玉米麸质去除废水中汞的研究

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随着三废治理的发展，人们对重金属废水的处理已提出了许多卓有成效的方法．如离子交换树脂法，活性炭吸附法，反渗透法，电解法，共沉淀法等．这些方法虽能有效地去除废水中的重金属，但处理费用较高．七十年代初，国外开始有用农副产品废物去除重金属的研究报道[1-3]，而用玉米麸质去除重金属的研究，国内外未见报道．

本文研究了玉米麸质对重金属汞的去除能力．结果表明，玉米麸质对汞有很好的去除作用，可以作为一种新的废水处理材料．

一、实验部分

1．主要仪器及材料

F-732 型测汞仪，25 型酸度计，

汞标准溶液：称氯化汞（A，R）1.3540g 溶于 0.5Mol 硫酸溶液中，用二次蒸馏水稀释至 1000ml（汞浓度 1mg/ml），实验用不同浓度的汞试液由标准溶液适当稀释而成．

10% 的氯化亚锡硫酸（0.5Mol）溶液．

正丁醇，盐酸，硫酸均为分析纯试剂．

玉米麸质是湿磨淀粉副产品，经适当处理而成．

2．实验方法

根据实验内容分别用直径为 10 mm 和 20 mm 两种柱子，填装玉米麸质．含汞水从高位储水瓶流下过柱，对流出水进行含汞量测定．在玉米麸质对汞去除的条件试验中，含汞试液用汞标准液逐级稀释而成；称 3.09 玉米麸质填装直径 10mm 的柱子进行试验；找出最佳条件．在玉米麸质处理模拟废水试验中，含汞废水用自来水加入汞标准液混合而成；称 25.0g 玉米麸质填装直径 20mm 的柱子进行试验．去除率按下式进行计算：

$$\eta = (1 - C_i/C_0) \times 100\%$$

其中：η 为去除率，C_i 为出口水含汞浓度．C_0 为进口水含汞浓度．

二、结果与讨论

1．玉米麸质去除汞的条件试验

（1）pH 值对汞去除率的影响　用 NaOH，HCl 溶液调节试液的 pH 值，含汞 10mg/L 的试液以 3ml/min 的速率过柱，结果如表1．结果表明 pH 值在 2—8 的范围内，玉米麸质对汞有很好的去除能力．pH 值为 10 时，去除率有所降低．

表 1　pH 值对汞去除率的影响

pH 值	2.0	4.1	6.5	8.0	10.0
出水汞浓度 (mg/L)	0.027	0.026	0.032	0.015	0.118
去除率 η	99.73	99.74	99.68	99.85	98.82

（2）过柱速率对去除率的影响　在其它条件相同的情况下，以不同的过柱速率用 10mg/L 汞试液过柱，测定出水中的汞浓度．结果如表 2．

表 2　过柱速率对汞去除率的影响

试液流过速率 ml/min	8.0	4.0	2.0	1.0
出水汞浓度 mg/L	0.054	0.022	0.006	0.003
去除率 η	99.46	99.78	99.94	99.97

过柱速率越慢，玉米麸质与汞试液的接触时间越长，去除效果越好，当流速为1.0ml/min时去除率达到99.97%。

(3) 过柱体积与出水中汞浓度的关系 用含汞 10mg/L 的试液过柱，测定不同流过体积中的汞浓度。结果如图1。

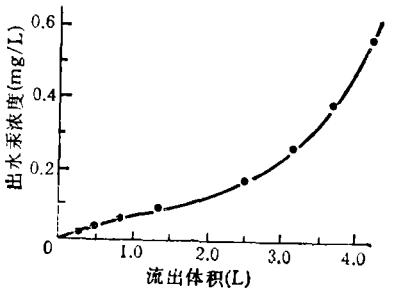

图1 过柱体积与出水汞浓度的关系
柱直径 $\phi = 10$mm 麸质重 $W = 3.0$g

由图可知，出水中汞浓度随流过体积增加而增加，当流过体积大于2.5L时出水中汞浓度迅速增加。

(4) 饱和吸收容量 用10mg/L汞试液过柱，不断取出口处水进行测定，直至出口处水中的汞浓度与进水浓度相同为止，测定流过体积中汞浓度，计算玉米麸质的饱和吸收容量。结果每克可吸收汞45mg。

2. 玉米麸质的再生

分别用不同浓度的盐酸，EDTA溶液对麸质进行了再生试验。结果大部分汞能被洗脱。下面是以2Mol盐酸再生的结果。

用含汞 200mg/L 的试液进行过柱，用2Mol 盐酸浸洗再生。再生对玉米麸质的去除率影响见表3。

结果表明，再生对汞去除率影响不大，但麸质对汞的吸收能力随再生次数增加而明显下降。

表3 再生次数对去除率的影响

再生次数	0	1	2	3
出水汞浓度 (mg/L)	0.048	0.070	0.079	0.095
去除率	99.97	99.96	99.96	99.95

3. 模拟含汞废水的处理

每升自来水中加入5.0ml的1mg/ml的汞标准溶液，混合后置于高位储水瓶中，以12ml/min的速率过柱。累计体积10L。流过柱的出水汞浓度为0.047mg/L，低于国家排放标准。

三、玉米麸质去除汞的机理探讨

研究中发现，调节不同 pH 值的汞试液过柱，当 pH 值大于 4 时，过柱后流出水 pH 值有所降低。当 pH 值为 2 的试液过柱后，pH 值有所升高。当 pH 值为 4 时，试液过柱后 pH 值基本不变。玉米麸质的这种缓冲作用，笔者认为主要是蛋白质的作用。而含汞试液在 pH 2—8 的范围内，玉米麸质对汞的去除率又基本无变化。这就说明，除了汞与蛋白质上的羧基，巯基等基团上的氢发生交换作用外，还可能与蛋白质上的其他含氮、氧的基团有络合作用。关于玉米麸质去除汞的机理，有待进一步研究。

四、结 束 语

用玉米麸质去除重金属汞，具有成本低廉，方法简单，效果好，原料广，可再生等特点。它可以作为一新的水处理材料，推广应用。尤其适用于中小型企业含汞废水的处理。

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The experimantal results show that under the conditions of carbon monoxide below 200 ppm within 16 hours of chambering time, there is no obvious injury on leaves of woody plants. But the ratio of photosynthesis is varied from different biocharacters of woody plants. When 100 ppm CO pollution, the relation of ratio of photosynthesis and the chambering time is exponential function, and $P_t/P_o = 5.75 \exp(0.001t)$ to *Fraxinus chinensis* and $P_t/P_o = 7.04 \exp(1.9\ 10t)$ to *Puruns davidiana*. (See pp. 27—29)

Injuries to Tree Leaves by Simulated Acid Rain and Resistant Nature of the Trees

Zhang Jiawu, Feng Zongwei et al. (Institute of Applied Ecology, Academia Sinica, Shenyang)

The paper gives a general description of the effects of simulated acid rain on tree leaves. The experiments have been done in Hunan Experimental Station of Forest Ecology. After the simulated acid rain were sprayed upon tree leaves, there appeared some symptoms: discoloration of greens, tissue necrosis, dewatering and early withering. And injurious extents on leaves were fundamentally due to the rain acidity, duration of spraying and conditions of sunlight and temperature. However, because of different tissue structures of the tree leaves, their resistant capacity were varied. (See pp. 30—33)

Toxicity of Floatation Agent S-808 of Phosphatic Ore and Mineral Wastewater to Fishes and Embryos

Zhang Fuying and Yin Yiwa (Institute of Hydrobiology, Academia Sinica, Wuhan)

Toxic test determining larvae of grass carp and guppy for 96-hour LC_{50} was 18 mg/L and 35 mg/L respectively, 10-day LC_{50} of grass carp embryo was 3.69 mg/L. For fish embryos in 1 mg/L, there appeared deformation. Deformation percentage and concentration were of positive correlation. In fish toxic test, deformed index was more sensitive than dead index. The toxic test showed that, according to classfication standard, S-808 was a "poisonous grade" of fish toxicity. S-808 in floating process was treated with physiochemical method and toxicity of dressing mineral wastewater decreased, so the value of LC_{50} in the test could not be determined, and there didn't appear deformation of fishes. (See pp. 34—37)

Tests on the Residues of 5% *Bestox* in Cotton Fields

Zhou Hou'an et al. (Institute of Zoology, Academia Sinica, Beijing)

Experiments on the residual kinetics of *Bestox* emulsion (5%) were carried out in the cotton fields. The results showed that the half-life of *Bostox* emulsion (5%) was 23 to 25 days in soil, and 3 to 5 days on leaves. The residues were not observed in cotton seeds even by using dosages 1.5 to 2.0 times of the conventional ones. *Bestox* is low toxic to mammals and there is no systemic action. The results can give a reliable basis for rationalizing the use of *Bestox* in the cotton field and limting MRL value in cotton seeds. (See pp. 38—41)

Ascertainment of Main Factors for Biological Denitrification System Using Orthogonal Test

Du Shelin et al. (Institute of Environmental Pretection, Shanghai Petrochemical Complex, Shanghai)

Hydraulic retention time (HRT), ratio of the volume of anaerobic tank to the volume of aerobic tank (I: R) and reflux ratio (r) have been established as three main factors in a biological denitrification system by using mathematically the orthogonal test method of Lg (3^4). Thus, in such a system for the treatment of a combined wastewater containing nitriles and sodium thiocyanate in high concentration, it was determined that HRT, I: R and r are 24 hours, 1:3 and 5.5 respectively, and they would be more favourable process parameters. In addition, an analysis of the whole system is made in this paper. (See pp. 42—46)

Removal of Mercury from Wastewater with Maize-Starch Dregs

Liu Manying and Kang Weijun (Hobei Medical College, Shijiazhuang, Hobei Province)

This paper deals with removal of mercury from wastewater by using maize-starch dregs. The experimental result shows that the rate of removal is 99.9%, and Saturated capacity is 45 mg/g. The method seems to be a cheap and efficient one for treating mercury-contained liquids. (See pp. 47—48)

Method for Determination of Twelve Phthalate Esters in Natural Water

Kang Junxing (Research Center for Eco-Environmental Sciences, Academia Sinica, Beijing) *Hing-biu Lee* (National Water Research Institute, Canada Center for Inland Waters)

An Analytical method was developed and validated, which permits determination parts per billion levels of twelve phthalate esters in natural water. Water sample was extracted with methylene chloride, and the extract was cleaned up by using silica gel liquid chromatographic column prior to determination of the phthalate esters by capillary column ECD-GC, (See pp. 49—54)

Spectrophotometric Determination of Trace Beryllium in Water and Wastewater after Adsorption concentration by Activated Carbon

Qiu Xingchu, Cheng Jun and Zhu Yingquan Ganzhou Institute of Environmental Science, Ganzhou, Jiangxi Province)

In this paper the optimum conditions of colour reaction of Be-CAS-CPC and adsorption concentration by activated carbon has been studied. In the buffer solution of urotropine pH 5.0. The adsorption maximum of the complex is near 605 nm. Beer's law is obeyed for 0-0.70 g *Be*/25ml (2cm cell) ranges. It is applied to determine the trace Be in Water by spectrophotometric method, which is simple exact and rapid. (See pp. 55—58)