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# PHYTO-AIR SYSTEM FOR EFFLUENT POLISHING: EFFECT OF CONTROLLED AERATION ON COD AND NITROGEN REMOVAL

***H. Khan*[1,*], *O. Schepers*[3], *D. van Oirschot*[4], *F. Ronsse*[1], *A. De Las Heras García*[2], *N. van Belzen*[2], *M. Martens*[5], *N. Roodbol*[3], *C.K. Groot*[2], *D.P.L. Rousseau*[1]**

[1] Ghent University, Belgium
[2] Dow Benelux BV, Terneuzen, The Netherlands.
[3] Evides Industriewater, Rotterdam, the Netherlands
[4] Rietland bvba, Belgium
[5] HZ University of Applied Sciences, Middelburg, The Netherlands
*Hafiz.Khan@Ugent.be

Water scarcity is a key challenge for the whole world and is predicted to further increase in the future. Among all water consumption sectors, the usage of fresh water in industries has increased immensely. The Dow Terneuzen industrial site (The Netherlands) currently needs about 22 million $m^3$/y of fresh water, of which 75% already originates from Local and circular sources. However, still about 4-5 million $m^3$/y comes from the river Meuse via the Biesbosch-area, a valuable freshwater source in the south of The Netherlands. Dow has the aim to reduce its dependency on Biesbosch water because it is considered as potable water source. To this end, Dow, in cooperation with Evides Industriewater, agreed on building a facility that allows the reuse of about 7-8 million $m^3$ of water annually, sourced from the effluents of Dow's own industrial wastewater treatment plant and the municipal wastewater treatment of Terneuzen, complemented with rainwater from the Dow terrain. Thus, to find the key design parameters, intensive pilot-scale research was conducted. In a first phase, nanofiltration and electrodialysis technologies were tested as a pre-treatment to improve the reverse osmosis (RO) desalination but fouling was found as a limiting factor. Hence, in a second phase, the use of aerated wetlands to provide biologically stable water to the desalination train (Ultrafiltration (UF)→Ion Exchange (IX) → RO) was researched.

Aerated wetlands are normally used for high oxygen demand conditions. However, in this research, aerated wetlands were applied in a high hydraulic loading rate situation (0.69 $m^3/m^2/d$, 12 hours hydraulic retention time) for further polishing of the abovementioned effluents. The experiments were done on two 350 $m^2$ horizontal subsurface flow constructed wetlands (HSSFCW), filled with expanded clay aggregates (Argex™) and planted with common reed (*Phragmites australis*). One wetland additionally had a physically separated central zone where Argex was mixed with 15% (v/v) biochar and which can be bypassed if desired. Each wetland was divided into three equal imaginary zones, each equipped with forced bed aeration (FBA) at the bottom. For this study, continuous (100% on) and time-based (50%-time on/off) aeration was compared versus set dissolved oxygen levels i.e. 3-4, 2-3, 1-2, and 2-3/0/0 mg $O_2$/L (2-3 mg $O_2$/L in zone 1 and no aeration in zones 2 and 3). Results showed optimal nitrification (nearly 100%) for all aeration regimes. COD was completely removed during 100% and 50% aeration but was reduced to below 30% during lower aeration modes (1-2 and 2-3/0/0 mg $O_2$/L). Denitrification was limited for municipal feed however, good $NO_3$-N removal (31-72%) was noted for industrial feed. The optimal balance between removal efficiency and energy consumption was found to be 2-3 mg $O_2$/L, consuming 7-11 Wh/$m^3$. No conclusion was made for biochar because the zone was isolated for longer duration. The findings of this study could be helpful for applying aerated wetland technology as a tertiary treatment.

**BIO:** Hafiz Khan is a PhD student at Ghent University (Campus Kortrijk), Belgium and working on intensified wetlands. He is currently focusing on pilot scale intensified wetlands at Dow industries (Terneuzen, the Netherlands).

**Contact Information:** Hafiz Khan, Laboratory for Industrial Water and Ecotechnology (LIWET), Department of Green Chemistry and Technology, Faculty of Bioscience Engineering, Ghent University Campus Kortrijk, Sint-Martens-Latemlaan 2B, B-8500 Kortrijk, Belgium. Cell: +32483-152819, Email: Hafiz.Khan@Ugent.be