

杭州西湖底泥释磷及其对富营养化的影响*

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摘要 杭州西湖是一个小型浅水湖泊,其底泥由上部藻骸腐泥和下部泥炭层构成。西湖底泥的显著特点是有机碳含量特别高,氮和磷含量也相当高。通过实验室和现场模拟研究,考察了 pH、温度、溶解氧、氧化还原电位及上复水种类等环境因素对底泥释磷量和释磷速率的影响。上复水 pH 值在 6.5—7.0 范围内底泥释磷量最低;在较高或较低 pH 值时,底泥释磷量倍增。升高水温或降低上复水溶解氧浓度均能加速磷释放。实验室模拟西湖底泥最大释磷量为 0.368 μg/g。夏季现场模拟平均释磷速率为 1.02 mg/m²·d;估算西湖底泥释磷量达 1.346 t/y,相当于年平均外部入湖磷负荷的 36.4%。底泥释磷对西湖富营养化有着不容忽视的影响。

关键词 底泥,磷,释放试验,富营养化。

驰名中外的杭州西湖,因库容量小,自然补给水源不足,加上流域内经济迅速发展而环境保护未能协调发展,致使氮、磷等营养物大量积蓄。至七十年代已重度富营养化,严重影响其游览观光价值。

为恢复和保护西湖原有良好的生态环境,七十年代末以来,杭州市有关部门通力合作,采取搬迁、截污、疏浚、引水和绿化等措施对西湖进行全面整治。这对减缓西湖水体富营养化进程、改善水质有一定的效果。但其营养状态未

见明显的改善,目前仍属富营养化湖泊。

我们采用实验室和现场模拟两种方法对杭州西湖底泥释磷进行较系统的研究,考察了 pH、DO、温度和上复水组成等环境因素对底泥释磷的影响,获得了底泥释磷量和释磷速率,定量地估算了底泥释磷对杭州西湖富营养化过程的影响程度。

一、西湖底泥的营养状况

根据最近对西湖 20 个点的底泥柱状样和

表 1 西湖底泥各层营养物的平均含量及与其它湖的比较

| 湖泊 | 层位 | 营养物 | | | | | | |
|--------|------------|-----------|------------|-----------|-----------|--------------|-------|-------|
| | | 层厚 (m) | 有机碳 (%) | 总氮 (%) | 总磷 (%) | 氨 氮 (ppm) | 碳/氮 | 氮/磷 |
| 西 湖 | 上腐泥层 | 0.27 | 12.24 | 0.92 | 0.073 | 54.1 | 13.86 | 13.36 |
| | 下腐泥层 | 0.31 | 10.00 | 0.84 | 0.075 | 91.2 | 15.53 | 11.24 |
| | 泥炭层 | 0.28 | 27.87 | 1.18 | 0.054 | 94.0 | 19.04 | 12.72 |
| | 基底粉砂层 | 0.40 | 3.03 | 0.13 | 0.029 | 163.2 | 10—15 | 5 |
| | 全湖平均(不含基底) | 0.86 | 16.70 | 0.98 | 0.067 | 79.8 | | |
| 武汉东湖 | | | 5.78 | 0.24 | 0.070 | | | |
| 江苏太湖 | | | 1.37 | 0.075 | 0.127 | | | |
| 安徽巢湖 | | | 1.11 | 0.056 | 0.058 | | | |

* 该研究系国家“七五”科技攻关项目

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表层样的系统调查^[1], 湖底沉积物自下而上可分为四层: 基底粉砂层、泥炭层、下腐泥层和上腐泥层。泥炭层由沼泽化沉积所致, 腐泥层系藻骸沉积物。基底上部湖沼层的平均厚度为 0.86m, 总体积达 $4.85 \times 10^6 \text{m}^3$ 。各层的营养物含量列入表 1。

由于基底粉砂层的营养物含量明显低于上复各层, 故对西湖富营养化产生影响的主要是基底上部的湖沼相沉积层, 有机碳含量特别高, 尤其是泥炭层属重污染水平, 显然这不全由现在人类活动所致。总氮含量亦较高, 属中等污染; 而总磷的含量相对较低, 属轻污染。但氮、磷含量自下而上大致呈增加趋势, 与人类活动污染有较大的关系。与国内其他富营养化湖泊相比, 西湖底泥含有丰富的碳和氮, 含磷量属中等水平。

二、底 泥 释 磷

(一) 实验室模拟试验

1. 试验材料

(1) 底泥 用采泥器分别采集湖心和涌金门(离湖岸约 50m) 两处的表层底泥, 静置过夜沥去水分后, 用塑料袋密封置于 5℃ 左右冰箱内待用。两种底泥的理化性质见表 2。

表 2 试验用底泥的理化性质

| 项目 \ 采集点 | 湖 心 | 涌 金 门 |
|----------|-------|-------|
| pH | 7.14 | 7.09 |
| 干固体物(%) | 18.95 | 18.18 |
| 有 机 碳(%) | 16.44 | 9.84 |
| 总 氮(%) | 1.30 | 0.72 |
| 总 磷(%) | 0.085 | 0.062 |
| 总 铁(%) | 0.028 | 0.028 |
| 碳/氮 | 12.65 | 13.67 |
| 氮/磷 | 15.23 | 11.61 |

(2) 上复水 取含磷较低的三潭内湖水, 经 $0.45 \mu\text{m}$ 微孔滤膜过滤后作试验用上复水(以下简称“试验用水”)。上复水影响试验, 用同法过滤后的闸口钱塘江水作对照。试验用水组成见表 3。

表 3 试验用上复水化学组成 (mg/L)

| 项目 \ 取样点 | 三潭内湖 | 湖心* | 闸 口 |
|-------------------------------|--------|--------|--------|
| K ⁺ | 1.88 | 1.59 | 1.45 |
| Na ⁺ | 7.00 | 6.34 | 3.73 |
| Ca ²⁺ | 25.30 | 16.20 | 13.60 |
| Mg ²⁺ | 2.60 | 2.55 | 2.18 |
| Fe ²⁺ | <0.01 | <0.01 | 0.07 |
| Cl ⁻ | 9.81 | 8.28 | 3.61 |
| SO ₄ ²⁻ | 18.91 | 19.29 | 10.21 |
| NO ₃ ⁻ | <0.30 | 0.52 | 5.37 |
| 总可溶性磷 (TDP) | 0.0065 | 0.0091 | 0.0109 |
| 总 磷 (TP) | 0.066 | 0.139 | 0.061 |
| 总 氮 (TN) | 1.23 | 1.95 | 1.62 |

* 湖心水样数据仅作参考。

2. 试验方法

(1) 释磷量试验 在烧杯中加入均匀湿底泥 50g, 再加 1.5L 上述试验用水, 20℃ 恒温下连续搅拌, 每隔 1—2 小时取一均匀泥浆样, 立即离心分离, 测定上清液中总可溶性磷 (TDP)。由 TDP-时间关系曲线获知达最大 TDP 浓度所需的时间(称“平衡时间”), 并按下式计算本试验条件下的最大释磷量 (W 、 $\mu\text{g/g}$):

$$W = \frac{(c - c_0)V}{G}$$

式中, c_0 和 c 分别是起始和达平衡时间时 TDP 浓度 ($\mu\text{g/L}$); V 试验用水体积 (L); G 底泥干重 (g)。

(2) 影响因素试验 取三角烧瓶若干只, 分别加入均匀湿底泥 5g 及 50ml 试验用水, 而后分别在预定的 pH、DO、温度及上复水组成等诸因素条件下, 用电动振荡机连续振荡至平衡时间, 立即将内容物离心分离, 测定上清液中的 TDP 浓度。

(3) 释磷率试验 在内径 85mm 带电动搅拌的玻璃筒内, 加入适量的底泥和试验用水, 使泥层和水层深度分别为 250 和 150mm 左右, 稍加搅拌后静置过夜, 次日取上复水作为起始样品。试验在好氧、遮光及预定的 pH、温度等条件下进行, 控制搅拌速度以消除上复水中磷酸盐的浓度梯度, 但不至于扰动底泥。每隔 1 或 2 天测定上复水的 TDP 浓度, 同时补充原

先的试验用水。按《湖泊富营养化调查规范》计算释磷速率。

(二) 现场模拟试验

现场试验在西湖涌金门附近离岸 50m 左右的湖内进行。该处水深约 1.5m, 底泥理化性状见表 2。试验现场垂直设置三个试验筒, 一个是内径 0.42m 的无底透光筒, 模拟湖内泥水间的磷交换; 另一个是内径 0.30m 无底遮光筒, 模拟在抑制藻类生长条件下泥水间的磷交换; 还有一个是内径 0.24m 的有底透光桶, 模拟无底泥条件下的藻类生息。试验前有底泥的两个筒内湖水全部用三潭内湖水替换, 无底泥桶内亦注入三潭内湖水。试验期间逐日测定筒内上复水及筒外湖水的 TP、TDP、TN、pH、DO 及温度等。

三、试验结果与讨论

(一) 实验室模拟试验

1. 底泥释磷量及影响因素

(1) 底泥释磷量 在 20℃、pH8.0 左右进行了连续 24 小时试验, 发现连续搅拌 4 小时后, 水中 TDP 浓度达最大值 (5.40 μg/L), 折算西湖底泥的最大释磷量为 0.368 μg/g。由此确定“平衡时间”为 4 小时。

(2) pH 在 20℃、pH3.0—9.8 范围内测定了 9 种不同 pH 下的释磷量, 发现 pH 对底泥释磷有重要影响。在 pH6.5 左右底泥释磷量最小; 而升高或降低 pH 值时, 释磷量倍增。TDP 释放量 (y) 与 pH (x) 呈抛物线相关 (图 1), 回归方程为

$$y = 24.513 - 7.572x + 0.586x^2.$$

pH 6.5 左右水中正磷酸盐主要以 HPO_4^{2-} 和 H_2PO_4^- 形态存在, 最易被底泥吸附, 故此时释磷量最小。降低 pH 时, 底泥释磷以溶解为主, 随着氢离子浓度增大 (pH 降低), 释磷量增大。而升高 pH 值, 释磷以离子交换为主, 体系中 OH^- 与铁和铝磷酸盐复合体中的磷酸盐发生交换, 亦能释放较多的磷^[2]。西湖水平年平均 pH 值在 8.0—9.5 范围内波动, 呈微碱性, 夏季常维持在 pH 9 以上, 在这样的 pH 条件下有

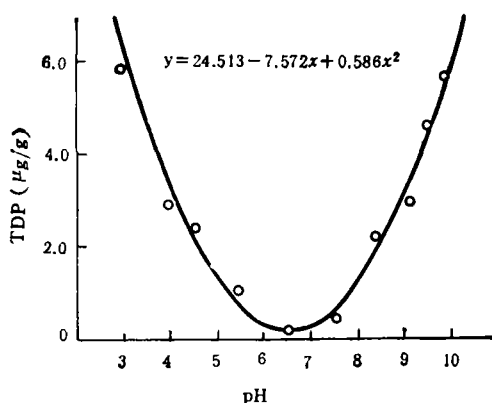


图 1 pH 对释磷量的影响 (20℃)

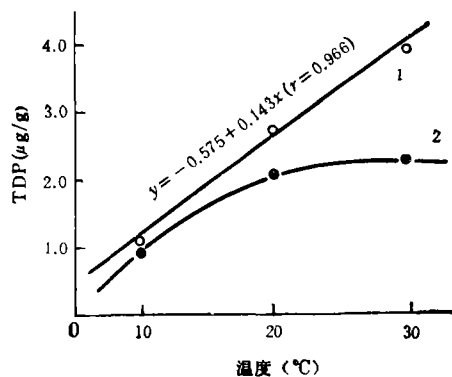


图 2 温度对释磷量的影响

1. 三潭内湖水 2. 闸口江水

助于底泥释磷。

(3) 温度和上复水 在 10℃、20℃、30℃ 条件下, 分别以三潭内湖水和闸口钱塘江水作上复水进行释磷量试验。随着温度升高, 释磷量明显增大 (图 2)。三潭内湖水作上复水时, 释磷量与温度呈正相关: $y = -0.575 + 0.143x$ ($r = 0.966$)。升高温度能增加底泥中微生物和生物体的活动, 促进生物扰动、矿化作用和厌氧转化等过程, 导致间隙水耗氧, 促使底泥表面呈还原状态, 利于 $\text{Fe}^{3+} \rightarrow \text{Fe}^{2+}$ 反应, 加速释磷^[3]。

试验还表明, 10℃ 时底泥向这两种上复水的释磷量相仿; 升高温度时, 三潭内湖水中释磷量明显大于闸口江水。

(4) DO-氧化还原电位 (Eh) 在 30℃、pH8.0 左右分别考察了 DO 为 6.52 和 0 mg/L 时的释磷量。发现厌氧释磷量达 1.82 μg/g, 为

好氧时的一倍左右。一般认为底泥释磷与铁磷关系密切,当表层底泥 Eh 较高时,有助于 $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$ 反应,使 Fe^{3+} 与磷酸盐结合成难溶的磷酸铁;而当 Eh 较低(小于 200mv)时,有助于 $\text{Fe}^{3+} \rightarrow \text{Fe}^{2+}$,使铁和被吸附的磷酸盐转变成溶解态而释出^[3]。西湖底泥-水界面的 Eh 在 67—141mv 之间,呈弱酸性还原状态。因此,尽管西湖底泥上复水中溶解氧充沛,但泥-水界面的还原状态有助于底泥释磷。

(5) 释磷与释铁 试验发现上复水 TP 浓度与铁浓度呈正线性相关: $y = 0.076 + 0.095x$ ($r = 0.986$)。这亦证实底泥中可释放的磷与铁磷密切相关。

2. 底泥释磷速率

在 10、20 和 30℃ 三种温度下分别进行 18 天释磷速率试验。温度越高,释磷速率越大,两者呈正线性相关: $y = -0.0177 + 0.00735x$ ($r = 0.998$)。10℃ 平均释磷速率为 $0.053\text{mg}/\text{m}^2 \cdot \text{d}$, 30℃ 时增至 $0.20\text{mg}/\text{m}^2 \cdot \text{d}$ 。

同时,在 20℃、pH9.0 左右测定了闸口江水作上复水的平均释磷速率为 $0.086\text{mg}/\text{m}^2 \cdot \text{d}$,略低于三潭内湖水 ($0.135\text{mg}/\text{m}^2 \cdot \text{d}$)。

(二) 现场模拟试验

试验于 1989 年夏季(6 月 7 日至 7 月 4 日)进行,历时 25 天。透光筒尽可能模拟西湖实际环境,上复水 TP、TDP 浓度变化是底泥释磷、藻类摄磷、颗粒物矿化、吸附、沉降及扩散等过程的综合影响结果,所获的释磷速率其实是上复水 TDP 的增长速率。遮光筒模拟抑制藻类生长的条件下底泥释磷,7 天后上复水中 DO、pH 急剧下降,呈厌氧和中性状态,底泥释放的磷大部分积蓄在上复水中。现场试验的上复水 TP 和 TDP 变化见图 3,测得的释磷速率列于表 4,夏季现场模拟西湖底泥平均释磷

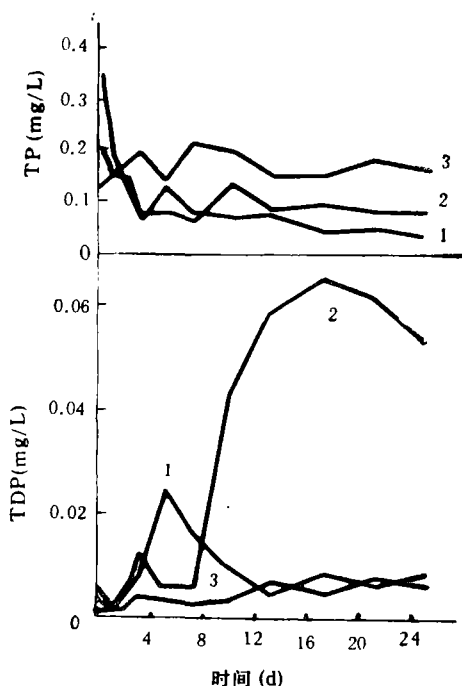


图 3 现场模拟试验测定的 TP 和 TDP 变化
1. 透光筒 2. 遮光筒 3. 筒外湖水

速率为 $1.02\text{mg}/\text{m}^2 \cdot \text{d}$ 。

参照实验室试验获得的释磷速率与温度的相关关系,由夏季现场试验值推算出春、秋和冬季的释磷速率。由此推算,西湖底泥全年向湖水释放 TDP 达 $1.346\text{t}/\text{y}$ 。

四、底泥释磷的污染影响及其对策

据最新研究成果^[1],由湖面降水、入湖径流、引水及未截污水等外部负荷年输入西湖的磷总量达 $3.70\text{t}/\text{y}$;而按底泥释磷研究估算,西湖底泥年释磷量为 $1.346\text{t}/\text{y}$,相当于外部磷输入负荷的 36.4%。因此,西湖底泥释磷是威胁西湖水体的一个重要污染源,对西湖富营养化产生不可忽视的影响。为消除底泥释磷的污染影响,结合西湖的实际情况,建议采取下述对策:

1. 彻底疏浚底泥

西湖在五十年代曾进行过较大规模的疏浚,这对消除污染源,增大库容量,改善水质均发挥了巨大的作用。此后尽管每年疏浚 3—6 万 m^3 底泥,对改善水质效果不很明显。为消除底

表 4 现场试验底泥释磷速率

| 试 验 条 件 | | | | 释磷速率 ($\text{mg}/\text{m}^2 \cdot \text{d}$) | |
|---------|---------|--------------------------|----------------------------|---|------|
| 光照 | pH | 水温($^{\circ}\text{C}$) | DO(mg/L) | 最大值 | 平均值 |
| 透光 | 7.1—8.6 | 25.2—29.2 | 4.2—13.8 | 4.70 | 1.02 |

泥释磷的污染影响,建议彻底清除 0.86m 厚的湖泊沉积层。

为使疏浚工作收效,一是要重点疏浚西湖南区及近岸湖区重污染地带的污泥;二是研究开发适宜于半流动态腐泥的疏浚技术和设备,将营养盐丰富的腐泥消除干净;三是妥善解决底泥的出路,以免二次污染。

2. 合理养殖水生生物

在不影响西湖景观的前提下,种植能吸收水中氮、磷等营养盐的水生植物,如荷花、水葫芦等,但要妥善管理,及时处理残枝。同时,适量放养吞食藻类的鱼类,但严格禁止投放饵料。

3. 充分发挥引水效能

根据西湖水情尽可能增加引水量,加速湖水更新,降低水中营养盐及藻类的含量。同时进一步研究引水流向,以期整个湖面水流均匀分布,提高引水效果。

当然,为制止西湖富营养化进程,改善其生态环境,除了上述消除底泥释磷的污染影响的对策外,还必须进一步发挥截污工程的效能,加强湖区旅游及流域内经济活动的管理,有效地控制外部营养源的输入。

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通风换气改善居室空气质量及健康效应的研究

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摘要 于1988年12月至1989年4月,对417户有儿童居室的通风换气与呼吸道健康状况进行了调查,并以模拟方式探讨改善措施。结果表明,85%居室每小时换气次数(ACH)介于0.5—1.0之间,ACH与儿童呼吸道每100人周(pw)症状率呈负相关关系($P < 0.01$),ACH < 0.5儿童呼吸道症状率3.52/100pw高于其他组;开窗时ACH为关门窗时的4倍,室内空气中CO₂、HCHO、²²²Rn浓度关门窗为开门时的1—3倍,室内风速 < 0.05m/s,通风效率E < 1,致使污染物逐渐累积,长期接触有害健康,如若以“对流论”组织通风,则可有效地改善空气质量,增进居民健康。

关键词 居室通风换气,空气质量,人体健康效应。

室内空气污染物浓度增高,是人们生活中一个严酷事实,即使污染物浓度不高,长期接触也可导致人群发病率,死亡率升高^[1]。Luly Trepte 强调通风是防止室内污染危害的有效措施,国际能源组织试图用空气质量知识获得保护健康的通风率标准^[2]表明通风研究有现实意义。本研究旨在提供居室换气现状,探讨正确利用大自然比较新鲜的空气来改善室内空气质量。

一、材料与方 法

1. 调查对象 从安徽南方两个自然村中抽取417户父母儿童三人合住居室进行现场调查,入选住宅为80年代建筑物(平房350户,楼房67户)。

2. 项目和方法

(1) 居室规模

(2) 空气指标 对15户居室及室外对照

Simulation and Analysis of Biological Stabilization Pond System. Wen Xinghua (Research Center for Eco-Environmental Sciences, Academia Sinica, Beijing), Qian Yi, Gu Xiasheng (Department of Environmental Engineering, Tsinghua University, Beijing, 100084, China): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 2—6

An ecological model was established by the authors to simulate the general operation characteristics of the biological stabilization pond system. It was concluded that the concentrations of organic carbon as well as nitrogen and phosphorus in each stage of a multi-stage pond increase with the increase of influent concentrations and therefore it is not proper to run a multi-stage pond at too high influent concentrations; the removal rate of the pond for organic nitrogen is rather high but not for total nitrogen for the pond system has a limited ability to remove inorganic nitrogen; the responses of carbon, nitrogen and phosphorus contents in bacteria cells to the influent concentrations follow the Monod formula; the responses of carbon, nitrogen and phosphorus content in algae cells are similar. There exists an optimum nutrient concentration for algae growth. In this study the concentration is:

$C_{O_2} = 72\text{Mg/L}$, $TN_i = 23.80\text{Mg/L}$, and $TP_i = 2.46\text{Mg/L}$. The elevation of algae concentration is beneficial to the removal of dissolved nutrients.

Key words: ecological model, simulation, biological stabilization pond, waste water treatment, organic carbon in waste water, nitrogen in waste water, phosphorus in waste water.

Effect of pH and Temperature on Cr(VI) Removal from Soil Solution. Chen Yingxu, Zhu Yinmei, Yuan Keneng and Zhu Zuxiang (Zhejiang Agricultural University, Hangzhou): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 7—10

The process of Cr(VI) removal from soil solution could be divided into two steps. The first step is a fast reaction depending mainly on the rate of Cr(VI) adsorption. The second step is a slow reaction depending mainly on the rate of Cr(VI) reduction. As the pH of soil solution increased, the rate constants, K_1 and K_2 of Cr(VI) removal by soils decreased obviously. The influence of temperature on the kinetics of Cr(VI) removal varied with various soils and was found to be quite complicated. The influence of temperature on the removal of Cr(VI) are mainly associated with Cr(VI) adsorption and reduction.

Key words: Chromium, adsorption, reduction, chromium in soil.

Preliminary Studies of the Buffering Effect of Tree Grown and Leaf Litter on Simulated Acid Rain. Deng shijian, Chen Chuying, Zhang Jiawu, Wang Silong (Institute of Applied Ecology, Academia Sinica, Shenyang): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 10—17

The studies of the buffering effect of crown, leaf litter and live leaves on acid rain were carried out with simulation methodology. The results show that buffering ability of broadleaf trees was greater than that of conifers, that tree species with higher leaf juice pH values are more capable of buffering acid rain than those with lower leaf juice pH values, and that the ability of broadleaf tree species is directly proportional to the area of leaves. As to conifers, however, the ability of tree species with larger leaf areas tends to be smaller. The order of buffering ability of different materials at pH2.00 and 3.00 was found to be: leaf litter > live leaves > crown, while at pH4.50 the order is leaf litter > crown > live leaves.

Key words: simulated acid rain, throughfall, leaf litter, leaf juices, buffering.

Study on Biodegradability of Terephthalic Acid. He Xinghai, Zhang Zhongxiang, Ma Shihao (Beijing Municipal Research Institute of Environment Protection): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp 18—25

A study on the biodegradability of terephthalic acid (TA) aiming at clarifying its biodegradation characteristics, biodegradation rate and metabolic pathways, by activated sludge was carried out. The results show that terephthalic acid can be biodegraded rapidly by microorganisms. The relationship between biodegradation rate and the concentration of TA can be fitted into Michaelis-Menten model. The biodegraded products from terephthalic acid by activated sludge were identified as m-hydroxybenzoic acid and protocatechuic acid and a metabolic pathway of terephthalic acid was accordingly proposed.

Key Words: Biodegradation of terephthalic acid, activated sludge, metabolism of terephthalic acid.

Phosphorus Release from Sediments and Its Effects on the Eutrophication of the West Lake.

Han Weiming (Hangzhou Institute of Environmental Protection, Hangzhou): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 25—29

The sediments of the West Lake in Hangzhou, a small and shallow lake, are characterized by high organic carbon content (average 16.70%) and pretty high nitrogen content (average 0.98%). Simulation studies in the laboratory and in the field were conducted to determine the effects of various environmental parameters including pH, temperature, dissolved oxygen concentration, redox potential and the type of overlying water on phosphorus release rate and release capacity from the sediments. The lowest release capacity was observed in a pH range of 6.5—7.0 of the overlying water. At higher or lower pH values, the release could be redoubled. Raising the temperature or decreasing oxygen concentration in the overlying water also led to the increase of phosphorus release. The highest release capacity was found to be 0.368μg/g in the laboratory. The average release rate measured in the

lake in summer was $1.02 \text{ mg/m}^2 \cdot \text{d}$. The total phosphorus release capacity from the sediments was estimated to be 1.346 t/y which is equivalent to 36.4% of the average annual external phosphorus loading. Sediment release of phosphorus is a major contributory factor for the eutrophication of the lake.

Key words: sediments, phosphorus, eutrophication.

Effect of Proper Ventilation on Improving Indoor Air Quality and Dweller's Health. Qiu Shicong, Chen Guifu (Wannan Medical College, Wuhu, Anhui): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 29—32

An investigation on the natural ventilation in 417 rural dwellinghouses with children living in was carried out in south China from December 1988 to April 1989. Meanwhile, a follow-up observation of respiratory health conditions for the dwelling children was performed. An experimental model was also established to explore the possible improving measures. The results revealed that in 85% of the dwellinghouses, the times of air changes per hour (ACH) ranged from 0.5 to 1.0, and ACH was negatively correlated to the rate of respiratory symptoms (RRS) in the children ($P < 0.01$); when ACH was less than 0.5, the children's RRS was 3.52/100pw, which is much higher than that of other groups with larger ACH; when room doors and windows were open, the ACH was 4 times as much as that when they were closed; moreover, closing doors and windows increased the indoor air concentrations of CO_2 , HCHO, and ^{222}Rn by 1—3 times; when the indoor air flow velocity was below 0.05 m/s the ventilation efficiency decreased to below 1.0, accordingly, the pollutants gradually accumulated and would finally impair the health of the residents. This study suggested that the proper arrangement of the ventilation in the light of the convection theory may effectively improve the air quality and thereby the health conditions of the residents.

Key words: ventilation in dwelling-house, indoor air quality, health efficiency.

Evaluation of the Pollution in Lake Dianchi with Zooplankton as Indicator. Huang haikui, Zhao Jia-chong (Kunming Municipal Institute of Environment Science): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 33—36

Analysis of the species and mass population of zooplankton was carried out by means of Sander's sparse curve and Shannon-Wiener's diversity index on different regions of lake Dianchi. Integrated with the output of the analysis of zooplankton indicator distribution, the following results were obtained: (1) the extent of pollution is obviously different in the inflake from the outlake i. e. the inflake is in α stage of pollution and the outlake is in β stage. (2) the gravity of pollution in different regions of lake Dianchi are: the exit of river Xinhe > the exit of river Daguang > the center of inflake > Huiwan > Darhewei > the middle of Guanyinshan. (3) the inflake is in the process of swamping.

Key words: lake Dianchi, zooplankton, pollution indicator, Sander's Sparse curve, Shannon-Wiener's diversity index.

Catalyst for Removing Carbon Monoxide at Room Temperature. Li Chunhua, Xu Hongbing and An Lidun (Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou): *Chin. J. Environ. Sci.*, **13**(3), 1992, PP. 37—39

Activated carbon compound carrier supported noble metal catalysts for the catalytical oxidation of CO were investigated in the following aspects: selection and preparation of supports and precursors of active components as well as preparation conditions of the catalysts. Results show that CO-20-2 catalyst made in this work can remove CO completely at room temperature. Both of its activity and stability are better than the catalysts available now.

Key words: palladium and platinum catalysts, carbon monoxide oxidation, activated carbon complex support.

Study on Pollution Contributions from Traffic in Beijing City. Han Zhixiong, Xing Yulan, Quan Baoling (Beijing Municipal Research Institute of Environmental Protection): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 40—42

This paper clearly defines the conceptions for both road and regional pollution contributions and gives a set of methods for the calculation of regional pollution contribution. As an example, the pollution contributions of CO, NO_x , and THC, which are major pollutants from vehicles, were studied for a central area of 158 km^2 of Beijing city. The study shows that the regional pollution contributions for CO, NO_x and THC reached 14.3%, 32.2% and 86.6% in winter and 58.4%, 68.7%, and 86.6% in fall, respectively. While, the road pollution contributions for CO, NO_x and THC reached 65.7%, 71.6%, and 37.6% in winter and 58.8%, 75.5% and 67.5% in fall, respectively.

Key words: air pollution, traffic pollution.

Assessment of the Maximum Removal Rate of Pulp-making Waste Water with Flocculation Treatment by UF Technology. Cheng Yanjun (Environmental Protection Institute, Ministry of Light Industry): *Chin. J. Environ. Sci.*, **13**(3), 1992, pp. 43—44

Relative molecular weight fractions of COD in the waste water were determined by UF technology, so as to estimate the maximum removal rate of COD with flocculation-treatment. It has been found that most of the COD in the water is associated with the fractions having molecular weight greater than 10000 or smaller than 3000; the maximum removal rate of COD is 71.3%.

Key words: UF, Flocculation, Pulp-making waste water, COD.

A Study on Denitrification of Coke-plant Wastewater through a Biological Process Wen Yibo