Effluent reuse in theme park Efteling

Towards an extensive P removal scheme with tertiary moving bed filtration

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J.W. Wouters*

* BW Products BV, the Netherlands (corresponding author: h.wouters@bwproducts.nl)

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Abstract

The popular theme park Efteling in Kaatsheuvel (the Netherlands) launched a drought prevention program to reduce the total volume of ground water abstraction to feed the numerous water ponds in the park. The ponds, water bodies and fountains are vital components for both the theme park and the adjacent golf course. Moreover the water is used for green keeping. Groundwater was used for green keeping, but as a result groundwater levels tended to drop. Therefore effluent from WWTP Kaatsheuvel has been used for replenishing water in the ponds since 1997. Particular attention was paid to extensive removal of phosphorus to levels below 0.10 mg/l total P to prevent any eutrophication in the ponds.

Drivers for P removal

Algae blooming in open surface water bodies are causing serious problems: excess growth will affect oxygen levels, light intrusion and may lead to release of toxic components. Therefore sensitive surface waters should be protected against high concentrations of P. Targets as low as 0.15 mg/l P are set for some receiving surface waters to prevent algae blooms from growing. As a result waste water treatment works effluent, discharging into these waters often require further treatment to achieve low P levels.

P-removal for waste water reuse

The popular theme park Efteling in Kaatsheuvel (the Netherlands) launched a drought prevention program to reduce the total volume of ground water abstraction to feed the numerous water ponds in the park. The ponds, water bodies and fountains are vital components for both the theme park and the adjacent golf course. Moreover the water is used for green keeping. Groundwater was used for green keeping, but as a result groundwater levels tended to drop. Therefore effluent from WWTP Kaatsheuvel has been used for replenishing water in the ponds since 1997.

To improve the bacteriological effluent quality and the nutrient levels the effluent was passed through reed bed filters before being reused. Four vertical flow reed bed filters with a total surface area of 8,000 m² were constructed for a total capacity of 80 m^3/h. Hence the infiltration rate is 10 l/(m^2.h). The reed beds are fed intermittently and the treated effluent is fed to one of the water ponds at the Efteling golf course.

WWTP effluent characteristics are shown in table 1. Although the effluent quality of the plant is already excellent and the reed bed filters were able to reduce the P levels further to 0.5 mg/l, it

did not prevent eutrophication in the ponds. Abundant blue algae blooms were reported in 1999, which appeared to be due to high phosphorus levels of up to 0.5 mg/l P in the reed bed effluent.

Table 1. - WWTP Kaatsheuvel tertiary filter feed characteristics (annual average 2001)

Parameter	**Value**
Biological capacity	63,200 i.e.
Hydraulic capacity	2,200 m^3/h
Suspended solids	5 mg/l
Total-nitrogen	3.4 mg/l N
Total-phosphorus	0.9 mg/l P

Further optimization of the reed beds proved to be difficult. Therefore it was decided to implement a tertiary treatment for phosphorus removal at the WWTP, before the treated water is fed into the reed beds. The core of the tertiary treatment comprised of moving bed filtration (MBF) (figure 1).

Figure 1 – WwTW Kaatsheuvel tertiary moving bed filtration

Secondary clarifier effluent is fed to the filter. $FeClSO_4$ is dosed to the filter feed to remove P. With a dosage of approximately 4 mg/l Fe^{3+} the phosphorus level is reduced to < 0.1 mg/l P. As the feed P levels fluctuate only slightly, P proportional dosing was not implemented for simplicity of operation and therefore the dosage of Fe^{3+} is only flow proportional. The process scheme is indicated in figure 2.

The installed filter area is 8 m^2 with a 1.8 m sand bed height, designed for a capacity of 80 m^3/h. The filtrate is discharged to a pump pit from which it is transferred to the reed bed filters. Continuously generated wash water (5 m^3/h) is recycled back to the head of the WwTW.

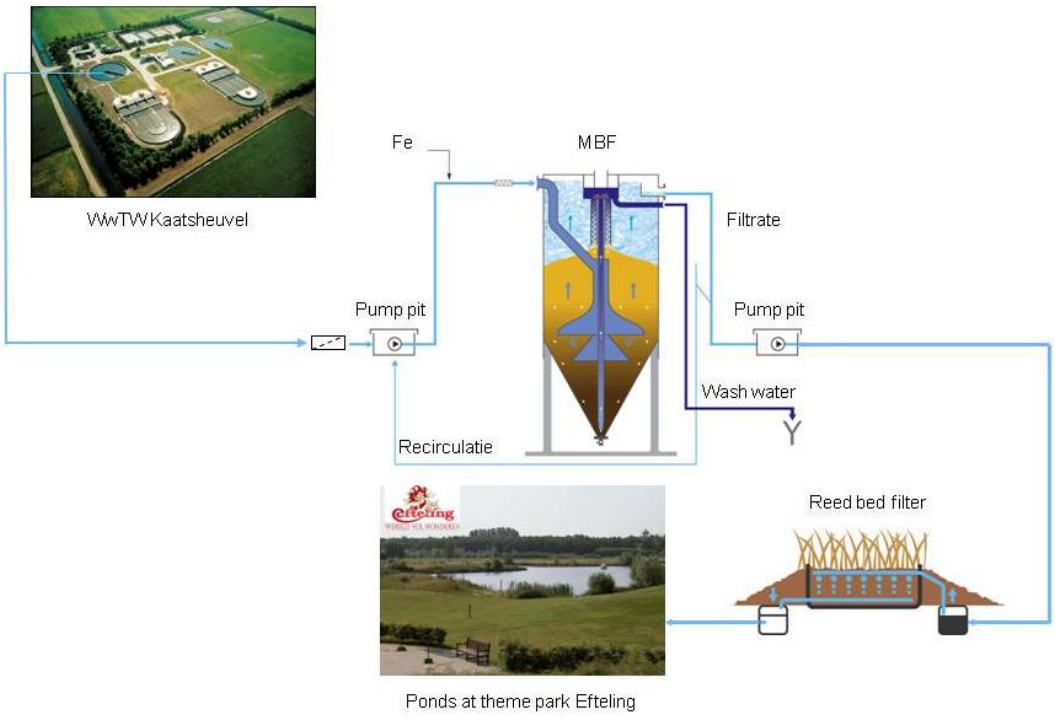

Figure 2 - Process scheme tertiary P removal treatment and reed bed filtration

The sand filter was put into service in 2002. The results from 2003 and 2004 (figure 3) show excellent removal rates for ortho-P and total-P of about 90%.
After reed bed filtration the water meets swimming water bacteriological consent levels set by the EU. Visibility in the ponds has increased to values of over 60 cm. Even in the Dutch summer of 2003, one of the warmest summers ever recorded in the Netherlands, algae blooms were not observed.

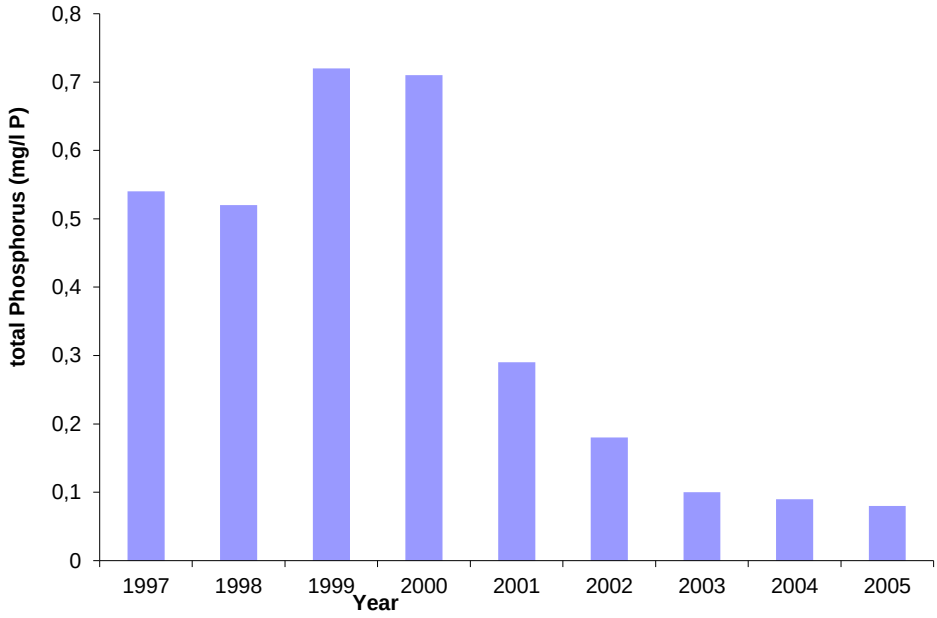

Figure 3 - Phosphorus removal at the tertiary filter plant of WwTW Kaatsheuvel