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Anammox SBR for treatment of yeast factory wastewater

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Developing the energetically effective waste management technology for autotrophic treatment of ammonium- and organic carbon-rich wastewaters (600-2000 mg NH_4^+-N L^{-1}, COD over 15400 mg L^{-1}) generated in food industry is important. Anaerobic ammonium oxidation (anammox) is beneficial for treatment of ammonium and carbon-rich streams by mixed-culture suspended sludge-based sequencing batch reactor (SBR) technology.Wastewater from yeast factory (located in Estonia, Salutaguse) anaerobic tank were treated in SBR. Efficient biomass with good average removal efficiencies of N (70 %) and total organic C (TOC) (30-60%) and rates was grown in floc-based SBR configuration with low volatile suspended solids (VSS) (0.65-0.86 g L^{-1}) concentration and with high volumetric exchange ratio (50%) at 26ºC. HRTs of 1-2 days were applied. Granulation step was determined to be not necessary to achieve sufficient TN removal rates (maximum over 250 mg Ng $VSS^{-1}day^{-1}$) with this simple technology.

Wastewater treatment process in 10 L SBR was performed with 3-20 times dilution of yeast factory wastewater throuhout 270 days. Maximum influent TN and TOC concentrations applied were 500 and 610 mg L^{-1} (COD of 1300 mg L^{-1}). The highest TN removal rates were coupled with high TOC removal rates (130 mg TOC g $VSS^{-1}day^{-1}$) with 3 times diluted yeast factory effluent. At the same time betaine (organic N-compound coming from molassis of yeast fermentation) decreased from 180 to 5.6 mg N L^{-1} in the effluent. Batch tests were performed in NH_4Cl / $NaNO_2$ (N: 1.32 / 1) with additions of bicarbonate, macro- and micronutrients (according to Zhang et al., 2009). Aerobic and anaerobic batch tests at initial SBR operation stage at temperature of 20ºC with VSS of 1-2 g VSS L^{-1} resulted in specific N conversion rates of 0.15 and 0.82 mg N g $VSS^{-1}h^{-1}$, respectively showing low aerobic activity of biomass. To improve biomass aerobic activity, along with increased TN and (non-biodegradable BOD7/COD=0.51) carbon loading, aeration intensity was adjusted to DO concentrations lingering at high range 0-4.7 mg L^{-1} in period with 6 times diluted yeast wastewater. After 270 days of SBR operation specific TN removal rate of 1.1 mg N g $VSS^{-1}h^{-1}$ showed biomass resistance to high–strength wastewater. Betaine biodegradation rate was 1.38 mg N g $VSS^{-1}h^{-1}$-higher than TN removal rate. Anammox microorganisms presence was proven similarly as during start-up period by polymerase chain reaction (data not shown). However, after 270 days of operation, heterotrophic denitrifyers were included into biomass consortium (capable of betaine reduction). NO_3^- production / $NH4^+$ consumption ratio was decreased from 0.24 (±0.16) to 0.07 (±0.04) during 200 days of operation.

In conclusion, floc-based SBR was efficient tool for simultaeous elimination of N (maximum TN removal rate of 250 mg N g $VSS^{-1}day^{-1}$) and C-compounds from high-strength yeast factory wastewater. Anammox microorganisms were also tolerant to high DO concentrations. In addition, nitrite oxidizing bacteria activity was held low by high volumetric exchange ratio of 50% and by heterotrophic denitrifyers reducing NO_3^-.

Biography

Ivar Zekker has completed his Ph.D at the age of 28 years from Institute of Chemistry, University of Tartu. He is the researcher of Institute of Chemistry, University of Tartu. He has published more than 9 papers in reputed journals and serving as an editorial board member of several journals.

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