Comparative experimental research on start – up of biological aerated filter with zeolite filler and combined packing

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Abstract: The start – up of Biological Aerated Filter (BAF) was compared by zeolite and zeolite – biochemical cotton combined packing. The flow direction was upflow. The filter was filled with activated sludge, and oxygen was supplied by the air compressor, and the primary clarifier effluent and the secondary clarifier effluent of a wastewater treatment plant were fed to the different BAFs, with incremental flow rate of feed water, until the media of BAFs were covered with stable biofilm. The results showed that the start – up of Biological Aerated Filter was successful after 33 days. In the conditions of the temperature was 16 ~ 24 ℃, HRT was 1 h and DO was 6 mg/L, the removal rate of COD_{Mn} and NH_4^+—N on zeolite BAF was 27% and 84%. The removal of zeolite-Biochemical Cotton filler BAF was best, which was 32% and 92%.

Key words: filler; biological aerated filter; start – up
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沸石填料 BAF 和组合填料 BAF 启动挂膜对比试验

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摘 要: 不同填料曝气生物滤池在相同条件下进行挂膜实验. 进水流向为上流式,挂膜方式为复合接种挂膜,即先用活性污泥闷曝接种,然后逐步提高进水流速,直到滤料表面形成稳定的生物膜. 结果表明,33 d 后挂膜成功,在温度为 16 ~ 24 ℃,水力停留时间(HRT)为 1 h, DO 为 6 mg/L 的情况下,沸石 BAF 的去除率分别为 27% 和 84%;组合填料 BAF 去除效果最好,去除率分别为 32% 和 92%.

关键词: 填料; 曝气生物滤池; 挂膜

Biological Aerated Filter integrated various purification functions such as filtration, adsorption and biological metabolism, which has many advantages for instance small floor area, better effluent quality, simple flow, little influence on environment [1]. In the United States and Japan, there are more than 50 BAF treatment facilities put into operation early in 1990s. the application of Biological Aerated Filter in feed water treatment is being a research hot spot [2-3].

The filler is the core part in Biological Aerated Filter, and its surface structure, physical and chemical properties are very important to attached growth

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Micro Biologics[4-6]. At present, research members from domestic and abroad study on the single packing Biological Aerated Filter more than combined packing. In this paper, we will analysis on start – up of biological Aerated Filter with zeolite and zerlite – Biochemical cotton filler, and explore the pollutant removal characteristic of two fillers during start – up.

1 Materials and methods

1.1 Experimental device and materials

The BAF reactor is processed into columnar structure with plexiglass that its wall thickness is 5 mm, the inner diameter is 30mm and the height is 1 500 mm. Two fillers are used by parallel operation. 1# columnar contains 2 ~ 3 mm zeolite filler, the thickness is 600 mm, and there is a sampling port located every 200 mm. The thickness of filter supporting bed is 100 mm. 2# columnar contains combined packing, the middle of upper layer and lower layer is separated by the porous plate. The height of 2 ~ 3 mm zeolite filler in the upper layer is 300 mm, and there is a 100 mm gravel filter supporting bed at the bottom. The suspended filler is in the lower layer. The experimental device is shown in Figure 1.

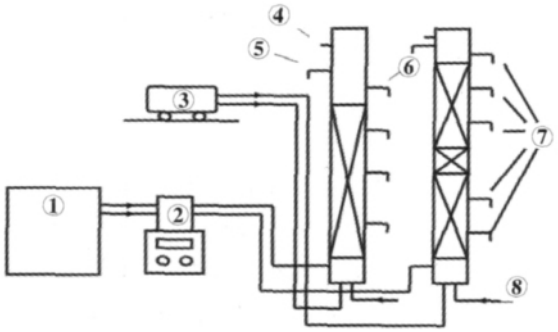

Figure 1 Experimental device

①Water tank; ②Peristaltic pump; ③Air pump; ④Overflow port; ⑤Backwashing effluent; ⑥ Effluent port; ⑦ Sampling port; ⑧ Backwashing influent

1.2 Measurement items and measurement items and methods

NH_4^+—N, COD_{Mn} were determined according to standard methods. The pH, DO, and temperature were measured by the dissolved oxygen instrument.

1.3 Start – up process

The experiment adopted the method of compound start – up with inoculums of polluted surface water. the direction of influent was upflow. First filled the experimental equipment with activated sludge, then only aerated . Changed small flow influent after only aerated continuously for six days(changing the water every three days) , And gradually increase the water flow to the design flow. In the conditions of the temperature was 16 ~ 24 ℃, HRT was 1h and DO was 6 mg/L, let microorganisms gradually adapt influent quality. During starting – up, permanganate index and ammonia nitrogen were measured everyday. Water quality of test sample was shown in Table 1.

Table 1 Water quality of test sample

NH_4^+— N/(mg·L^{-1})	COD_{Mn} /(mg·L^{-1})	pH	θ/℃	UV_{254}
12 ~ 13	14 ~ 15	6.5 ~ 7.5	20 ~ 27℃	0.335 ~ 0.463

2 Result and discussion

2.1 Removal effect of COD_{Mn}

As can be seen from Figure 2 and 3, COD_{Mn} of influent was in the 14 ~ 15 mg / L, after 5 days since BAF process had been starting – up, COD_{Mn} of effluent in 1# and 2# was 11.57 mg/L and 11.48 mg/L respectively. It showed that biofilm on the zeolite was not mature at this stage, the removal effect mainly depended on zeolite adsorption. But this adsorption was limited. Previous study showed that zeolite only removed larger molecular organics of natural water, it had bad removal effect on small molecular organics. The removal rate in 2# was higher than 1#, the reason that besides zeolite adsorption in the upper layer, suspended carrier in the lower layer also played a role in interception . In the fifteenth day, removal rate of COD_{Mn} respectively reached 22% and 26%, it showed that heterotrophic bacteria had been a mass growth and played a role in the degradation of organic compounds. In 33th day, the removal rate was 27% and 32% respectively, indicated that quantity of heterotrophic bacteria was the maximum and stable . Biofilm had been maturity , except that the degradation of permanganate, microorganism flcos of the biofilm also reduced the gap between fills, played adsorption and filtration on organic in the water .

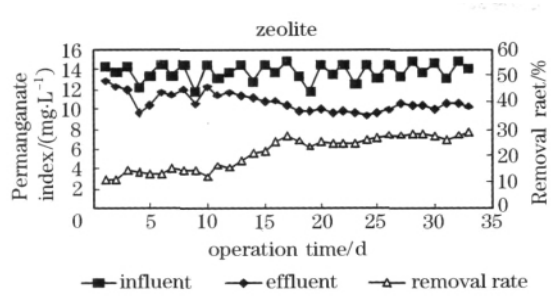

Figure 2 Removal effect of COD_{Mn} on zeolite BAF during starting – up

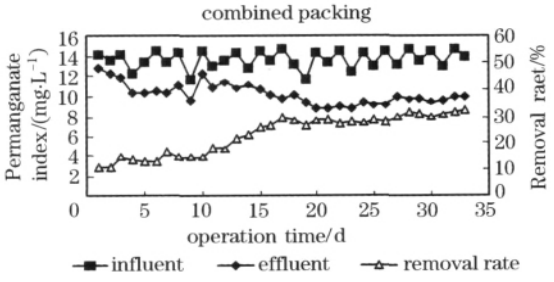

Figure 3 Removal effect of COD_{Mn} on combined packing BAF during starting – up

2.2 Removal effect of NH_4^+—N

Removal effect of NH_4^+—N of 1# reactor and 2# reactor during starting – up were shown in Figure 4 and 5. When the average concentration of influent ammonia nitrogen was 12.2 mg/L, the concentration of effluent ammonia nitrogen was 8.7 mg/L and 8.2 mg/L respectively, the removal rate was 28.7%, 33.1% respectively. In the 16th day, The removal rate suddenly decreased, then present a rising tendency. The concentration of effluent was 1.4 mg/L and 0.9 mg/L respectively and the removal rate was the the maximum value in the 33th day. At the initial stage of starting – up, there was no biofilm formed on the surface of zeolite, highter removal effect of ammonia nitrogen on zeolite was mainly due to the ion – exchange action. In the 16th day, the ability of ion exchange ammonia nitrogen was saturable, which caused the removal rate of influent ammonia nitrogen decreased. The rate was gradually rised because of numbers of nitrobacteria had been increased with the time. Ammonia – nitrogen removal primarily depended on biological nitrification. About 30 days, the quantity of nitrobacteria tend to be stable. there existed dynamic process of ammonium adsorption and biological analysis in the zeolite filler BAF and zeolite-biochemical cotton filler BAF . Ammonia nitrogen which was adsorbed by zeolite transformed to nitratenitrogen under the function of nitrobacteria that played bio – regeneration role on zeolite. Adsorption sites of the surface of zeolite was vacated that made zeolite have ability to readsorb ammonia nitrogen.

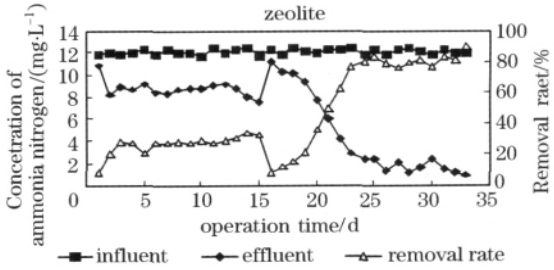

Figure 4 Removal effect of NH_4^+—N on zeolite BAF during starting – up

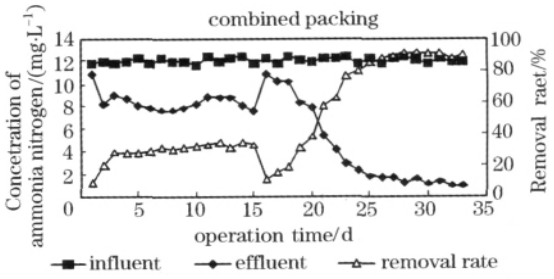

Figure 5 Removal effect of NH_4^+—N on combined packing BAF during starting – up

3 Conclusion

1) Using the BAF process study on Start – up of Biological Aerated Filter with zeolite and zeolite-biochemical cotton filler. Under the same condition, biofilm culturing had been successfully after 33 days.

2) The removal rate of COD_{Mn} and NH_4^+—N on zeolite BAF is 27% and 84% respectively; the removal of zeolite-biochemical cotton filler BAF is better. The removal rate is 32% and 92% respectively .

参考文献:

[1] CANLER J P. Biological Aerated Filters: Assessment of the process based on 12 sewage treatment plants [J]. Wat Sci Tech, 1994, 29(10 – 11): 13 – 22.

[2] STEPHENSON T, MAN A, UPTON J. The small footprint wastewater treatment process [J]. Chemistry & Industry, 1993 (19): 533.

[3] GILBERT D, FRANK R. Biofiltration as a compact technique for small wastewater treatment plant [J]. Sci Tech, 1990, 22 (3): 145.

[4] FATIHAH S, DONNELLY T. Effect of media volume on mixing of biological aerated filters [J]. J. Environ. Eng. Sci., 2008, 7: 229 – 236.

[5] MOORE R, QUARMBY J, STEPHENSON T. The effects of media size on the performance of biological aerated filters [J]. Water Science and Technology, 2001, 35(10): 2514 – 2522.

[6] MANN A T, MENDOZAESPINOSA L, STEPHENSON T. Performance of floating and sunken media biological aerated filters under unsteady state condition [J]. Water Research, 1999, 33(4): 1108 – 1113.

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参考文献:

[1] JING C Y, LIU S Q, MENG X G. Arsenic leachability and speciation in cement immobilized water treatment sludge [J]. Chemosphere. 2005, 59: 1241 – 1247.

[2] 蒋轶锋, 王 琳, 王宝贞, 等. 污泥臭氧化对MBR运行效能的影响[J]. 中国环境科学, 2002, 5(5): 519 – 522.

[3] LOW E W, CHASE H A, MILNER M G. Uncoupling of metabolism to reduce biomass production in the activated sludge process [J]. Wat. Res. 2000, 34(12): 3024 – 3212.

[4] ROSENBERGER S, WIZIG R, MANZ W, *et al*. Operation of different membrane bioreactors: experimental results and physiological state of the microgrganisms [J]. Water Sci Technol, 2000, 41(10 – 11): 269 – 277.

[5] 艾恒雨, 汪群慧, 谢维民. 生物捕食污泥减量化系统的污泥特性[J]. 给水排水, 2006, 32(增刊): 72 – 75.

[6] 张连凯, 于德爽, 孔范龙, 等. 利用微型动物减少污泥产量的工艺探讨[J]. 环境工程, 2005, 23(6): 71 – 73.

[7] 吴 敏, 杨 健. 蚯蚓生态床处理剩余污泥[J]. 中国给水排水, 2003. 19(S): 59 – 60.

[8] 魏源送, 刘俊新. 利用寡毛类蠕虫反应器处理剩余污泥的研究[J]. 环境科学学报, 2005, 25(6): 803 – 808.

[9] WEI Y S, ZHU H, WANG Y W, *et al*. Nutrients release and phosphorus distribution during oligochaetes predation on activated sludge. Biochemical Engineering Journal, 2009 (43): 239 – 245.

(上接170页)

[11] 张连凯, 于德爽, 孔范龙, 等. 利用微型动物减少污泥产量的工艺探讨[J]. 环境工程, 2005(6): 71 – 73.

[12] 柳学伟, 王志远. 利用微型动物捕食进行污泥减量的研究进展[J]. 山西建筑, 2007(7): 342 – 344.

[13] TIAN Y, LU Y B. Simultaneous nitrification and denitrification process in a new Tubificidae – reactor for minimizing nutrient release during sludge reduction [J]. Water research, 2010, 44(20): 6031 – 6040.

[14] 欧阳二明, 王 伟, 龙 能, 等. 污泥内层和外层胞外聚合物的三维荧光光谱特性研究[J]. 光谱学与光谱分析, 2009(5): 1313 – 1318.

[15] CHEN W, WSETERHOFF P, LEENHEER J A, *et al*. Fluorescence excitation – Emission matrix regional integration to quantify spectra for dissolved organic matter [J]. Environmental science & technology, 2003, 37(24): 5701 – 5710.

[16] 唐书娟, 王志伟, 吴志超, 等. 膜 – 生物反应器中溶解性有机物的三维荧光分析[J]. 中国环境科学, 2009(3): 290 – 295.

[17] SHENG G P, YU H Q. Characterization of extracellular polymeric substances of aerobic and anaerobic sludge using three – dimensional excitation and emission matrix fluorescence spectroscopy [J]. Water Res., 2006, 40(6): 1233 – 1239.