

有机锡化合物对底栖动物的急性毒性研究*

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摘要 研究有机锡化合物对摇蚊幼虫等 4 种底栖动物的急性毒性作用, 包括致死浓度(LC)和致死时间(LT)。结果表明: ①3 种丁基锡化合物的毒性依次是三丁基锡(TBT) > 二丁基锡(DBT) > 单丁基锡(MBT)。②TBT 对羽摇蚊幼虫的 24h LC_{50} 为 26.86×10^{-9} ; 对六附器毛突摇蚊幼虫的 24h LC_{50} 为 241.55×10^{-9} ; 对苏氏尾鳃蚓的 24h LC_{50} 为 145.55×10^{-9} ; 对霍甫水丝蚓的 24h LC_{50} 为 355.63×10^{-9} 。③TBT 浓度与尾鳃蚓的半致死时间(LT₅₀)成明显的负相关。

关键词 有机锡化合物, 底栖动物, 急性毒性。

近几十年来, 有机锡化合物在工农业生产中, 如塑料工业、农药杀虫剂和船体防污涂料等, 使用日益广泛, 使得有机锡化合物已成为金属有机化合物中商品种类最多的一类, 其产量也爱年增长, 1955 年尚不足 5000t, 到 1988 年猛增至 35000t^[3]。其中用于船体防污涂料的三丁基锡(TBT)对水生生态系统的危害最为严重, 已受到世界各国的普遍关注。法、英两国分别在 1982 年和 1985 年制定了相应的法规以控制 TBT 的使用^[4]。国内外有机锡的监测与毒性试验已有较多的研究报道, 但主要针对海湾与海洋生物。本试验选择适应在内河与河口生活的两类重要的底栖动物——摇蚊幼虫和颤蚓作为试验动物, 进行了以 TBT 为主的有机锡化合物的急性致死浓度(LC)与致死时间(LT)试验, 以便进一步了解有机锡化合物的毒性及对水生生态系统结构与功能的影响研究提供依据。

1 材料与方法

1.1 试验动物

羽摇蚊 *Chironomus plumosus* 幼虫与六附器毛突摇蚊 *Chaetocladius sexpapilosus* 幼虫由鱼市购得; 两种颤蚓(霍甫水丝蚓 *Limnodrilus hoffmesteri* 与苏氏尾鳃蚓 *Branchiura sowerbyi*)采自天津卫津河。以上生物均在实验室经过清水驯养后, 备用。羽摇蚊幼虫均重 20mg/条, 龄期: 4 龄; 六附器毛突摇蚊幼虫均重 12mg/条, 龄期: 3—4 龄; 霍甫水丝蚓均重 3.8mg/条; 苏氏尾鳃蚓均重 25mg/条。

1.2 试验方法

试验在 1000ml 烧杯中进行, 每杯放试验动物 10 条。设 5 个浓度组, 3 个平行样。试验水配方^[2]: NaCl 0.5g, MgSO₄ 0.3g, CaCl₂ 0.27g, NaHCO₃ 0.05g, KH₂PO₄ 0.02g, 1% FeCl₃ 0.1ml 加蒸馏水至 10L。人工配水使用前经充分曝气。试验在黑暗条件下进行, 温度 $23 \pm 1^\circ\text{C}$ 。

急性致死的死亡判断标准, 摇蚊幼虫根据 Cushman^[2]以玻棒轻压尾部 3 次后不作“8”字运动为死亡。水丝蚓和尾鳃蚓在染毒后, 身体很快自溶和萎缩, 以溶至不再运动为死亡。

1.3 试验药物

试验用有机锡化合物全部为丁基锡氯化物[氯三丁基锡(TBTCl₃), 氯二丁基锡(DBTCl₂)和氯单丁基锡(MBTCl₃)]。

2 结果与讨论

2.1 有机锡化合物对底栖动物的半致死浓度

LC_{50} 见表 1, 图 1。结果显示: ①2 种摇蚊幼虫对 TBT 的抗性表现出明显的种的特异性, 六附器毛突摇蚊幼虫的 LC_{50} 值是羽摇蚊幼虫的 12 倍, 分析其原因, 主要是六附器毛突摇蚊幼虫具有比较坚硬的几丁质外壳, 且体表没有外鳃, 所以对毒物表现出强的抗性; 而羽摇蚊幼虫和苏氏尾鳃蚓具有突出在体表的外鳃, 外鳃的表皮极

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表 1 有机锡化合物对底栖动物的 LC₅₀及回归分析参数

化合物	试验动物	24h LC ₅₀ (×10 ⁻⁹)	回归分析参数		
			a	b	r
TBT	羽摇蚊幼虫	25.65	-2.85	3.44	0.985
TBT	六附器毛突摇蚊幼虫	241.55	-4.53	2.75	0.997
TBT	苏氏尾鳃蚓	145.55	-5.02	3.25	0.983
TBT	霍甫水丝蚓	355.63	-4.59	2.58	0.991
DBT	羽摇蚊幼虫	335.62	-7.38	3.68	0.996
MBT	羽摇蚊幼虫	在 50×10 ⁻⁶ 的浓度下, 试验时间(48h)内无死亡			

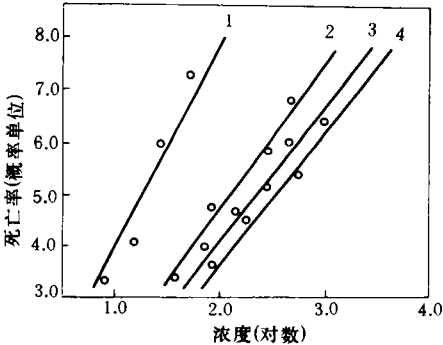


图 1 三丁基锡(TBTCl)对底栖动物的浓度效应关系

1. 羽摇蚊幼虫
2. 苏氏尾鳃蚓
3. 六附器毛突摇蚊幼虫
4. 霍甫水丝蚓

薄,容易接触和吸收毒物,导致迅速中毒死亡;霍甫水丝蚓是最耐污的生物,在试验中表现出对(TBT)最大的抗性。②3种丁基锡化合物对羽摇蚊幼虫的毒性,以三丁基锡(TBT)的毒性最强,它比二丁基锡(DBT)强10倍以上,单丁基锡

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3 结论

(1)使用铬渣烧结矿,实现了在30m³高炉上的工业化炼制含铬生铁的生产试验。铬渣中六价Cr的还原率接近100%,总Cr的金属化还原率达94%以上。平均每吨含铬生铁吃渣量2.298t,最高为2.785t,万吨铬盐厂配用30m³小高炉可将铬渣全部消化,并创造300万元/a以上的经济效益。

(2)保持较高的炉温(大于1480K),控制较低的碱度,并配入辅料降低炉渣熔点,可显著改善炉渣的流动性,成功地使渣、铁分离,顺利排渣

(MBT)毒性最弱,在50×10⁻⁶高浓度下,24h仍能全部成活下来。

2.2 三丁基锡对苏氏尾鳃蚓的半致死时间

LT₅₀见表2,图2中LT₅₀与浓度成负相关。

表 2 三丁基锡(TBTCl)化合物对苏氏尾鳃蚓的 LT₅₀

TBTCl 浓度 (×10 ⁻⁹)	LT ₅₀ (h)	回归分析参数		
		a	b	r
160	27.2	-2.32	3.01	0.936
280	14.5	-1.81	3.28	0.968
500	5.3	-6.20	5.02	0.999

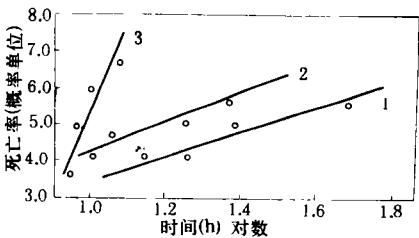


图 2 三丁基锡(TBTCl)对苏氏尾鳃蚓的半致死时间与浓度的关系

1. 160×10⁻⁹
2. 280×10⁻⁹
3. 500×10⁻⁹

参考文献

1 曾庆韬. 生物学杂志. 1986, 2: 41

2 Franco P J et al. . Acute toxicity of a synthetic oil, aniline and phenol to laboratory and natural populations of Chironomid (Diptera) larvae. Environ. Pollut. (series A) 1984, 34: 321

3 Laughlin R B et al. . Fate and effects of organotin compounds. AMBIO 1985, 14(2): 988

4 Robert G H et al. . Environ. Sci. Technol. 1992, 26(2): 232

出铁。

(3)通过调节铬渣烧结矿的配入比例,可在一定范围内调节生铁产品中的含铬量。若需炼制含Cr大于10%的生铁,则应配入一定比例的铬铁矿增铬。

(4)生产废水闭路循环,水淬渣作水泥原料,高炉除尘器积灰烧结回用,可避免二次污染;应注意控制高炉煤气放散,以降低厂区含铬生产性降尘。

参考文献

1 蔡金炉. 化工环保管理与信息. 1990, (1): 17

2 任庆玉. 环境工程. 1989, 7(3): 51

waste gas, energy recovery could be made while the goal of pollution control being achieved.

Key words: catalyst, noble metal, organic waste gases.

Comparison in Vehicular Exhaust Emissions between Hong Kong and Guangzhou Cities. L. Y. Chen (Ph. D) and W. T. Hung (Civil and Structural Eng. Dept. Hong Kong Polytechnic, Hunghom, Hong Kong), Y. Qin (Institute of Environ. Sci., Zhongshan University, Guangzhou 510275); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 56—60

The monitoring results of vehicular exhaust emissions in the urban areas of Hong Kong and Guangzhou were discussed. The monitoring exercise was carried out by using automatic gaseous analyser mounted on road side in Hong Kong for four years and for nine days in Guangzhou. The results show that the pollution level at Castle Peak Road of Hong Kong was comparatively lower than that in Guangzhou. The pollution level in Hong Kong satisfied the national air quality standard (Class 2) of China in both years 1988 and 1989. The pollutant concentration along Jiefang Middle Road was very high and exceeded the national air quality standard (Class 3). The traffic flow speed and composition were discovered to be the major reasons for the difference in pollutant concentrations in both cities.

Key words: vehicular exhaust emission, combined emission factor, traffic flow speed and composition.

SDS-PAGE Separation and HPLC-FID Identification of Selenoproteins in Soybean from Enshi Area Having a Higher Level of Selenium in Soil. Xie Shenmeng, Wang Zijian and Peng An (Research Center for Eco- Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 61—62

Selenoproteins in soybean from Enshi area where selenium in soil was at a higher level were separated by using sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and then identified by using high performance liquid chromatography with a fluorescent indication detector (HPLC-FID). Of 27 protein or protein subunit bands identified, 13 were found to be selenium species. According to a standard protein kit, their molecular weights were estimated at 58.3—60.3, 52.5—53.7, 46.8—50.1, 29.5—30.9, 28.8, 25.1—25.7, 24.3, 19.7—20.9, 18.4—18.6, 16.8—17.9, 16.1—16.2, 15.2—15.8 and 14.3—14.8 KDa, respectively.

Key words: SDS-PAGE, HPLC-FID, selenoprotein, speciation.

Acute Toxicity of Organotin Compounds to Benthos. Chen Tian'yi et al. (Dept. of Environ. Sci., Nankai University, Tianjin 300071); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 63—64

The acute toxicities of three organotin compounds, i. e., monobutyltin (MBT), dibutyltin (DBT) and

tributyltin (TBT), to benthos (Chironomid larvae and tubificids) were reported. The results show that (1) the toxic effects of these compounds in a decreasing order were TBT > DBT > MBT; (2) the median lethal concentration (24h LC₅₀) of TBT to 4 species of benthos was 26.85 ppb for chironomid larvae (*Chironomus plumosus*), 241.55 ppb for chironomid larvae (*Chaetocladius sexpilosus*), 145.55 ppb for tubificids (*Branchiura sowerbyi*), and 355.63 ppb for tubificids (*Limnodrilus hoffmesteri*); (3) there was a strong negative correlation between the concentration of TBT and the median lethal time (LT₅₀) for *B. sowerbyi*.

Key words: organotin compounds, benthos, acute toxicity.

Effects of CO₂ on the Grain Compositions of Winter Wheat and Soybean. Gao Suhua and Wang Chun'yi (Chinese Academy of Meteorological Sciences, Beijing 100081); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 65—66

Winter wheat and soybean crops were treated with different CO₂ concentrations in top-open chambers. The matured grains harvested from the crops were analysed for their compositions by using visible ultraviolet spectrometer, protein analyzer, gas chromatograph, YG-2 fat extractor and automanual nitrometer. The results show that an increased CO₂ concentration can have a positive effect on the contents of both rough protein and rough fat in soybean grain; and as the CO₂ concentration increases, the soybean grain would have an increased level of unsaturated acids and a decreased level of saturated acids. The change in CO₂ concentration had a more complicated effect on the levels of rough protein and lysine in winter wheat grain. In terms of both indicators of rough protein and lysine, a doubled concentration of atmospheric CO₂ had a negative effect on the quality of grains of the present varieties of winter wheat.

Key words: top-open chamber, CO₂ concentration, grain composition, winter wheat, soybean.

Study on the Fluorometric Determination of Beryllium Using Morin. Zhao Zhenhua et al. (Beijing Municipal Research Institute of Environmental Protection, Beijing 100037); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 67—70

The fluorometric spectra of beryllium-morin complex were characterized and the graphs of excitation spectrum, emission spectrum and synchronous fluorescence spectrum were given. The synchronous spectrum of beryllium-morin in an alkaline solution had an optimum specific λ of 100nm. A synchronous scanning spectrofluorometry was used to determine beryllium at a level of submicrogram, with a detectable limit of 5 ng/ml Be²⁺. The results obtained with this method were comparable with those obtained with an atomic absorption spectrophotometric method for air samples and water samples.