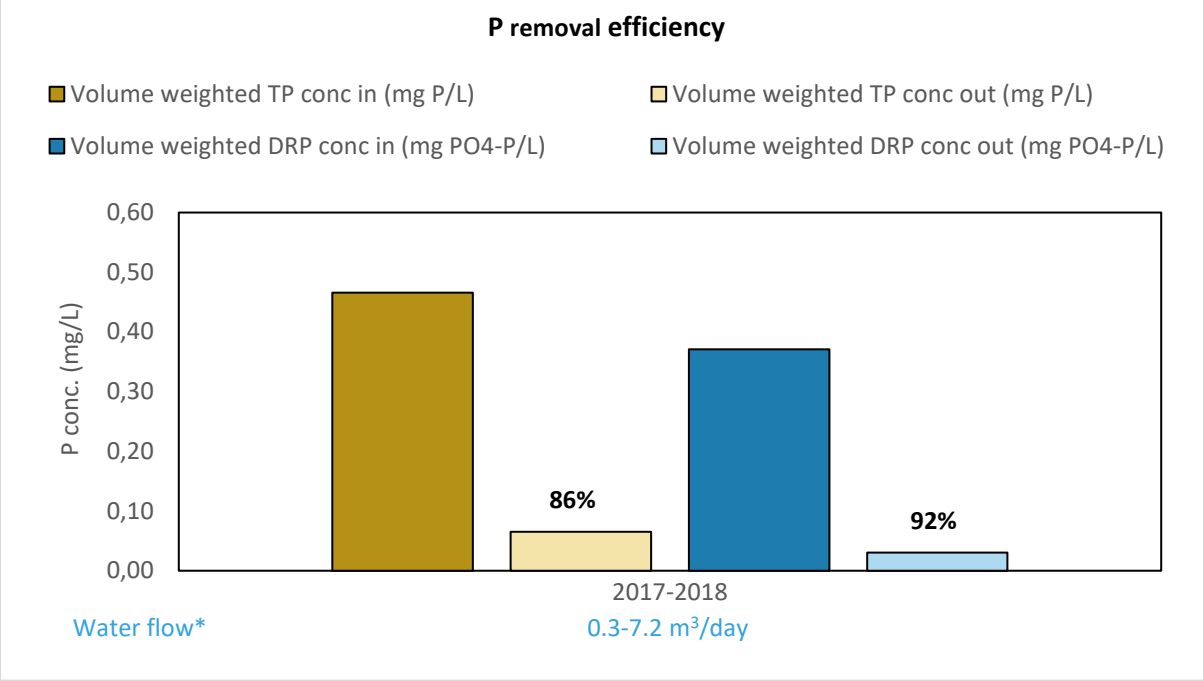

Figure 5. P removal efficiency of a custom-made filter ton during the season of 2017-2018.

*water flow was measured every week and this range represented the water flow on the measuring days.

At the site of Anzegem, 65% of total phosphorus (TP) and 60% of dissolved reactive phosphorus (DRP) was removed by the filter box during the period of 21/12/2017 - 16/4/2018 with an average water flow of 1.9 m^3/day. Clogging problems occurred between 9/2/2018-6/3/2018 and frost problems during the period of 22/2/2018 - 28/2/2018.

Season of 2018-2019 (custom-made filter with renewed ICS)

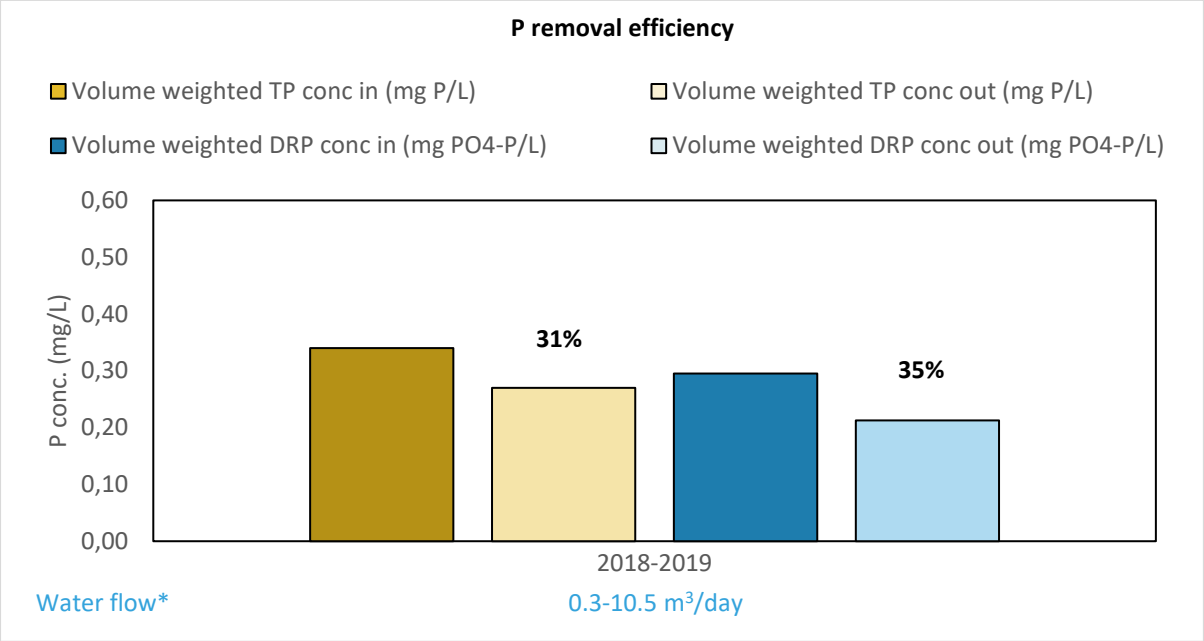

Figure 6. P removal efficiency of a custom-made filter ton during the season of 2018-2019.

*water flow was measured every week and this range represented the water flow on the measuring days.

At the site of Anzegem, 31% of TP and 35% of DRP was removed by the filter box during the period of 13/12/2018 - 18/4/2019 with an average water flow of 2.1 m^3/day. Overflow occurred on 7/2/2019.

Season of 2019-2020, 2020-2021, and 2021-2022 (prototype filter)

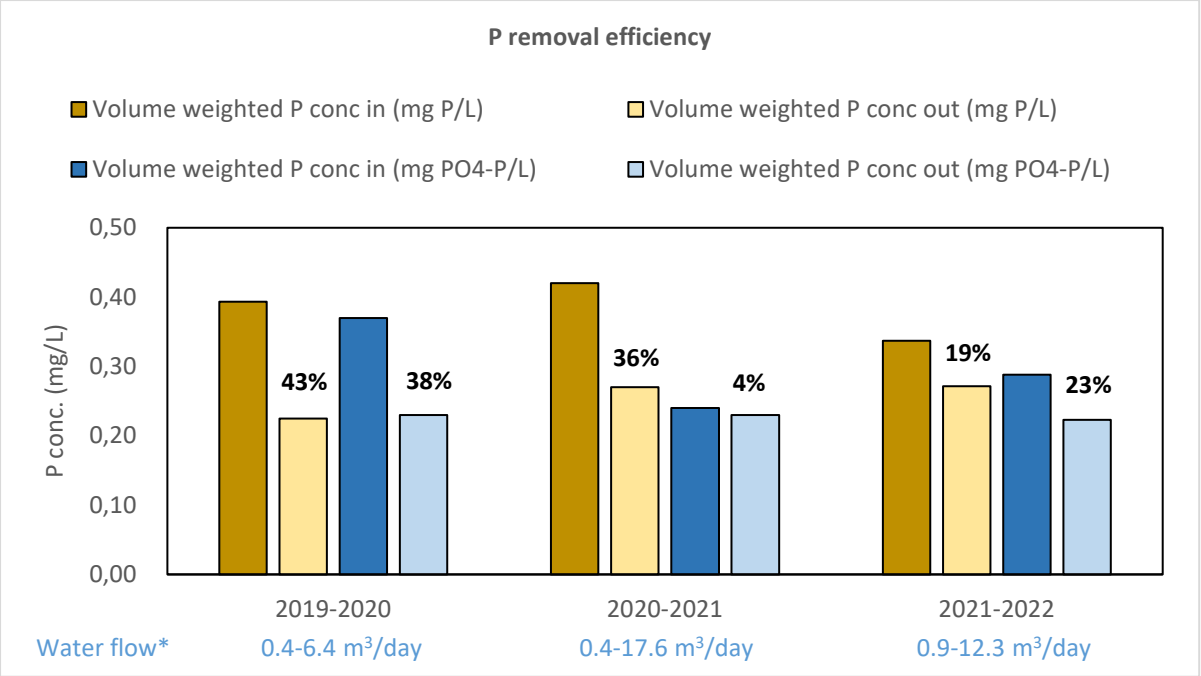

Figure 7. Long-term performance of the prototype filter in Anzegem over three drainage seasons.

*water flow was measured every week and this range represented the water flow on the measuring days.

The prototype filter was installed at Anzegem and tested for three drainage seasons: 2019-2020, 2020-2021, and 2021-2022. 43% of TP and 38% of DRP was removed during the period of 23/12/2019 – 23/3/2020 with a water flow of 0.4-6.4 m^3/day. During the following two seasons, the P removal efficiency of the prototype filter decreased to 36% and 19% for total P (TP) and 4% and 23% for dissolved reactive P (DRP), respectively (Figure 7). As seen in Figure 4, the filter box was clogged in the season of 2020-2021 and this could be one of the reasons to explain the low P removal efficiency. The higher flow rates in the later two drainage seasons than the first season could be another reason for the low P removal efficiency.

Conclusion

During the five seasons, different filter boxes filled with fresh ICS showed that the P removal efficiency varied from 43-86% of TP and 38-92% of DRP while the long-term performance of ICS reduced to 19% of TP and 4% DRP. The water flow of the drain could play an important role. Comparing between season 2017-2018 and 2018-2019: the first season had a lower water flow (max 7.2 m^3/day) and showed a much higher P removal efficiency even with the higher average P level. In general, the P removal efficiency in Anzegem was rather low compared to filters in Zedelgem due to the larger water flow (up to 18 m^3/day) which was beyond the designed processing capacity (6-8 m^3/day). Also it was noted that the sediments could be a problem at this site. Regular cleaning or a prefilter would be necessary to ensure the optimal performance of the filter at this site.