# REACTIVE FILTER FOR PHOSPHATE CONTROL IN BACKYARD POND 

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## Introduction

Algae control is the main problem faced by the owners of the backyard ponds. Extended sunlight, warm water temperature, and high ammonia and phosphate levels are likely working together to accelerate algae growth. Fish waste, decomposed uneaten food, organic matter and water plants substrate are the sources from which nutrients are released into the water. Aesthetics of the pond is the great challange for the pondkeeper.

## Case study description

In this study, two seasons of observations of water transparency, $\mathrm{pH}, \mathrm{BOD}_{5}$ and $\mathrm{PO}_{4}-\mathrm{P}$ of a garden pond are presented (fig.1). In the season 2013, UV sterilizer, two aerators, foam fractionator and zeolite filter were used to achieve desirable aesthetics of the pond. In the season 2014, the zeolite was replaced by P-reactive material Polonite ${ }^{\circledR}$. The predicted role of the filtration system was to prevent phosphate occurance in water.
The mass of the reactive material used amounted $2,420 \mathrm{~g}$, the volume of pond amounted $3,800 \mathrm{~L}$, and the time of water interchange was estimated on 4 hours ( 6 turnovers per day). At the beginning of the season 2013 the pond was cleaned and filled out with the tap water. At the beginning of the season 2014 only part of the sediments was removed by vacuum cleaner. Samples were taken during weekends from March to October


Fig.1. Garden pond

## Material

The reactive material investigated in the study was Polonite ${ }^{\circledR}$. Chemical composition and physical properties of material used in the study are presented in tab. 1 and its P-sorption kinetics on fig. 2. Laboratory scale tests show that the material has a potential to sorb P from water.
Table 1. Characteristic of Polonite ${ }^{\circledR}$

| Chemical composition [mg kg $\left.{ }^{-1}\right]$ |  |
| :--- | :---: |
| $\mathrm{SiO}_{2}$ | 551.1 |
| CaO | 238.6 |
| $\mathrm{Al}_{2} \mathrm{O}_{3}$ | 56.5 |
| $\mathrm{Fe}_{2} \mathrm{O}_{3}$ | 21.0 |
| $\mathrm{~K}_{2} \mathrm{O}$ | 10.4 |
| Grain size $[\mathrm{mm}]$ | $2.0-5.0$ |
| Bulk dentisty $\left[\mathrm{g} / \mathrm{cm}^{3}\right]$ | 0.78 |
| Porosity $[\%]$ | 38 |
| Hydraulic conductivity $[\mathrm{m} /$ day $]$ | 530 |
| Estimated P-sorption capacity $[\mathrm{g} / \mathrm{kg}]$ | 292 |



Fig.2. P-sorption kinetic


Fig. 5. a) filling up the pond with the tap water (2013); b) cleaning the pond with vacuum cleaner (2014); c) uneaten fish food; d) water plants; e) wildlife; f) ornamental goldfish; g) string algae removed from the pond; h) material used in the study: fresh (left) and used (right)

## Results

The maximum $\mathrm{PO}_{4}-\mathrm{P}$ concentration observed in reference season amounted $0.718 \mathrm{mg} \mathrm{L}{ }^{-1}$. Mean $\mathrm{BOD}_{5}$ was $4.6 \pm 3.5 \mathrm{mg} \mathrm{L}{ }^{-1}$. The main aesthetic problem was low water transparency and occurance of green and string algae (fig.3). In the season 2014, visual state of the pond was satisfactory with high transparency (fig.3), however string algae occurred in the pond. $\mathrm{PO}_{4}-\mathrm{P}$ concentration didn't exceed $0.039 \mathrm{mg} \mathrm{L}^{-1}$. The mean $\mathrm{BOD}_{5}$ amounted $5.4 \pm 3.6 \mathrm{mg} \mathrm{L}^{-1}$ and was higher than in 2013, as the effect of cumulation of organic sediment in the pond (fig.4). pH of water in both seasons varied from 7.5 to 8.4.


Fig. 3. Water transparency in 2013 (left) and 2014 (right)


Fig. 4. $\mathrm{BOD}_{5}$ and phosphate concentration in 2013 (left) and 2014 (right)

## Conclusions

Comparing efficiency of filtration materials used in both seasons, in case of water transparency and control of planktonic algae, Polonite appeared to be more effective. Zeolite, as a ion-exchange material, has to be often replaced or recharged, what was not acceptable for the pondkeeper. High P-sorption capacity of Polonite obtained in laboratory tests was not proved or busted in the open water pond. However, desorption tests of material used in the filter showed, that no phosphorus was sorbed on it. This suggests, that the filter worked as a biological, not chemical one. Biological filters transform ammonia to nitrate, thus help clear pond from planktonic algae. As a biological filter begins to clog with organic matter, heterotropic bacteria populations take up residence. They are fare more efficient consumers of phosphorus than the much larger and less productive algae.

It takes about 2 months before biological filters are operated fully. This creates the risk of planktonic algae ocurrance in the spring time. Even if the pond is cleaned and filled up with the tap water it is not free from phosphorus (eg. tap water used for filling up the pond in 2013 had a phosphate concentration of $0.021 \mathrm{mg} / \mathrm{L}$ ). In our opinion this is a good time for reactive filter. Than, the main role in controlling nutrients and algae in garden pond rested on biological filtration.

