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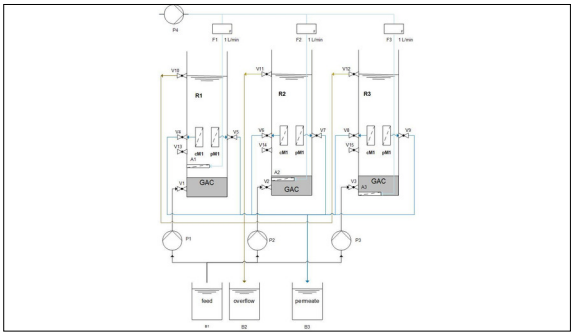
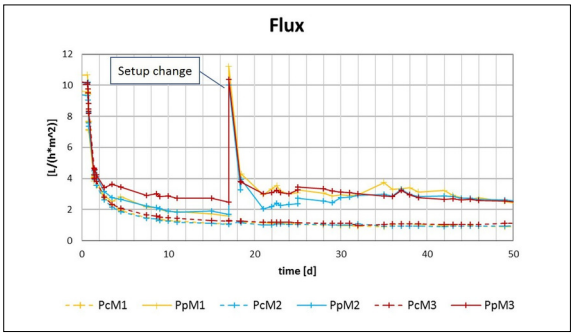
Subject Area	Water treatment

GAC Biofilm integrated GDM-Reactor for Wastewater Treatment

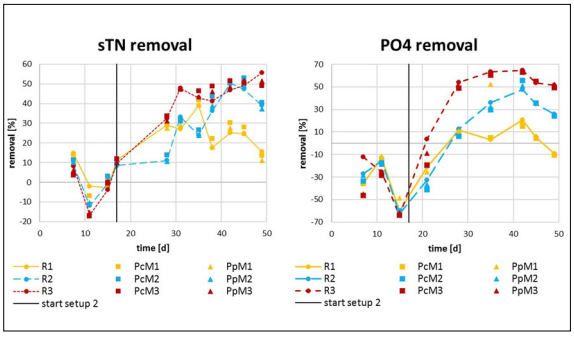
Feasibility of bubble-free Aeration



Scheme of the setup
Own presentment



Comparison of the flux through ceramic and polymeric membranes
Own presentment



Removal of soluble total nitrogen and soluble phosphate
Own presentment

Objective: In rural areas often no centralized infrastructure for water treatment is available and sewage is discharged untreated contaminating water resources. An option for treating decentralized wastewater at low-cost is the combination of gravity driven membrane filtration (GDM) with the activated sludge process. This combination is known as membrane bioreactor (MBR). To intensify the nutrient removal the reactor is aerated intermittent which results in nitrification and denitrification. Since the aeration is very energy intensive and accounts for 45 to 75% of a wastewater plant's total energy costs, the use of bubble-free aeration which has a high oxygen transfer efficiency is proposed. This thesis aimed to investigate the feasibility of bubble-free aeration within a GDM-MBR system. In addition, the application of ceramic membranes was examined.

Approach: The setup consisted of three reactors (R1, R2, R3) with an inserted granulated activated carbon (GAC) layer. Each reactor was aerated intermittent (cycle: 30 min on / 60 min off, flow: 1 L/min) by a membrane air diffuser. The air diffusers were positioned in different hights (R1: above GAC layer, R2: in upper part of the GAC layer, R3: at the bottom of the GAC layer). In each reactor a ceramic and a polymeric membrane were used for filtering the wastewater.

Bubble-free aeration could not be achieved by the used hydrophobic membrane. Also, the air diffusor was affected by severe fouling resulting in a higher resistance.

Result: The nutrient removal inside the reactor depends largely on the dissolved oxygen (DO) concentration. Alternating aerobic and anoxic conditions which result in nitrification and denitrification could be achieved when the air diffusor was inside the GAC layer. When the air diffusor was above the GAC layer the DO was too high for denitrification to occurr. The total nitrogen removal was about double when the air diffusor was inside the GAC layer. Phosphorus removal is also correlated to the DO concentration and was better when the air diffusor was inside the GAC layer.

The ceramic and polymeric membranes performed differently. The flux was 2.7 times lower for the ceramic membranes due to a higher cake resistance. The cake resistance can be removed by physical cleaning which would increase the energy consumption. The irrreversible resistance was higher for the polymeric membranes. The water quality was not much affected by the membrane type. A slightly higher dissolved organic carbon concentration was found in the permeates of the ceramic membranes, while a slightly higher nitrate concentration was found in the permeates of the polymeric membranes.

The use of polymeric membranes is recomended
because the flux is higher, less cleaning is required and the water quality is not much different from the ceramic membranes.