

Treatment of Mature Landfill Leachate by Improved A²O Process

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Abstract. The paper presented an economic and efficient method of "anaerobic SBR - UASB - SBR" for disposal mature landfill leachate with high COD, ammonia nitrogen concentration but low B/C ratio. Started up the unified process under 500% reflux ratio whose inflow of water maintained 3L/d. Improved the reflux ratio gradually and determined COD, NO₃-N, NO₂-N, TN, NH₄-N of the effluent. Under the optimal reflux ratio of 2200%, the removal rates of COD, NH₄-N and TN by the system reached 96.30%, 92.12% and 90.57% respectively, the mass concentration of COD, NH₄-N and TN in effluent water were 49.52, 2.14, 38.71mg/L respectively. Under the optimal technical parameters, the effluent quality met the specification for emission standard in water quality meets emission standard in Standard for pollution control on the landfill site of municipal solid waste (GB16889-2008).

Introduction

Due to precipitation, surface water and waste comes, degradation of water pooling will produce large amounts of landfill leachate, and with the growth of useful life of landfill, leachate water quality is becoming more and more complex, and its biodegradability decline^[1]. Adopting biological process in the leachate organic pollutants and ammonia nitrogen is the most economic way. In recent years, shortcut nitrification and denitrification, shortcut nitrification bacteria and anaerobic ammonia oxidation combination process, salon, artificial wetland treatment technology was applied to practical engineering^[2-6]. Parts adopt biological treatment technology of landfill leachate study show that ammonia nitrogen and total nitrogen of effluent from the system can not meet the requirement of the discharge, or need additional carbon source for denitrification, it increases the cost of processing^[7-9]. About 2.3 million tons of waste produce every day in Shenyang, and Lao Huchong landfill is responsible for handling 49% of the urban living garbage^[10-11]. The paper presented an economic and efficient method of "anaerobic SBR - UASB - SBR" for disposal mature landfill leachate without need additional carbon source, and water quality meets emission standard.

Experimental

The experimental setup consists of inlet cistern, preposition anaerobic SBR, middle cistern 1, modified medium temperature UASB, middle cistern 2, aerobiotic SBR and effluent cistern (Fig.1). Three reactors of the test are all made by organic glass cylinder, the height of the anaerobic SBR reactor is 1000 mm, the inner diameter is 150mm, the effective volume is 17L, and the sludge concentration is between 3500 ~ 4500mg/L, it is mixing with the electric mixer. The modified medium temperature UASB is 3.5m high, the effective height of reaction zone is 2m, the external diameter is 200mm, the inner diameter is 100mm, it is using centrifugal pump for hot water circulation to make sure the temperature of modified medium temperature UASB between (35 ± 2)°C. The effective volume is 15.7L, and the sludge concentration is between 20000 ~ 26000mg/L. The height of the aerobiotic SBR reactor is 2m, the diameter is 200mm, and the effective volume is 50L.

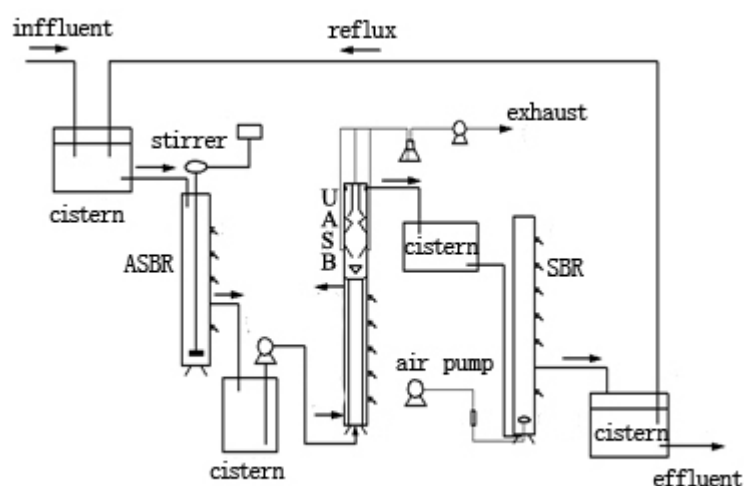


Fig.1 Experimental setup

The landfill leachate derive from Shenyang Lao Huchong landfill. The major pollution indicators of landfill leachate are shown in table 1.

Table 1 Characteristics of the landfill leachate

ρ (COD) /($\text{mg} \cdot \text{L}^{-1}$)	ρ (BOD ₅) /($\text{mg} \cdot \text{L}^{-1}$)	ρ (NH ₃ -N) /($\text{mg} \cdot \text{L}^{-1}$)	pH
15000-22000	5000-11000	1600-1900	7.6-8.5

Results and analysis

Treatment effect analysis of unified operations process

Pollutants removal effect of each unified operations is shown in figure 2.

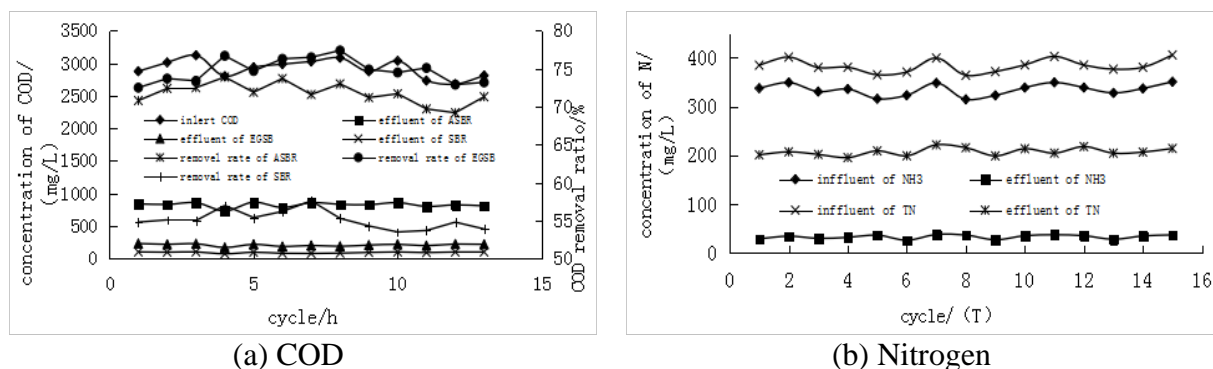


Fig.2 The pollutants removal in each reactor during the unified operations stage

The figure 2 (a) shows that, in unified operations stage, COD removal rate of anaerobic SBR reactor maintain at about 70%, COD removal rate of UASB reactor maintain at about 73%, COD removal rate of aerobiotic SBR reactor only maintain at about 55%. And total removal rate of system maintain at about 95%. Except anaerobic SBR, the COD removal rate of both UASB and aerobiotic SBR all have significantly reduced while they were in isolated operation. Analysis of the causes may that leachate through UASB and SBR biochemical decline gradually, lead to the treatment effect can reduce than they were in isolated operation. It basically stable because the COD in effluent main difficult degradation of organic compounds. And ammonia concentration has not decreased, there is a certain increase after the first two combination process. This suggests that the combination process of ammoniation is significant. This research results is similar with Cao's study^[12].

Ammonia nitrogen removal rate is not specifically anoxic denitrification period of water ammonia nitrogen concentration, especially the landfill leachate concentrate in figure 2 (b).

Combination process of ammonia nitrogen removal rate can be stable at more than 98%, the effluent total nitrogen was still not achieve discharge standard. This is mainly because the final step of system is aerobic nitrification process, and there is no denitrification process after the nitrification, so the high nitrate nitrogen and nitrate in water is the main causes of high total nitrogen. It took each reactor effluent per hour and measured a cycle of each reactor the change of COD and ammonia nitrogen(Fig.3) in order to reflect nitrogen in a reaction system transition period better.

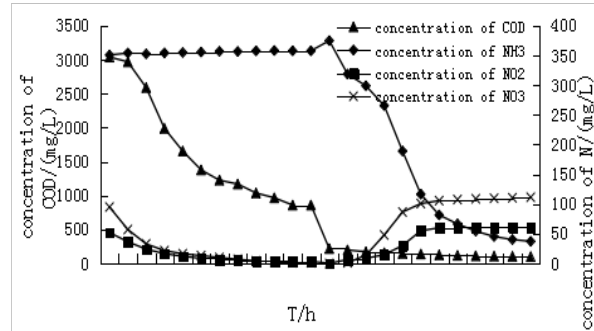


Fig.3 Variation of COD and nitrogen concentration in one reaction period

The degradation of COD mainly in the combined process of anaerobic SBR and UASB reactor in one period. It's in the aerobic degradation of ammonia nitrogen nitrification in SBR reactors and partial hydrolysis acidification of small molecule organic matter. Because of the water ammonia nitrogen is high in aerobic SBR, it can not occur denitrification reaction, which is the main causes of high total nitrogen. Effluent has a high nitrite nitrogen concentration because of relatively high free ammonia of nitrifying bacteria produce a certain degree of inhibition, nitrification reaction stay on the nitrosation reaction stage. In order to make the water of the system meets emission standard, we need to reduce the system water ammonia nitrogen concentration. Reflux ratio by increasing system, determination of optimal reflux ratio to ake the system treated water reached the landfill pollution control standard (GB16889-2008) emissions requirements.

The influence of reflux ratio on system treatment effect

Under different reflux ratio, the reactor for removal efficiency of pollutants in the system is shown in figure 4.

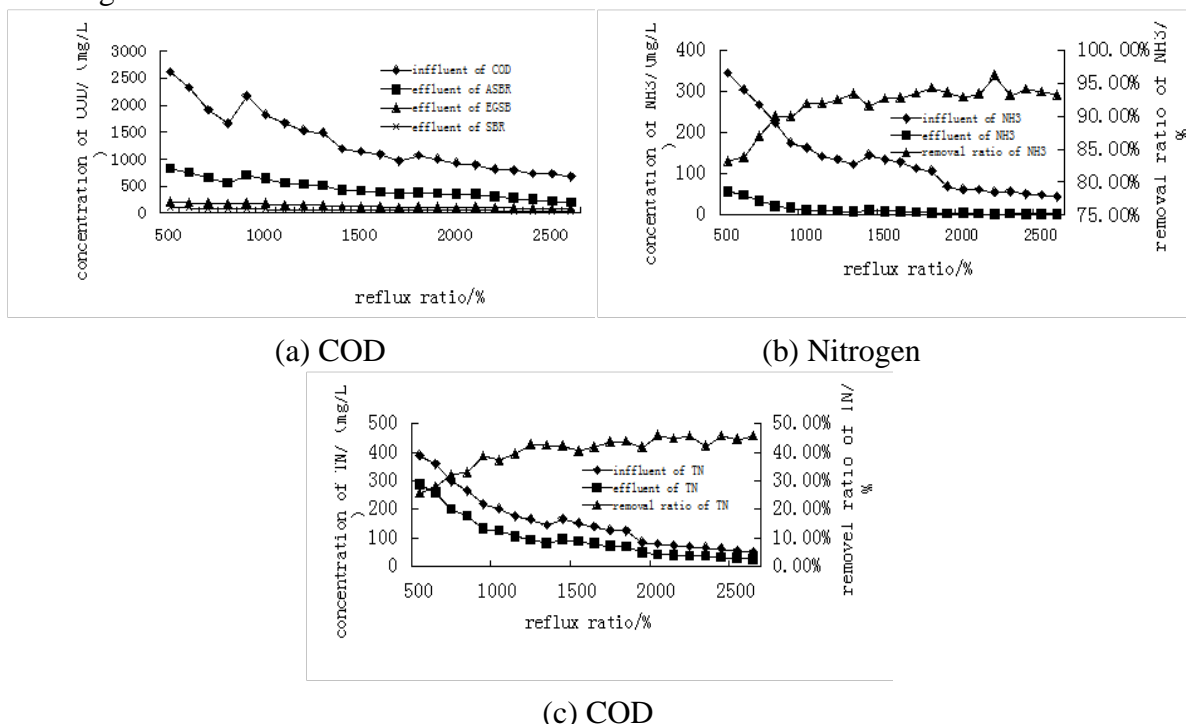


Fig.4 The pollutant removal efficiency in different reflux ratio

The figure 4 (a) shows that, in the process of regulating reflux ratio from 500% ~ 2600%, COD total removal rate of system maintain at about 96.30%, when the reflux ratio of 700%, effluent has been stable below 100 mg/L. Even increasing reflux ratio that COD processing efficiency is not improved. The reason may be that the presence of organic matter in landfill leachate which is non-degradable or refractory organics. This part of the COD cannot be removed by reflux ratio increased further^[13].

The figure 4 (b) shows that, in the process of regulating reflux ratio from 500% ~ 2600%, the removal rate of ammonia nitrogen gradually stabilized at about 92.12% from 500% ~ 1300%, the effluent ammonia nitrogen at about 10mg/L, but this phase of the water does not meet the garbage leachate concentration pollutant discharge standards. Since reflux ratio reached 1300%, the factors on the system has little effect on ammonia nitrogen removal rate. When the reflux ratio reached 1500%, the effluent ammonia nitrogen under 10mg/L and effluent can meet the discharge standard requirements. When the reflux ratio reached 2200%, the effluent ammonia nitrogen under 5 mg/L steadily, the removal rate of ammonia nitrogen promotion effect is not obvious. When the reflux ratio reached 2600%, the effluent ammonia nitrogen at 2.9mg/L, Ammonia nitrogen removal efficiency increase is smaller than when the reflux ratio reached 1300%.

The figure 4 (c) shows that, system processing efficiency of total nitrogen affected by the change of reflux ratio, system in aerobic period of total nitrogen removal rate is higher. With the gradual improvement of the reflux ratio, When the reflux ratio reached 2200%, the removal rate of effluent total nitrogen gradually stabilized at about 38mg/L. Therefore combination process in the system when the reflux ratio of 2200% water meet the landfill pollution control standard (GB16889-2008) emissions requirements.

Conclusion

The resistance to impact load capacity of COD is better than the resistance to impact load capacity of ammonia nitrogen with entire biological process. When the reflux ratio reached 2200%, the mass concentration of COD, NH₄-N and TN in effluent water were 49.52, 2.14, 38.71mg/L respectively, which meet the landfill pollution control standard (GB16889-2008) limit requirements of COD 100mg/L, NH₄-N 25mg/L and TN 40mg/L.

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References

- [1] Halim A A. Removal of ammoniacal nitrogen and COD from semi-aerobic landfill leachate using low-cost activated carbon zeolite composite adsorbent[J]. International journal of environment and waste management, 2009, 28(5): 399-411.
- [2] SRI S, KURIAN J. Start-up of the SHARON and ANAMMOX process in landfill bioreactors using aerobic and anaerobic ammonium oxidising biomass [J]. Bioresource technology, 2013, 149 (12): 474-485.
- [3] Silviya L, BOGDANA K. Influence of recirculation in a lab-scale vertical flow constructed wetland on the treatment efficiency of landfill leachate [J]. Bioresource Technology, 2010, 101 (3): 1756-1761.
- [4] Zhang Shujun, Peng Yongzhen. Organic matter and concentrated nitrogen removal by shortcut nitrification and denitrification from mature municipal landfill leachate[J]. Journal of environmental

sciences,2007,12(19):647-651.

[5] Wang Kai,Wang Shuying,ZHU Rulong Peng Yongzhen. Shortcut nitrification combined anaerobic ammonia oxidation treatment of landfill leachate[J].Journal of central south university,2013, 44(5): 2136-2143.

[6] PENG Juwei.Research on Wastewater Teatment by Technology of Divisional Influent ABR-Multi-stage Vertical-flow Constructed wetland[D].Ji Lin:Jilin University,2013

[7] Song Yanjie,Peng Yongzhen, The research progress of bio-integrated process for landfill leachate treatment[J]. Technology of water treatment, 2011,4(37):9-13

[8] WANG Shuying,WANG Yan,SUN Hongwei,et al.Single-stage UASB-A /O System for Treatment of Real Landfill Leachate[J].Journal of Beijing University of Technology,2011,37(12):1836-1842.

[9] Sun Hongwei,YANG Qing,PENG Yongzhen, et al. Nitrite accumula-tion during the denitrification process in SBR for the treatment ofpre-treated landfill leachate [J].Chinese journal of chemical engi-neering,2009,17(6):1027-1031.

[10] REN Wanxia. Geng Yong. Xue Bing. Emission and generation forecasting of municipal solid waste in Shenyang[J]. Environmental science&technology, 2011, 34(9):105- 110.

[11] ZHOU Xiaoqiang. Study on scheme of domestic waste energy utilization model in shenyang city[D]. Shenyang Aerospace University,2013

[12] CAO Mingshuai.Study on Processes Debugging and Operation for Treatment of Wastewater from Spice Industrial Park by UASB+A/O+BAF Method[D].Nan Chang:Nanchang University,2014.

[13] Xiong Xiao-jing,Feng Zhe-wen. Study on Nitrogen Removal Behavior in Landfill Leachate Treatment by a Combination of Anaerobic Bio Filter and Aerobic Membrane Bioreactor Process[J]. Journal of huaqiao university (natural science) , 2008,29(1):68-72