Nitrogen removal from Hanoi groundwater by attached immobilized nitrifier using a novel acryl-roster

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Introduction

Groundwater, the only sources for Hanoi water supply at present is contaminated with high level of ammonia. Ammonia concentration (NH_4-N) in Hanoi according to analytical results changed from trace to about 30 mg/l, and the effectiveness of ammonia removal efficiencies are very low in the most of water supply treatment plants by aeration, sedimentation and filtration [4]. NH_4-N concentration for Hanoi tap water are commonly exceeded the regulatory limit for ammonium of both the Vietnamese drinking water standard and the WHO guideline in potable water of 10 mg-N/l [1].

Update available nitrogen removal technologies are air stripping, breakpoint chlorination, ion exchange and biological nitrification – denitrification (N/DN) methods. In biological nitrogen removal, NH_4^+ firstly is biologically oxidized into NO_3^- in nitrification process, and then is biological reduced from NO_3^- into N_2 in denitrification process. This N/DN process holds an environmental and economical advantages over other methods because it simple, selective and cost effective. The objectives of this research were

a) To ascertain the maximum acceptable loading capacity of biological nitrification on continuous flow treatment by using a novel acryl-resin fiber material as biomass carrier.

b) To investigate the physical, chemical, and biological characteristics of the sludge as they pertain to attached capacity and retention.

Materials and method

Experimental set-up

The biomass carrier is a novel biofringe material composed of fringe yarns (NET Co.Ltd., BF-18) attached to a support filament. The staple fiber of fringe yarns was a hydrophilic acrylic composite. The seed sludge was Lab's activated sludge cultivated by fill and draw under total oxidation conditions using a synthetic wastewater containing peptone and meat extract. The synthetic groundwater used in this study was prepared with similar compositions of the polluted groundwater of Hanoi and its' composition was shown in Table 1.

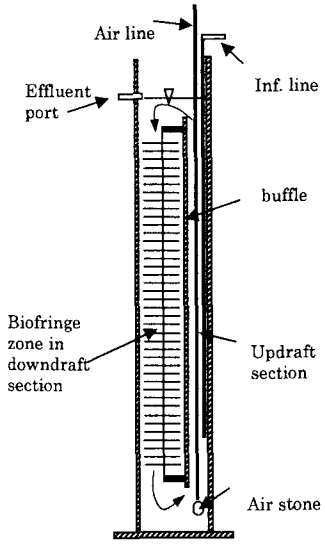

Fig. 1. The schematic diagram of the experimental system

Reactors description and operational conditions

Fig. 1 shows the schematic diagram of the experimental system. The reactor used in this study was constructed of acryl resin, it having downdraft and updraft sections in a parallel upright arrangement. Influent was feed deeply within the drafts section by using a variable speed peristaltic pump. Air was also introduced near the base of the updraft section, which served to mix and oxygenate the polluted groundwater while circulating it though the reactor.

The reactor was operated at 25^{0}C. The alkalinity and pH of influent in the reactor contents were regulated by addition of $NaHCO_3$ solution.

Table 1. Composition of the synthetic groundwater (mixed in tap water)

Composition	Concentration (mg/l)	Source	Composition	Concentration (mg/l)	Source
NH_4-N	30	NH_4-Cl	Ca	25	$CaCl_2.2H_2O$
NO_3-N	3.2	$NaNO_3$	Mg	13	$MgCl_2.H_2O$
SO_4^{2-}	2.8	tap water	Na	35	tap water
SiO_2	30.9	tap water	K	5.7	Tap water
Fe (II)	0-18	$FeCl_2$	Alkalinity	100 – 250 (as $CaCO_3$)	$NaHCO_3$

Analytical methods

Sludge retention capacity of BF and biomass concentration was estimated by SS, MLSS and MLVSS, respectively. According to Standard methods for examination of water and wastewater [3], determination of nitrite and nitrate in the study was carried out with nitrate was determined by the UV spectrophotometer screening method, nitrite by the colorimetric method, alkalinity by the titration method, hardness by calculation. NH_4^+ was determine by OPP method [2], The pH level was measured using a pH meter (320 TOLEDO). Dissolved oxygen (DO) was measured using DO meter (HORIBA).

Results and Discussion

The attachment of sludge during a 32 hours period is 8.9 g amounted to 17.8 g/m of biofringe support filament.

Ammonium removal capacity: Following the sludge attachment periods, influent was started with an initial (NH_4-N) concentration of approximately 30mg/l (Starting influent composition had mentioned above). The influent flow rates were changed from 0.32 to 2.57 l/hour, which caused that the nitrogen volumetric loading rate (VLR) changing from 0.03 to 0.24 g-N/l.day.

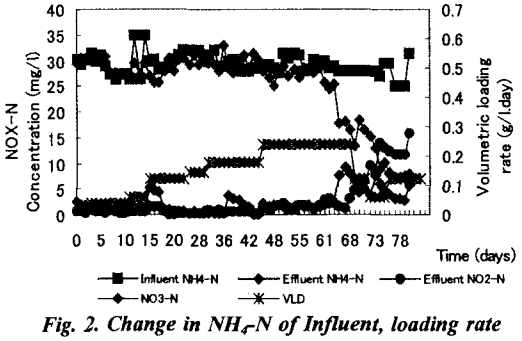

Fig. 2. Change in NH_4-N of Influent, loading rate and NH_4-N, NO_2-N, NO_3-N of effluent

The maximum amount of nitrifying activated sludge attached on BF and was 8.9 g. Effects of operation condition such as temperature, pH, dissolved oxygen (DO), alkalinity etc. on the maximum acceptable ammonium loading capacity of the reactor and ammonium removal efficiency were examined. The temperature have affected on the maximal growth rate of nitrite oxidizers, when temperatures as high as 28°C impaired with a short retention time, nitrite oxidizers was selectively detached and washed out from the system so that nitrification failed. Nitrification was also affected by DO. When DO as low as 3 mg/l, nitrite accumulation took place.

NH_4-N was converted to NO_3-N in this process, and effluent NO_2-N concentration closed to zero, the alkalinity consumption per unit of NH_4-N nitrifier to NO_3-N ranged from 6.5 to 7.1 mg as $CaCO_3$, the pH changed little from 6.8 to 7.4 mg/l .

The DO requirement was 5-6 mg/l to complete removal of applied ammonium at hydraulic retention time (HRT) of 3 hours. Effluent suspended solid concentrations were below 0.02 g/l owing to the complete retention of activated sludge on acryl resin fiber carrier.

Conclusion

NH_4-N removal by attached immobilized nitrifiers using a novel biofringe material was carried out to investigate the effective treatment of Hanoi groundwater, which is contaminated by high level of ammonia. 95-100% of ammonia removal efficiencies were obtained at volumetric loadings up to 0.24 kg NH_4-N/m^3.d and HRT as shorts as 3 hours on the first period of 66 days. Both ammonia oxidizing and nitrite oxidizing bacteria as same as nitrification efficiency have be inhibited completely when DO < 3 mg/l and temperature higher than 28°C.

Reference

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