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# 稀土元素对小球藻生长的影响\*

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摘要 研究稀土元素镧(La)、铈(Ce)、镨(Pr)、钕(Nd)及其混合物对蛋白核小球藻(Chlorella pyrenoides)生长的 影响。结果表明,低浓度(2 mg/L)稀土元素对小球藻生长影响不大;随处理浓度的提高(10-200 mg/L),稀土元 素对小球藻生长产生明显的抑制作用。各元素对小球藻的毒性顺序(按 ECso计)依次为: Nd>Ce>Pr>La>混合 稀土,但毒性差异很小。

关键词 稀土元素,小球藻,生长影响。

尽管国内外开展稀土的生物和生态效应研 究较早,但主要集中于温血动物的毒理作 用<sup>[1-3]</sup>,对鱼类等水生动物的影响亦有一些报 道<sup>[4,5]</sup>,但稀土尤其是单一稀土元素对水生植物 的影响则报道较少。

小球藻是较常见的光合自养藻种,作为低 等水生植物,对水体污染较为敏感。Lue Kin 等 (1980)曾研究了镉对小球藻的毒性作用<sup>[6]</sup>,但 有关稀土元素对小球藻的影响则鲜见报道。本 文就主要轻稀土元素镧(La)、铈(Ce)、镨(Pr)、 钕(Nd)及其混合物对蛋白核小球藻(Chlorella pyrenoides)生长的影响作了初步研究。

### 1 材料与方法

1.1 稀土贮备液的配制

取各稀土的氧化物(纯度>99%,为包头稀 土研究所提供)适量,加少量去离子水及10 ml 浓 NHO₃(优级纯)加热溶解,然后用去离子水 分别稀释配制成1000 mg/L 浓度的 La、Ce、 Pr、Nd(以+3 价离子计)贮备液各5 L。

分别取上述4种稀土元素贮备液各500 ml, 混匀配制成1000 mg/L总浓度的混合稀土贮备 液2L(每种稀土元素浓度均为250 mg/L)。

# 1.2 小球藻的分离与纯化

取杭州华家池水适量接种在水生4"固体培养基上培养分离小球藻,然后将藻种移入液体

培养基中;反复 3—4 次,即可得到较纯的试验 藻种——蛋白核小球藻(Chlorella pyrenoides)。

水生 4<sup>#</sup>培养基化学组成见文献 7。其中固 体培养基是在液体培养基(水生 4<sup>#</sup>)中加入适量 琼脂(15 g/L),经加热溶解、冷却而成的。

1.3 稀土元素对小球藻生长影响试验

用水生 4<sup>#</sup>液体培养基和稀土贮备液配制成 分别含 La、Ce、Pr、Nd 及混合稀土元素各为 2、 10、50、100、200 mg/L 的处理培养液各 1000 ml,置于 1000 ml 玻璃烧杯中,同时设一组平行 和一组空白(不含稀土元素),然后分别接种入 经提纯的蛋白核小球藻适量,在温度 20—30 C、 光照强度为 2000 - 3000 Lux、光暗周期为 13/11 h的条件下培养。

在接种培养后第1、2、3、4、5、7d取样 (摇匀的培养液)适量,以培养液的光密度值 (OD)作为小球藻生长量(个体数)的间接指 标<sup>[8]</sup>,用722型分光光度计在波长692 nm 处测 定 OD 值。

## 2 结果与讨论

2.1 单一稀土元素对小球藻生长的影响

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\*\* 现在杭州市拱墅区环保站工作 收稿日期: 1995-07-30 图 1一图 4 分别为 La、Ce、Pr、Nd 4 种稀 土元素(离子态)不同处理浓度下小球藻生长量 的变化情况。

由图 1-4 可见,4 种稀土元素对小球藻生 长量的影响大致相同。低浓度(2 mg/L)时影响 不明显,除 La 外,其余 3 种稀土元素此浓度



图 1 La<sup>3+</sup>对小球藻生长量的影响



图 2 Ce3+对小球藻生长量的影响



图 3 Pr<sup>3+</sup>对小球藻生长量的影响



图 4 Nd<sup>3+</sup>对小球藻生长量的影响

下在试验初期对小球藻的生长略有刺激促进作 用,但在试验中后期这种作用逐渐减弱和消失。 随着处理浓度的提高,各稀土元素对小球藻生 长的抑制作用明显增强,至100 mg/L 时,小球 藻已基本停止繁殖增长。

用概率统计法进一步计算得 4 种稀土元素 对小球藻的 96 h 半数效应浓度(EC<sub>50</sub>)分别为 91.09 mg/L(La)、89.88 mg/L(Pr)、88.88 mg/L(Ce)和 85.73 mg/L(Nd),即表明 4 种稀 土元素对小球藻的毒性大小顺序为Nd>Ce>Pr >La,但毒性差异很小,这与田田善一的结论 基本一致<sup>[9]</sup>。

2.2 混合稀土元素对小球藻生长的影响

图 5 为 4 种稀土元素混合处理下,小球藻 生长量随时间的变化(浓度值为 4 种稀土元素的 加和)。



图 5 混合稀土离子对小球藻生长量的影响

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构模为佳,各自不同的生态结构,显示了不同 的生态效益。其中以乔灌草型较好。说明成层 较复杂的生态结构有较好的生态效益。

3.4 经济效益的估算和预测。

在示范区的农业复垦中,平均可获纯收益 1500-2250 元/hm<sup>2</sup>;药材及经济植物中甘草平 均可获纯收益 1630 元/hm<sup>2</sup>;乔木类预计 10 年 成材可获纯收益 17.56 万元/hm<sup>2</sup>;果树类按 6 年后可获稳定产量计可获年纯收益 11.67 万元/ hm<sup>2</sup>;苗圃预计 3 年出圃可获纯收益 1.14 万元/ hm<sup>2</sup>。 4 结语

通过在准格尔露天煤矿的生态恢复示范工 程建设研究说明,在黄土高原矿山开发区搞生 态恢复工程建设不但可行,而且可补偿矿山开 发对环境、草地、农田造成的损失,利用其迅速 增加的地表植被,在较短的时间内改变开发区 的生态环境。研究结果也说明利用立体生态结 构模式所建立起的人工植被具较大优越性和实 用性。

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可见,混合稀土元素对小球藻生长的影响 情况与单一稀土元素的作用大致相同;统计得 到的 EC<sub>50</sub>值为 92.19 mg/L,略低于单一稀土元 素的毒性,但差异很小,这表明混合稀土元素 的毒性基本为4种稀土元素毒性的相加作用。

#### 3 结语

稀土元素 La、Ce、Pr、Nd 及其混合物对小 球藻生长有一定影响,但从其 EC50来看,毒性 不是很大且相当接近,依次为 Nd>Ce>Pr>La >混合稀土元素。稀土元素对小球藻生长的影 响机制可能与其它重金属元素的作用机制相似, 但尚有待于进一步深入研究和论证。

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Province, Danzai Mercury Deposit.

Study on the Catalytically Hydrogenated Conversion of CO<sub>2</sub> Using Ru/Al<sub>2</sub>O<sub>3</sub> Catalyst. Zhao Ruilan et al. (Research Center for Eco-Environmental Sciences, Academy of Sciences, Beijing 100085); Chin. J. Environ. Sci., 17(2), 1996, pp. 23-25

In this paper the catalytically hydrogenated conversion of  $\text{CO}_2$  was studied using  $\text{Ru}/\text{Al}_2\text{O}_3$  catalyst, the influence of different reaction conditions, such as reaction temperature  $(260-520^{\circ}C, 5000-10000 h^{-1})$  and  $CO_2/H_2$  ratio in inlet gas, on CO<sub>2</sub> conversion efficiency and CH<sub>4</sub> formation were reported. At reaction temperature higher than 350°C the CO<sub>2</sub> conversion efficiency was over 95%. and CH<sub>4</sub> formation rate was about 45% - 79%. There was no significant influence on CO<sub>2</sub> conversion efficiency and H<sub>2</sub>O formation when the space velocity from 5000  $h^{-1}$  to 10000  $h^{-1}$ . However, for the CH<sub>4</sub> formation efficiency there was a trough at the space velocity of  $7000 - 9000 \text{ h}^{-1}$ . The CO formation changed a little at space velocity of  $5000-9000 h^{-1}$ , but it increased a lot at 10000 h<sup>-1</sup>. The higher CH, formation efficiency was obtained when there existed excess of H<sub>2</sub>. The highest CH<sub>4</sub> formation efficiency obtained was 98%.

Key words: carbon dioxide, catalyst, catalytically hydrogenated, methane.

Monitoring on The Concentration of Atmospheric Methane of A Rice Cropping Region in Beijing Area. Cui Ping et al. (Chinese Research Academy of Environmental Sciences, Beijing 100012): Chin. J. Environ. Sci., 17 (2), 1996, pp. 26-28

Monitoring on methane concentration in the atmosphere in the rice cropping region was carried out between Oct. 1991 and Nov. 1993. Results indicated that the average concentration of methane of the two testing years in the local region were 1.16 and 1.17  $\mu$ g/L respectively. The variation of methane concentrations showed a strong seasonal pattern. The concentration and concentration deviation were high in summer and low in winter. During rice vegetation period, the methane concentrations were closely related with the variation of methane emission rates from rice paddies indicating rice paddies is one of the most important methane sources of the region. Running analysis showed that the average increasing rate of atmospheric methane in the region was 0.2%, much lower than some previous reports.

Key words: methane, rice, monitoring, Beijing area.

A simulation Study on the Accumulation of Added Rare Earth Elements in Aquatic Ecosystem. Chen Zhaoxi et al. (Dept. of Chem. Eng., East China Institute of Metallurgy, Maanshan 243002): Chin. J. Environ. Sci., 17(2), 1996, pp. 29-31

The accumulation and distribution coefficients of added rare earth elements (RE) in various parts of simulated aquatic ecosystem were investigated. The results showed that concentrations of added RE in bottom mud and water bodies varied smoothly and in *Lemna minor* and *Cyprinus carpio* varied extremely with the time in the period of experiment. Distribution coefficients of added RE in bottom mud were higher than 96%, in *Lemna minor*, were range of 0. 26-1.61%, in water, were range of 0. 54% -0.91%; and in carp were less than 0.035%, but almost on linear increment in the period of experiment. Bioconcentration of added RE in carp was also discussed.

Key words: aquatic ecosystem, accumulation, rare earth elements, bioconcentation.

The Quantum Chemistry Studies of the biradical Mechanism of Destroying Ozone in the Atmosphere. Sun Huabin et al. (Institute of Military Medicine, Jinan Command, Jinan 250014): Chin. J. Environ. Sci., 17(2), 1996, pp. 32-34

The reaction mechanisms of the singlet biradicals NH, CH<sub>2</sub>, CCl<sub>2</sub> with ozone in the atmosphere have been studied using RHF method of quantum chemistry. The geometries of the reactants, intermediates and products of the above reactions are optimized with the gradient technique at the 3-21G level, their energies have been calculated at the 6-31G or 6-21G level. The structure data of all species have been obtained. The calculated results show that there are two stages in the above reactions, the reactions of the biradicals with ozone take place first to form the stable intermediates, then the intermediates are decomposed by illuminating to the stable molecules HNO, H<sub>2</sub>CO and Cl<sub>2</sub>CO etc., respectively. In terms of dynamics two reactions in two stages belong to the types  $[\pi_{44} +$  $W_{2s}$  and  $[\pi_{2s} + \pi_{2s}]$ , respectively, and they are permitted thermodynamically. In this study, a method to investigate complicated reaction based on the combining thermodynamics with Woodward-Hoffmann approach without calculation of transition state was attempted to provide by authors.

Key words: biradical, loss of ozone, reaction mechanism.

The Structure and Toxicity Relationship Study for Nitroaromatics to Scenedesmus obliquus. Lu Guanghua et al. (Dept. of Environ. Sci., Northeast Normal Univ., Changchun 130024): Chin. J. Environ. Sci., 17(2), 1996, pp. 35-36

 $E_{\rm LUMO}$ ,  $E_{\rm HOMO}$ ,  $\Delta(\Delta H_i)$ ,  $\mu$  and  $Q_{\rm NO_2}$  of 18 nitroaromatic compounds were calculated using the quantum chemical method MNDO. The quantitative structure-activity relationships (QSAR) were developed using the five quantum chemical descriptors for the acute toxicity of nitroaromatics to *Scenedesmus obliquus*. Through step-wise regression analysis, one best equation contained three variables was obtained :  $-\log EC_{50} = 2.92 - 0.077 \Delta(\Delta H_i) + 0.08 \mu$  $+ 0.28E_{\rm HOMO}$ , n = 18, r = 0.961, S = 0.173. The equaiton was used to estimate the toxicity of the studied compounds, and the toxic effect was discussed.

**Key words**: structure, toxicity, nitroaromatics, Scenedesmus obliquus.

Effects of Rare-Earth Elements on Growth and Reproduction of Chlorella pyrenoides. Hu Qinhai et al. (Dept. of Environ. Sci., Zhejiang Agricultural University, Hangzhou 310029): Chin. J. Environ. Sci., 17(2), 1996, pp. 37-38

It was studied that effects of rare-earth elements (La, Ce, Pr, Nd and their mixture) on growth and reproduction of *Chlorella pyrenoides*. The results showed that effects of rare-earth elements on growth and reproduction of *Chlorella pyrenoides* were not apparent under lower concentration (2 mg/L), but it was inhibited as the concentration increased; and the toxicity (EC<sub>50</sub>, 96 h.) of rareearth elements on *Chlorella pyrenoides* was insequence as: Nd > Ce > Pr > La > mixture of them, but little difference.

**Key words**: rare-earth element, *Chlorella pyrenoides*, effect on growth and reproduction.

Study on in-Bed Desulfurization within Fluidized Bed Coal Gasifier. Bu Xuepeng et al. (Beijing Research Institute of Coal Chemistry, Central Coal Mining Research Institute, Beijing 100013): Chin. J. Environ. Sci., 17 (2), 1996, pp. 39-41

The data obtained from the tests indicated that both limestone and dolomite can be used effectively for capturing sulfur during the gasification of high sulfur coals. Desulfurization efficiencies can be improved with increasing the Ca/S molar ratio, the efficiencies were maximum when the ratio was 3, or by increasing total sulfur in raw coals. The effect of operating pressure on desulfurization efficiency is determined by temperature and partial pressure of carbon dioxide. The desulfurization rate was range of 50% - 85% under different conditions.

Key words: fluidized bed gasification, in-bed desulfurization, desulfurizaiton sorbent.

Mass Transfer-Reaction Process Mechanism of Wet Flue Gas Desulfurization with Lime. Wu Zhongbiao and Tan Tian'en (Dept. of Chem. Eng., Zhejiang University, Hangzhou 310027): Chin. J. Environ. Sci., 17 (2), 1996, pp. 42-44

By studying experimentally wet flue gas desulfurization with lime as absorbent and rotating-stream-tray scrubber as absorber, the mass transfer and reaction process on  $Ca(OH)_2$  slurry absorbing SO<sub>2</sub> is analyzed. Furthermore, the process mechanism is proposed. According to the mechanism, the total reaction rate is controlled by SO<sub>2</sub> diffusion in gas phase and Ca(OH)<sub>2</sub> dissolution and diffusion in liquid phase. The reaction process can be divided into three stages, the stage controlled by gas phase resistance, by gas phase and liquid phase resistance, and by liquid phase resistance. The process mechanism has been verified by the experiment. These results will help to optimize the design and operation of the industrial installation of wet flue gas desulfurization with lime.

Key words: flue gas desulfurization, mechanism, mass transfer-reaction process, lime, wet.

Effects of Three Sorts of Anaerobic Promoter on Anaerobic Digestion of the Waste Liquor from Ammonium Sulfite Pulping of Straws. Zhang Renquan (Dept. of Resource and Environ. Sci., Hefei Univ. of Technol., Hefei 230009); Chin. J. Environ. Sci., 17(2), 1996, pp. 45-46

The effects of activated carbon, ferrous sulphate and bentonite on anaerobic digestion of the waste liquor from ammonium sulfite pulping of straws have been analysed on the basis of the experimental results of anaerobic batch assays with the waste liquor. The results indicate that, with a dose of 2.5 g/L, each sort of the anaerobic promoter can substantially promote anaerobic digestion of the waste liquor, which can increase 30 day total gas production of the anaerobic system by 16. 1%, 13. 9% and 26. 1% respectively compared with the control. The action mechanisms of the three sorts of anaerobic promoter have been discussed preliminarily.

**Key words**: anaerobic promoter, waste liquor from ammonium sulfite pulping of straws, anaerobic digestion, action mechanisms.

Using Hydra Reaggregations Evaluating the Safety of Two Kinds of Food Additives. Cheng Qinyao et al. (Dept. of Biology, Anhui University, Hefei 230039); Chin. J. Environ. Sci., 17(2), 1996, pp. 47-48

This paper studied the safety of two kinds of food additives using Hydra reaggregations. The results showed that both sodium benzoate and sodium nitrite inhibited the growth of reaggregations. The minimum effective concentrations were 34.  $7 \times 10^{-4}$  mol/L and 2.  $9 \times 10^{-3}$  mol/L respectively. In addition, the negative correlation existed between the depolymerization time of the reaggregations and the concentration of food additives. Therefore, Hydra reaggregations technique will be a rapid screening method for predicting the potential toxicity of food additives.

**Key words**: *Hydra* reaggregation, food additive, evaluation safety, rapid screening.

A Study on Long-wave Pulsed Electromagnetic Fields Around A Long Range Navigation Station. Yao Gengdong et al. (School of Public Health, Zhejiang Medical University, Hangzhou 310031); Chin. J. Environ. Sci., 17(2), 1996, pp. 49-50

A measurement and a theoretical calculation of long-wave pulsed electromagnetic fields (PEMF) around the antenna of the first long range navigation station in China were conducted. The results showed that the electric field intensities were 0.5-3.6 V/m (RMS) corresponding to peak values of 38.5-276.9 V/m in the PEMF generating room; in the residential area which is 850-1100 m away from the antenna, the electric fields were 0.7-3.9 V/m corresponding to peak values of 53.9-300.3 V/m; the PEMF decreased in environment with the distance away from the antenna and when the distance is over 1200 m from it, the fields tended towards minimum.

Key words: pulse, long-wave, environment, electric field intensity.

Determination of Hydraulic Load Cycle in Rapid Infiltration Treatment System of Waste Water. Wu Yongfeng et al. (Dept. of Environ. Sci., China University of Geosciences, Beijing, 100083); Chin. J. Environ. Sci., 17(2), 1996, pp. 51-53

Hydraulic load cycle is the most important operation parameter in rapid infiltration treatment system of waste water. The decrease curve and recovery curve of infiltration rate in flooding and drying periods are obtained from the in situ test with the area of 80 m<sup>2</sup> and flooded with brewery waste water. The curves can be expressed with exponential and logarithmic equations respectively. A quantitative method is proposed to determine the hydraulic load cycle with maximum hydraulic load. The calculated result is 1.78 days flooding and 2.77 days drying, very similar with the test results.

**Key words**: rapid infiltration, hydraulic load, hydraulic load cycle, infiltration rate.

A New Way to Accelerate the Start-up of UASB Reac-