

固定化脱色菌-活性污泥的脱色性能研究*

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摘要 将所筛选的高效脱色菌群, 采用聚集-交联法固定在活性污泥上, 形成絮状立体网状微观结构。固定化脱色菌-活性污泥的脱色酶活力较未经固定的活性污泥提高 70% 左右。经厌氧条件下处理针织厂印染废水, 色度平均去除率为 77.3%, COD_{Cr} 平均去除率为 65.1%。

关键词 聚集-交联固定化, 固定化脱色菌-活性污泥, 脱色酶活力。

近年来利用固定化细胞技术处理工业废水或微生物难降解物质日益受到国内外学者的重视^[1-4]。固定化方法多采用包埋法及吸附法, 包埋法由于材料较贵, 大批量生产有困难, 因而影响大规模工业化应用。本文采用了聚集-交联固定化法将脱色菌固定于活性污泥上, 处理活性艳红 X-3B 及山西针织厂印染废水。经聚集-交联固定化后可提高反应器内生物浓度, 避免高效菌体流失而增强脱色能力。该法操作简单、适用范围广泛、便于推广, 具有广阔的应用前景。

1 材料和方法

1.1 菌种和污泥

试验用菌种是从山西针织厂及山西纺织印染厂活性污泥中分离筛选出的紫色非硫光合细菌及其它脱色异养细菌混合菌群。

厌氧污泥取自山西纺织厂曝气池回流污泥, 固定化之前加入适量葡萄糖、尿素等营养源, 好氧活化培养 1 周, 厌氧驯化培养 3 d。

1.2 培养基

(1) 紫色非硫光合细菌 Y_P 培养基及修改的 Van Niel 液体培养基, 在 30—37℃ 厌氧光照, 强度为 1000—3000 lx, 培养 3—5 d。

其它脱色异养菌: 营养液体培养基, 在 35℃ 恒温培养 48 h。

1.3 染液及工业废水

脱色酶性质静态试验所用染液为活性艳红 X-3B 染料, 配制成浓度为 1000 mg/L 染液。

厌氧动态试验用工业废水为山西针织厂印染废水与厂区生活污水的混合排水。水中 COD 200—800 mg/L; BOD 平均 150 mg/L; 色度 300—500 倍; pH8—10。

1.4 固定化脱色菌-活性污泥的制备

取活化后的活性污泥与脱色菌混合液以 1 : 2 比例混合, 利用凝聚剂将菌体及活性污泥聚集在一起, 再加入微量戊二醛交联处理, 形成絮状立体网状微观结构的脱色菌-活性污泥, 经解毒活化后待用。

1.5 酶活力测定

取 1g 湿重菌体及活性污泥制备固定化脱色菌-活性污泥, 分别放入 100 ml 三角瓶内, 加入 50 mg/L 的活性艳红 X-3B 染液 47.5 ml 及 1% 的酵母抽提液 2.5 ml, 在 pH8、37℃ 水浴中脱色 2 h, 加热终止酶活性反应, 再以转速为 5000 r/min 离心分离处理液 40 min, 然后测上清液中活性艳红残存量。在上述条件下, 以 1 h 降解 1 μg 活性艳红的酶量定义为一个酶活力单位。

1.6 活性艳红及 COD_{Cr} 测定

用 721 分光光度计在波长 510 nm 处比色测活性艳红量; 标准重铬酸钾法测定 COD_{Cr} 值。

2 结果和讨论

2.1 固定化脱色菌-活性污泥的脱色酶性质

2.1.1 最适 pH 值与最适温度

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用缓冲液将固定化脱色菌-活性污泥(简称固定化污泥)及等量未经固定的活性污泥及脱色菌(简称自然污泥)分别调至不同 pH 和不同温度条件下脱色反应 2 h, 结果见图 1 和图 2。

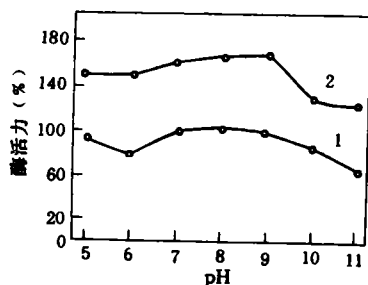


图1 pH值对脱色酶活力的影响(37℃)

1. 自然污泥 2. 固定化污泥

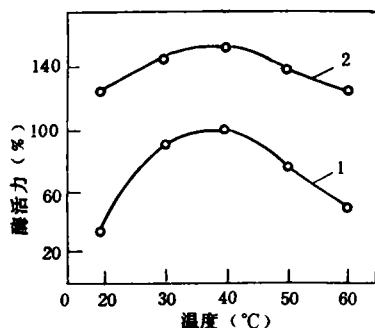


图2 温度对脱色酶活力的影响(pH8)

1. 自然污泥 2. 固定化污泥

自然污泥对 pH 适应范围为 7—9, 固定化污泥 pH 适应范围为 6—9, 并且比自然污泥酶活力提高 70%。pH5 时仍表现有一定的酶活力是与强酸作用有关。连续反应 24 h 后, 固定化污泥仅在 pH11 时不能完全脱色(浅红色), 而自然污泥在 pH5、6、11 为紫灰色。这说明固定化污泥较自然污泥扩大了 pH 值适应范围。2 种污泥最适应温度相同, 均为 30—40℃, 固定化污泥酶活力较自然污泥酶活力提高 50%左右。

2.1.2 脱色酶的 pH 稳定性及热稳定性

将 2 种污泥分别置于不同 pH 值的磷酸盐缓冲液中, 在 37℃ 恒温箱中处理 24 h, 测定脱色酶活力, 结果见图 3。固定化污泥在 pH7—10 范围内酶活力比较稳定, 并比自然污泥酶活力提高 70%。

热稳定性测定是将 2 种污泥悬浮于 pH8 的

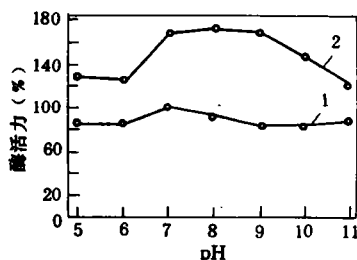


图3 2种污泥 pH 值稳定性(37℃)

1. 自然污泥 2. 固定化污泥

磷酸盐缓冲液中, 分别于 30、40、50 及 60℃ 水浴中恒温处理 30 min, 测定其酶活力, 结果见图 4。30—50℃ 2 种污泥稳定性良好, 固定化污泥耐热性比自然污泥稍高。60℃ 处理后酶活力丧失 40%左右。

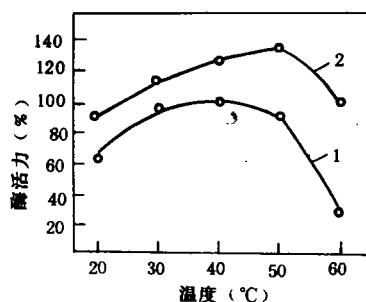


图4 2种污泥热稳定性(pH8)

1. 自然污泥 2. 固定化污泥

2.2 固定化脱色菌-活性污泥电镜扫描观察

脱色菌经聚集-交联固定于活性污泥上, 菌体分布均匀、密集, 菌体之间架桥交联形成稳定的絮状立体网状微观结构。与自然污泥电镜扫描比较, 固定化污泥孔隙度、比表面积增大, 细胞通透性增强, 因而传质速度快, 介质滞留时间延长, 有利于有机物降解转化, 且菌体不易流失。

3 厌氧处理针织印染废水动态试验

试验用 UASB+AF 反应器, 为直径 200 mm 有机玻璃柱, 总高 3000 mm, 有效容积 63.09 L, 固定化污泥层 1400 mm, 上部滤层 1000 mm 为半软性纤维填料, 见图 5 所示。

连续运转 15 个月, HRT 由 21 h 缩短至 9.7 h, COD 容积负荷 1.74—11.65 kg/(m³·d), COD_{Cr} 去除率变化范围 57.4%—75.7%, 平均

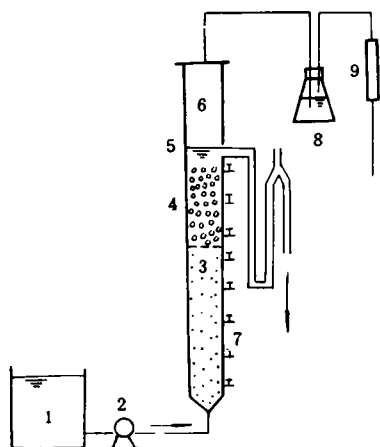


图5 试验装置流程图

1. 贮水池 2. 提升泵 3. 污泥床 4. 滤层 5. 澄清区
6. 气室 7. 取水口 8. 水封 9. 流量计

去除率 65.1%；色度去除率变化范围 58.2%—94.5%，平均去除率 77.3%。

脱色菌-活性污泥经固定化后沉降性能较好，利于污泥浓度的富集，经 65 d 培养可形成微型颗粒状污泥，稳定运行时 SVI 值为 20 左右，VSS/SS 比值为 67%，污泥区污泥量分布为：距柱底部 230 mm 处为 45.96 g/L，460 mm 处为 35.9 g/L。出水 SS 为 18—52 mg/L 之间。

固定化污泥对温度变化具有较强的适应能力，并且在常温条件下便可培养出颗粒污泥。本试验表明，冬季水温在 10—15℃ 时厌氧启动困难，污泥难以颗粒化，出水混浊，处理效果差，色度和 COD 去除率分别为 38% 和 37%；增加保温措施温度达到 15—18℃ 时重新启动，色度和 COD 去除率逐渐提高。这说明固定化污泥能在 15℃ 以上这一较低温度下厌氧启动。一个月之后，水温继续升至 20—23℃，65 d 后便可观察到颗粒污泥开始形成，说明固定化污泥在常温下可培养出微型颗粒污泥。经过一段时间稳定运行，色度和 COD 去除率分别达 90% 和 72% 以上。当水温下降至 15—17℃，色度和 COD 去除率仍分别达 82% 和 70%，并且随着温度的回升去除效果也随之恢复，说明微型固定化颗粒污泥具有耐温度冲击能力。图 6 和图 7 为 9 月份稳定运行数据。

4 结论

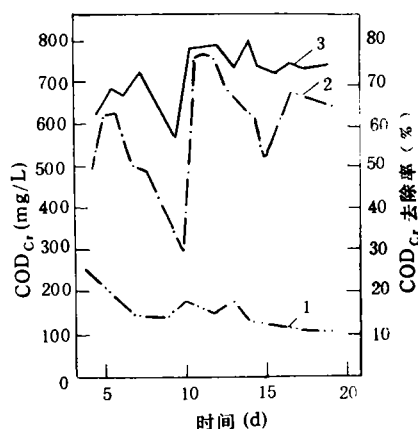


图6 COD去除情况

1. 出水 COD_{Cr} 2. 进水 COD_{Cr} 3. COD_{Cr} 去除率

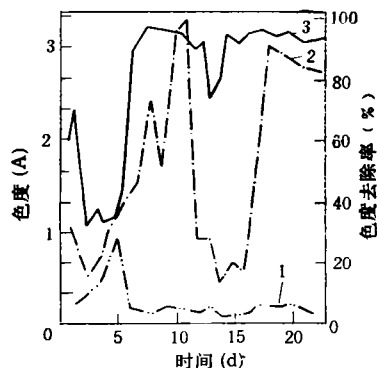


图7 色度去除情况

1. 出水色度 2. 进水色度 3. 色度去除率

(1) 脱色菌经固定化后，可减少菌体流失，提高有效生物浓度，改善污泥组成以保持高效菌种在水处理系统中的优势。

(2) 聚集-交联固定化污泥使沉降性能增强，酶活力及细胞通透性增大，介质传递速度加快，延长介质停滞时间而提高处理效率。

(3) 固定化所用凝聚剂种类较多，根据处理水质不同应依固定化污泥的酶活力及处理效率进行筛选。固定化过程中交联剂戊二醛的浓度、交联时间及解毒活化是影响固定化污泥酶活力的重要因素。

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autumn. In addition, the concentration of nitrate and sulfate were often of high values in one or two days before raining and in 3 or 4 days after raining. This indicates that rainfall had a significant effect of scavenging particulates. The level of nitrate in particulates was found to have a much better correlation with ozone concentration than the level of sulfate in particulates.

Key words: particulate, nitrate, sulfate, ozone, ion chromatography.

Study on the Photocatalytic Degradation of Organo-Phosphorus Pesticides. Chen shifu et al. (Dept. of Chemical Eng., Zhengzhou Institute of Technology, Zhengzhou 450002); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 61–63

The feasibility of photocatalytic degradation of three different structures' organophosphorus pesticides using TiO_2 powders as a photocatalyst was studied. The results show that different structures of organophosphorus pesticides had different photodegradation efficiencies, and four organophosphorus pesticides of 1.0×10^{-4} mol/L were completely photocatalytically degraded into inorganic phosphate after 40 min illumination with a medium pressure mercury lamp of 375 W. Some intermediate products of photocatalytic degradation of monocrotophos were detected and the effects of the parameter, such as amount of TiO_2 , flow rate of air and Fe^{3+} concentration, on the photocatalytic degradation were also investigated. The mechanism were discussed preliminarily.

Key words: organophosphorus pesticides, photocatalytic degradation, TiO_2 powders.

Preliminary study on the relationship between seasonal dynamics of microfauna in the root system of water hyacinth and their effects on the purification of waterbody. Li Baolin (Beijing Municipal Research Academy of Environmental Protection, Beijing 100037); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 64–66

Seasonal variation characteristics of microfauna in the root system of water hyacinth has been primarily studied when it was used to treat sewage water from the Beijing Zoo. 70 species of microfauna was found in the water-root system in 1992, with the largest number of 60 species in 49 genera in August. Biomass (by relative quantity and average wet weight) of microfauna was heavier in July and August, and the weight percentage of protozoa in the same two months were 76.9% and 64.1%. The dominant species (po-

pulation) examined in each month (June to October) was reported. The main physical and chemical indexes such as TN, TP and BOD varied seasonally. The removal of TSS was up to 82.9% and those of BOD and TP were 66.6% and 91.6%. This study demonstrates that the purifying efficiency of water-hyacinth system was in a relationship with the seasonal characteristics of the microfauna built up in its rootsystem.

Key words: water hyacinth, root system, microfauna, purification.

Study on the Decolourization Activity of Activated Sludge with Immobilized Decolourization Bacteria. Zhang Lin et al. (Dept. of Environ. Eng., Taiyuan Univ. of Technology, Taiyuan 030024), Ma Minghuan (Shanxi Textile Industry Designing Institute, Taiyuan 030002); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 67–69

The highly efficient decolourization bacteria were selected and immobilized on an activated sludge by using an aggregated/cross-linked immobilization method to form a microstructure of cross-linked floccule-granule. The activity of decolourization enzyme increased by about 70% as compared with a non immobilized activated sludge. The results of textile dyeing wastewater treatment under anaerobic condition show that there was an average colour removal 77.3% with an average COD_{Cr} removal of 65.1%.

Key words: aggregated/cross-linked immobilization, the activated sludge with immobilized decolourization bacteria, activity of decolourization enzyme, dyeing wastewater.

Study on Environmental Etiology Among a Population at a High Risk of Gastric Cancer in Xianghuangqi County of Inner Mongolia: An Appraisalment on the Endogenous Synthesis of Nitrosamines in Human Body. Song Xiuxian et al. (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085), Liu Kezhong (Inner Mongolia Autonomous Region's Hospital, Huhhot 010017); *Chin. J. Environ. Sci.*, **16**(5), 1995, pp. 70–71

The contents of nitrites in water from 15 rural areas in Xianghuangqi, Xilinguole Meng, Inner Mongolia Autonomous Region, were measured. The results show that the contents of nitrites in water widely varied and could be classified broadly into three groups with an average nitrite level of 0.186, 0.640 and 3.840 $\mu\text{g}/\text{ml}$ respectively. The contents of amines in mildewed cheese were