综合利用

电解法处理废料贵铅的电极极化研究

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摘要　以含金银铅废料制成贵铅为原料，利用电化学热力学和动力学理论，对贵铅电解法实现金银与铅的分离和得到纯铅的电极过程极化行为与工艺条件的关系进行了研究。从而确定了贵铅电解时的电解液组成为[pb^{2+}] 70g/L，$\sum$[SiF_6^{2-}]100g/L，温度为40℃，β-萘酚/胶联合添加剂等工艺条件。同时根据动力学的研究证明了贵铅电解的电极反应速度受扩散控制，其扩散速度常数 $K_{扩}=1.917\times10^{-3}$cm/s，扩散层厚度为0.0051cm，在 $\eta_K=75$mV 时的阴极过程活化能为16.10kJ/mol，为贵铅电解工业分离回收金银铅提供了可靠的理论依据和设计参数。

关键词　回收，电解，金银铅，电极极化。

随着现代化工业的发展，贵金属的使用范围不断扩大，因而产生的金银废料中成分更加复杂和品位极低，有些废料还含有毒成分，这样增加了金银废料处理的困难和直接影响到金银回收率，因此开展低品位金银废料回收再生新方法的研究具有很大的经济效益。国内外从低品位废料回收再生金银的主流程是通过火法冶炼富集为贵铅，然后进行灰吹分离或酸溶再进行电解精炼。这些方法虽然有效，但存在金银回收率低和铅损失及带来二次污染。本项目利用低品位金银铅废料为原料，首先采用火法冶炼制成贵铅，然后贵铅直接电解法实现金银与铅的分离和制得合格的金银及纯铅。

1　研究方法

1.1　原料来源与样品制备

原料为含金灰和含银铅废料。含金抛灰主要来源于金笔厂和金泊厂，主要组成为石英粉35%，长石粉35%，铁红3%，含金0.1%，其余为硬酯酸，松香和精石腊等。而含银铅废料来自无线电加工行业，除含0.4%以上的银外，还含有铅氧化物30%，同时是以极毒的红丹 Pb_3O_4 存在，上述2种原料按重量比1∶1进行还原熔炼制成贵铅。

1.2　贵铅电解方法

以贵铅做阳极而纯铅为阴极始极片，在电流作用下使铅溶解而后又在阴极析出得纯铅，而金银不溶呈海绵状残留富集在阳极泥中。为此，对贵铅电解分离金银的电极过程热力学与动力学研究是获得金银高回收率和纯铅的关键。

(1)方法和装置　由电镀参数测试仪、函数记录仪及电解液池组成的线性电位扫描装置见图1。并采用电位扫描法测定阴阳极极化曲线。

(2)条件　温度40±0.5℃，用超级恒温水浴维持溶液温度。电解槽液量200ml，电极表面

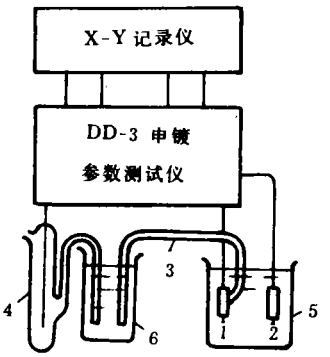

图1　动电位扫描装置

1. 研究电极　2. 辅助电极　3. 盐桥　4. 参比电极(217型饱和甘汞电极)　5. 电解槽　6. 饱和氯化钾溶液

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距离 30mm，研究电极面积为 0.49cm²，辅助电极面积 6.25cm²。

阳极成分(%)为：Pb 87.45，Ag 7.4675，Au 0.14185，Bi 2.12；阴极成分为 99.99%Pb。阳极扫描速度 45mV/s，阴极扫描速度 6mV/s。

2 结果与讨论

本实验的目的在于研究电解液组成，温度和添加剂对贵铅阳极和铅阴极极化的影响，并由此选择合适的电解液组成及添加剂的组合和浓度，以便达到适当的阴极极化值，从而获得致密平整的阴极沉积物。同时考虑阳极极化曲线应具有较大的斜率($dD/d\eta$)，以有利于阳极溶解和降低阳极电位。

2.1 贵铅电解分离金银的热力学

设贵铅电解时电解槽属下列化学系统：

阴极铅(纯)/$PbSiF_6 \cdot H_2SiF_6 \cdot H_2O$/阳极铅(Au，Ag)

电解液各组分在溶液中离解成下列各种离子：$PbSiF_6 \rightleftharpoons Pb^{2+} + SiF_6^{2-}$，$H_2SiF_6 \rightleftharpoons 2H^+ + SiF_6^{2-}$，$H_2O \rightleftharpoons H^+ + OH^-$

阴极上反应：$Pb^{2+} + 2e = Pb$，$E^0 = 0.217V$，

$2H^+ + 2e = H_2$，$E^0 = 0.00$

现假定一组接近实际的电解液成分为：Pb^{2+} 100g/L，$c_{Pb^{2+}} = 0.48mol/L$；H_2SiF_6 72g/L，即 H^+ 1g/L，$c_{H^+} = 1mol/L$。温度 298K，电流密度为 100—200A/m²，活度系数 $\gamma_{Pb^{2+}} = \gamma_{H^+} = 1$，超电压 $\eta_{Pb^{2+}} = 0.0$，$\eta_{H^+} = 1.1V$。则根据能斯特方程式计算得铅在阴极上的放电电位为 $E_{Pb^{2+}} = -0.1364V$，而 $E_{H^+} = -1.1V$。由此可知，在正常情况下在阴极上只有 Pb^{2+} 的放电反应而析出铅，而氢离子则不能放电。如果两者同时放电析出，则应 $E_{Pb^{2+}} = E_{H^+}$，即 $\lg \frac{c_{H^+}}{c_{Pb^{2+}}} = 32.83$，也就是说只有当铅离子浓度降低至 $10^{-32.83}mol/L$ 时，氢才会与铅一起在阴极上放电，在一般情况是不可能发生的。

阳极上可能进行的反应：$Pb^{2+} - 2e = Pb^{2+}$，$E^0 = -0.1274V$，$2OH^- - 2e = H_2O + \frac{1}{2}O_2$，$E^0 = +0.40V$，$SiF_6^{2+} - 2e = SiF_6$，$E^0 = +0.48V$，同时还有 $SiF_6 + H_2O = H_2SiF_6 + \frac{1}{2}O_2$。用能斯特方程式计算得到：$E_{Pb^{2+}} = -0.136V$，$E_{OH^-} = +1.299V$，$E_{SiF_6} = +0.489V$。由此可知，在阳极上只发生铅的溶解反应，而只有在阳极附近 Pb^{2+}，OH^- 和 SiF_6^{2-} 浓度相当大时，才会引起阳极不溶解而仅析出氢，但这种可能性是难以出现的。

贵铅阳极中的金银及杂质金属的行为决定于其标准电位及其在电解液中的浓度。一般而言，电位比铅低的金属杂质 Zn、Fe、Cd、Co、Ni 等随铅一道溶解，但不会在阴极上析出。电位比铅高的 Au、Ag 及 Bi、Sb、Cu、As 等在电解时不溶解而进入阳极泥。

2.2 电解液组成对铅电极过程的影响

2.2.1 铅离了浓度对阴阳极极化的影响

在总酸浓度固定不变条件下，改变铅离子浓度时的动电位扫描阴阳极化曲线如图 2 所示。由图 2(a)可知，阴极极限电流密度随着铅离子浓度降低而剧烈下降。在常用电流密度下，铅离子低的溶液(30.0g/L)电解时具有较大的极化值。图 2(b)则表明铅离子浓度在 30.0—70.0g/L 范围内，存在有大致相近的峰值电位(φ_P)和峰值电流(I_P)，而更高的铅离子浓度将导致 φ_P 的显著增大和 I_P 的急剧降低。因此从电极过程综合考虑，铅离子浓度以选择 70.0g/L 左右为宜。

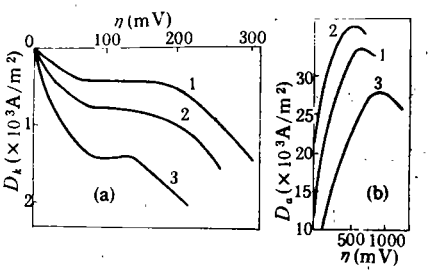

图 2 不同 Pb^{2+} 浓度的动电位扫描极化曲线

1. Pb^{2+} = 30.0g/L 2. Pb^{2+} = 70.0g/L 3. Pb^{2+} = 110.0g/L

(a) 阴极 (b) 阳极 总酸 110g/L

2.2.2 总酸度对阴阳极极化的影响

在铅离子浓度恒定条件下，$\sum[SiF_6^{2-}]$浓度对阴阳极极化的影响如图 3 所示。从图 3(a)中可见，$\sum[SiF_6^{2-}]$的变化对阴极极化曲线的影响

不大。而对阳极过程，由图3(b)可知，以$\sum[SiF_6^{2-}]$为100g/L时阳极极化曲线的斜率($dD_a/d\eta$)最大，所以电解液中$\sum[SiF_6^{2-}]$选100g/L为宜。

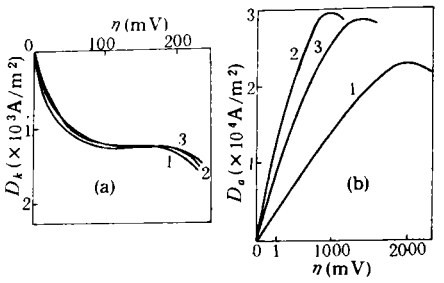

图3　不同$\sum[SiF_6^{2-}]$时动电位扫描阴极极化曲线

Pb^{2+}=70.0g/L　总酸浓度(g/L)：60.0，100.0，140.0

(a) 阴极　(b) 阳极

2.2.3　电解液组成的极化曲线

在无添加剂时，选定Pb^{2+} 70g/L和总酸$\sum[SiF_6^{2-}]$100g/L的电解液的阴阳极极化曲线如图4所示。在工业常用的阴极电流密度为100A/m²条件下，阴极过电位η_{100}仅为2.2mV，不足以引起阴极表面各部分电流密度的均匀化，一般只能得到颗粒平均线尺寸≥10—3cm的枝状沉积物。由图4(b)可计算过电位在0—300mV范围内阳极极化曲线的斜率($dD/d\eta$)为49.65(A·m⁻²/mV)。

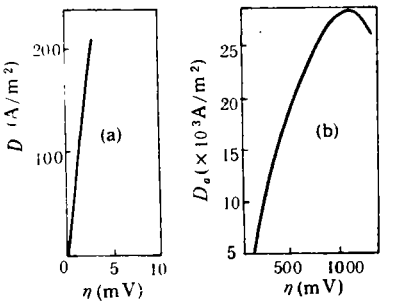

图4　不加添加剂时铅极化曲线

(a) 阴极　(b) 阳极

2.3　添加剂对阴阳极极化的影响

2.3.1　添加剂的筛选及其效果

在电解时加入添加剂对改善和提高电解技术经济指标可起到重要作用，几种添加剂对阴阳极化的影响如图5所示。

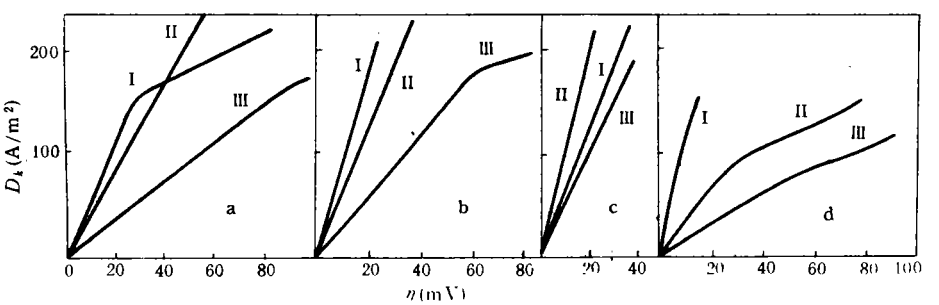

图5　单独添加几种添加剂的阴极极化曲线

a. 添加骨胶：Ⅰ 0.5g/L　Ⅱ 2.5g/L　Ⅲ 6.0g/L　b. 添加木质磺酸钠：Ⅰ 0.5g/L　Ⅱ 2.0g/L　Ⅲ 3.0g/L

c. 添加明胶：Ⅰ 0.1g/L　Ⅱ 0.3g/L　Ⅲ 1.0g/L　d. 添加β-萘酚：Ⅰ 0.01g/L　Ⅱ 0.06g/L　Ⅲ 0.1g/L

由图5可知：单独添加木质磺酸钠不能达到制取细密平整结晶所必须的阴极极化值，添加大量胶质时，虽能提高阴极极化，但对溶液比电导产生不利影响，β-萘酚对阴极过程有强烈的阻化作用，在所研究范围内，选用适当的β-萘酚可以达到适当的极化值。

2.3.2　联合添加剂对阴阳极极化的影响

在选定电解液组成条件下进行了β-萘酚(变化量)-骨胶(固定0.5g/L)联合添加影响试验(图6、7)。由图6可知，在有胶存在时，阴极极化值随着电解液中β-萘酚量的增加而急剧增大。

图7中曲线1表明，β-萘酚含量为0.001—0.002g/L时阴极过电位处于20—80mV范围内。图7中曲线2表示添加剂含量与阳极极化曲

线斜率($dD_a/d\eta$)的关系，由图7可知，随着β-萘酚量的增加$dD_a/d\eta$几乎呈直线增大，说明β-萘酚和骨胶共同存在而产生协同效应有利于促进阳极

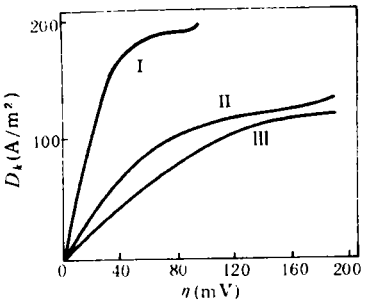

图6 添加β-萘酚-骨胶的阴极极化曲线

β-萘酚(g/L)/骨胶(g/L)

Ⅰ. 0.001/0.5 Ⅱ. 0.002/0.5 Ⅲ. 0.003/0.5

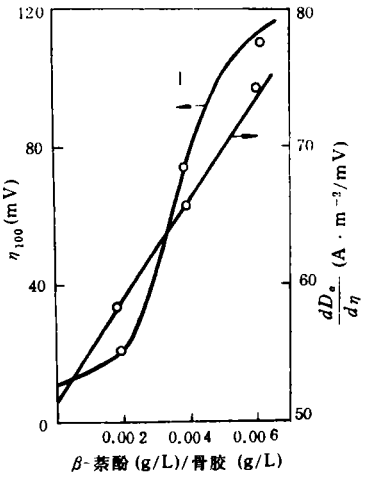

图7 β-萘酚-骨胶含量与η_{100}及$dD_a/d\eta$的关系曲线

表1 5种联合添加剂对阴阳极极化的影响[1)]

添加剂(g/L)	阴极极化值(η_{100}(mV)	阳极极化曲线斜率$dD_a/d\eta$(A·m^{-2}/cm)
无添加剂	1.5	49.65
β-萘酚/骨胶:0.001—0.003/0.5	20—110	58.50—73.50
β-萘酚/明胶 0.005—0.02/0.3	24—100	46.00—61.00
β-萘酚/木质磺酸钠 0.05—0.10/2.0	20—75	43.60—45.90
骨胶/木质磺酸钠 2.0—4.0/2.0	20—75	39.50—42.50
明胶/木质磺酸钠 1.0—3.0/2.0	20—60	38.00—41.25

1) Pb^{2+} 70g/L 总酸 100g/L

溶解。此外其它5种联合添加剂的影响见表1。

从表1可知，联合添加剂可对阴阳极极化产生协同效应。β-萘酚/胶是强极化剂，当加入量极少时，既能达到极化要求又不致引起电解液比电阻升高而有利降低电耗。另外，该添加剂的$dD_a/d\eta$值均较无添加剂电解液大而有利于阳极溶解，因此β-萘酚/胶是比较理想的联合添加剂。

2.4 电极过程动力学讨论

2.4.1 速度控制步骤及其动力学参数

从图3(a)中可知，不加添加剂时，在较小的电流密度下铅阳极的电极过程受扩散步骤所控制，即电极反应速度的控制步骤为扩散步骤，也可以利用图4(a)极化曲线，在电流密度100A/m²附近线段上，取不同的D_k(40，80，100，120，140A/m²)和与之相对应的极化电位η，然后作η-$\lg(1-\frac{D_k}{D_l})$图(图8)，D_l为阴极极限极化电流密度，从图4(a)中可知$D_l=1250A/m^2$。

由图8可知，η-$\lg(1-\frac{D_k}{D_l})$作图得一条直线，说明电极过程是受扩散控制的。所以阴极浓差极

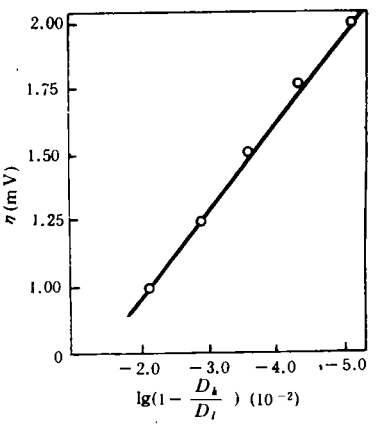

图8 η与$\lg(1-D_k/D_l)$的关系

化为：$\eta=-\frac{RT}{nF}\lg(1-\frac{D_k}{D_l})=-\frac{2.303RT}{nF}\lg(1-\frac{D_K}{D_l})$，式中，$T=313K$。

$\frac{2.303RT}{nF}$为图8直线斜率等于−0.033，则

$-\frac{2.303RT}{nF}=-0.033$，$n=1.89$。

n 为电极反应涉及电子数，铅电极反应所涉及电子数为2，即 $Pb^{2+}+2e=Pb$。

根据 Fick 扩散第一定律，$\Pi_{xi}=-D_i(dc_i/dx)$ 式中，D_i 为粒子扩散系数，可以得到 Pb^{2+} 向阴极附近扩散的速度为：

$$v=\Pi_{Pb^{2+}}=D_{Pb^{2+}}\frac{(c^0-c_k)}{\delta}$$

$$=K_{扩}(c^0-c_k)\text{mol/s}\cdot\text{cm}^2$$

式中，c^0、c_k 为溶液主体及阴极附近溶液中 Pb^{2+} 浓度(mol/cm³)；δ 为扩散厚度(cm)；$K_{扩}=\frac{D_{Pb^{2+}}}{\delta}$ 称为扩散速度常数(cm/s)。

稳态扩散的电流密度 $D_k=nF(-\Pi)$，所以铅电极的稳态扩散电流密度为 $D_k=nFD_{Pb^{2+}}\frac{c^0-c_k}{\delta}$，其极限电流密度为 $D_l=nFD_{Pb^{2+}}c^0/\delta$，$K_{扩}=\frac{D_l}{nFc^0}$。

$D_l=1250\text{A/m}^2=0.125\text{A/cm}^2$，$c^0_{Pb^{2+}}=70\text{g/L}=3.378\times10^{-4}\text{mol/cm}^3$，$K_{扩}=0.001917\text{cm/s}=1.917\times10^{-3}\text{cm/s}$

由于 Pb^{2+} 的扩散系数 $D_{Pb^{2+}}=0.98\times10^{-5}\text{cm}^2/\text{s}$，可以得到铅电极表面扩散层的厚度 $\delta=\frac{D_{Pb^{2+}}}{K_{扩}}=\frac{0.98\times10^{-5}}{1.917\times10^{-3}}=0.0051\text{cm}$。

2.4.2　温度对电极极化影响和电极过程活化能

在选定的电解液组成和无添加剂条件下，温度对阴极极化的影响如图9所示。由图9可知，随着温度升高阴极极化显著下降，但温度过低，则溶液比电阻增大而增加电耗，因此电解温度以40℃为宜。

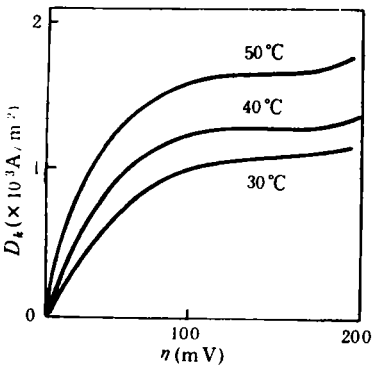

图9　不同温度下动电位扫描阴极极化曲线

将 Arrhneius 方程应用于电化学过程，可获得阴极过程速度 D_k 与温度 T 的关系，$\lg D_k=\frac{U}{2.3RT}+c$，由该式可知，$\lg D_k$ 与 $\frac{1}{T}$ 可作图成线性关系(图10)。可由直线的斜率 $-\frac{U}{2.3RT}$ 求出阴极的活化能 U。图10中直线斜率 $=-842$，则 $-\frac{U}{2.3R}=-842$，可求出 $U=16.10\text{kJ/mol}$。根据此活化能值也证明了电极过程处于扩散动力学区。

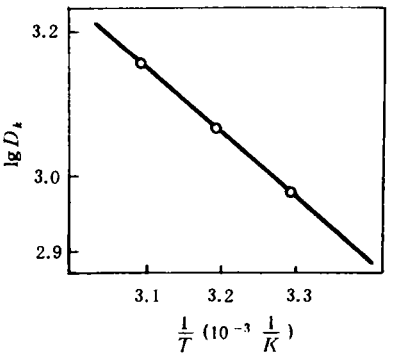

图10　$\eta=75\text{mV}$ 时，$\lg D_k-\frac{1}{T}$ 的关系图

3　结语

(1)对贵铅电解时的电解液组成，温度和添加剂等因素对电极过程极化的影响进行了详细地研究，为电解最佳工艺条件的确定提供了理论依据。

(2)电极反应速度受扩散控制步骤所限制。电极反应粒子数 $n=2$，扩散速度常数 $K_{扩}=1.917\times10^{-3}\text{cm/s}$，扩散层厚度为0.0051cm。在40℃时根据电流密度与温度的关系，计算的 $\eta_k=75\text{mV}$ 时阴极过程的活化能为16.10kJ/mol。这些可为强化电极反应速度和降低电耗及获得高的金银与铅的分离回收率提供理论依据和实践应用上的设计参数。

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experiment, atmospheric monitoring.

Study on the Biodegradabilities of Dyes under the Aerobic Conditions. An Huren (China-Japan Friendship Environ. Protection Centre, Beijing 100029), Qian Yi et al. (Dept. of Environ. Eng., Tsinhua University, Beijing 100084): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 16—19

Three simple and practical aerobic biodegradability test methods, i. e., static flask screening test, Warburg respirometry and semi-continuous activated sludge system, were chosen depending on the characteristics of dyes to test the biodegradabilities of 26 water soluble dyes. The results of tests using these three methods were compared and the reasons for the differences between these results were explained. The effects of environmental factors on the biodegradability tests were also discussed. It was found that most of the dyes studied are refractory under the aerobic conditions, and the semi-continuous activated sludge system is a favourable and more precise test method although it takes a longer time.

Key words: dyes, biodegradability, aerobic.

Study on the Mechanism of the Bacteria-added Biological Contact Oxidation Process in the Treatment of Wastewater from Jiemycin Production Process. Luo Guowei and Yang Danqing et al. (Institute of Environ. Sci., South China Normal University, Guangzhou 510631): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 20—22

This paper deals with a treatment system in which the "hydrolytic acidification-two staged biological contact oxidation-coagulation" process was used to treat a high strength wastewater from the production process of jiemycin. Particularly, it relates to the characteristics, distribution patterns and degradative functions of its aerobic microbial films. The selection and breeding of efficiently degradative bacteria, and whether or not the added bacteria can keep its dominance in the reactor were also studied to explore the mechanism of treating jiemycin wastewater by using the bacteria-added biological contact oxidation process. By the separation and identification of aerobic microbial films from this system, 18 strains bacteria species in 11 genera were obtained. Their distribution of bacteria counts and the effectiveness of degrading organics show that after passing through a pilot operation the added bacteria still exist in the reactor and take the dominant position, and the most dominant strain was identified to be in *Aeromona*. Both qualitative and quantitative analyses of the effluents from pilot aerobic treatments were made to find the reasons for causing the remaining COD_{Cr} values.

Key words: jiemycin wastewater, bacteria-added biological contact oxidation process, dominant species of bacteria, biodegradability, GC/MS.

Classification of Atmospheric Pollution Areas and Afforestation Models. Zhao Yong and Li Shuren (Henan University of Agriculture, Zhengzhou 450002): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 23—27

Based on the monitoring and predictive analysis of atmospheric pollutants, the clustering analytic method and synthetic index method were used to classify the pollution areas into four types and to classify the greening vegetations into three types in terms of the size of index value. Then further based on the features of pollution for each type of pollution areas, corresponding afforestation models and plant species were selected to green the areas in order to improve the atmospheric environmental quality there. The study demonstrates that more serious single and compounded pollutions generally took place at 300 to 4000m leeward from pollution sources, where an afforestation model consisting of the proper combination of arbor, bush and grass was better in improving the quality of atmospheric environment.

Key words: afforestation model, atmospheric pollution, synthetic index.

Study on the Database System for the Biodegradabilities of Organics in Wastewaters. Huang Xia and Jiang Bin (Dept. of Environ. Eng., Tsinghua University, Beijing 100084): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 28—32

Based on analyzing in an all-round way the status of demand for the database systems for biodegradabilities of organics in wastewaters and their features, and by using a software engineering method, the systems analysis and systems design of the users-oriented database system have been completed that form a firm basis for further implementing the system.

Key words: wastewater, organics, degradability, database system.

Study on the Electrode Polarization in the Electrolytic Treatment of Lead Wastes Containing Gold and Silver. Zhang Zhongyan, Liang Huqi et al. (Shanghai University of Technology, Shanghai 200072): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 33—37

A detailed study, based on the theories of electrochemical thermodynamics kinetics, was carried out on the polarization behavious and process conditions in the electrode processes of separating gold and silver from lead and obtaining a pure lead

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from lead wastes containing gold and silver. It was determined that the electrolysis of lead wastes containing gold and silver was preferred to be conducted at a temperature of 40℃ by using an electrolytic solution composition of 70 g/L of Pb^{2+}, 100 g/L of SiF_6^{2-}, and a combined additive of β-naphtol/glue. The kinetic study on the electrolysis of lead wastes containing gold and silver shows that the rate of electrode reaction was determined by the diffusion determinant step, with a diffusion rate constant $K_d = 1.917 \times 10^{-3}$cm/s, a diffusion layer thickness of 0.0051 cm, and a cathodic activation energy of 16.10 kJ/mol at $\xi_k = 75$ mV. These results provide a reliable scientific basis and the design parameters for the industrial practice of separating gold, silver and lead from lead wastes containing gold and silver.

Key words: lead wastes, recovery, electrolysis, gold, silver, lead.

Study on the Desulphurization Performance of SW Type Desulphurizer. Ren Ailing, Guo Bin et al. (Dept. of Environ. Eng., Hebei College of Light and Chemical Industries, Shijiazhuang, 050018), He Qiang (Dept. of Environ. Eng., Tsinghua University, Beijing 100084): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 38—40

A SW type desulphurizer has been developed by preparing it from pyrite cinders generated from the production process of sulfuric acid and its performance of desulphurization was studied. Its application on a full scale of industrial production demonstrates that the SW type desulphurizer has a higher removal of H_2S from marsh gas or coal gas and can reduce the concentration of H_2S from 3000—5000 mg/m^3 to less than 20 mg/m^3 in compliance with the national standards. The desulphurizer has a working sulfur capacity of up to 30% and the main performances which are comparable with those of similar products in home and abroad.

Key words: desulphurizer, hydrogen sulfide, coal gas, marsh gas.

Use of Chromic Slags for Manufacturing Microcrystal Vitreous Ceramics as Decorative Building Panels. Li Youguang, Gong Qiyi et al. (Dept. of Building Materials, Chongqing College of Architectural Eng., 630045): *Chin. J. Environ. Sci.*, **15**(6), 1994, *pp.* 41—42

The toxic slags which are discharged in a large amount from the production processes of chromates and can cause a serious environmental pollution were used as a starting material, through the process stages of smelting, shaping, heat treatment and polishing, to manufacture microcrystal vitreous ceramics as decorative building panels. The slags had a proportion of up to 50% in the compositions of raw materials and less than 0.25 mg/kg of leachable chromium were found in the products which were better in physical and chemical properties than natural granite and natural marble. With this newly developed process having a thorough detoxification and larger consumption of toxic slags, it is planning to construct a production line with a capacity of consuming 8000 t/a of chromic slags.

Key words: chromic slags, microcrystal vitreous ceramics, decorative panel, use of chromic slags.

Full Scale A/O Biofilm System for the Treatment of Acrylonitrile Wastewater. Du Shelin (Institute of Environ. Protection, Shanghai Petrochemical Company, Ltd., Shanghai 200540), Du Guoqiang (2nd chemical plant, shanghai Gaoqiao Petrochemical company, shanghai 200137): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 43—46

A full scale acrylonitrile wastewater treatment system with a capacity of 1400—1600 t/d was set up and by adopting an A/O biofilm process developed. The pilot operation of this system for a long time gave satisfactory results, with an effluent in which the concentration of suspended solid (SS) was as low as 20 mg/L and from which the water samples without removing SS had all water quality indicators in compliance with the national and local standards. In view of this, no clarifier was installed for this treatment system. This system had an A/O tank volume ratio of 1 : 3. When it was operated at an average hydraulic residence time (HRT) of 22.6 h, a recirculating ratio of 3.2 and a water temperature of about 35℃, there were the following average removals: COD_{Cr}, 88.36%; BOD_5, 97.49%; TN (total nitrogen), 77.6%; and AN (acrylonitrile), 99.4%. In this case, there were the following concentrations of pollutants in effluent: COD_{Cr}, 53.57 mg/L; BOD_5, 5.6 mg/L; TN, 14.94 mg/L; NH_3-N, 6.92 mg/L; NaSCN, 2.67 mg/L; and AN, 1.02 mg/L.

Key words: acrylonitrile, wastewater treatment, A/O biofilm process, nitrogen removal, full scale pilot operation.

Pilot Study on Terephthalic Acid (TPA) Wastewater Treatment Using an A/O Biofilm Process. Zhao Hongbo (Third Design Institute, Ministry of Chemical Industry, Hefei 230024): *Chin. J. Environ. Sci.*, **15**(6), 1994, pp. 47—50

A continuously operating pilot plant consisting of a two-stage A/O biofilm system and a biological activated carbon unit was used to treat a wastewater from a fine TPA production process. It was found that when the pilot plant was operated at a hydraulic