Simultaneous Clarification and Endogenous Post Denitrification by Up-flow Through a Layer of Floating Media

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Introduction

Methods to comply with the most updated low effluent total nitrogen (TN) regulations include, in addition to a high internal circulation ratio to a pre-denitrification stage, either a large intermediate anoxic zone, or a post denitrification stage with addition of an external, purchased, carbon source [ ]. Wastewater treatment cost considerations have yielded processes for on-site production of readily biodegradable organic carbon, in the form of VFA, by fermentation of primary sludge [ ], whereas secondary sludge has been found to be a less attractive source for carbon [ ]. These general principles apply to both suspended and attached growth wastewater treatment processes.

The work described in this document started off in an attempt to enhance endogenous denitrification following an attached growth bio-reactor, by holding a high concentration of suspended solids in the designated zone of the reactor, using a layer of structured floating media and a generally upwards flow pattern. However, the tested reactor also improved suspended solids settling properties and produced an effluent with low TSS.

Materials and Methods

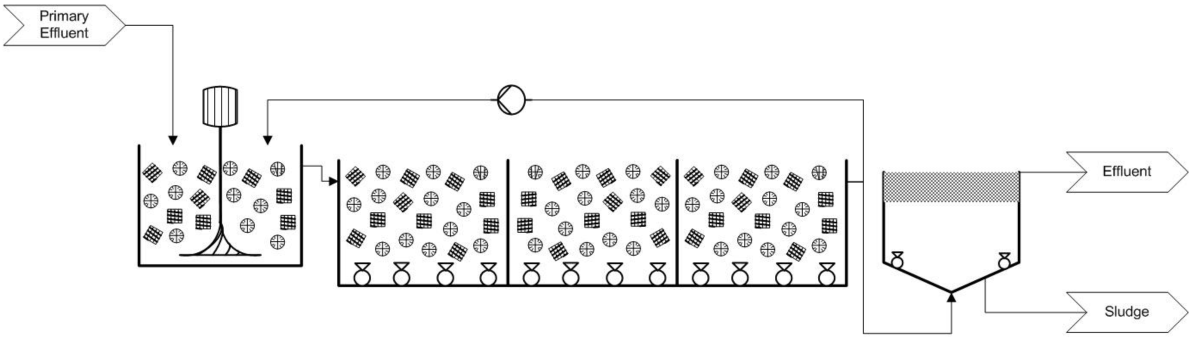
The pilot unit was a continuous 4-stage mixed bed reactor (AGAR® process), followed by the test unit. Feed was primary effluent from a municipal wastewater treatment plant. System parameters are listed below in table 1, and a schematic drawing is shown in figure 1.

Ammonia, nitrate, suspended solids and soluble COD concentration profiles along the entire system were determined regularly. Sludge was discharged from the test unit according to hydraulic head loss, and effluent TSS, nitrate and ammonia concentrations.

Total Volume	4.4	m^3
HRT	11	hours
Volume of each stage	20	% of total
Aerobic zones fill ratio	50	% of volume
Biomass carrier type	ABC4	see figure 2

Table 1: Pilot system main parameters

The test unit was a cylindrical tank with a conical bottom, through which it was fed. Water would flow upwards at a velocity of 2 m/h, through a layer of media (ABC4) that occupied about 20% of the volume, and retained most of the suspended solids. Partially clarified effluent would then discharge over a weir covered with a screen. The test unit was installed with aeration diffusers that could be turned on in order to release solids from the media.



Stage No.:	1	2	3	4	5
Process:	Pre-denitrification	Aerobic 1	Aerobic 2	Aerobic 3	Post-denitrification and clarification

Figure 1: Pilot system setup

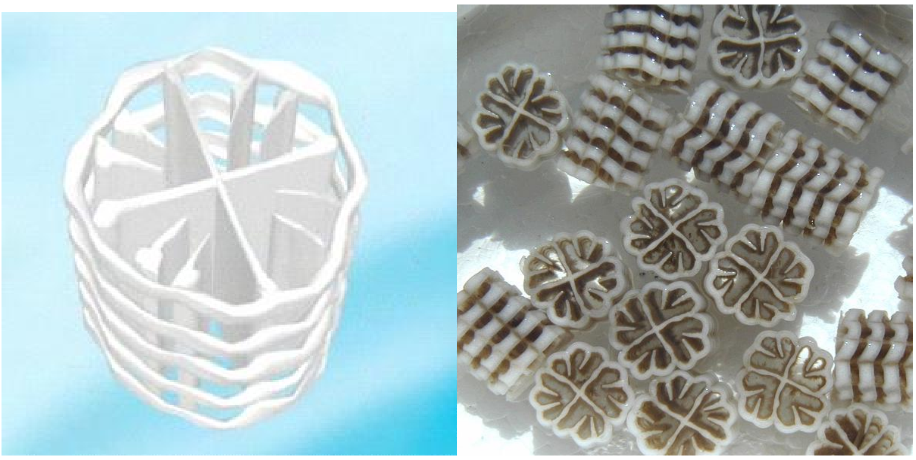


Figure 2: ABC4 biomass carrier

Main Results

A profile of average ammonia and nitrate concentrations along the entire system for a period of 2 months are shown in figure 3, where stream numbers refer to the drawing in figure 1.

At operating conditions of about 350% circulation ratio from the last aerobic zone to the pre-denitrification tank, about 25% of the system denitrification took place in the post denitrification unit, and about 75% in the pre-denitrification tank.

TSS concentration and sludge age in the test unit were controlled by the sludge wasting rate. High sludge concentrations and ages yielded better denitrification results. However, endogenous decay of the secondary sludge released ammonia into the effluent, especially noticeable at high SRT. Also, the existence of an optimal solids holdup was demonstrated by breakout of soluble COD at high sludge ages.

Average clarification performance of the test unit, for the entire period reported at this stage of the work, is illustrated in figure 4. The average results show a removal efficiency of about 75%. However, the average is highly influenced from the variability in these preliminary results, much of which were affected from improper operation and tank hydraulics. Many of the results show a removal efficiency of more than 90% and effluent TSS of 10-20 mg/l.

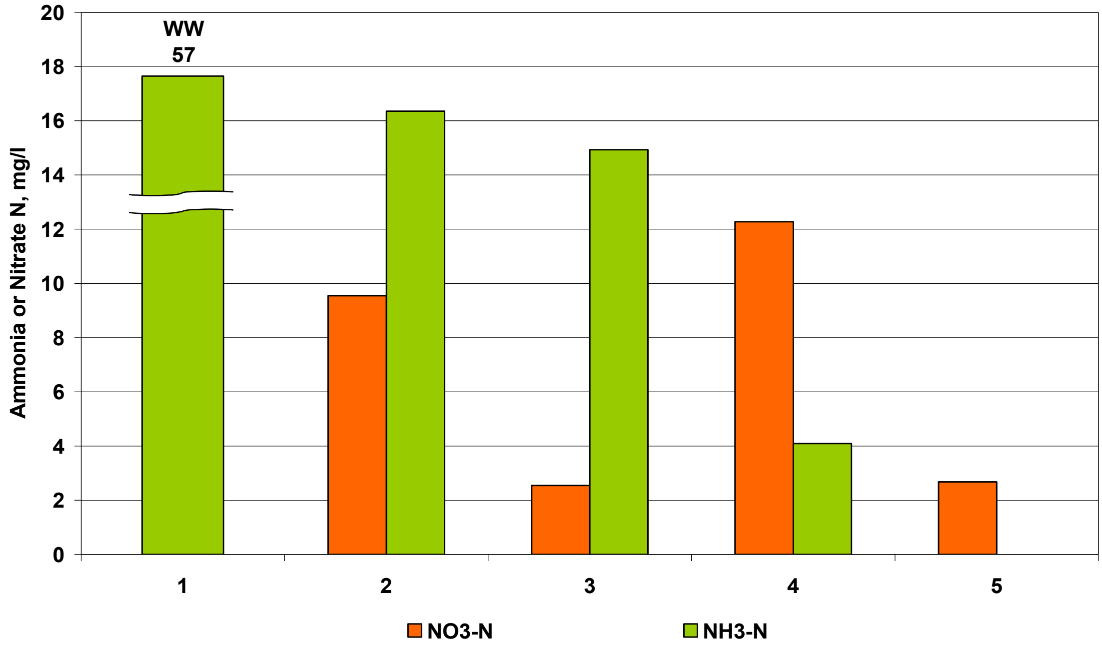


Figure 3: Ammonia and nitrate concentration profiles along the systems - 2 months averages

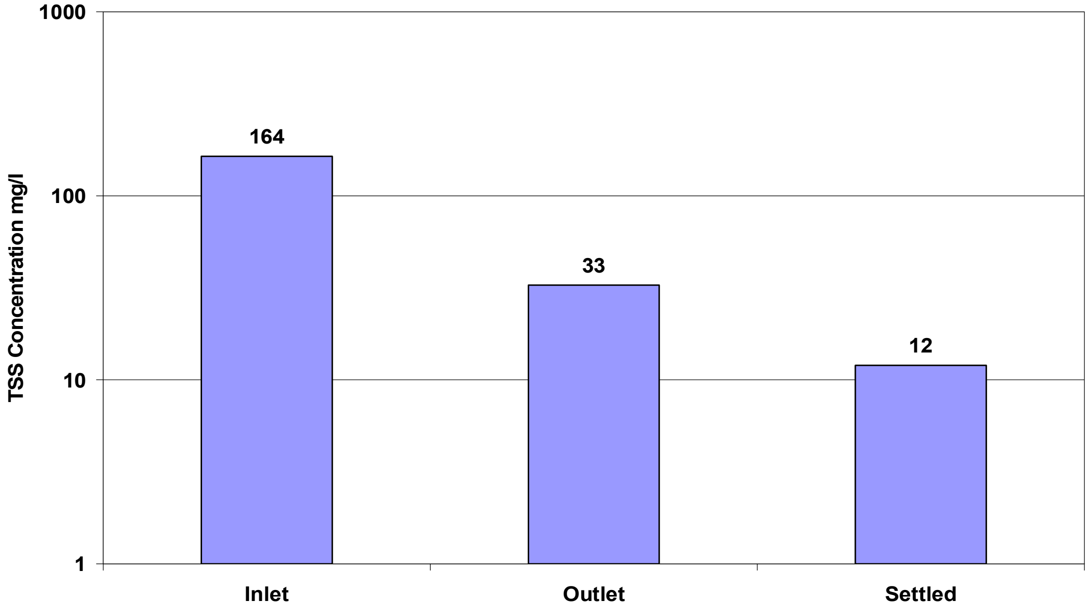


Figure 4: Average TSS removal in the test unit

Conclusions

Preliminary pilot testing of an upwards flow tank filled with a layer of floating media, following a mixed bed reactor, show efficient endogenous post denitrification and simultaneous partial clarification. Effluent suspended solids concentration directly complies with regulations in some parts of the world. Otherwise, the suspended solids readily settle to about 10 mg/l, or can be filtered to less than that. Optimization of the required sludge wasting rate, including control of the wasting rate with respect to effluent parameters, are still being studied.