Comparison of steady state performance of sulphide driven DEAMOX process under intermittent and continuous feeding

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Introduction

The recently proposed DEAMOX process (Kalyuzhnyi *et al.*, 2006) combines the anammox reaction with autotrophic denitrifying conditions using sulphide as an electron donor for the production of nitrite from nitrate within an anaerobic biofilm (reactions 3 and 4).

UASB reactor: N-organics + $SO_4^{2-} \rightarrow NH_4^+ + HCO_3^- + CH_4 + HS^-$ (1)

Nitrifying reactor : $NH_4^+ + O_2 \rightarrow NO_3^- + NO_2^-$ (2)

DEAMOX: $4NO_3^- + HS^- \rightarrow 4NO_2^- + SO_4^{2-}$ (3)

$NH_4^+ + NO_2^- \rightarrow N_2 + 2H_2O$ (4)

The concept of the DEAMOX process was experimentally proved using such a strong nitrogenous wastewater as baker's yeast effluent and the laboratory set-up consisted of 3 reactors (Fig. 1).

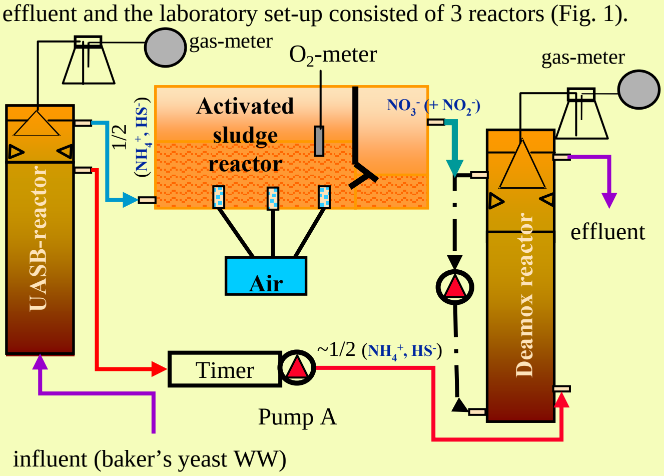

Fig.1. Process flow diagram of the DEAMOX process

The objective of this poster was to compare a steady state performance of the process for intermittent and continuous supply of nitrified and anaerobic effluents to the DEAMOX reactor under variation of nitrogen loading rates (NLR) using baker's yeast wastewater as the primary influent to the system (Fig. 1).

Materials and Methods

The real wastewater from Moscow baker's yeast factory was used for this study and had the following characteristics (g/l, except pH): **total COD – 5.1-5.5; total N – 0.2-0.4; total P – 0.01-0.015; sulphate – 0.7-0.9; pH -5.5**. For intermittent loading, the pump A was connected with the timer which was "on" during 0.5 h and then "off" - during 0.5 h. The flow rate of the pump A was set about 85% of the flow of the influent feed pump of the UASB reactor. For continuous loading, the timer was removed and the flow rate of the pump A was set about 40% of the flow of the influent feed pump of the UASB reactor. The overflow from the nitrifying reactor was flowing by gravity into the recycle pump of the DEAMOX reactor for both the feeding regimes investigated.

Results and Discussion

UASB and nitrifying reactors performance. The UASB reactor demonstrated a stable performance in the range of OLR - 3.9-9.5 g COD/l/d; the total COD removal - 71±2%; effluent ammonia - 222±14 mg N/l; effluent sulphide - 264±14 mg S/l. The nitrifying reactor also functioned without problems throughout an entire study showing near 100% nitrification efficiency under ammonia loading rates of 111-350 mg N-NH4/l/d with nitrate as a prevailing product over nitrite.

Performance of the DEAMOX reactor. The steady-state data in both the feeding regimes are generalised in Figs. 2-3. It is seen that, independently on feeding mode and in spite of decrease of HRT from 0.65 to 0.21 days and, hence, increase of the NLR from 300 to 858 mg N/l/d, the reactor demonstrated only a slight trend in deterioration of its performance: the average ammonia, nitrate and total inorganic nitrogen removals (nitrite was completely consumed) decreased by only a few percents.

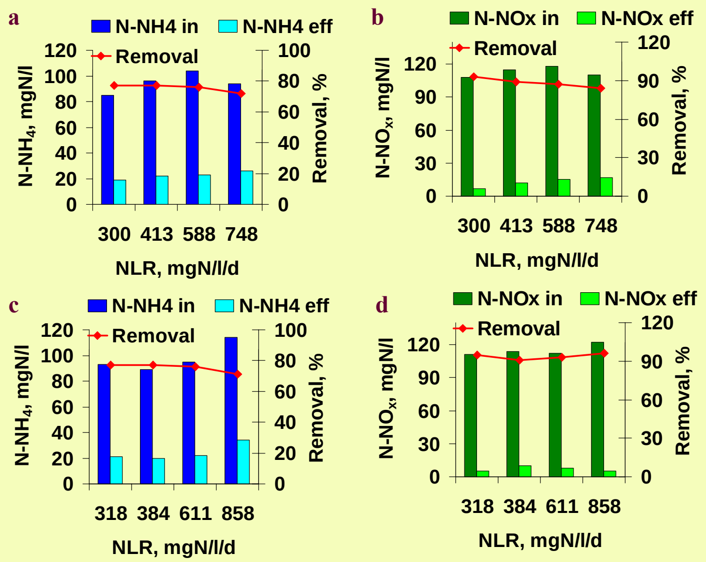

Fig. 2. Performance of the DEAMOX reactor under intermittent (a, b) and continuous (c, d) feeding.

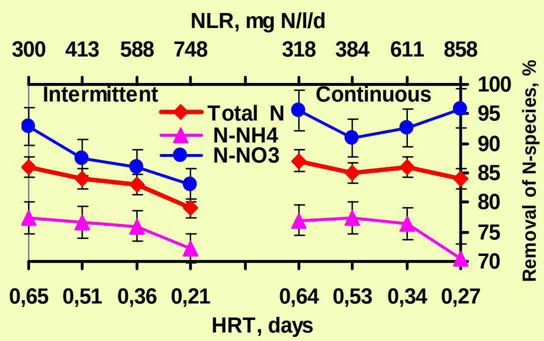

Fig. 3. The average removal of nitrogen species by the DEAMOX reactor under the intermittent and continuous supply of nitrifying and anaerobic effluents and variation of HRT (NLR).

The continuous supply of anaerobic and nitrifying effluents to the DEAMOX reactor seems to be better than the intermittent one in terms of total nitrogen removal (Fig. 3). Some enhancement of the latter parameter was due to a more complete nitrate removal under continuous feeding, whereas the ammonia removal was similar for both the feeding regimes applied under the comparable NLR (Fig. 3). A possible explanation of these observations can be related with the structure of sludge aggregates which are presumably formed with the outer layers of sulphide oxidizing denitrifiers and the inner layers of anaerobic ammonia oxidisers. Thus, during continuous feeding (simultaneous supply of nitrate and sulphide), there were less mass transfer limitations for denitrification. On the contrary, ammonia oxidation presumably occurring inside the aggregates apparently suffered from nitrite mass transfer limitations under both the feeding regimes. Future research has to disclose the real reason(s).