Application of Membrane Bioreactor Seeded with Aerobic Granular Sludge for Livestock Farm Wastewater Treatment

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Abstract: Nitrogen and organic substances in the synthetic livestock farm wastewater were efficiently removed by using an aerobic granular sludge membrane bioreactor where biofilm was fixed on a hollow-fiber membrane. The effluent COD and NH_4^+-N concentration were 46.6 mg/L and 4.8 mg/L on average under the conditions of HRT 8 h, the volume load of COD 600 mg/L, and the concentration of ammonia nitrogen 40 mg/L. The removal efficiency of nitrate nitrogen and nitrite nitrogen were approximately 90%. In addition, the introduction of aerobic granules into the MBR system was beneficial to controlling membrane fouling.

Key words: membrane bioreactor; livestock farm wastewater; aerobic granular sludge
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The high concentration ammonium nitrogen wastewater from the livestock farm is one of important pollution sources, which causing non-point pollution in Chinese country. Membrane bioreactor (MBR) process is of great potential both technically and economically, especially in treatment of this kind of wastewater[1-2]. Aerobic granular sludge MBR systems have potential for simultaneous removal of organic substances and nitrogen[3-4].

1 Material and methods

1.1 Materials

The MBR made of polycarbonate had an effective volume of 5×10^4 cm^3. The wastewater treated was separated with 0.1 μm polypropylene hollow fiber microfiltration membranes in MBR.

1.2 Experimental methods

Aerobic granular sludge was cultured by flocculent activated sludge and fed with glucose as organic substrate in the reactor. A synthetic wastewater mainly consisting of glucose, $NaHCO_3$, NH_4Cl, KH_2PO_4 and trace element solution was used to simulate the composition of real livestock farm wastewater. The influent wastewater and intermittent effluent were automatically controlled through a sensor set to maintain hydraulic retention time at 8 h.

2 Results and discussion

2.1 Microstructure of aerobic granular sludge

Granules appeared spherical shape obtained by cultivated work (Fig.1). The SEM analyses revealed that there were fluffy biolayers on the granule surface, in which filamentous attached by bacilli and cocci could be observed. This is probably attributed to enable the aerobic granules to have better treatment efficiency.

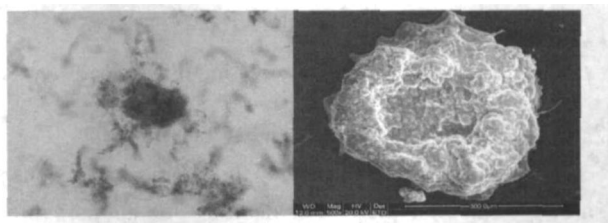

Fig.1 Phorograph and SEM of aerobic granular sludge

2.2 Property of COD removal

As shown in Fig.2, the effluent COD was averaged at 46.6 mg/L under the conditions of the volume load of influent COD 600 mg/L. The COD removal efficiency kept above 92% in the whole process due to biological degradation. The possible reason of that good performance might be due to the high biomass concentration and syntrophic relationship among different spe-

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cies of microorganisms in the granules.

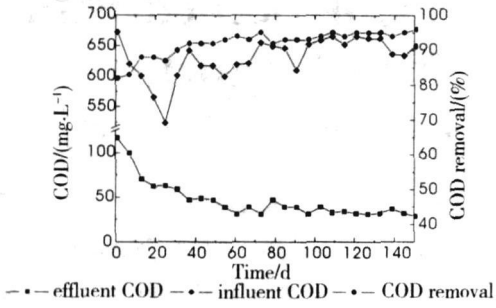

Fig. 2 Removal of COD in MBR system

2.3 Property of nitrogen removal

As shown in Fig. 3, N removal utilizing simultaneous nitrification and denitrification (SND) was successful in this system[5]. The effluent NH_4^+-N average concentration was 4.8 mg/L and removal efficiency achieved to 90%. The NO_3^--N and NO_2^--N in the effluent became very low, which the influent concentrations were 3.17 mg/L and 0.05 mg/L, respectively.

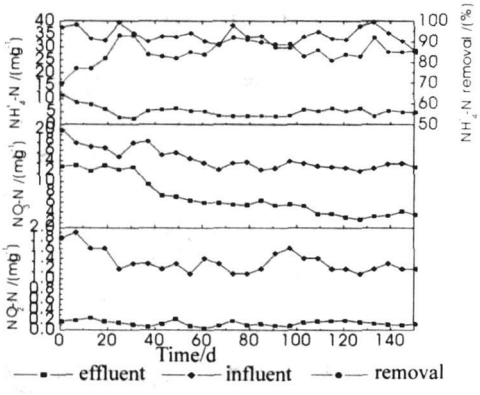

Fig. 3 Removal of nitrogen in MBR system

2.4 Membrane flux in MBR system

A decrease in permeate flux may be because short-term immediate flux decline due to pore blocking and cake formation on the membrane, long-term gradual flux decline due to cake compaction and irreversible fouling. The flux could keep at a relative stable level during the operation period. The membrane fouling was controlled by using the aerobic granule sludge MBR.

3 Conclusions

The removal of organic substances and nitrogen compounds from the synthetic livestock farm wastewater could occur simultaneously in an aerobic granular sludge membrane bioreactor. The system was responsible for 83% ~96% of the overall COD removal mainly due to biological degradation. Nitrogen was removed through the SND process. The effluent NH_4^+-N average concentration was 4.8 mg/L at a loading of 40 mg/L. The efficiencies of NO_3^--N and NO_2^--N removal were approximately 90%. And the introduction of aerobic granules into the MBR system was beneficial to controlling membrane fouling.

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好氧颗粒污泥膜生物反应器处理畜禽废水

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摘 要: 采用好氧颗粒污泥膜生物反应器处理畜禽废水, 分别对 COD、NH_4^+-N、NO_2^--N、NO_3^--N的去除效果和对膜通量的影响进行了研究。结果表明: 在水力停留时间 (HRT) 为 8 h, 进水 COD浓度为 600 mg/L, NH_4^+-N浓度为 40 mg/L的条件下, 出水 COD、NH_4^+-N的浓度分别为 46.6和 4.8 mg/L, NO_2^--N和 NO_3^--N的去除率也可达 90%以上。并且好氧颗粒污泥的加入减缓了膜的污染。

关键词: 膜生物反应器; 畜禽废水; 好氧颗粒污泥

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