ABSTRACT

This study processes was carried out to quantify the contribution of nitrification and denitrification to overall N-removal by measurement of nitrification and denitrification rates in pilot scale algae based ponds (ABPs) and duckweed based ponds (DBPs). The pilot plant scheme is located at Birzeit University Campus and consisted of a holding tank followed by two parallel wastewater treatment systems of four algae and duckweed based ponds, operating in series.

Nitrification and denitrification rates were measured using nitrate reduction technique in batch incubation (Experiment 1) at three different depths (0.1m, 0.45m and 0.9m from water surface) in both ABPs and DBPs. In situ measurements (Experiment 2) for the whole water column including sediments were done over the pond depth to confirm the results of batch incubations. The ponds were monitored for a period of 30 days in two modes of experiments (Batch incubations and in situ measurements) and the collected samples were analyzed for different physical and chemical parameters.

Despite the fact that a dense mat covers the surface of duckweed based ponds – which have suppressed algal growth and reduced the changes in the environmental conditions in the pond - aerobic zones were developed in the water column with higher dissolved oxygen concentration ([DO]) measured in algae based ponds than duckweed based ponds. Dissolved oxygen concentration was highest at the top layer in all ponds and decreased at increasing distance from the water surface. In addition anoxic zone was observed at the bottom 15cm depth of both ponds with DO concentration less than 0.5mg/L in all ponds due to settlement of suspended solids down the pond.

The nitrification rate (NR), denitrification rate (DR), in addition to physical and chemical parameters were measured in terms of pond line (ABPs, DBPs), pond depth (top "at 0.1m", middle "at 0.45m" and sediment "at 0.9m") and pond number (1, 2, 3 and 4).. The results demonstrated that NR and DR was higher in ABPs than DBP in all ponds. The range of nitrogen loss due to denitrification in ABPs and DBPs ranged between 15-20% of the total influent nitrogen correspondingly.

The nitrification process occurred in the aerobic water column and varied vertically along the water column of both systems. Typically, the NR was not significantly different along all ABPs and DBPs. This is possibly due to adsorption of nitrifies to suspended solids and subsequent sedimentation to the bottom zone. The nitrification rate was higher in the water column than at the bottom layer and there is no significant difference between the top and middle layer of all ponds. This may be referred to the continuous oxygen transfer through duckweed in DBPs (Alaerts, *et al.*, 1996) and photosynthetic oxygen in ABPs which was above 0.5 mg/L (Taylor and Bishop, 1989). Negligible NR was found at the sediment layer (although pH exists in this layer is suitable for the growth of nitrifiers) due to low rate of aeration ([DO] < 0.5 mg/L).

The denitrification process occurred in the reduced environment of the water column or in the sediment with higher denitrification rate measured in ABPs than DBPs where anoxic conditions prevailed. This may be due to the thicker sediment layer - as dead algae settles in the bottom as sediments - that contained more denitrifying organisms and organic matter in comparison with thin layer of sediment presents in DBPs. In both systems, the presence of dissolve oxygen in the water column caused low denitrification rate which ranged between 50-71 mg-N/m^2.d for both ABPs and DBPs.

The measured nitrification rate for in situ measurement ranged between 343-549 mg-N/m^2.d and 284 - 400 mg-N/m^2.d for both ABPs and DBPs respectively; whereas, the denitrification rate ranged between 352 - 513 mg-N/m^2.d and 302 - 364 mg-N/m^2.d for both ABPs and DBPs respectively. The depth of the water column illustrated considerable difference for both NR and DR in both systems.