

斜生栅藻与单甲脒的相互作用*

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摘要 为研究斜生栅藻与单甲脒的相互作用, 采用评价化学品对藻类毒性的标准实验方法, 得出了单甲脒抑制斜生栅藻生长的 96 h-EC₅₀ 为 6.5 mg/L. 实验结果还表明, 在单甲脒浓度分别为 2、4 和 8 mg/L 下, 斜生栅藻都不具备降解单甲脒的能力.

关键词 斜生栅藻, 单甲脒, 藻类毒性, 降解.

斜生栅藻与单甲脒的相互作用在水质评价和有机废水的生物处理方面都具有重要的意义. 据报道, 斜生栅藻对酚类化合物^[1]和六六六、DDT 等多种农药^[2]有明显的降解作用, 降解机理是藻所分泌的黄素蛋白可以增强农药的光化学性和降解活性^[3]. 然而, 阎海等^[4]的研究结果表明蛋白核小球藻不具备降解单甲脒的能力. 本文通过单甲脒对斜生栅藻的毒性和斜生栅藻降解单甲脒的实验, 对二者之间的相互作用进行了较全面的研究和探讨.

1 实验部分

1.1 试剂

单甲脒, 密度 1.08 mg/L, 纯度 25%, 武汉国营慈慧化工厂生产, 为避免单甲脒在实验中碱性条件下水解, 溶液初始 pH 值调为 5.0.

斜生栅藻(*Scenedesmus obliquus*)购自中国科学院武汉水生生物研究所, 毒性评价和降解实验藻细胞的初始浓度都为 1.0×10^5 个/ml

1.2 实验方法与条件

采用美国环保局推荐的培养基^[5], 毒性评价实验单甲脒浓度分别为 2、4、6、8 和 10 mg/L, 降解实验单甲脒初始浓度分别为 2、4 和 8 mg/L. 实验温度 $24 \pm 2^\circ\text{C}$, 12 h 照明黑暗循环, 光照强度 3000 Lux 左右. 实验容器 100 ml 三角瓶, 培养物体积 25 ml, 平行样 3 个.

1.3 生物量测定

通过在显微镜下用血球计数板进行藻细胞计数和在波长 650 nm 下测定藻液光密度, 建立了不同藻细胞浓度下的藻细胞浓度和光密度之间的线性关系, 实验中以计数的藻细胞浓度和测定的光密度表示藻生物量, 并通过二者的线性关系进行检验.

1.4 单甲脒浓度测定和对照实验

水中单甲脒浓度测定方法和对照实验同参考文献[4].

2 结果与讨论

2.1 斜生栅藻细胞浓度与光密度的线性关系

图 1 显示, 在不同藻细胞浓度下, 通过计数

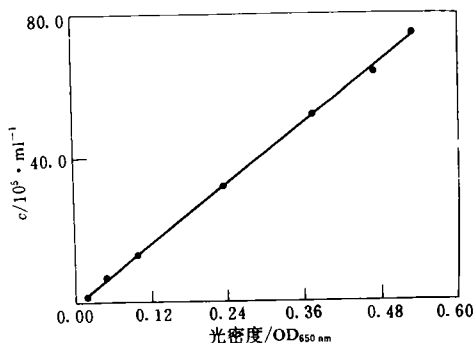


图 1 斜生栅藻细胞浓度与光密度的线性关系

* 国家自然科学基金和环境水化学国家重点实验室基金联合资助项目

收稿日期: 1996-02-12

的藻细胞浓度(y)和在波长 650 nm 下测定的光密度(x)之间的线性关系,得到的线性回归方程为:

$y(10^5/\text{ml}) = -0.688 + 140.558x (r = 0.998)$

用此方程计算出的藻细胞浓度和实测浓度之间的平均相对偏差为 2.6%。

2.2 毒性评价

在单甲脒浓度分别为 0、2、4、6、8 和 10 mg/L 下,斜生栅藻细胞浓度随时间延长的增长过程见表 1 和图 2,可以看出随单甲脒浓度的增加,抑制斜生栅藻生长的作用加强,特别在藻生长指数期更加明显,针对 96 h 藻细胞浓度的生长结果,单甲脒浓度对数(x)与机率单位(y)的一元线性回归剂量反应方程为:

$y = 6.144 - 1.406x \quad (r = -0.981)$

当机率单位为 5 时,通过上述方程计算出的单甲脒抑制斜生栅藻生长的 96 h-EC₅₀为 6.5 mg/

L. 对此方程的 X^2 检验结果(表 2)显示,当自由度为 3 时,查表 $X^2_{0.05}$ 为 7.82,计算 X^2 等于 1.37,因为 $X^2_{0.05} > X^2$,故此剂量反应方程符合精度要求,用此剂量反应方程计算出的 96 h-EC₅₀为 6.5 mg/L 真实可靠。

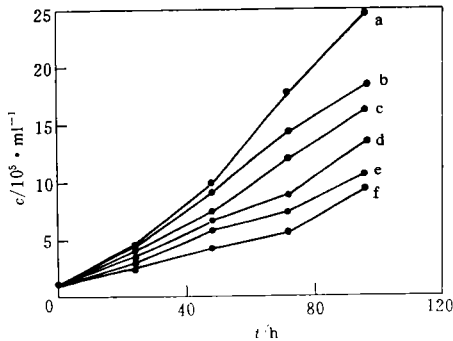


图 2 单甲脒对斜生栅藻生长的效应
单甲脒浓度: a. 对照(不加) b. 2 mg/L
c. 4 mg/L d. 6 mg/L e. 8 mg/L f. 10 mg/L

表 1 单甲脒对斜生栅藻的毒性实验结果

单甲脒浓度/mg · L ⁻¹	0	2	4	6	8	10
单甲脒浓度对数		0.30	0.60	0.78	0.90	1.00
光密度/OD _{650 nm}	0.180	0.135	0.120	0.100	0.081	0.072
藻细胞浓度/10 ⁵ · ml ⁻¹	24.60	18.30	16.15	13.35	10.65	9.40
反应率/%	100.00	74.39	65.65	54.27	43.29	38.21
经验机率单位		5.652	5.403	5.108	4.829	4.696

表 2 单甲脒剂量反应方程的 X^2 检验

浓度对数 X	机率单位 Y	对应反应率 P	对照反应率 $K/\%$	实际反应率 $r/\%$	$KP/\%$	$r-KP$	$(r-KP)^2 / (KP(1-P))$
0.30	5.772	0.7640	100	74.39	76.40	-2.01	0.224
0.60	5.300	0.6167	100	65.65	61.67	3.98	0.670
0.78	5.047	0.5185	100	54.27	51.85	2.42	0.235
0.90	4.879	0.4530	100	43.29	45.30	-2.01	0.163
1.00	4.738	0.3960	100	38.21	39.60	-1.39	0.080
X^2							1.373

2.3 降解实验

在单甲脒浓度分别为 2、4 和 8 mg/L 下,也就是在单甲脒不同程度抑制斜生栅藻生长的情况下,液相色谱测定结果表明,5 d 时间内斜生栅藻都不具备降解单甲脒的能力。

3 结论

(1) 单甲脒抑制斜生栅藻的 96 h-EC₅₀为 6.5 mg/L,稍高于单甲脒抑制蛋白核小球藻生
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超过 45℃ 酶活性下降。

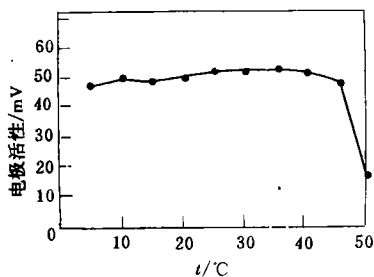


图 2 温度对固化 AChE 活性的影响

图 3 是 pH 值和离子强度对固化 AChE 活性的影响。实验表明, 磷酸盐缓冲液 pH 值为 9.0, 离子强度为 0.01 mol/L, 底物浓度为 10^{-3} mol/L 时酶电极活性最高。但许多农药在碱性溶液中易分解, 故缓冲液 pH 选在 8.4 左右。因有机磷抑制 AChE 的机制是与底物乙酰胆碱一起竞争酶的活性中心, 所以底物浓度不宜过大, 实验表明选择乙酰胆碱浓度为 10^{-3} mol/L 较合适。

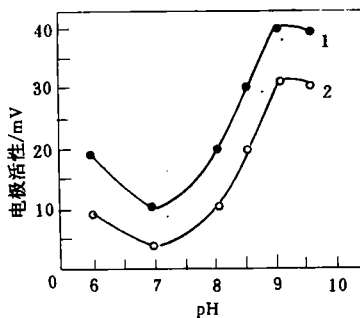


图 3 pH 值和离子强度对固化 AChE 活性的影响

1. 缓冲液离子强度 0.01 mol/L,
2. 缓冲液离子强度 0.02 mol/L

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长的 96 h-EC₅₀ 3.5 mg/L^[6], 说明斜生栅藻比蛋白核小球藻对单甲脒的敏感度低。尽管如此, 在自然水环境中单甲脒的存在仍然对斜生栅藻的生长产生较大的影响。

(2) 在单甲脒初始浓度分别为 2, 4 和 8 mg/L 情况下, 斜生栅藻都不具备降解单甲脒的能力。另外, 蛋白核小球藻也没有降解单甲脒的能力^[6], 这更进一步说明了单甲脒可能是藻

类难降解的有机污染物。

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the U content after purification decreases with decrease of U content in digested solution. The optimum pH for coprecipitation is about 5.8.

Key words: U, $\text{Fe}(\text{OH})_3$, coprecipitation, removing uranium.

Study on Correlation Between Influent and Effluent Substrate Concentrations of Biofilm Reactor. Yu Liu (Dept. of Civil and Structural Eng., Hong Kong Univ. of Science and Technology, Hong Kong), Qingliang Zhao (Dept. of Environ. Eng., Harbin Univ. of Architecture and Eng., Harbin 150001); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 28–30

This paper mainly investigated the effect of influent substrate concentration (S_0) on steady state effluent quality (S_e) for anaerobic, heterotrophic-aerobic and nitrifying biofilm reactors. It was found that variation pattern of S_e as S_0 changes is subject to a semi-U shaped curve. Based on the known linear model, a nonlinear S_0 - S_e model was developed. It was demonstrated that this model can provide a quantitative description for experimental data, also was confirmed by the data from literature. The proposed concept of critical influent substrate concentration has great importance in future design and operation of biofilm reactor.

Key words: biofilm, substrate, reactor, modeling.

Automatic Control of Polymer Addition for Belt Press Sludge Dewatering System. Tian Xiumin et al. (Research Institute of Machinery Science and Technology, Beijing 100044); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 31–32

The relation between polymer dosage and sludge concentration had been determined. The model of automatic control for polymer addition was established. The control system was installed on a two-metre belt press dewatering raw sludge of Tangshan Xijiao Sewage Treatment Plant by measuring sludge concentration and flow rate in line. The evaluation was conducted by comparing the results of historical manual operation with those achieved on the same press under automatic control. Analysis of the data indicated that average 15% polymer can be saved, the dewatering effect can be improved and more uniform performance of the dewatering machine will be realized.

Key words: sludge dewatering, belt press, automatic control for dosage.

Photocatalytic Degradation of Organophosphorus Pesticides Using TiO_2 Supported on Fiberglass. Chen Shifu et al. (Dept. of Chem. Eng., Zhengzhou Institute of Technology, Zhengzhou 450002); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 33–35

Photocatalytic degradation of organophosphorus pesticides using supported TiO_2 as a catalyst, which is prepared by thermal decomposition and calcination of colloidal solution made from hydrolytic of titanium tetraisopropoxide [$\text{Ti}(\text{iso-OC}_3\text{H}_7)_4$] on fiberglass was studied. The results showed that four organophosphorus pesticides of lower concentrations were completely photocatalytically degraded into PO_4^{3-} within a short time illumination with a medium pressure mercury lamp of 375 W. The TiO_2 supported on the fiberglass was not removed easily, after 120 h illumination there was no significant loss of the photocatalytic activity of TiO_2 , it could be used continually. The reasons of the different chemical structures of organophosphorus pesticides affecting photodegradation efficiency were investigated.

Key words: supported TiO_2 , photocatalytic degradation, organophosphorus pesticides, titanium tetraisopropoxide.

Ecological Effects of Multi-Effects-Triazole on Soil Microbe. Gong Ping (Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang 110015), G. Beudert (Institute for Aquatic Environmental Engineering, University of Karlsruhe, D-76128 Karlsruhe, F. R. Germany); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 36–38

Effects of multi-effects-triazole (MET) on soil nitrification, dehydrogenase activity (DHA), respiration and microbial biomass C were investigated through laboratory incubation and field experiments. It is derived from this study that MET has no adverse long-term influence on soil microbe. However, its short-term effects are notable and need further studies.

Key words: multi-effects-triazole (MET), soil microorganism, ecological effects.

An Interaction between *Scenedesmus obliquus* and N-(2, 4-dimethylphenyl)-N'-methylformamidine. Yan Hai et al. (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ.*

Sci., **17**(4), 1996, pp. 39—40

To study an interaction between *S. obliquus* and N-(2, 4-dimethylphenyl)-N'-methylformamidine, a standard method of algal bioassay for evaluating the toxicity of toxic chemicals was applied and 96 h-EC₅₀ of N-(2, 4-dimethylphenyl)-N'-methylformamidine on inhibition of *S. obliquus*'s growth was calculated as 6.5 mg/L. It was found that N-(2, 4-dimethylphenyl)-N'-methylformamidine can not be biodegraded by *S. obliquus* at the initial concentration of 2, 4 and 8 mg/L respectively.

Key words: *Scenedesmus obliquus*, N-(2, 4-dimethylphenyl)-N'-methylformamidine, algal bioassay, biodegradation.

A Study on the Selective Inhibition of Immobilized Acetyl Cholinesterases of Different Biosources by Organophosphorus insecticides.

Yu Xiaoying (Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550002); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 41—43

The enzyme electrode method was used to study the selective inhibition of acetyl cholinesterases (AChE) extracted from three different biosources by organophosphorus insecticides. It was found that the inhibition extent of AChE by DDVP follows the order of fly, electric fish, chicken liver. In addition the capacity of five kinds of insecticides to selective inhibition AChE extracted from electric fish was studied. It was found that 9.8×10^{-8} mol/L phoxim is sufficient enough to inhibit 10% of AChE's mobility of electric fish. The detection limits of various kind of insecticides are also presented in this paper. The experiment also showed that in the range of 20—45°C temperature would exert almost no influence on the mobility of AChE. The optimum pH value, ionic strength and the mechanism of selective inhibition which affect the mobility of AChE were discussed.

Key words: organophosphorus insecticides, acetyl cholinesterases, selective inhibition, enzyme electrode.

Research of Upflow Solid Reactor (USR) Treating Chicken farm wastewater at Anaerobic Digestion Condition. Zhou Mengjin et al. (Dept. of Biology, Capital Normal University, Beijing 100037); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 44—46

The paper presents the result of Chicken farm

wastewater anaerobic digestion in upflow solid reactor (USR) at 35°C. The influent concentration was as follows: COD: 41900—61500 mg/L, SS: 50—60 g/L, TVA: 3174 mg/L, pH = 6.61. After 67 days of USR proceeding, the loading rate of USR reached to 10.45 g/(L·d), gas production rate achieved 4.88 L/(L·d), and average amount of CH₄ was 59.75% in which, the COD removing rate increased to 86.62%. At 5 days of HRT, the SRT was 24.8 d, SS removing rate was 66.16%.

Key words: upflow solid reactor (USR), Chicken farm wastewater, anaerobic digestion.

Preparation of Compound Granulated Adsorbent of Attapulgit and Studies on Its Adsorbability to Lead.

Qin Fei, Xu Ouyong (Dept. of Environ. Sci. and Eng., Nanjing University, Nanjing 210093), Jiang Tingda (Research Center for Eco-Environmental Sciences, Chinese Academy of sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 47—50

The granulated adsorbent of Attapulgit (AT) with some additive which includes cement (SN), quartz sands (SS) and steel crumbs (CS) was researched in order to produce a practical adsorbent for removal of lead in the waste water. The manufacture progress of granulated adsorbent and its adsorbability were discussed in detail. Optimum adsorbent is AT-SS among adsorbent of AT-SS, AT-SN and AT-CS. It has a capacity of adsorbing lead of 500 mg/g under the static conditions and of 60 mg/g under the dynamic conditions when it was manufactured at a AT-SS mixing ratio of 5:1 and by roasting at a temperature of 700°C for 120 min. The penetration time is 20 h and the regeneration rate is 48.3% with the current velocity of 1.5 ml/min. The Pb concentration of effluence is lower than standard within 236 times bed volume at the intake concentration of 200 mg/L.

Key words: wastewater treatment, adsorbent, lead, attapulgit, cement, quartz sands, steel crumbs.

Effect of Nitrate on Acclimatic Process for Terephthalic Acid Anaerobic Degradation. Li Xiaoming et al. (Dept. of Biotechnology, Wuxi University of Light Industry, Wuxi 214036); *Chin. J. Environ. Sci.*, **17**(4), 1996, pp. 51—53

Nitrate can promote the acclimatic process for