

微污染源水中 NO₂⁻—N 的去除

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摘 要:采用生物接触氧化法对北京某水库的微污染源水进行了去除 NO₂⁻—N 的试验研究。结果表明,运行期间,生物接触氧化柱(简称生化柱)对 NO₂⁻—N 的去除率最高可达 98%。水温对 NO₂⁻—N 的去除效果有很大影响,水温越高,生化柱去除 NO₂⁻—N 的效果越好;在原水水温相同的条件下,原水中 NH₄⁺—N 浓度越低,生化柱去除 NO₂⁻—N 的效率越高;原水中 NO₂⁻—N 浓度越高,生化柱去除 NO₂⁻—N 的效率越高。

关键词:微污染源水; NO₂⁻—N; 生物接触氧化

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目前水源水污染日益严重,水中不仅有机物浓度增加,而且氨氮浓度、亚硝酸盐浓度也升高,而自来水厂传统的净水工艺不能有效地去除氨氮和亚硝酸盐,因此生物预处理技术就很必要。

生物预处理是指在常规净水工艺之前增设生物处理工艺,借助于微生物群体的新陈代谢活动,对水中的有机污染物、氨氮、亚硝酸盐等污染物进行初步去除,这样既改善了水的混凝沉淀性能,使后续的常规处理更好地发挥作用,也减轻了常规处理和后续深度处理过程的负荷,最大可能地发挥水处理工艺的整体作用,保证出水水质。

作为微污染源水的生物预处理方法主要有生物滤池^[1-3]、生物硫化床^[4-5]、生物转盘^[6]、生物接触氧化^[7-8]等。

本试验采用生物接触氧化工艺作为生物预处理方法,对微污染源水中 NO₂⁻—N 的去除效能进行了研究,探讨了原水水温、NH₄⁺—N 浓度、NO₂⁻—N 浓度等因素对生化柱去除 NO₂⁻—N 效果的影响。

1 试验装置与试验方法

1.1 试验装置与流程

试验在作为北京水源水的某水库的取水站内进行,进水为未预氯化的水。试验装置设在取水站的调流泵房附近,在调流泵的一个水质监测出口处连接进水管,水压为 0.2~0.4MPa。调流泵的出水未加氯,而且没有经过长距离的管道输送,这为研究水库水质净化情况提供了可靠的保障。试验装置如图 1 所示。

1.2 试验方法

生化柱的运行参数为流量 40L/h、HRT = 1.325h、有效水深 3m。柱内填装 YDT 型弹性立体填

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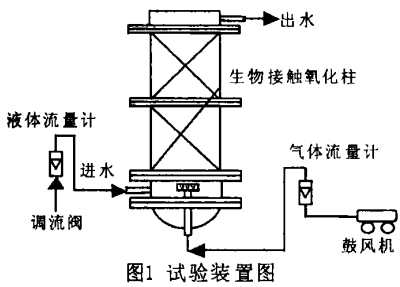


图1 试验装置图

料,充氧曝气保证水内 DO 不低于 4mg/L,水气同向流动。

2 结果与讨论

2.1 生化柱对 NO₂⁻—N 的去除效果

水源水中 NO₂⁻—N 的浓度较低且稳定,运行结果见图 2~图 5。图 2 结果表明,启动阶段原水中的 NO₂⁻—N 浓度在 0.003~0.036mg/L 之间,平均浓度为 0.012mg/L,生化柱出水中的 NO₂⁻—N 浓度在未检出至 0.027mg/L 之间,平均浓度为 0.009mg/L,去除率在 -170%~97%。

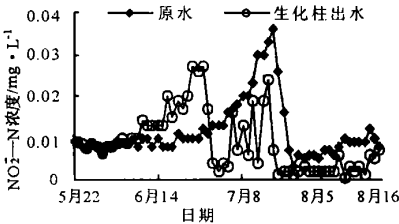


图2 启动阶段生化柱进出水NO₂⁻—N

图 3 结果表明,稳定阶段原水中 NO₂⁻—N 浓度在 0.004~0.015mg/L 之间,平均浓度为 0.010mg/L,生化柱出水中的 NO₂⁻—N 浓度在未检出至 0.010mg/L 之间,平均浓度为 0.005mg/L,去除率在 4%~98%,说明生化柱对 NO₂⁻—N 有很好的去除效果。

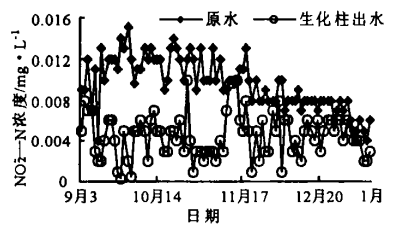


图3 稳定阶段生化柱进出水NO₂⁻-N历时变化

从图 4 可以看出,试验期间原水中 NO₂⁻-N 浓度月平均统计浓度在 0.008 ~ 0.020mg/L 之间,生化柱出水中 NO₂⁻-N 浓度月平均统计浓度在 0.004 ~ 0.016mg/L 之间。

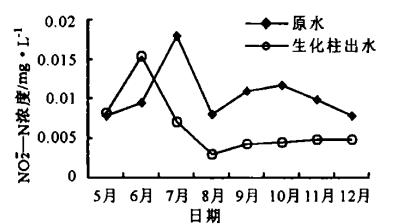


图4 生化柱进出水NO₂⁻-N浓度月统计值

从图 2、图 4 和图 5 中可知,5 月、6 月出现 NO₂⁻-N 累积的现象,这是因为生化柱从 5 月份开始挂膜,这时生物膜还未长成,硝化菌和亚硝化菌数量很少,对水源水中污染物的降解能力都很弱,填料柱出水中的 NO₂⁻-N 浓度略高于原水,增加约 3 %;当生物膜形成并趋渐成熟时,亚硝化菌已经成为优势菌种,可以将水中的 NH₄⁺-N 转化成 NO₂⁻-N,但是硝化菌生长速度比亚硝化菌慢,此时还不能将亚硝化菌由 NH₄⁺-N 氧化成的那部分 NO₂⁻-N 及时地氧化成 NO₃⁻-N,因此造成 NO₂⁻-N 的累积,累积率达 63 %左右;到 7 月份,硝化菌已经成熟,对原水中的 NO₂⁻-N 的去除率在 43 % ~ 63 %,有较好且稳定的去除作用。

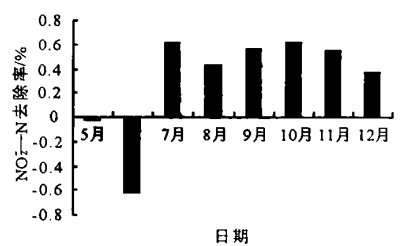


图5 生化柱对NO₂⁻-N去除率的月统计值

2.2 生化柱去除 NO₂⁻-N 的影响因素分析

2.2.1 原水水温对生化柱去除 NO₂⁻-N 的影响

硝化菌受温度影响作用显著。较高温度下硝化菌生长繁殖快、新陈代谢活动异常旺盛,低温下硝化菌生长繁殖极其缓慢,生命代谢活动也几乎停止。生化柱

在常温和低温下去除 NO₂⁻-N 的效果存在着显著的差异,说明水温对硝化菌去除 NO₂⁻-N 的影响作用很大。水温对生化柱去除 NO₂⁻-N 的影响见图 6。

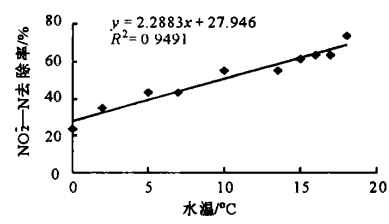


图6 水温对生化柱去除NO₂⁻-N的影响

从图 6 中可以看出,水温对生化柱中硝化菌去除 NO₂⁻-N 的效果有很大的影响。水温越高,去除 NO₂⁻-N 的效果就越好;反之,冬季低温下,去除效果就差。不过,在极低水温情况下(接近 0),仍有 32.5 %的去除率。生化柱去除 NO₂⁻-N 的机理是,生物膜上吸附的硝化菌在原水充分曝气供氧的情况下,利用水中的氧将水中 NO₂⁻-N 迅速氧化成 NO₃⁻-N 而有效去除。

2.2.2 原水中 NH₄⁺-N 浓度对生化柱去除 NO₂⁻-N 的影响

生化柱对 NO₂⁻-N 的去除效果与原水中 NH₄⁺-N 浓度有关,在同一水温及其它水质条件相近的情况下,考察了原水中 NH₄⁺-N 浓度对生化柱去除 NO₂⁻-N 效果的影响,结果如表 1 所示。

表 1 原水中 NH₄⁺-N 浓度对生化柱去除 NO₂⁻-N 效果的影响

原水水质				生化柱出水	生化柱
水温 () (NTU)	浊度	NH ₄ ⁺ -N (mg/L)	NO ₂ ⁻ -N (mg/L)	NO ₂ ⁻ -N (mg/L)	NO ₂ ⁻ -N 去除率 (%)
17.6	3.8	0.128	0.012	0.004	67
17.7	4.4	0.173	0.012	0.006	50
14.5	1.33	0.047	0.020	0.006	70
14.5	1.27	0.093	0.020	0.013	35
13.0	4.2	0.139	0.012	0.010	17
13.3	3.8	0.085	0.012	0.006	50

从表 1 可以看出,原水水温和 NO₂⁻-N 浓度相同时,原水 NH₄⁺-N 浓度越高,生化柱去除 NO₂⁻-N 的效率越低。低温时,原水中 NH₄⁺-N 浓度对 NO₂⁻-N 去除率的影响更大。这是由于大量 NH₄⁺-N 被亚硝化菌氧化成 NO₂⁻-N,而 NO₂⁻-N 又来不及被硝化菌及时氧化所致。低温时,原水中 NH₄⁺-N 浓度增高易导致 NO₂⁻-N 转化不完全,因为硝化菌生长繁殖世代期较长,受低温的影响作用很大,原水中硝化菌数量稀少,附着生长也十分缓慢,所以难以适应原水水质变化。

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在此阶段,各色素指标变化不一,其中 CD 和 TC 较高,说明湖泊生产力稳定在较高水平; O_{sc} 和 M_{yx} 均呈下降趋势,说明湖泊水体富营养化程度有所缓解,但仍维持在相当高的水平,可能与武汉市政府自 20 世纪 80 年代后期以来利用世界银行贷款进行截污和入湖污水处理,控制东湖周边地区污水的排放,使湖泊营养成分减少有关; CD/TC 和 O_{sc}/M_{yx} 指标仍表明湖泊沉积物有机质以内源为主,蓝藻植物群仍很单调。

3 结论

研究表明,近代尤其是 20 世纪 50 年代以来,由于人类大规模的工农业活动及生活污水、工业废水的大量排入,带入大量的有毒、有害和营养元素(P、N),使东湖水体环境发生了根本性的改变,在人类活动的强烈干扰下发生了严重的富营养化。近 20 年来,由于人们的环境意识逐渐增强,东湖的环境状况引起了社会的广泛关注。在各级政府大力支持和相关职能部门的积极干预下,经过多方治理,武汉东湖的严重富营养

化趋势已得到初步遏制;但是污染状况依然没有明显的改观,亟需进一步采取强力措施,控制污染源,清除淤泥,从根本上治理武汉东湖的污染状况,恢复其生态环境和动态平衡。

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2.2.3 原水中 $NO_2^- - N$ 浓度对生化柱去除 $NO_2^- - N$ 的影响

在同一水温及其它水质条件相差不大的情况下,考察了原水中 $NO_2^- - N$ 浓度对生化柱去除 $NO_2^- - N$ 效果的影响,结果如表 2 所示。

表 2 原水中 $NO_2^- - N$ 浓度对生化柱去除 $NO_2^- - N$ 效果的影响

原水水质				生化柱出水	生化柱
水温 () (NTU)	浊度 (mg/L)	$NH_4^+ - N$ (mg/L)	$NO_2^- - N$ (mg/L)	$NO_2^- - N$ (mg/L)	$NO_2^- - N$ 去除率 (%)
16.8	1.74	0.03	0.030	0.004	87
16.2	2.20	0.03	0.012	0.007	42
15.8	1.28	0.06	0.016	0.002	88
16.0	1.95	0.06	0.009	0.005	44
15.2	1.16	0.09	0.013	0.002	85
15.0	1.36	0.09	0.003	0.001	67
5.0	1.63	0.04	0.008	0.005	38
5.0	1.97	0.04	0.009	0.003	67

从表 2 可以看出,原水中 $NO_2^- - N$ 浓度越高,生化柱去除 $NO_2^- - N$ 的效果越明显。原水中 $NO_2^- - N$ 浓度较高时,生化柱内填料上附着生长的硝化菌数量较多,抗冲击负荷能力较强,能够抗击原水中 $NO_2^- - N$ 的冲击负荷。

3 结论

采用生物接触氧化法预处理微污染水源水, $NO_2^- - N$ 的去除率最高可达 98 %。

工艺启动阶段出现 $NO_2^- - N$ 累积现象,累积率最高达 - 170 %。

水温对 $NO_2^- - N$ 的去除效果有很大影响,水温越高,生化柱去除 $NO_2^- - N$ 的效果越好;在原水水温相同的条件下,原水中 $NH_4^+ - N$ 浓度越高,生化柱去除 $NO_2^- - N$ 的效率越低;原水中 $NO_2^- - N$ 浓度越高,生化柱去除 $NO_2^- - N$ 的效率越高。

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An Experimental Study of Biodegrading

2,6-Di-tert-butylphenol by Immobilized Microorganism

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Abstract ID:1003-6504(2005)03-0001-03-EA

Abstract:Using a specific degrading microorganism *Alcaligenes* sp. immobilized in calcium alginate, the capability of degradation of 2,6-Di-tert-butylphenol (2,6 DTBP) has greatly improved. The biodegradation of 2,6 DTBP in different concentrations was studied, showing a removal of 81 % with initial concentration 100mg/L, period of 12 days. The experiment indicates that the degradation follows 1st order kinetics, half life of 2,6 DTBP being 5.63 days. SEM images have been used to observe growth of the microorganism.

Key words:immobilization; dominant bacteria; kinetics; 2,6-Di-tert-butylphenol (2,6 DTBP); calcium alginate

Purification Function of Wetland Wastewater

Treatment System at Nanhui Beach,

Estuary of the Yangtze River

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Abstract ID:1003-6504(2005)03-0003-03-EA

Abstract:Purification effects of coastal wetland to wastewater were studied during August to December 2002 at Nanhui Beach, Estuary of the Yangtze River. Concentration variation of nitrogen and phosphorus and relationship to corresponding functional bacteria content in the sediment, as well as the directly removal of pollution of *Phragmites australis* harvesting were analyzed. Results showed the wetland purification effect to wastewater was distinct, and purification efficiency to TN, TP and COD in wastewater were 94.06 %, 76.82 % and 92.47 % respectively; the nitrogen and phosphorus concentration in sediment declined with the distance to the increased outfall; $\text{NH}_4^+ - \text{N}$, $\text{NO}_3^- - \text{N}$ and dissolved inorganic phosphorus in the sediment have mostly positive relationship with corresponding functional bacteria amount. The directly nitrogen and phosphorus removal by *P. australis* harvesting only account for $2.201 \times 10^{-5} \%$ TN and $4.552 \times 10^{-4} \%$ TP of annual inflow to the wetland. Wastewater purification in the beach wetland includes physical process such as dilution and removal by tide,

sedimentation, sediment adsorption and biological process as microorganism decomposing. The directly removal effect of beach vegetation is very limited.

Key words:estuary of the Yangtze River; coastal wetland; wastewater purification; sediment; water quality; *Phragmites australis*

Inhibition Effect of Benzidine on Alkaline

Phosphatase and Its Kinetics Study

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Abstract ID:1003-6504(2005)03-0006-03-EA

Abstract:Spectrophotometry was used to study activity of alkaline phosphatase in the presence and absence of benzidine. Relative activity of alkaline phosphatase was calculated according to the absorbance variation. Results showed the activity of alkaline phosphatase was obviously inhibited by benzidine. The inhibition type and inhibition constant of benzidine on alkaline phosphatase were determined by using double reciprocal plot. The kinetics of substrate reaction with different concentrations of substrate p-nitrophenylphosphate (PNPP) and inactivator benzidine suggested a competitive complex mechanism for inactivation by benzidine, which is a competitive inhibitor of alkaline phosphatase, with inhibition constant of $1.28 \times 10^{-7} \text{ mol/L}$.

Key words:alkaline phosphatase; benzidine; inhibition; kinetics

Impact of Zeolite Addition on Membrane Pollution in Submerged Membrane Bioreactor

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Abstract ID:1003-6504(2005)03-0009-03-EA

Abstract:Membrane pollution can be controlled through addition of various concentration of zeolite in submerged membrane bioreactor to treat urban household wastewater. The variation of membrane pollution resistance with zeolite addition in combined liquid of water and activated sludge was analyzed, and results showed that membrane pollution resistance decreased with time due to addition of zeolite. The optimum addition and action mechanism of zeolite was also discussed.

Key words:household wastewater; submerged membrane bioreactor; zeolite; membrane pollution resistance

Removal of $\text{NO}_2^- - \text{N}$ in Micro-polluted Source Water

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Abstract ID :1003-6504(2005)03-0011-03- EA

Abstract :This paper related to a study of removing nitrites contained in micro-polluted source water of a reservoir in Beijing. The bio-contact technology was used and the results showed that up to 98 % removal of $\text{NO}_2^- - \text{N}$ had been obtained. Factors affecting nitrites removing were investigated, such as temperature and initial concentrations of ammonia and nitrites in the water.

Key words :micro-polluted source water; $\text{NO}_2^- - \text{N}$; bio-contact technology

Mathematical Modeling of Pressure Drop in Designing Pneumatic Cyclones

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Abstract :The factors that contribute to the pressure drop are analyzed. The mathematical models of pneumatic cyclone are constructed. The trouble is solved to compute the pressure drop in designing pneumatic cyclones, and the models are compared with actual examples in the design. The verification of the modeling proves the effectiveness for the design.

Key words :pneumatic cyclone; pressure drop; design; mathematical model

Experimental Study on Simultaneous Nitrification/ Denitrification by an Aerobic Biofilm System

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Abstract :The removal of COD_{mn} and nitrogen in biofilm system was studied with pH controlled in 7.0 ~ 7.5 and temperature in 20 ~ 28 in the experiment. The impact of various DO, hydraulic retention time and ratio of C/N on removal efficiency of TN was discussed. Results showed that simultaneous nitrification/denitrification is feasible in biofilm system, with removal efficiency of TN up to 53.6 % when C/N ratio of 8:1, hydraulic retention time of 6h and DO 0.5 ~ 1.0 mg/L.

Key words :simultaneous nitrification/denitrification; biofilm; hydraulic retention time; C/N ratio; DO

Photocatalytic Degradation of 4BS Dyes Using TiO_2 /Serpentine

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Abstract : TiO_2 /serpentine was obtained by hydrolysis-precipitating method using TiOSO_4 and natural serpentine. The photocatalytic degradation of organic dyes 4BS were studied in TiO_2 /serpentine. Results showed the dyes were remarkably decolored in pH 2 - 4 and temperature 500 under a 500w high

pressure mercury lamp.

Key words : TiOSO_4 ; serpentine; TiO_2 photocatalytic degradation

Experimental Study on Phosphorus Removal in Secondary Effluent with Micro-flocculation Fibre Filter

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Abstract :Micro-flocculation fibre filter was used for advanced treatment of secondary effluent, and several influencing factors on phosphorus removal were analyzed. Results showed that phosphorus was effectively removed with micro-flocculation fibre filter, which can meet phosphorus requirement on advanced reuse of municipal wastewater regeneration.

Key words :wastewater reuse; secondary effluent; phosphorus removal; micro-flocculation fibre filter

Electro-Fenton Treatment of 4-nitrophenol Using $\text{IrO}_2/\text{Ta}_2\text{O}_5$ as Anode and Graphite as Cathode

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Abstract :Simulated wastewater of 4-nitrophenol (4NP) was electrolyzed by a new system combined $\text{IrO}_2/\text{Ta}_2\text{O}_5$ as anode and graphite as cathode. Ferrous ion was introduced to generate an effective Fenton reaction. Under the optimum conditions of current 0.3A, pH 5.30, air flow rate 40mL/min, c (Na_2SO_4) 3g/L and c (Fe^{2+}) 1mmol/L, the final removal of COD could be up to 84 % for the degradation of 100mg/L 4NP in 2h. $\text{IrO}_2/\text{Ta}_2\text{O}_5$ anode has some advantages over anode of Pt and PbO_2 , which presents a new way for the option of anode in wastewater treatment.

Key words :titanium anode $\text{IrO}_2/\text{Ta}_2\text{O}_5$; electro-Fenton; 4-nitrophenol

Study on Sulphur Removal and Its Transformation with RO in Wastewater Irrigation

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Abstract :Wastewater irrigation is a sort of watering in irrigation area, with some risks because of complicated wastewater components. A new fast removal method with photosensitive RO was proposed to minimize the impact of sulphur ion in irrigation water on rice. Soil tests showed absorbing of RO in soil was in accordance with Langmuir's law. The removal efficiency of sulphur was 87.5 % at RO addition 10 $\mu\text{mol/L}$, lighting time 30min under 3000lx, while 78.1 % under 2000lx, and without photosensitive pollution.

Key words :wastewater irrigation; sulphur; photo-oxidation; RO