Online Control of External Carbon Addition to Predenitrification Process

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Abstract: With domestic wastewater of low ratio of carbon and nitrogen (C/N), the control of external carbon dosage was studied for the predenitrification process with continuous flow. The objective is to keep the external carbon usage as low as possible while nitrate plus nitrite concentrations (NO$_3^-$-N) of outflow under demand. The experimental results show that nitrogen removal efficiency couldn't be improved by increasing total recirculating rate with total recirculating rate more than 2 for lack of carbon source and removal efficiency of TN couldn't be largely improved by double dosage of carbon source with constant recirculating rate when NO$_3^-$-N concentration reaches about 2 mg/L. Based on the analysis of the relationship between the external carbon addition and total recirculating rate, a control method was proposed. The external carbon dosage is controlled by keeping NO$_3^-$-N concentration of anoxic zone at the level of 2 mg/L, and the total recirculating rate is determined by stated effluent NO$_3^-$-N concentration. The control method not only can determine the reference point of carbon dosage, but also can optimize the usage of carbon addition. It is easy to be carried out in wastewater treatment plants.

Key words: predenitrification; low C/N; external carbon addition; recirculating rate; on-line control
Fig. 1 Schematic diagram of experimental equipment of denitrification process

1. COD: 3.5~4.0 mg/L
   TN: 20~40 mg/L
   NH₃-N: 10~20 mg/L
   NO₃-N: 8~10 mg/L
   pH: 7.1

2. DO: 2~6 mg/L

3. MLSS: 4000~5000 mg/L
   COD: 0.19~0.41 kg/(kg* d)
   NH₃-N: 0.06~0.11 kg/(kg* d)
   COD: ≤50 mg/L

NH₃-N: ≤2 mg/L

2.1. NO₃-N: ≤22%
   NH₃-N: ≤10%
\[ \text{TN} = \frac{S_{\text{AN}}}{S_{\text{NO}_3\text{-AN}}} X_{\text{B}} \]

\[ V_{\text{obs}} = \mu_{\text{obs}} \left( \frac{S_{\text{AN}}}{S_{\text{NO}_3\text{-AN}}} + \frac{S_{\text{NO}_3\text{-AN}}}{S_{\text{NO}_3\text{-AN}}} \right), \text{mg} \cdot (L \cdot d)^{-1}; \mu_{\text{obs}} \text{, d}^{-1}; S_{\text{AN}} \text{, mg} \cdot L^{-1}; S_{\text{NO}_3\text{-AN}} \text{, mg} \cdot L^{-1}; K_s \text{, COD} \]
\[ \text{COD} \times \text{NO}_3^-\text{N} \times \text{TN} \times \text{N} \times \text{COD} \times \text{NO}_3^-\text{N} \times \text{TN} \times \text{N} \]

\[ S_{\text{NO}, \text{AE}} = S_{\text{NO}, \text{AN}} + (1 - r) Q_{\text{inf}} S_{\text{TN,inf}} / Q \] (2)

\[ Q = Q_{\text{inf}} + Q_{\text{int}} + Q_r \] (3)

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\[ R_i = \frac{1}{(1 - r) S_{TN,ai} - S_{NO,AE} - 1} \]