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01 高级氧化体系中污染物的分子结构特征对降解效率及主导自由基的影响探究

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摘　要　高级氧化技术（AOPs）作为一种高效的污染物去除技术而受到广泛的关注，该方法在降解污染的过程中往往会产生多种活性氧物种（ROS）如硫酸根自由基（$SO_4^{\bullet-}$），羟基自由基（•OH）和单线态氧（$^1O_2$），其在有机污染物的降解过程中起着至关重要的作用。不同种类的有机污染物降解过程中，起主导作用的 ROS 往往是不同的，因为 ROS 的主导作用会受多种因素影响，如 ROS 的浓度、氧化还原电位以及与污染物反应的二级速率常数等，另外有机污染物的分子结构可能也是一个重要的影响因素，但以往一直被忽视。本研究构建了 CoCaAl-LDO/PMS 体系作为典型的高级氧化研究体系，可产生多种 ROS（$SO_4^{\bullet-}$，•OH 和 $^1O_2$），探究了污染物分子结构对其降解效率和降解中 ROS 占主导作用的影响。研究结果表明，在该体系中不同类型共计 19 种污染物的降解效率存在差异，整体上的降解顺序为：卡马西平类> 双酚类> 磺胺类> 三嗪类> 四环素类> 喹诺酮类。同时，理论计算（DFT）的结果表明具有较高的最高占据分子轨道能（EHOMO），较低的能隙（ΔE＝ELUMO－EHOMO）和较低的垂直电离势（VIP）的化合物更容易被降解（图.1（a））体系中产生的 ROS 类型及各种 ROS 对不同污染物降解的贡献率，其中 $^1O_2$ 更倾向攻击磺胺类和双酚类的化合物并成为降解过程中的主导 ROS，•OH 更容易攻击三嗪类化合物并成为主导 ROS，$SO_4^{\bullet-}$更容易攻击卡马西平类化合物并成为主导 ROS（图.1（b））。对于同类化合物，它们共有的组分或基本母体结构往往是主要的攻击位点；不同的 ROS 在降解反应中具有各自的反应特点，有机化合物结构上的物里化学差异会引起与 ROS 反应过程中有效反应时间（ERT）和二级反应速率常数出现差异，进而表现出多 ROS 的体系中不同类型污染物降解过程中主导的 ROS 不相同。本研究有助于加深对 ROS 为何起主导作用的理解；同时，对于处理含有各种有机污染物的废水，推荐设计一个可以产生多种且高浓度 ROS 的系统，以同时实现对多种类型污染物的去除；当处理含有一种或几种污染物的特殊废水时，可以通过理论计算来预测其降解过程中起主导作用的 ROS，为准确且经济高效地设计或选择催化剂提供指导，以充分利用生成的 ROS 的氧化能力，最终实现高效且低能耗地去除有机微污染物。

关键词：高级氧化；分子结构；主导自由基；降解效率；污水处理

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02 污水臭氧氧化的溴代含氮副产物及其毒性特性

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摘　要　针对臭氧氧化的副产物，当前研究普遍关注溴酸盐而忽视了有机溴代副产物的风险。此外，污水处理厂二级出水中通常含有一定浓度氨氮。二级出水在臭氧/溴离子/氨氮共存条件下会生成毒性更高的含氮副产物和溴代含氮副产物。研究发现溴离子导致污水臭氧氧化后有机副产物的毒性显著增加。与不含溴离子的臭氧氧化水样相比，100 μg/L 的溴离子即可显著增加细胞毒性和遗传毒性。尽管溴酸盐也会在一定程度上增加毒性，但毒性增加幅度十分有限。TOBr 是导致毒性增加的主要原因。氨氮抑制了溴酸盐和总有机溴生成，但是导致了氮元素与有机物结合生成有机氮，生成了更多溴代乙酰胺和溴代硝基甲烷。含氮副产物尤其是高毒性溴代含氮副产物的生成可能是氨氮导致毒性升高的原因。

关键词：污水；臭氧氧化；有机溴；细胞毒性；遗传毒性

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03 贵州草海内源磷释放机制及原位控制技术研究

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摘　要　草型富营养湖泊因沉积物中磷负荷高、释放风险大及治理难度大而广受关注。然而，由于浅水湖泊沉积物-水界面磷的生物地球化学过程非常复杂，至今尚缺乏对沉积物中磷的释放机制认识以及适宜的高效内源磷控制技术。本研究以典型草型湖泊——草海作为研究对象，通过对草海湖水、孔隙水和沉积物等进行系统采样和实验，揭示碳酸盐地质背景条件下湖泊沉积物中磷的释放机制，同时结合室内模拟实验，建立适宜于高原喀斯特湖泊的底泥原位钝化与沉水植物群落构建技术。研究区沉积物-水界面磷的释放通量非常高，平均值为 0.37 $mg \cdot m^{-2} \cdot d^{-1}$。沉积物中不断沉积和降解的磷酸酯类有机磷（磷酸单磷和磷酸二酯）是维持湖泊高生产力的关键，其矿化过程对内磷的释放起着重要作用。虽然沉积物中无机磷含量较高（约占沉积物总磷的 60%），但以铁氧化/氢氧化物结合磷为主的还原机制对内磷负荷贡献较小，这可以从沉积物中铁-锰/铁-铝结合磷（BD-P 和 NaOH-P）低的释放速率以及剖面中不稳定磷与不稳定铁不显著正相关中看出。底泥控制实验结果表明，与单一处理组相比，联用处理组内部磷的释放通量以及孔隙水中 SRP 的减少量更明显。修复过程中联用处理组对表层沉积物中氧化还原敏感的化学形式的转化更显著。镧改性凹凸棒石+沉水植物组内磷释放通量分别较单一的镧改性凹凸棒石组和沉水植物组降低了 55%和 55%，镧改性膨润土+沉水植物组组分别较镧改性膨润土组和沉水植物组降低了 16%和 46%。同时镧改性材料对沉水植物生长率、长度等性状较单一植物组差异较小，并在不同程度上增强沉水植物对磷酸盐的吸收效果。实验中镧改性凹凸棒石+沉水植物组和镧改性膨润土+沉水植物组沉水植物体内磷酸盐的含量分别较单一植物组增加了 24%和 11%。这些结果表明，镧改性材料在对有机磷主导的草型浅水富营养湖泊修复中可与沉水植物产生协同效应，并在一定程度上强化生态恢复的效果。

关键词：磷；沉积物；^{31}P NMR；大型植物；富营养化；草海

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备注：该研究分别于 2022 年发表在“Frontiers in Environmental Science”和“Water”，没有发表意向期刊。

04 富氧空位二维 CoOx 纳米片活化过一硫酸盐降解双酚 A 机理研究

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摘　要　近年来，高级氧化技术在深度处理废水中难降解有机污染物方面受到了广泛关注。基于非均相催化活化的过一硫酸盐（PMS）高级氧化过程作为一种高效的有机污染物降解策略，其依赖于催化剂的设计使 PMS 进一步转化为•OH、$•SO_4^-$、$^1O_2$ 等具有强氧化性的活性氧物种，从而将难降解有机污染物完全矿化成 H_2O 和 CO_2。本研究成功制备了富氧空位的二维纳米片状 CoO_x 氧化物材料并将其应用于 PMS 的活化降解内分泌干扰素双酚 A (BPA)。结果表明，在最佳反应条件下（[BPA] = 20 mg/L，[催化剂] = 20 mg/L，[PMS] = 200 mg/L，初始 pH = 7，反应温度 = 25 ℃），二维纳米片状 CoO_x 在 2 min 内实现 100 %的污染物去除效率，并具有良好的循环稳定性；同时钴离子溶出量远低于环境标准限值。通过自由基猝灭实验和活性氧物质捕获实验证实了自由基路径是该反应的关键反应过程。本研究为高效 PMS 活化催化剂的设计，及反应机理的探究提供了新见解。

关键词：高级氧化技术；过硫酸盐活化；二维 CoOx；自由基路径；富氧空位

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05 钴掺杂碳基催化剂修饰均相电芬顿阴极降解水体中邻苯二甲酸酯性能与机理研究

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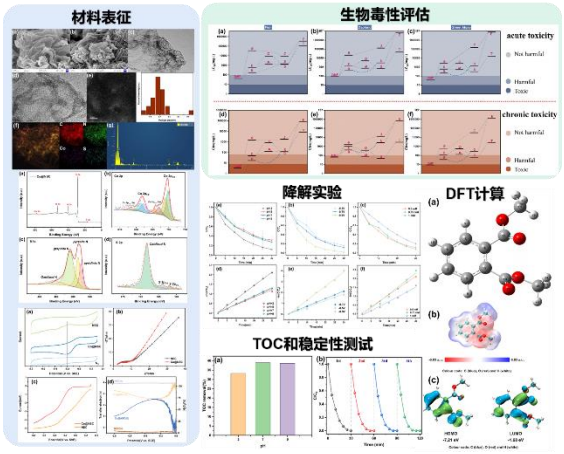
摘　要　在以三聚氰胺为软模板的条件下，将 Co 掺入其中并经高温煅烧形成二维单原子催化剂。该材料含有 Co、N、S 和 C 四种元素。通过对 Co@NSC 的表征发现该材料属于介孔结构，主要孔径分布在 1.3-16 nm 之间，比表面积和孔体积分别为 223.26 m^2/g 和 0.392 cm^3/g。在电化学性能测试中，结果表明，在钴掺杂的情况下，材料的双电子氧还原能力可以得到有效提升。使用 Co@NSC 作为电芬顿阴极降解 DMP 可以在 30 分钟内完全去除，即使在中性和碱性条件下也具有优异的降解效率（100%）和 TOC 矿化率（40%）。在降解机理探索中，发现•OH 和 $^1O_2$ 是主要贡献者。根据 DFT 理论计算和 LC-MS 结果，合理推测了 DMP 的易损位点和降解路径。降解产物的生态毒性评价表明，Co@NSC 电芬顿体系显示出显着降低 DMP 毒性的能力。Co@NSC 不仅可以减少金属的使用量来降低成本，而且可以充分利用每一个金属站点，这是一个具有成本效益且非常有前景的选择。

本研究以三聚氰胺为软模板的钴掺杂碳基催化剂，掺杂钴并经高温煅烧形成二维结构，具有超高的比表面积和体积，可充分利用金属场地。在电化学性能测试中，结果表明钴掺杂后材料的双电子氧还原能力得到有效提升。此外，Co@NSC 作为电芬顿阴极降解 DMP，可在 30 min 内去除 100%，即使在中性和碱性条件下也具有优异的降解效率和 TOC 矿化。通过改变反应条件和加入猝灭剂，验证了体系中•OH 和 $^1O_2$ 的存在。根据 DFT 理论计算表明，DMP 的苯环部分易发生亲电反应，支链部分易发生亲核反应。结合 LC-MS 的结果，推测 DMP 的降解路径和中间产物的生物毒性评价是合理的。我们的工作为有机污染物的完全矿化提供了一种还原-氧化介导的电芬顿技术。我们的工作为不同 pH 值的实际废水中完全矿化持久性有机污染物的提供了新的思路。

关键词：电芬顿；生物质炭；邻苯二甲酸二甲酯；降解路径；生物毒性



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06 固定化苯并芘降解菌对焦化废水中苯并芘的降解研究

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摘　要　随着焦化废水污染治理技术的发展，生物修复技术因为具有成本低和环境友好的特点备受关注，而固定化微生物技术具有降解率高、稳定性强、耐冲击等优点。为探讨降解菌对实际焦化废水微生物群落结构的影响和固定化技术后对废水中苯并芘（Bap）的降解效率。本研究以前期筛选出的高效 Bap 降解菌 *Acinetobacter* XS-4 为研究对象，研究其对实际焦化废水处理前后微生物种群变化，并以海藻酸钠（SA）-聚乙烯醇（PVA）为载体对降解菌进行包埋固定化技术，且探讨不同比例固定化小球的理化性能及对模拟废水和焦化废水中 Bap 的降解效果，以期为菌株在焦化废水中的应用提供实践参考。结果表明，在焦化废水中直接添加游离菌后，并未对系统造成破坏，丰富了废水中微生物群落且增加了优势菌属 *Proteobacteria* 的相对丰度。10%PVA+0.5%SA 为小球最佳配比，菌球成球效果较好，疏松多孔且颗粒内部与表面均存在微生物附着生长。7d 后，固定化小球对模拟废水和焦化废水中 BaP 的去除率分别为 62.36%和 71.55%，较游离菌分别高出 7.87%和 22.5%，因小球自身吸附效果，微生物能良好生长，且通过自身代谢作用将小球吸附的 BaP 加以利用转化，形成一个小球吸附-微生物利用-小球继续吸附的循环工作状态。可见利用微生物固定化技术处理实际焦化废水具有实际应用潜力。

关键词：微生物固定化；苯并芘；生物降解；焦化废水

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07 基于碳基阴极修饰的电芬顿降解水体 BPS 性能及机理研究

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摘　要　随着社会经济的快速发展，内分泌干扰素和抗生素的过度使用导致大量持久性有机污染物(Persistent Organic Pollutants, POPs)进入环境中，对环境产生了长期潜在的危害。目前，持久性有机污染物去除存在成本高、去除不彻底、容易产生二次污染的问题。针对该科学问题，本论文采用硝酸氧化的方法制备了 Co 纳米颗粒负载的氧化碳黑(Co-OBC)作为电芬顿阴极催化剂，以水体双酚 S(BPS)为目标污染物，研究了电芬顿降解污染物的性能和机理。材料表征结果显示，Co-OBC 呈现球状形貌并且 C、N、O、Co 含量分布均匀，具备较高的亲水性、较多的介孔结构以及吡咯氮和含氧官能团含量，有助于 2 电子氧还原反应的发生。电化学性能测试结果显示，Co-OBC 具有较正的氧还原电位、起始电位、半波电位以及大的极限电流密度，证实了 Co-OBC 具有很好的氧还原性能，同时旋转环盘电极测试结果显示，Co-OBC 的转移电子数接近于 2。当 Co-OBC 作为阴极催化剂用于电芬顿降解 BPS 时，在最佳反应条件下($c(Fe^{2+})$ =0.3 mM, pH 3, U=-0.5 V)，可以实现 15 min 内 BPS 的全部降解，120 min 内总有机碳 47.8%的(Total Organic Carbon, TOC)去除率。通过电子顺磁共振(EPR)确定反应体系主要活性物种为·OH，并结合高效液相色谱-质谱联用和理论模拟计算推测了 BPS 的三条降解路径，同时 ECOSAR 软件预测出中间产物的毒性是逐步递减，具有一定的环境保护意义。

关键词：碳基催化剂；电芬顿；BPS；机理分析

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08 喀斯特河流-水库系统“生物碳泵效应”潜在碳增汇机制研究

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摘　要　全球超 70%河流被筑坝拦截，河流大坝拦截效应明显。在我国西南喀斯特流域由于水源充沛，建有相当数量的大坝，是我国水电开发的重点区域。岩溶河流筑坝后水力滞留时间加长，库区生物碳泵效应明显，改变了原有流域碳的迁移和转化过程。而当前对岩溶水库生物碳泵效应这一稳定碳酸盐风化碳汇的关键机制研究还不足，不利于在大坝建设背景下准确评估全球流域碳收支。前期我们在乌江干流梯级水库和支流的红枫湖水库进行为期一年的样品采集，对非日调节的水库包括：洪家渡水库、东风水库、乌江渡水库、思林水库、红枫湖水库进行了河流-水库系统不同区域（河流区、过渡区、静水区及剖面、下泄水区）的系统采样以探究喀斯特河流-水库系统生物碳泵效应对碳循环的影响和潜在固碳增汇机制。研究结果表明，非日调节水库库区均在丰水期出现明显热分层，二氧化碳分压（pCO_2）在丰水期库区明显偏低，甚至在洪家渡，红枫湖等水库中出现明显的 CO_2 负排放效应。多碳稳定及放射性同位素（$d^{13}C$&$D^{14}C$-DIC, DOC, PIC, POC）研究结果表明，在非日调节水库库区无机碳相较于河流区明显年轻化，且在沉积物中沉积相当可观的自源有机质及颗粒无机碳。这表明喀斯特河流筑坝后，非日调节水库库区湖沼学发育明显，导致水库的生物碳泵效应显著提高，在岩溶水库库区存在明显的碳增汇效应。然而，当前对岩溶水库生物碳泵效应研究较少，这一潜在增汇潜能可能被低估，今后需要进一步评估其环境效应。

关键词：喀斯特；水库；碳循环；同位素；生物碳泵效应

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09 养猪场污水处理厂及周边环境中抗生素抗性基因的迁移转化

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摘　要　中国是世界上最大的抗生素使用国，全球大约 50%的抗生素消耗来自中国，其中一半被用于畜牧业，特别是养猪行业。由于牲畜对抗生素的利用率较低，30~90%的摄入量随尿液和粪便排出，这也导致大量的养猪场废水和粪便中含有大量抗生素，进而诱导的抗生素抗性基因（ARGs）。因此，养猪场废水和粪便被认为是 ARGs 的重要来源和储存库。然而，目前大多数养猪场污水处理厂（WWTPs）只注重处理常规污染物，没有考虑到 ARGs 和病原微生物等污染物的去除。这些未去除的 ARGs 可以随着回用水或排水进入周围的河流和土壤环境中，从而有可能对农作物和水生生物造成基因污染。因此，探究养猪场 ARGs 的分布情况以及其向周边环境中的动态传播显得尤为重要。

在本研究中，采用实时定量聚合酶链反应（q-PCR）和宏基因组学的方法跟踪 ARGs 在 WWTPs 及周边环境中的分布和迁移，并分析了 ARGs 与微生物群落和环境因素之间的相关性。在污水处理厂的 AO 工艺和消毒池出水中，ARGs 的绝对丰度显著下降。但在通过厌氧罐后的出水中却检测出了新的 ARGs。同时，污水处理厂附近的土壤和水体中 ARGs 的绝对丰度分别比背景值高出 10 倍和 35 倍，附近水井中的 ARGs 丰度值更是比地下水正常值高出一个数量等级。此外，我们还在猪粪及堆肥过程中检测到高丰度的 ARGs。在堆肥后期，大多数 ARGs 被消除，但磺胺嘧啶类抗性基因 sul1 却增加了 10.5 倍。高通量分析显示，污水处理厂改变了周围环境中的微生物群落结构，与对背景值相比，污水处理厂附近的土壤和水样中分别有 52%和 37%的 OTU 是独有的。在土壤和水样中 *Proteobacteria*、*Choroflexi* 和 *Actinobacteriota* 三种菌属占主导地位。此外在周围的土壤和水样中还发现了三种致病菌属。宏基因组分析在这些菌属中确定了 14 种 ARGs 大类，其中多药型抗性基因的比例最高，占比为 47%。共检测出不少于 28 种 ARGs 亚型，其中 macB 的丰度最高，同时它也是人类的三大处方药之一。相关性分析显示，三种关键菌属 *Proteobacteria*, *Actinobacteria* 和 *Acidobacteria* 是 ARGs 主要的潜在宿主，并与 ARGs 的组成结构呈显著正相关，外排泵（60-66%）是主要的抗性机制，而且每种抗性机制在微生物群落中的分布比例相似。

关键词：抗生素抗性基因；养猪场；污水处理厂；微生物群落；宏基因组学

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10 氧环境改变对陆基循环水养殖鱼粪碳、氮、磷释放特征及细菌群落的影响

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摘 要 为探究氧环境改变对陆基循环水养殖系统（RAS）中鲈鱼粪 N、P、溶解性有机质（DOM）释放特征及鱼粪细菌群落多样性的影响，采用室内模拟的方法，分析氧环境（好氧、厌氧）改变对鱼粪及其上覆水理化性质及鱼粪细菌群落特征的影响，并揭示其间的相关关系。结果表明，第 1~16 d，厌氧处理上覆水中 NH_4^+-N、TP、COD 和 TOC 明显高于好氧处理，在第 16~33 d，NH_4^+-N 持续增加、TP 降低至低于好氧处理组、COD 和 TOC 降低，但仍高于好氧处理。三维荧光光谱表明，氧环境改变下上覆水 DOM 主要是蛋白质类、腐殖酸物质，但厌氧条件下各组分含量均较多。细菌分析表明，不同处理鱼粪细菌群落相对丰度存在差异，优势菌门为 Proteobacteria、Firmicutes、Actinobacteria、Bacteroidetes、Chloroflexi，相对丰度均大于 5%；厌氧处理组优势菌属包括 *Acinetobacter*、*Propioniciclava*、*Ornithinibacter*、*Paraclostridium* 等，好氧处理组优势菌属为 *Acinetobacte*、*Kurthia*、*Comamonas*、*Propioniciclava* 等。细菌群落聚类特征与环境因子相关性表明，随反应时间增加，好氧、厌氧处理组细菌群落结构趋于相似，COD、TP 与细菌群落具有明显的相关性（$P<0.05$）；厌氧处理下 DOM（C1、C2、C4）、反应时间、COD、TOC、全 N、全 P、NO_3^--N 是影响细菌属的关键环境因子，好氧处理下细菌属与反应时间、EC、DOM（C1、C2、C4）、NH_4^+-N、有明显的相关性。研究显示，厌氧处理能够显著影响鱼粪及上覆水的理化性质，促进氮磷及有机质的释放，并对细菌群落结构和多样性产生一定的影响，其次是好氧处理。

关键词：陆基循环水养殖；鱼粪；氧环境改变；碳氮磷释放；细菌群落结构

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11 珠江上游万峰湖抗生素抗性基因及沉积物微生物群落分布特征

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摘　要　万峰湖作为珠江流域上游典型喀斯特高原湖泊，为抗生素和抗生素抗性基因（ARGs）传播提供了有利条件。本文初步探讨了湖区 20 种抗生素、9 个 ARGs 和 2 个移动遗传元件（*intl1* 和 *intl2*）及沉积物中微生物群落结构之间的关系。研究结果表明，万峰湖水体和沉积物中主要的抗生素是喹诺酮类，水体中抗生素总浓度水平为 ND~372.72 ng/L，浓度最大为 OFX（169.48 ng/L）。沉积物中抗生素总浓度水平为 ND~151.62 ng/g，浓度最大为 FLU（122.54 ng/g）。定量 PCR 分析表明，ARGs 在水体和沉积物中的丰度大小依次为磺胺类抗性基因（*sul*）>大环内酯类抗性基因（*erm*） >四环素类抗性基因（*tet*）> 喹诺酮类抗性基因（*qnr*），说明磺胺类抗性基因是主要的污染类型。宏基因组结果分析表明，沉积物中所有采样点微生物群落结构分布相似，优势微生物为 *Planctomycetes*、*Proteobacteria*、*Euryarchaeota* 和 *Chloroflexi*。沉积物中共 22 种 ARG 类型，包括 574 个亚型，主要类型是 Multidrug 和 Tetracycline 抗性基因。Pearsons 相关性分析表明，水体和沉积物中抗生素和 ARGs 呈正相关，四环素类抗性基因与 *intl1* 显著正相关，沉积物中抗生素和 ARGs 与微生物之间存在显著相关，这说明抗生素对 ARGs 存在在压力，同时微生物为 ARGs 进化和传播提供驱动力。该研究为进一步调查湖泊中抗生素和 ARGs 的发生和传播提供了依据。

关键词：万峰湖；水体；沉积物；抗生素；抗生素抗性基因；微生物群落

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12 百花湖流域土壤活性腐殖质的含量分布及光谱特性

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摘　要　本文利用紫外-可见光谱和三维荧光光谱分析了百花湖流域土壤活性腐殖质中腐殖酸（HA）和富里酸（FA）的含量分布及光谱特征。紫外-可见光谱分析表明：百花湖流域土壤腐殖酸（HA）的含量大于富里酸（FA），腐殖酸和富里酸组分含量分布不均匀，变异系数分别为47.6%-58.4%、51.3%-57.7%，腐殖酸的腐殖化程度及分子量均大于富里酸，其芳香性和疏水性也明显强于富里酸。三维荧光光谱特征结果表明，百花湖流域土壤活性腐殖酸的荧光指数（FI）均值和自生源指数（BIX）均值分别为0.72和0.44，富里酸的FI均值和 BIX均值分别为1.24和0.57，除个别样点外，百花湖流域土壤的活性腐殖质主要来自于外源性物质的腐殖化过程，说明了当地土壤受到人类活动的影响较大。

关键词：流域土壤；胡敏酸；富里酸；光谱特性

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13 典型喀斯特河流溶解性有机质生物降解特性及其温度敏感性研究

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摘 要 喀斯特河流受特殊生物地球化学过程影响，其溶解性有机质（DOM）变化具有显著的区域特征。然而，当前对其 DOM 空间变化规律，特别是生物降解特性的研究十分有限，急需相关内容的补充。以我国典型喀斯特河流—芙蓉江为对象，探索了 DOM 光学参数（a_{254}、a_{350}、E2/E3、$S_{275\sim295}$、BIX、FI、FrI 和 HIX）的空间格局，同时揭示了不同温度条件下 DOM 的生物降解特性。结果表明：原位水体 a_{254} 和 a_{350} 值分别为（8.22 ± 1.82） m^{-1} 和（5.32 ± 1.72） m^{-1}。E2/E3 和 $S_{275\sim295}$ 值分别为 0.85~3.25 和 0.002~0.011。河流 BIX 和 FI 值分别为 0.77~1.11 和 2.14~2.39 nm^{-1}，说明内源和外源输入均为 DOM 的重要贡献源。HIX 和 Frl 分别为 0.54 ± 0.16 和 0.86 ± 0.06，说明水体腐殖化程度低而新生 DOM 丰度高。经过 15 ℃暗箱培养，a_{254} 值在第 28 d 显著升高（（14.8 ± 3.12）m^{-1} ）（$p < 0.05$），a_{350} 在 0~21 d 培养阶段下降（7 d：(3.12 ± 1.18) m^{-1}；14 d：(2.79 ± 1.17) m^{-1}；21 d：(3.11 ± 1.11) m^{-1}）而 28 d 后升高（（8.20 ± 0.88）m^{-1} ）（$p < 0.05$），而 E2/E3 值的变化趋势与之相反。同时，河流 HIX（0.23 ± 0.05）显著降低而 Frl（0.91 ± 0.13）升高，说明大分子腐殖质被不完全降解为新生 DOM。增加培养温度（30 ℃）进一步提升 DOM 的生物可用性，最终加强大分子组分的降解和小分子组分的生物矿化作用。该研究为喀斯特区域河流 DOM 动态过程提供有用信息，同时有望响应全球及区域碳循环过程。

关键词：光学特性；溶解性有机质；喀斯特河流；空间变化；生物降解

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14 富 Ca 香菇菌渣自催化功能化制备纳米 $CaCO_3$-生物炭复合物及其对含磷废水处理性能研究

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摘　要　在贵州，食用菌菌渣是伴随着食用菌产业蓬勃发展而出现的新兴固体废弃物，其产量大、富含营养成分（如 K、糖分、蛋白质等），易于滋生病原菌，是农村土壤污染和水体污染的重要源头。开发食用菌菌渣合理的处理、处置途径将有助于推动食用菌产业的绿色发展。本研究以香菇菌渣为原料，通过分析香菇菌渣热解所得碳材料的性质及其对对含磷废水的处理性能，探究热解在食用菌菌渣资源化方面的可行性。通过对组分分析发现，香菇菌渣灰分含量为 16.67%，较菌渣原料（桉木屑、稻壳、麸皮等）均有明显提高。进一步分析表明（ICP），该灰分主要由 Ca 组成，含量达 5.56×10^4 mg/Kg。XRD 分析显示，Ca 在香菇菌渣中分散均匀，且主要以无定形形态存在。在热解过程中，香菇菌渣中高含量的 Ca 能够强化香菇菌渣自身的分解、抑制中间产物的缩聚、促进碳产物（生物炭）孔隙结构的发育、促进碱性官能团的生长。其中，香菇菌渣生物炭较去除灰分后的香菇菌渣制备的生物炭的比表面积提升了约 45 倍，为 133.30 m^2/g。SEM 及 XRD 分析发现，香菇菌渣中的 Ca 经过热解后在生物炭的表面形成分布均匀、粒径为 80-120 nm 的颗粒突起（Ca 含量为 1.56×10^5 mg/Kg），由此将所得香菇菌渣生物炭命名为纳米 $CaCO_3$-生物炭复合物。进一步研究发现，纳米 $CaCO_3$-生物炭复合物对模拟废水中的磷（PO_4^{3-}）具有优异的吸附性能，在 2 h 内纳米 $CaCO_3$-生物炭复合物对磷的吸附效率即超过 85%，在 4 h 左右即达到平衡。Langmuir 吸附等温线模型拟合发现，纳米 $CaCO_3$-生物炭复合物对磷的理论最大吸附量达 104.17mg/g，优于文献所报道的大部分吸附剂。XRD 和 XPS 分析发现，吸附磷后的纳米 $CaCO_3$-生物炭复合物表面存在大量 $Ca_3(PO_4)_2$ 相关的物质，表明纳米 $CaCO_3$-生物炭复合物中分散均匀的纳米 $CaCO_3$ 作为磷的高效吸附位点，对磷的吸附去除扮演着重要作用。 由此表明，热化学转化制备碳材料并用于废水处理是食用菌菌渣可行的资源化路径。

关键词：食用菌菌渣; Ca; 热解; 生物炭; 复合物

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15 高原喀斯特湖库 DOM 组分特征与 DBPs 的贡献

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摘　要　溶解性有机质（dissolved organic matters，DOM）是形成消毒副产物（disinfection by-products，DBPs）的重要前体物质。为探明典型高原喀斯特代表性湖库（贵阳市阿哈水库）不同时空 DOM 的来源及 DBPs 的生成路径，利用紫外-可见光光谱（UV-Vis）和三维荧光光谱（3D-EEM）对平水期、丰水期和枯水期阿哈水库 3 个特征位点水样 6 种组分 DOM 进行表征，并对原水和 DOM 组分进行氯化消毒后 DBPs 的生成趋势分析。结果表明，阿哈水库 DOM 的组成以内源释放为主，在丰水期内源 DOM 含量最高。在检测出的六种氯代 DBPs 中，TCM 占 DBPs 生成势（DBPsFP）65%以上，DCAN、1,1-DCP、1,1,1-TCP 的生成势均高于 TCAN 和 TCNM，后两者的生成势较小，仅占 0.016%和 0.007%。此外，经组分分离探究各 DBPs 前体物质的来源，TCM、DCAN、1,1,1-TCP 前体物质最主要来源为 HON；1,1-DCP 前体物质主要源于 HOB；HIA 是 TCAN 主要贡献组分；TCNM 主要是由 HOA 产生。平行因子（EEM-PARAFAC）和 UV-Vis 分析表明，疏水组分主要由类胡敏酸和富里酸组成，亲水组分主要是可溶性微生物代谢副产物组成，疏水性组分 DBPs 生成势占 DOM 组分的 94.5%以上。因此，疏水类 DOM 组分对于 DBPsFP 的主要贡献证据充分。

关键词：溶解性有机质；喀斯特湖库；消毒副产物生成势；平行因子分析；紫外-可见光分析

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16 核桃壳生物炭对水溶液中 Pb^{2+}、Zn^{2+}的吸附特性及吸附机理的研究

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摘 要 为探寻更为有效的 Pb^{2+}、Zn^{2+}吸附材料和实现农林废弃物的资源化利用，以核桃壳为原料，采用限氧裂解法在 600 ℃条件下制备核桃壳生物炭，探究了生物炭投加量、初始 pH、吸附时间、温度和初始浓度对生物炭吸附 Pb^{2+}和 Zn^{2+}的影响，并通过红外光谱（FTIR）对生物炭进行了表征。利用 Langmuir 和 Freundlich 等温吸附模型，准一级、准二级和 Elovich 吸附动力学模型分别进行等温吸附和吸附动力学分析。结果表明，核桃壳生物炭吸附 Pb^{2+}和 Zn^{2+}的最佳 pH 分别为 5 和 6。核桃壳生物炭吸附 Pb^{2+}和 Zn^{2+}分别在 720 和 480 min 内达到吸附平衡，核桃壳生物炭最佳投加量分别为 0.1、0.2 g/L,最大吸附量分别为 25.871、10.800 mg/g。Pb^{2+}的吸附过程符合 Langmuir 等温吸附和 Elovich 吸附动力学模型,说明其吸附过程是近似单分子层的化学吸附；而 Zn^{2+}的吸附过程更佳符合 Elovich 动力学和 Freundlich 等温吸附方程，表明核桃壳生物炭对 Zn2+的吸附为多层吸附。

关键词：核桃壳生物炭；铅；锌；吸附；吸附机理

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17 贵阳市南明河干流水质水量时空分布特征及主要污染物分析

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摘 要 本文选取贵阳市南明河三江口、甲秀楼、新庄断面作为南明河城区段的上、中、下典型断面，分析 2012 年及 2017 年-2020 年各断面的化学需氧量（COD）、氨氮、总磷(TP)的时空分布特征，通过南明河综合治理主要指标前后对比分析，识别污染关键区、关键问题和主要污染因子。采用单因子水质指数和综合水质标识指数法分析显示，2017 年以后三个断面的主要超标因子为氨氮。三江口断面综合水质标识指数均值为 4.1，最小值达 2.8，综合水质较好但稳定性相对较差。甲秀楼断面综合水质标识指数均值为 4.9，综合水质处于 IV 类水下限。新庄断面综合水质标识指数月均值为 4.6。分析显示，南明河各断面在每年的 4 月-5 月出现污染物浓度增高，存在季节性影响。相关性分析和回归分析显示，断面的综合水质标识指数与氨氮、COD、TP 的相关性系数分别为 0.921、0.873、0.866，标准化 β 值分别为 0.474、0.332、0.315，表明改善河道氨氮指标是下一步提升河道水质的重点。水量分析结果显示，南明河现状新庄二期下游总水量约 197 万吨/天，其中污水厂尾水占 80%，生态基流占 6.4%，污水厂尾水对河道补水是南明河河道的主要来源。随着新建污水厂尤其是城区中下游地下式污水厂的处理负荷不断提升，以及管网进一步完善和清污分流工作的实施完成，南明河的水质预期将进一步提升。

关键词：南明河；统计分析；时空变异；单因子水质标识指数；综合水质标识指数

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18 基于电子调控的光催化记忆型氮化碳复合材料灭活水中病毒的性能与机制研究

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摘　要　寻求安全有效的病毒灭活技术对保障饮用水安全具有重要意义。基于光催化材料的消毒技术在利用太阳能灭活水中病毒方面具有广阔的应用前景，但其面临着光照下病毒灭活效率偏低及黑暗下病毒出现复活现象等难题。本研究基于电子调控策略，利用氧化钨电子存储介质和生物炭电子传递介质以协同强化氮化碳的光催化延续性和活性，构筑具有光催化记忆效应的新型氮化碳复合材料，用于水中病毒的安全有效灭活。本研究所研发的新型氮化碳/氧化钨/生物炭光催化记忆材料在光暗交替条件下表现出优异且连续的光催化活性，可有效且彻底地灭活水中人类腺病毒（无复活现象）。新型光催化记忆材料在 6-h 可见光照射下能够灭活 3.9-log 的病毒，并在随后 6-h 黑暗下额外灭活 1.1-log 的病毒，其增效灭活病毒机制归因于 1）电子的调控效应；2）异质结的构建;3)电子转移途径的改变，有助于光照条件下光生电子的转移和储存及随后黑暗条件下电子的释放，从而显著促进了光暗交替条件下杀病毒关键自由基（羟基自由基）的持续产生。本研究对新型环境功能材料的理性构筑及饮用水微生物污染的有效控制具有指导价值。

关键词：水源污染物控制；光催化记忆；氮化碳；病毒；灭活

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19 单原子层 Cu_5 纳米团簇构筑双催化位点助力 H_2O_2 活化

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摘　要　H_2O_2 是典型的环境友好型氧化剂，被广泛使用于环境修复、有机物转化、生命科学等多个领域。H_2O_2 活化可以产生过氧化氢自由基（•O_2H）、超氧自由基（•O_2^-）、羟基自由基（•OH）等多种活性氧物种。鉴于不同活性物种的氧化能力差异，H_2O_2 定向转化成期望的活性氧是其高效、安全使用的关键。由于 H_2O_2 同时具备电子受体和供体特性，它和单一金属位点之间的氧化还原反应难以控制，无法选择性生成特定活性氧物种，这也是为何单一金属中心控制的 H_2O_2 活化通常被称为“半催化反应”。在本研究中，我们通过实验与理论计算证明 Cu 原子可以在（001）面暴露的黄铁矿（FeS_2）表面自组装成单原子层 Cu_5 纳米团簇，并且在催化剂界面周边构建 Cu-Fe 双催化位点。不同于“半催化”的单一 Cu 或 Fe 催化位点与 H_2O_2 发生矛盾的氧化还原反应，Cu_5/FeS_2 催化剂上的 Cu-Fe 双位点通过与 H_2O_2 形成桥连 Cu-O-O-Fe 络合物促进 H_2O_2 的吸附和自发解离，实现 H_2O_2 到•OH 的持续稳定活化，从而解决 H_2O_2 活化无法精准调控产物的瓶颈问题。得益于此，Cu_5/FeS_2- H_2O_2 体系可以在宽泛的 pH 范围内氧化降解多种有机污染物，克服传统 Fenton 技术面临的去污效率低、金属污泥累积和催化剂失活等多个问题。这项工作强调了双金属催化位点的概念，在表面分子水平上操纵 H_2O_2 选择性活化，同时为开发高效 Fenton 催化剂提供了一种新思路。

关键词：异相 Fenton 反应；双位点催化；双氧水活化；羟基自由基；有机污染物降解

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20 “穿流式”多金属三维纳米电极系统去除地下水中硝酸盐

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摘　要　地下水硝酸盐污染严重，威胁人类健康，已成为亟待解决的环境问题。电化学法是去除硝酸盐的有效手段，但存在反应能耗高、终产气体氮气选择性差的问题，根本原因是其电子转移路径长、传质效率低。因此，研究并阐明电极固液界面双电层反应机制并加以调控是解决传质问题的关键。本研究拟通过选择特征材料和合适结构制备电极，调控电极固液界面双电层中 Helmholtz 层厚度，缩短电子转移路径；通过电极的三维纳米尺寸效应和单分散暴露更多活性位点的协同作用实现硝酸盐高还原率；通过构建“穿流式”电极系统，调控双电层中扩散层厚度，进一步缩短电子转移路径，从而解决电极固液界面物质传递的关键问题，降低反应能耗；通过负载特征金属实现终产气体的高氮气选择性；在此基础上揭示界面电子转移与物质传递规律，阐明电极界面反应机制，预测并优化反应能耗及氮气转化率响应模型。本研究将为有效解决村镇分散式地下水供水水质问题提供重要的理论依据和技术支持。

关键词：地下水污染；地下水污染防治；硝酸盐；电化学；三维纳米电极

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21 煤化工废水处理中反渗透系统的膜污染空间分布特征解析

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摘　要　我国煤化工废水排放量大，成分复杂难处理，废水重复利用率低。以“双膜法”（超滤+反渗透）为主的膜结合工艺广泛应用在煤化工废水回用中。但是，在多段式的反渗透工艺中，由于沿程水质的变化，导致不同空间位置的膜污染主要类型与特征存在差异，识别反渗透系统的膜污染空间分布特征十分关键。

本研究于煤化工厂进行废水和膜污染样品的采样。在一段（M1）和二段（M2）反渗透膜元件中各取一张膜，将每张膜片分为图 1 所示的 12 个区域并依次编号,以便后续膜表征。采用①SEM、AFM 和接触角，②XPS 和 ICP，③TOC、3D-EEM 和 FTIR，④ATP、HPC 和序列统计分别表征表面性质、无机、有机和生物污染。

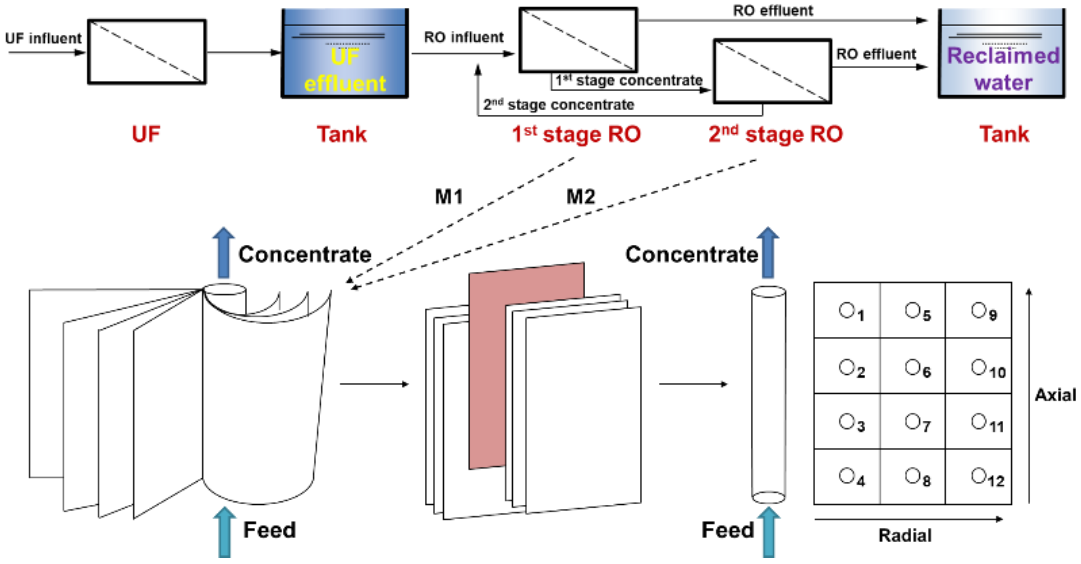

图 1. 煤化工厂反渗透污染膜样品的采样示意图。

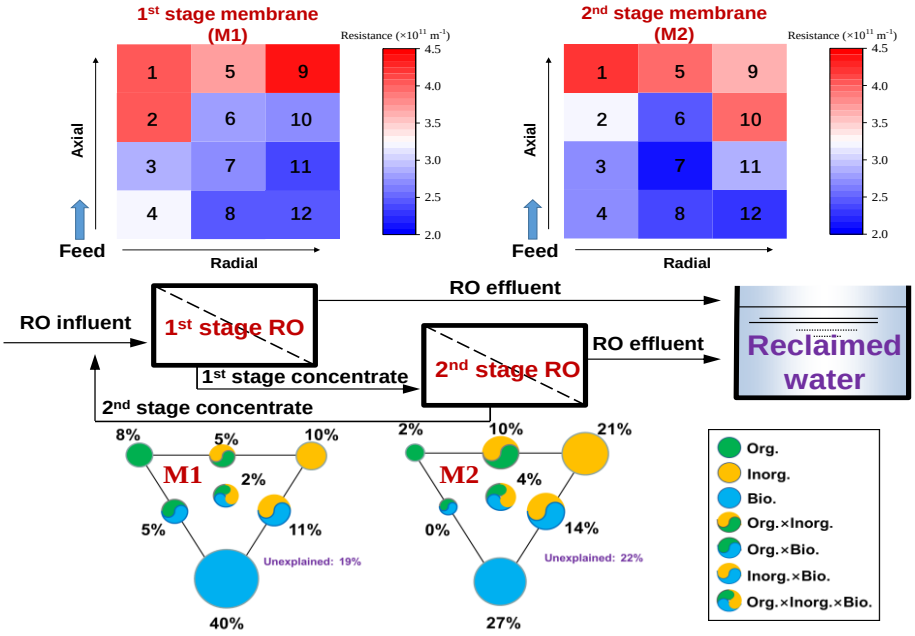

图 2. 膜污染阻力分布情况及各类污染对膜通量下降的贡献率。

研究结果表明，在两段反渗透膜的污染层中，Fe 都是含量最多的无机离子，Al 和 Si 次之，随后是 Ca 和 Mg。这表明在污染层中可能形成 Fe、Al 和 Si 的胶体污染物，而 Ca 和 Mg 易与胶体污染物加剧复合膜污染。一段污染层中，腐殖酸含量较高；二段污染层中，蛋白含量较高。膜污染速率由一段到二段逐渐加重，且两段反渗透膜均呈现从进水侧到浓水侧膜通量递减、膜污染愈重的变化规律。有机污染在膜面上的空间分布较为均匀，无机污染、生物污染及其复合作用对膜通量下降的贡献较为显著。总体上，从一段始端到二段末端，膜污染的主要类型逐渐由生物污染，向无机-有机和无机-生物复合污染转变。

关键词：煤化工；反渗透；膜污染；空间分布；统计学分析

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22 阴/阳极耦合调控电催化过程机制强化微污染物降解

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摘 要 污水再生利用是缓解水资源危机的重要策略，新兴微污染物的高效去除是污水再生领域关注的焦点。与传统深度处理技术相比，电催化膜技术集成了膜过滤与电催化氧化的有益特点，是最有潜力的深度处理技术之一。电催化膜过程蕴含着丰富的阳极、阴极反应，对其相互影响机理和调控机制的系统解析对于电催化膜技术性能的提升具有重要意义。然而，现有多数研究仅关注以电催化膜为阳极或阴极的半反应过程，而针对含阴、阳极双电催化膜系统的耦合应用研究仍较少，目前已报道的相关研究的结论也并不一致，这与电催化过程的复杂反应机制和丰富的阴/阳极耦合运行形式密切相关。阐明双膜耦合过程机制是双膜电催化系统性能提升的重要基础。本研究构建了阳极-阴极耦合的双膜电催化过滤系统，研究了膜电极顺序和间距等对电催化过程的影响机理， 提出了阴/阳极耦合双膜系统的调控策略。 阐明了阴/阳极双膜耦合对电催化过程的影响机理和降解效能调控机制： A-C_0.9 构型最大程度上发挥了 h+直接电子转移氧化机理， C-A_9 构型最大程度上实现 1O2 的产生。 基于解析的不同耦合模式降解机理，明确了当需优先利用阳极直接氧化时，宜采取阳极-阴极构型和较小的电极间距（0.9 mm）；当需优先利用间接产生的 1O2 氧化时，宜采取阴极-阳极构型和适当的电极间距（9 mm）。

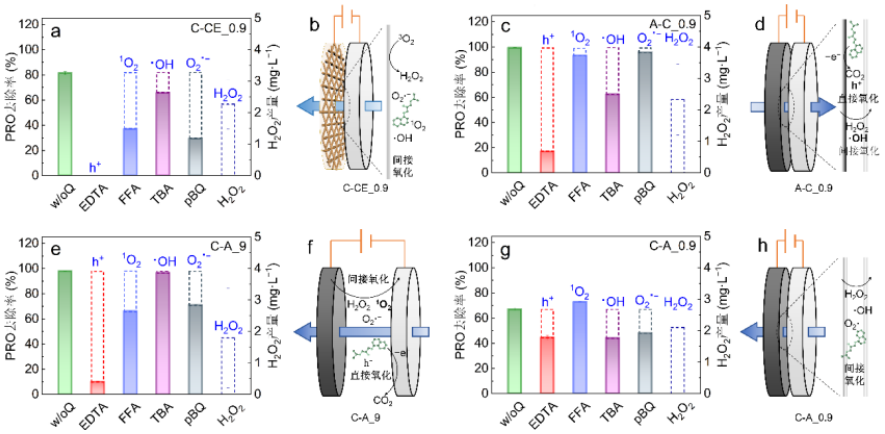

图 1 阴/阳极耦合调控电催化过程机制强化微污染物降解

关键词：电催化膜； 阴/阳极耦合； 过程机制；微污染物； 氧化降解

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23 竖流 A/RPIR 运行工况优化和脱氮除磷性能分析

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摘　要　为了解决传统市政污水处理工艺占地面积大，脱氮除磷效率低，运行成本高的问题，本研究开发了一种省地节能的竖流气升环流反应器（A/RPIR）反应器用于市政污水的处理。竖流 A/RPIR 通过在反应器中部和底部分层安装曝气装置，在反应器顶部设置环流澄清器，实现了缺氧区和好氧区，反应和沉淀的纵向耦合。竖流 A/RPIR 的中间曝气盘安装高度、分区溶解氧（DO）浓度、污泥龄（SRT）、外部硝化液回流比被优化，结果表明最优的运行条件为：中间曝气盘高度为 2.4 m，缺氧区和好氧区的 DO 为 1.0 和 0.15 mg/L, 污泥龄为 50-60 d，外部硝化液回流比 100%。在最优的运行工况下，竖流 A/RPIR 反应器的出水可稳定实现 COD <50 mg/L, TN <10 mg/L, TP<0.5 mg/L。氮素分布和微生物群落分布结果表明，在竖流 A/RPIR 反应器内部可实现同步硝化反硝化，促进反应器高效脱氮。磷平衡实验结果表明，竖流 A/RPIR 可通过生物除磷实现磷的高效去除。与传统 AAO 工艺相比，竖流 A/RPIR 的占地面积可减少 48%，运行电耗可减少 22.5%。竖流 A/RPIR 占地面积小和运行费用低的工艺特点使其具有更高的应用价值和推广意义。

关键词：气升环流反应器；生物脱氮；硝化反硝化；一体化脱氮

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24 基于生态系统模型 PCLake 的浅水湖泊生态修复措施效果评估方法

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摘　要　受到频繁的人类活动影响，国内众多城市湖泊面临严重的富营养化问题，并急需开展生态修复。然而，湖泊生态系统具有复杂且非线性特征，现阶段尚缺少科学量化的评估方法用于指导其修复工程。湖泊生态系统模型 PCLake 模型包含湖泊中的草藻竞争关系及食物网间的物质循环过程，可通过分叉分析方法模拟浊水藻型与清水草型湖泊之间的稳态转换并计算出湖泊生态系统的营养盐阈值。本研究选取了一个水深 2m，吹程 1000m 的虚拟湖泊，采用 PCLake 模型模拟底泥疏浚、沉水植物修复、生物操纵等典型湖泊生态修复措施，分别计算修复前后湖泊生态系统的营养盐阈值。通过比较湖泊修复前后的阈值变化，判断相应措施是否提升了湖泊生态系统的恢复力或弹性，即是否具备更强的抵抗外界环境压力的能力，进而评估生态修复措施效果。本研究结合湖泊稳态转换理论，提出了一种针对湖泊生态修复措施的量化评估方法，为今后的生态修复评估工作提供参考。

关键词：稳态转换；湖泊富营养化；营养盐阈值；量化评估；生态修复

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25 底泥-地下水自驱动系统修复地下水中硝酸盐的响应曲面优化研究

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摘　要　通过 Box-Behnken Design 实验及曲面响应数学模型，对底泥-地下水自驱动修复系统去除硝酸盐的运行条件进行分析和优化。探讨硝酸盐初始浓度、水力停留时间和 COD 初始浓度对反应后硝酸盐氮去除率和亚硝酸盐氮浓度的影响，三因素三水平的响应面分析结果表明：硝酸盐初始浓度对硝酸盐去除率的影响最显著，出水亚硝酸盐浓度受 COD 初始浓度影响最显著。并通过满意度函数对运行条件进行优化分析，优化目标是：出水硝酸盐浓度最低，中间产物亚硝酸盐积累最少。得到的最优方案条件为：初始硝酸盐氮浓度为 33.0 mg/L，COD 浓度为 35.02 mg/L，HRT 为 8 h 时，出水硝酸盐氮浓度为 3.5 mg/L，亚硝酸盐氮浓度为 0.01 mg/L，且通过实验验证了模型结果可信，该方法可行。研究成果为不同环境条件下地下水中硝酸盐污染的修复提供了科学的技术支撑。

关键词：地下水；硝酸盐；水力停留时间；生物电；响应曲面法

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本文尚未发表，意向期刊：环境科学学报

26 三峡工程湖北库区农村饮用水安全状况调查评价

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摘　要　本研究针对三峡工程湖北库区农村移民安置区农村饮水安全巩固提升状况调查，开展“十三五”期间湖北库区移民安置区农村饮水安全评价。结果表明三峡湖北库区农村移民安置区已基本建成以规模化供水工程为主、小型集中供水工程为辅、分散供水工程为补充的农村供水保障体系，基本解决饮水安全问题。但湖北库区农村移民安置区农村供水工程设施体系尚不完善，供水工程运行管护机制仍不健全。指出未来工作重点是不断提升农村供水标准和保障水平，推进农村饮水安全向农村供水保障转变，并提出下阶段农村饮水安全巩固提升建议，确保农村供水安全，为湖北库区“十四五”农村供水保障提供决策依据。

关键词：三峡工程；湖北库区段；农村供水；饮水安全；调查评价

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论文发表意向期刊名称：《环境科学学报》

27 城市供用水管理措施的水环境效益分析及优化研究

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摘　要　为实现水资源管理目标，各地政府提出并实施了多种水资源管理策略和措施。本研究通过多目标优化与边际减排成本方法的结合，以北京市为研究区域，从城市供用水系统整体出发，评估了 4 种供水端 10 种用水端共 14 种水资源管理措施的水环境效益及成本。北京市通过实施水资源管理措施可实现其 2020 年和 2035 年的总用水量、污染物排放量限制性目标。2035 年预计总节水潜力、COD 减排潜力、NH_3-N 减排潜力分别比要求所需高 8%、18.7%和 21.7%，存在一定水资源管理措施实施的优化空间。所有考察的水资源管理措施中，污水再生利用为水环境效益的主要贡献者，在 2020 年和 2035 年分别占总水环境效益的 38.4% 和 24.1%，单位效益成本为 1.6 元/m^3 H_2O-eq。在城市水资源管理目标的前提下对水资源管理措施进行优化，结果表明考虑用水终端节水措施与污水再生利用之间的相互作用关系，对各措施的最优化实施率和水资源管理措施成本估算（+10.8%）有一定影响。

关键词：城市水系统；水资源管理；水生态；多目标优化；成本-效益曲线

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28 河岸过滤中新污染物的生物降解机制研究进展

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摘　要　新兴污染物，如药物、个人护理产品、全氟烷基和多氟烷基物质以及内分泌干扰物等在水生环境中的出现，即使在痕量水平，也对水质安全和人类健康构成了重大威胁。在本研究中，针对人们对饮用水中存在的新污染物日益增加的担忧，系统回顾了典型新污染物的研究现状，包括它们的来源、命运、降解转化机制以及与周围环境的相互作用机制。最重要的是，阐述了河岸过滤系统中新污染物的主降解机制，并详细的介绍了作为主要去除机制的生物降解途径，对其主要去除机理以及影响生物降解的主要因素进行了概括、总结，并在此基础上提出生物降解新污染物的研究方向，对全球饮用水厂规划未来的处理策略具有总要意义。

关键词：新污染物；饮用水；河岸过滤；生物降解；饮用水水源

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29 基于微生诱导法的水陆环境中金属污染修复-前沿与进展

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摘　要　由于水生和陆生环境中人为阻碍而导致重金属在水生环境中浓度富集不平衡，通过不同的食物链循环后会产生潜在的生态健康风险。本文以水生环境和陆生环境中超标重金属修复为目的，开展重金属污染修复研究。微生物诱导碳酸盐沉淀（MICP）法由于其高效稳定性逐渐受到研究人员的关注。本文回顾了 MICP 过程中涉及的代谢途径、机制和影响因素。随后，讨论了 MICP 在水生环境和陆生环境中重金属污染修复方面的最新进展。最后，阐述了与 MICP 方法技术瓶颈相关的关键挑战和前景。在前瞻性研究中，本文提出 MICP 技术可以与吸附材料一起使用，以最低的修复成本和改善的修复效果来处理水生环境和陆生环境中高浓度的重金属污染，以达到降低生态系统潜在生态风险的目的。

关键词：重金属；微生物诱导碳酸盐沉淀；污染修复；生态风险

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30 复杂土地利用类型下无机氮转化机理与来源

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摘　要　华南粤东的韩江三角洲及其他入海流域内主要包括韩江、榕江和练江三大河流。流域内城乡交错，土地利用类型复杂，无机氮来源种类多样。本研究运用多同位素示踪剂技术，揭示了流域无机氮的转化机理和无机氮来源与土地利用之间的定量关系。根据土地利用情况（LUI，土地利用指数）和社会经济发展水平（GDP，各产业国内生产总值），结合 ArcGIS 的空间分析技术，将研究区域定量分为四个区域：农村地区、发达城市地区、发展中城市地区和工业城市地区。水体氧化还原条件和同位素结果表明：韩江和榕江流域内水体呈氧化状态，无机氮以硝态氮（NO_3^--N）为主，主要发生的是硝化反应；而练江流域内无机氮以铵态氮（NH_4^+-N）为主，既没有发生硝化反应也没有发生反硝化反应。在确定以上无机氮转化机理的基础上，通过 R 中的稳定同位素分析模型（SIAR）和二端元混合模型定量解析了这四个区域的无机氮来源比例。在农村地区，丰水期的硝态氮（NO_3^--N）主要来自于流域增施的氮肥（占 42%-56%），枯水期的硝态氮（NO_3^--N）主要来自于土壤氮的硝化作用（占 33%-62%）。在城市地区，土壤氮、粪肥和污水以及工业废水对无机氮的贡献表现出较大的季节和空间差异，且其变化特征受以 GDP 为基础的环境管理水平影响。在发达和发展中的城市地区，土壤氮贡献最大，丰水期分别占 NO_3^--N 的 41%和 47%，枯水期分别占 47%和 54%；第二大贡献来自粪肥和污水，且没有明显的季节差异（占 30%-41%）。在工业城市地区，丰水期 NH_4^+-N 的主要贡献来自粪肥和污水（81%），而在枯水期则主要来自工业废水（84%）。本研究阐明了无机氮的多种来源和转化机理，揭示了土地利用类型与无机氮来源的定量关系，研究成果可应用于无机氮来源的追踪管理，有助于解决复杂土地利用流域的氮污染问题。

关键词：多同位素；流域无机氮；来源；转化机理；复杂土地利用

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31 典型高原湖泊溶解性有机质光谱特征浅析

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摘　要　溶解性有机质（DOM）是水生生态系统中最为活跃的有机质组分，在湖泊生态系统中分布广、活性高且结构、成分复杂。DOM 是陆地生态系统和水生生态系统之间碳转移的桥梁，同时控制着湖泊系统污染物迁移转化过程。高原湖泊生态系统脆弱、受水体富营养化影响强烈。贵州草海是典型的高原湖泊生态系统，近年来水质逐渐恶化、水生生态系统退化，正处于从清水稳态向浊水稳态转变的关键时期。本研究通过分析草海水体紫外-三维荧光光谱特征，揭示不同时期草海水体 DOM 的来源和化学组成。结果表明，草海流域土壤 DOM 主要为腐殖质类物质（富里酸和腐殖质），沉积物 DOM 主要为腐殖质组分（C_1+C_2），占 75%，而类蛋白组分（C_3）占 25%。枯水期草海水体 DOM 主要为腐殖质类组分，其中陆源组分贡献 77%，其中 C_1 组分占 48%， C_2 组分占 29%，内源组分类色氨酸（类蛋白）组分 C_3 贡献 23%；丰水期内源贡献 72%，其中 C_1 占 41 %，C_2 占 31%，内源组分贡献 28%。草海水体中 DOM 以陆源性输入为主，自生源为辅，陆源性物质以类腐殖质为主，腐殖质类占总 DOM 的 70%以上。此研究为识别高原湖泊 DOM 来源提供了关键数据，并加深了对湖泊碳循环的理解。

关键词：DOM；荧光光谱；来源；化学组成 ；草海

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32 长江三峡流域水体颗粒有机质来源示踪

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摘　要　颗粒有机质（POM）作为生源要素的重要载体，在河流生态系统碳循环中发挥着重要作用，并记录了流域内自然及人类活动的痕迹。筑坝拦截导致河流天然属性的改变，进而影响流域碳循环过程。长江三峡流域是我国重要战略型淡水资源库，水体中 POM 的碳氮含量、化学组成、迁移与沉降特征迥异于天然河流与湖泊。研究三峡流域水体 POM 的来源和空间分布可为认识筑坝对河流水体 POM 的迁移转化机制提供重要理论依据。本研究以长江三峡流域为研究对象，利用碳氮稳定同位素（$\delta^{13}C$-$\delta^{15}N$）揭示了碳酸盐地质背景下长江三峡流域水体 POM 中颗粒有机碳（POC）和颗粒态氮（PN）含量的空间分布特征，并运用同位素混合模型定量估算了各来源端元对水体 POM 的贡献率。结果表明，长江三峡流域水体 POC 和 PN 均值分别为 1.92 mg/L 和 0.54 mg/L。由于流域自上游至下游水体流速逐渐降低，颗粒物快速沉降，导致水体 POC 和 PN 含量均表现为自上游至下游逐渐下降的变化特征。受流域碳酸盐风化作用影响，研究区各各采样点水体 $\delta^{13}C$-POM（均值-25.81‰）较全国河流偏正，而水体中较高的 $\delta^{15}N$-POM 值（均值 3.1‰）表明该区域受人类活动影响较大。土壤和陆源 C3 植物是长江三峡流域水体 POM 的主要来源，贡献率分别为 30%和 32%，浮游植物对水体 POM 的贡献为 22%，而陆源 C4 植物贡献最小（16%）。本研究为识别长江三峡流域 POM 来源提供了关键数据，并加深了对河流-筑坝体系生源要素迁移转化过程的理论认识。

关键词：碳循环；颗粒有机质；来源；碳氮同位素；长江三峡

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英文摘要集（43 篇）

01 Achieving a High Selectivity for Nitrate Electrochemical Reduction to Ammonia over Ru_xO_y Clusters[1]

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Abstract: Nitrate electroreduction to ammonia is a sustainable alternative for ammonia synthesis, which can solve the water environment pollution and simultaneously turn waste into high-value ammonia. However, as conversion NO_3^- into NH_4^+ involves multielectron transfer reaction that could a series of nitrogen oxyanions and hydrogen as undesired byproducts, it is a mighty challenge to selectively transform NO_3^- into NH_4^+ by designing efficient catalysts. In this work, we reported a Ru_xO_y clusters stabilized on nickel metal-organic frameworks (RuNi-MOFs) and evaluated its electrocatalytic nitrate reduction performance. The catalyst exhibits near 100% NH_4^+ selectively with an NH_4^+-N yield rate of up to 1.37 mg h^{-1} cm^{-2} at -1.7 V vs. Ag/AgCl and a maximal NH_4^+ Faradaic efficiency (FE) of ~73% at -1.2 V vs. Ag/AgCl. The theoretical calculations showed that the intermediate NO_2^- is easy to be further reduced into NH_4^+, which could be contributed to maintain nearly 100% NH_4^+ selectivity. This discovery will provide a new idea for green ammonia synthesis.

Keywords: Nitrate; Selective; Ammonium; Electrocatalysis; Nanoclusters

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[1] J. Qin, et al., J. Mater. Chem. A, 2022, DOI: 10.1039/D1TA09441F.

02 Efficiently Nitrate Electrochemical Ammonia Synthesis via Surface Engineering in Cu_2O [100] Facets[1]

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Abstract: Revealing the reactivity of different exposed facets is crucial for designing high-effective electro-catalysts to selectivity reduce nitrate (NO_3^-) to ammonia (NH_4^+). Herein, two dominant exposures of Cu_2O (100) and Cu_2O (111) facets are designed to explore the effects of interfaces on properties. Cu_2O (100) achieved a relatively high NH_4^+ yield rate of 743 μg h^{-1} $mg_{cat.}^{-1}$ associated with a Faradaic efficiency of 82.3% at -0.6 V versus the reversible hydrogen electrode (RHE), attributed to a relatively lower energy barrier (0.18 eV) for NH_3 production than Cu_2O (111) surface (1.43 eV). Besides, ^{15}N isotope labeling experiments was used to quantitatively analyze the yield rate of NH_4^+ and further confirmed the reliability of nitrogen sources. This work provides a reliable evidence to improve the selectivity of NO_3^- to NH_4^+ by crystal facet engineering.

Keywords: Nitrate; Selective; Ammonium; Electrocatalysis

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[1] Jiangzhou Qin, et al. ACS Applied Energy Materials, 2021, DOI: 10.1021/acsaem.1c02319

03 Stability of nano Ti electrode for simultaneous nitrate removal and magnesium recovery from a mimicked RO brine by the electrochemical-chlorination process

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Abstract: Although nitrate removal from reverse osmosis (RO) brine can be environmentally friendly, without ammonia and nitrite accumulation by the breakpoint chlorination with in situ chloride ion. There is a limitation of electrode stability by the simultaneous hardness ions (such as Mg and Ca) precipitation in previous study of Cu/Zn electrode with simple plate structure. In this study, an efficient nano Ti electrode (ENTE) with nano structure was used to simultaneously remove nitrate and remover Mg from a mimicked RO brine with in situ chloride. More than 78% of nitrate-N was removed completely with energy consumption of 1.7 kWh g^{-1}-N. After 5 cycles of operation, even though the electrode surface was obviously covered by the precipitation that consisted of micron bulk-like and stripy particles (Ca-based mainly) and nano flake-like structured particles (Mg-based mainly), the electrochemical reduction efficiency of nitrate was 73.5% with no significant decrease compared with that in the first cycle and was much higher than that of Cu/Zn (plate structure) in previous study, resulting from the nanotube structure of the ENTE surface. Simultaneous Mg recovery as $Mg(OH)_2$ precipitation from the brine can be efficiently achieved. A potential electrode-control of those byproducts was exhibited, even though chlorination byproducts resulted from the over oxidation of chloride were accumulated during the electrochemical-chlorination process. The results of this study have demonstrated the surface structure dependent stability of the simultaneous nitrate removal and Mg recovery performance, and would also provide new information such as chlorination byproducts distribution and pollutants degradation capacity control in electrochemical treatment of chloride contained wastewater like refining wastewater.

Keywords: Electrochemical-chlorination; Electrode stability; Nitrate removal; RO brine; Magnesium recovery

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04 Highly efficient electro-peroxone process with ozone diffusion electrode for simultaneously removal of pharmaceutical contaminants and pathogenic microorganisms in real hospital wastewater

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Abstract: Herein, a highly efficient electro-peroxone (E-peroxone) process with graphite felt as ozone diffusion electrode (ODE) was developed for the synchronous removal of pharmaceutical contaminants and inactivation of pathogenic microorganisms in real hospital wastewater. Under optimal conditions, the total organic carbon (TOC) removal rate of real hospital wastewater could reach 93.9%. Importantly, 126 of pharmaceutical compounds (antibiotics, antivirals, analgesics, antiepileptics, hormones, and others) were determined in hospital wastewater by using ultra-performance liquid chromatography−quadrupole time-of-flight premier mass spectrometry (UPLC-Q-TOF-MS/MS). 110 of pharmaceutical compounds could be efficiently degraded in E-peroxone system. Concurrently, the microbial community analysis through high-throughput sequencing showed that E-peroxone process exhibited an excellent disinfection effect in real hospital wastewater. Escherichia coli as a bacterial indicator could be completely inactivated in E-peroxone process. H_2O_2 and hydroxyl radical (•OH) were found in E-peroxone system based on the results of chemical probe experiments and electron paramagnetic resonance (EPR) analysis. The in-situ generation of H_2O_2 from cathodic oxygen reduction in ODE can react with ozone to produce •OH, and realize high efficiencies for the elimination of pharmaceutical and sterilization. This work established a green and effective way without extra addition of chemical reagents for high-efficiency treatment of real hospital wastewater.

Keywords: Electro-peroxone process; Hospital wastewater; Pharmaceutical compounds; *Escherichia coli*; Disinfection

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05 Consumer perceptions of marine pollution risks could impact food system nutrition supply and GHG emissions

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Abstract: Seafood is vital for a nutritious and climate-friendly food system but could be overshadowed by food safety risks from marine contamination. A Marine Pollution-induced Food System Risk Assessment and Response (MP-FSRAR) model was developed to investigate the effects of the planned Fukushima Nuclear Wastewater Discharge (FNWD) into the Pacific Ocean on nutrition supply and greenhouse gas (GHG) emissions. Our estimates suggested a protein supply deficit of 740-1360 million kg yr^{-1} and 40-73 million kg $year^{-1}$ nutritional loss of polyunsaturated fatty acids (PUFA), equivalent to a daily protein supply gap of 1.5-2.7 g/person and a nutritional loss of 0.08-0.14 g/person of PUFA, respectively. An additional supply of 3.2-15.8 billion kg yr^{-1} protein-rich foods (e.g., aquatic animals, livestock products, dairy, and pulses) would be required to close the protein gap, increasing 1-79 billion kg CO_2e yr^{-1} global net GHG emissions. The livestock-based substitution pathway would have 40 times higher GHG emissions than the plant-based substitution pathway. We found that a redirection toward plant-based diets represents a viable pathway to mitigate climate change and the potential fallout of the FNWD. Our ex-ante analysis provided new information for global stakeholders to re-evaluate the potential consequences of FNWD and prepare countermeasures for a more resilient and low-carbon food system.

Keywords: food system; consumer perceptions; marine pollution risks; nutrition; GHG emission

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06 Impacts of pulp and paper production on global water resources

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Abstract: The pulp and paper industry consumes large amounts of water and produces considerable water pollutants such as COD and AOX due to its production characteristics, which exacerbates the problem of freshwater scarcity and threatens the quality of water bodies. Research on pulp and paper industry about water has focused on sporadic enterprise survey, environmental standards in individual countries, and the enhancement of specific technologies of water conservation and pollution reduction. The lack of a comprehensive picture and historical evolution of water use and pollution on global and national level may hinder the proposal of more effective policies to reduce water use and pollution in this industry. Here, we quantified water use and water pollution resulting from pulp and paper production at the global and national levels from 1961-2019, and analyzed the potential for water savings and pollution reduction in the pulp and paper industry in each country for 2020-2050 under different scenarios. The results show that global water use for pulp and paper production increased steadily to 3 billion m^3 until the 1990s and declined sharply after 1997. In terms of cumulative volume, the US, the UK, Japan, Germany and China account for more than 70% of global water consumption and major pollution, but the hot spots of have gradually shifted over time from developed countries to China, India, Brazil and Southeast Asia. In 2050, at least 50% of the current pulp and paper technology in each country must be replaced with the best available technology in order to control water consumption to a level lower than that of 2019. The reduction of water pollution will then require an improvement in technologies and management of production, in coordination with moderate measures during wastewater treatment. Based on historical estimation and scenario analysis, we propose country-specific strategies for the pulp and paper industry to reduce water use and water pollution from a water-resources-industry-development perspective.

Keywords: pulp and paper industry; water use; water pollutants; bottom-up modelling

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The intended journal: Environmental Science & Technology

07 Co-adsorption performance and mechanism of nitrogen and phosphorus onto Eupatorium adenophorum biochar in water

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Abstract: In recent years, water eutrophication has become a global environmental problem. Ammonium and phosphorus are the limiting elements for eutrophication of water. Therefore, the removal of ammonium and phosphate is of great significance to control the eutrophication of water and promote environmental health. Among various technologies, the adsorption method is one of the most practical methods for recovering nutrients from aqueous due to its convenience, easy operation and simple design. Biochar is gradually attracted widespread attention due to its lower production cost and its ability to effectively adsorb organic and inorganic pollutants. In this study, invasive plant *Eupatorium adenophorum* was used to prepare biochar under different pyrolysis temperatures for the co-adsorption of nitrogen and phosphorus. The influencing factors of the co-adsorption of ammonium and phosphate onto EBC and its adsorption mechanism were systematically studied. The results show that *Eupatorium adenophorum* biochar (EBC) has rich functional groups and high specific surface area. Low pyrolysis temperature (300°C) and alkaline condition are beneficial for the co-adsorption. The adsorption of ammonium and phosphate by EBC is more in line with the pseudo-second-order kinetics and Langmuir-Freundlich model (Q_{max} is 2.32 mg P/g and 1.909 mg N/g). The adsorption mechanism of nitrogen and phosphorus by biochar was explored using site energy analysis for the first time. Site energy analysis further confirms that electrostatic attraction is the main mechanism. This study shows that EBC could be used as a low-cost and effective adsorbent to simultaneously remove ammonium and phosphate from water. Furthermore, the preparation of *Eupatorium adenophorum* into biochar may achieve the purpose of resource utilization of invasive plants, and solve the problem of eutrophication of water.

Keywords: Invasive plant; Eutrophication; Ammonium; Phosphate; Site energy analysis

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08 Co-metabolism mechanism of Ofloxacin in an aerobic methane oxidation coupled denitrification system

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Abstract: Ofloxacin (OFL), one of representative fluoroquinolone antibiotics, can pose a major risk to ecological environment and is difficult to be degraded in traditional wastewater treatment processes. Hence, a system of aerobic methane oxidation coupled with denitrification (AME-D) was constructed in a batch biofilm reactor to treat antibiotic wastewater containing OFL. As a result, removal rate of OFL reached up to 93.25%. Further analysis of the residual OFL in the sludge showed that OFL was removed primarily by the microorganic biodegradation, with little adsorption. FTIR analysis showed that methane was oxidized to alcohols, and OFL might be degraded into aromatic esters, ketones and aromatic compounds. Metagenomic sequencing showed that OFL could be biodegraded by type-II methanotroph *Methylocystis* (16.44%), *Methylotenera* (2.85%) and *Methylbium* (1.72%), the functional microorganisms in this system. In addition, the system showed a good nitrogen removal effect, and it was proved that methanotroph, nitrifying bacteria and denitrifying bacteria could coordinate removal of nitrogen. *Nitrosospira* (0.10%), *Pseudomonas* (0.53%), *Hypomicrobium* (2.49%), *Nitrospira* (0.15%) and *Thermomonas* (0.73%) were detected in this system. KEGG annotation found that there were complete methane-related metabolic pathways including methane oxidation, Calvin cycle (CBB Cycle), Serine pathway (Serine Cycle) and Ribulose monophosphate pathway (RuMP Cycle), as well as nitrogen metabolic pathways such as nitrification and denitrification. Decoding genes of those key enzymes including pMMO, sMMO, and MDH for methane oxidation in the system were 4622 hits, 3224 hits and 2398 hits, respectively; and AMO decoding genes, *nirS*, *nirK*, *norB*, *narG* and *norC* for nitrogen metabolism were 2792, 2460, 6846, 6896 and 1162 hits, respectively. The results were expected to provide a theoretical basis for removal of residual antibiotics in sewage treatment plants.

Keywords: AME-D; Ofloxacin; Microbial co-metabolism; Biodegradation; Denitrification

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09 Direct Z-scheme Bi2MoO6/UiO-66-NH2 heterojunctions for enhanced photocatalytic degradation of ofloxacin and ciprofloxacin under visible light

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Abstract: Antibiotics in the environment can induce drug resistance in bacteria, thereby increasing the abundance of antibiotic resistance genes. In this work, direct Z-scheme Bi_2MoO_6/UiO-66-NH_2 (BUN-x) heterojunctions are successfully synthesized by a facile solvothermal method. The photocatalytic activities of the flower-like BUN-x composites are evaluated using typical fluoroquinolone antibiotics, namely, ofloxacin (OFL) and ciprofloxacin (CIP), under visible light. The OFL and CIP removal efficiencies using the BUN-100 composite are the highest (100% and 96%, respectively) within 90 min. This good photocatalytic performance is attributed to the Z-scheme charge transfer between Bi_2MoO_6 and UiO-66-NH_2. Moreover, the good stability and adaptability of BUN-100 are verified via recycling experiments, photocatalysis in ambient water, and photodegradation of OFL and CIP mixtures. Additionally, trapping experiments and ESR analyses are performed to identify the active species generated by BUN-100 (·OH, h^+, and $\cdot O_2^-$). Comparisons are made between the active sites and intermediates of OFL and CIP based on DFT calculations and LC–MS results. The degradation mechanism and pathways are also speculated. QSAR analysis predicts that the degradation processes of both OFL and CIP can gradually reduce toxicity. This work provided a new insight for antibiotics removal by visible-light-driven MOF-based materials.

Keywords Photocatalysis; Bismuth molybdate; Metal-organic frameworks; Direct Z-scheme; Antibiotics; DFT calculation

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10 Effective removal of arsenide from aqueous solutions using mesoporous CoFe2O4/graphene oxide nanocomposites assisted by artificial intelligence

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Abstract: This study investigated the arsenide removal by using mesoporous $CoFe_2O_4$/graphene oxide nanocomposites based on batch experiments optimized by artificial intelligence tools. These nanocomposites were prepared by immobilizing cobalt ferrite on graphene oxide and then characterized using various techniques, including small angle X-ray diffraction, high-resolution transmission electron microscopy and energy-dispersive X-ray spectroscopy. Artificial intelligence tools associated with response surface methodology were employed to optimize the conditions of the arsenide removal process. The results showed that back propagation neural network combined with genetic algorithm was suitable for the arsenide removal from aqueous solutions by the nanocomposites based on the minimum average values of absolute errors and the value of R2. The optimal values of the four variables (operating temperature, initial pH, initial arsenide concentration, and contact time) were found to be 25.66 °C, 7.58, 10.78 mg/L and 46.41 min, and the predicted arsenide removal percentage was 84.78%. The verification experiment showed that the arsenide removal percentage was 86.62%, which was close to the predicted value. Three evaluation methods (gradient boosted regression trees, Garson method and analysis of variance) all demonstrated that the temperature was the most important explanatory variable for the arsenide removal. In addition, the arsenide removal process can be depicted with pseudo-second-order kinetics model and Langmuir isotherm, respectively. The thermodynamics investigation disclosed that the adsorption process was of a spontaneously endothermic nature. In summary, this study showed that ANN-GA was an efficient and feasible method in determining the optimum conditions for arsenic removal by $CoFe_2O_4$/graphene oxide nanocomposites.

Keywords: Arsenide removal; Mesoporous $CoFe_2O_4$/graphene oxide nanocomposites; Artifcial intelligence Response surface methodology; Back propagation neural network combined with genetic algorithm

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11 OpenKarHydro: Simulation of the influence of typical vegetation on the long-term soil water balance in the Loess Plateau

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Abstract: To explore the impact of different land-uses (VR: V*igna radiata, SB:Stipa bungean and MS: Medicago sativa*) on the long-term soil water balance in China' s Loess Plateau, OpenKarHydro model was developed based on the field experiments of soil water dynamic monitoring at depths of 0-4 m. The evolution characteristics of hydrological variables including soil water storage, canopy interception, runoff, deep leakage and evapotranspiration were quantified from 2021 to 2050. The results showed that OpenKarHydro gave a good capture of soil moisture dynamics for VR, SB and MS plots with RMSE of 0.058, 0.046 and 0.046 and R^2 of 0.615, 0.605, 0.582, respectively. Different soil water conditions are mainly caused by canopy interception and evapotranspiration. Canopy interception of precipitation is lower in the VR (11.46%) was less than SB (21.93%) and MS (27.73%), and the loss through evapotranspiration was greater in VR (83.74%) than SB (77.46%) and MS (76.77%). Precipitation can afford the water consumption in the VR plot, VR and MS plots emerged in negative water balance. At 1-9 years after MS planting, soil water storage of 0-4 m decreased at a rate of 43.23 mm/a, the depth of the dried soil layer had been reached at 400 cm in the 7th year. OpenKarHydro results indicated that the soil water balance modes varied under different land-uses. Planting vegetation with high-water-consumption could cause negative balance of soil water and led to serious soil desiccation, which then had a negative effect on soil water supply.

Keywords: water balance; land use; vegetation restoration; OpenKarHydro model; long-term evolution

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12 Prediction of Mine Water Inflow Based on Weighted Multivariate Nonlinear Regression and Its Application

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Abstract: Mine water inflow prediction is very significant to the safety production of mines. In order to improve the prediction accuracy of mine water inflow, this paper, on the basis of fully analyzing the hydrogeological conditions of the studied mine, determines the main influencing factors of mine water inflow: precipitation, aquifer thickness, mining area, mining depth, mining thickness and driving footage. Furthermore, correlation analysis and multiple nonlinear regression analysis are conducted to each influence factor, and the entropy method is used to determine the weight of each influence factor to construct a weighted multiple nonlinear regression prediction model of mine water inflow. The proposed model is used to predict the mine water inflow of typical coal mines. The results show: the Mean Absolute Percentage Error of the prediction accuracy is 16.44%; the Root Mean Square Error is only 4.67. Compared with the traditional multiple linear regression prediction model, Mean Absolute Percentage Error is decreased by 29.44%, and Root Mean Square Error decreased by 9.89. The weighted multiple nonlinear regression prediction model makes up for the defect of the traditional method of not considering the importance difference among the factors through weighting.
Keywords: mine water inflow; multiple regression; prediction; multifactor; weighted

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13 Recent Progress on Cathode Material Regulation for Improving the performance of Electrochemical Nitrate Reduction to Ammonia

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Abstract: The accumulation of nitrate from industry and agriculture in the environment breaks the nitrogen cycle and threats human health. The explored methods such as bio-denitrification, chemical reduction, physical, and electrocatalysis reduction methods were applied to remove nitrate, the nitrate electroreduction especially is a promising technique because it can convert nitrate to ammonia without high post-treatment costs, which provides a novel and sustainable alternative for ammonia synthesis under ambient conditions. The reasonable design of electrocatalysts determines the performance of selectively producing ammonia. This minireview emphasizes the strategies to modulate the adsorption by tuning the electronic structure and its surface atom, including defect and crystal facet engineering, heteroatom doping, and alloying strategy. The product detection and intermediates in-situ characterization techniques are discussed to understand the mechanism of electrocatalytic nitrate reduction reaction (NO_3RR). Finally, some challenges and reasonable opinion for exploring novel efficient catalysts for artificial ammonia from nitrate are summarized.

Keywords: Electrocatalysis; Nitrate reduction; Cathode material regulation; ammonia synthesis

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14 Simultaneous reclaiming phosphate and ammonium from aqueous solutions by calcium alginate-biochar composite: Sorption performance and governing mechanisms

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Abstract: Excessive input of nitrogen and phosphorus into water may lead to serious water eutrophication. However, nitrogen and phosphorus are also essential nutrients for plant growth. To reduce water eutrophication and recover nitrogen and phosphorus in water, different types of solid wastes (distillers grains, rice straw, and *Eupatorium adenophorum*) were used to prepare ball-milled biochar, and further synthesize calcium alginate-biochar composite (CA-BC) for simultaneous recovery of phosphate and ammonium from aqueous solutions. The physicochemical properties of CA-BC were characterized by scanning electron microscope (SEM), Fourier infrared spectroscopy (FTIR), Zeta potential, etc. The effects of different conditions (pyrolysis temperature, dosage, solution pH, and coexisting ions) on the adsorption performance were studied. According to the adsorption kinetics, isotherms, and the characterization results of physicochemical properties of CA-BC before and after adsorption, the co-adsorption performance and governing mechanisms of phosphate and ammonium onto CA-BC were explored. The results showed that the alkaline condition was more conducive to the adsorption of phosphate and ammonium by CA-BC than the acidic condition, and the adsorption capacity of phosphate by CA-BC was better than that of ammonium. The maximum adsorption capacities of CA-BC for phosphate and ammonium were 24.0-31.8 mg g^{-1} and 9.90-12.27 mg g^{-1}, respectively. The main adsorption mechanisms for phosphate were electrostatic attraction, surface precipitation, and ligand exchange, while for ammonium were ion exchange and electrostatic attraction. This study indicates that CA-BC could be used as an effective adsorbent for simultaneous recovery of phosphate and ammonium from water.

Keywords: Calcium alginate; Biochar; Phosphate; Ammonium; Simultaneous adsorption

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15 Source-sink process of microplastics in a small catchment basin of Lake Aha, Southwest China

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Abstract: Rivers were major transport pathways for microplastics into the lake but the recognition of source-sink process of microplastics in a small catchment basin remained limited, hindering precise source treatment. Microplastics in the Lake Aha of China were systematically investigated by sampling the estuary water and sediment cores. The impacts of land use and population on the characteristics and abundance of microplastics in watershed-lake system were conducted. Microplastics were detected in all samples, with an average abundance of 608.33 ± 261.57 (mean ± std dev) items/m^3 for water and 1083.33 ± 584.52 items/m^3, 916.67 ± 620.93 items/kg, 501 ± 213.43, in sediment cores (0-5 cm, 5-15 cm, and 15~ cm), respectively, with polypropylene being the most abundant polymers. A generally increasing trend of microplastic abundance from deep to surface sediment was identified, which were attributed to the increased population density and human activity over time. Based on the principal co-ordinates analysis (PCOA), samples in different depth were divided into two classes: agriculture-oriented and urban-oriented types (mainly including surface and middle sediments in S3). Microplastics in different depths were significantly different by the analysis of similarities and divided into agriculture-oriented or urban-oriented types by the principal co-ordinates analysis. Linear discriminant analysis effect size (LEfSe) analysis has potential for source analysis of microplastics. Microplastic characteristics in sediment cores could reflect the changes of land use types in the last 20 years.

Keywords: microplastics; land use; source-sink process; watershed-lake system; sediment cores

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16 Spatial and temporal distribution characteristics of pCO_2 and CO_2 evasion in karst rivers under the influence of urbanization

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Abstract: The carbon cycle in karst areas is a critical part of the global carbon cycle, in which rivers play a vital role in the migration and transformation of inorganic carbon in karst areas. CO_2 in karst rivers is affected by temperature, precipitation and anthropogenic activities with the same as non-karst rivers, but the difference is that CO_2 in karst rivers is more easily controlled by the weathering of carbonate rocks, and the pollution caused by urbanization will accelerate the process of carbonate rock weathering, therefore, karst rivers have higher dissolved inorganic carbon storage than non-karst rivers, and it will be efficiently and fast converted into CO_2 and released into the atmosphere owing to the increase of anthropogenic activities. The dissolved CO_2 in karst river closely with the carbon cycle process in karst areas, there are numerous studies revealed the geochemisry behavior of CO_2 in karst rivers under natural environment. In recent year, the urbanization degree of the karst region in southwest China is accelerating, however, the issue of carbon emissions from karst rivers in urbanized areas has not yet attracted enough research attention, and the spatial and temporal patterns of CO_2 emission are still unclear. Therefore, exploring the CO_2 evasion process of karst rivers affected by urbanization can help understand the potential impact of urban development on karst river ecological environment and global change.

Guizhou is the center of the karst region in the southwest of China, and its provincial capital, Guiyang, is also the most urbanized city in the province. The main stream of Qingshui River flows through the highly urbanized area of Guiyang, while most of its tributaries flow through the suburbs. Therefore, we take the Qingshui River basin as the research object, and the pCO_2 and CO_2 fluxes are derived from model calculations using measured water chemistry indices. The results showed that 95% of the sample sites had positive CO_2 fluxes in three sampled period, this indicated that the area appeared to be a source of atmospheric CO_2. The pCO_2 of the Qingshui River during the wet, dry and flat periods ranged from 371.54 to 5754.40μatm (mean of 1852.58±983.87μatm), 281.84 to 6309.57μatm (mean of 1437.34±958.29μatm), 147.91 to 3890.45μatm (mean of 1055.40±796.46μatm) and the CO_2 fluxes ranged from -0.86~124.59mmol/(m^2·d) (mean of 36.02±24.07mmol/(m^2·d)), -2.32~95.92mmol/(m^2·d)(mean of 18.24±16.19mmol/(m^2·d)), -13.26~179.50mmol/(m^2·d) (mean of 28.63±40.37mmol/(m^2·d)), respectively. On the whole, the pCO_2 and CO_2 fluxes in wet season were higher than in dry and flat seasons, this is related to the abundant biogeochemical processes during the wet season. Spatially, the pCO_2 showed obvious spatial variation in the three hydrological periods, that a trend of high in the western region and low in the eastern region, this coincides with that the river flowing through urban areas performanced higher pCO_2. Therefore, karst rivers affected by urbanization sitll need further research, since it has a higher CO_2 emission potential.

Keywords：Karst rivers; Urbanization; Partial pressure of carbon dioxide; Carbon dioxide flux; Guiyang

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17 Water environment evolution of typical karst underground river system in coal-antimony mining area based on hydrogeochemical analysis

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Abstract: Qinglong County is rich in coal and antimony ore resources, and large-scale mining activities in the mining area produce a large amount of solid waste and mine wastewater that flows into the karst groundwater system. Karst groundwater is an important water resource in southwestern China. Due to the ecological sensitivity and fragility of karst groundwater, mining activities have led to increased levels of heavy metals such as antimony (Sb) in groundwater and similar problems. Therefore, it is of great significance to deeply understand the evolution characteristics and genesis of the water environment of the karst underground river system under the influence of coal-antimony tailings ponds. However, the evolution law of the water environment of the karst underground river system and the migration and transformation of polluted components under the influence of mining activities in the mining area are still unclear. In order to elucidate the evolution of the water environment of the karst groundwater system under the influence of coal-antimony ore, groundwater and surface water were collected from the karst underground river systems (Shuiya Underground River and Longbaiwei Underground River) on both sides of the watershed in Qinglong Antimony Mine. Analysis of heavy metals such as Sb, As and main conventional ions. (1) The content of heavy metals in different underground river systems is different. The content of Sb in the SY underground river system is (0.316-5.554μg/L) and the content of As is (0.118-5.973μg/L); the content of Sb in the LBW underground river system is (0.25-14.35μg/L) L), As content is (0.09-5.07μg/L). Among them, the Fe and Mn contents in the SY underground river are relatively high (0.016-183.2mg/L) and (0.002-17.12), respectively, which are greatly affected by the upstream coal mining area. However, the Fe and Mn contents in the LBW system are relatively low, respectively

(0.01-1.91 mg/L) and (0.001-1.66 mg/L). (2) The variation characteristics of Sb and As elements in the SY and LBW underground river systems are consistent along the direction of the underground river, and the points closest to the coal-antimony slag yard (SY16, SY17, LBW6, LBW7) Sb, As, Fe, Mn element concentration is the highest, and it decays along the way to the outlet of the underground river. The main hydrochemical phases identified in Piper's three-line diagram are: HCO_3-Ca, HCO_3-SO_4-Ca, SO_4-Ca, SO_4-HCO_3-Ca, the weathering and dissolution of widely distributed carbonate rocks and the ion exchange process are the control The most important hydrogeochemical processes of groundwater chemistry in karst regions are also controlled by secondary influences from anthropogenic sources such as mining activities. The main mineral components of the coal-antimony tailings yard were obtained by X-ray diffraction (XRD) technology: calcite, quartz, fluorite, gypsum, dolomite, pyrite, antimonite, etc. The Gibbs plot and bivariate plot reveal the influence of the coal-antimony deposit yard on the karst subsurface and the hydrogeochemistry of the system. The main conclusions include: (1) The chemical composition of groundwater along the karst underground river changes from HCO3-Ca type to SO4-Ca type; (2) The dissolution reaction of pyrite in the solid waste of the mine produces obvious sulfuric acid. Participates in and accelerates carbonate weathering. (3) The hydrogeochemistry in the karst underground river system is mainly dominated by cation exchange. The results of the saturation index calculated based on PHREEQC software show that 70% of the water sample points in SY are in a state of dissolution equilibrium, while 38.5% of the water sample points in LBW are in a state of dissolution equilibrium. 20% of dolomite is in a state of dissolution equilibrium, and gypsum and fluorite are in an unsaturated state (SI<-0.5), indicating that the degree of water-rock interaction is high, and hydrogeochemistry is the main factor controlling the karst groundwater environment (hydrochemical evolution). factors, and thus the extensive mixing and dissolution of contaminants in the mining area has resulted in changes in the overall water environment in the underground river system. This paper mainly introduces the complex water environment evolution process of the karst groundwater system under the influence of the coal-antimony mining area storage yard, and provides a scientific basis for the water environment evolution and pollution prevention and control of the typical karst underground river system under the influence of the mine.

Keywords: Water environment, Antimony, Karst underground river system, hydrochemical characteristics, mining activities

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18 Efficient degradation of acetaminophen in natural pyrite/PMS system

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Abstract: In this study, natural pyrite was used to activate peroxymonosulfate (PMS) for acetaminophen (APAP) degradation. The kinetics of APAP degradation in natural pyrite/PMS system and its mechanism were explored in detail. Additionally, the applicability of natural pyrite/PMS in a series of contaminants and the reusability of natural pyrite was assessed. The results suggested that APAP could be efficiently degraded in natural pyrite/PMS system, specifically, the degradation efficiency up to 99% for 20 μmol L^{-1} APAP was achieved in the presence of 0.5 g L^{-1} natural pyrite, and 0.15 mmol L^{-1} PMS at pH 3.0 after 15 min. APAP degradation in natural pyrite/PMS system was strong pH-dependence. The presence of coexisted ions and fulvic acid had slight impact APAP degradation. Electron spin resonance (ESR) and radical scavenging experiments revealed APAP degradation process largely occurred at the surface of natural pyrite, simultaneously, surface-bonded sulfate radical, surface-bonded hydroxyl radical as well as high-valent iron predominantly participated into APAP degradation at pH 3.0. Moreover, natural pyrite displayed excellent reusability and applicability for a series of romantic contaminants. The results illustrate that natural pyrite/PMS has a great application potential in treatment of refractory contaminants.

Keywords: acetaminophen (APAP); pyrite; peroxymonosulfate (PMS); sulfate radical

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19 The application of an Integrated Two-stage Biofilm Reactor (ITBR) treating Dispersed Domestic Sewage in rural areas

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Abstract: Traditional wastewater treatment technology for distributed domestic wastewater is faced with the challenges of difficult collection, high investment and operation cost. Especially in the economically backward rural areas of Guizhou, typical karst landform is the biggest obstacle to the construction of sewage collection pipe network system. In this study, Integrated Two-stage Biofilm Reactor (ITBR) was designed treatment real decentralized domestic wastewater. The results shown, system reached a stable condition after start-up 43 days. Removal efficiency of chemical oxygen demand (COD), ammonia nitrogen (NH_4^+-N), suspended solid (SS), total nitrogen (TN) and total phosphorus (TP) are reached 94.24%, 88.76%, 94.47%, 85.65%, 82.84%, respectively. Effluent concentration of pollutants was lower than the first level of local rural pollutant discharge standards. Simultaneously, the removal efficiencies of different HRT and temperature were gathered to analyze the stability of contaminant removal. Microbial community analysis shows, *Acinetobacter, Rhodobacter* played a major role in the degradation of organic matter, *Brachymonas, Coriobacteriaceae, norank_o_JG30-KF-CM45, Candidatus, Roseomonas* were mainly responsible for the explanation of nitrogen and phosphorus in sewage. This study provided a practical reference for decentralized wastewater treatment with integrated equipment in the rural area.

Keywords: Dispersed domestic sewage, ITBR, low energy-consumption, shock load resistance

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20 Screening and characterization of a novel Acid Orange 7 degrading Microbacterium sp. and bioaugmentation in an aerobic sequencing batch reactors

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Abstract: Acid orange 7 (AO7) is well known for its toxic and carcinogenic effects on human beings and the aquatic environment. In this study, a highly effective AO7-degrading bacteria strain, LX-1, was screened from the acclimated activated sludge of a dye wastewater treatment system. This strain, identified as Microbacterium sp., utilises AO7 as the sole source of carbon and energy for growth. The influences of culturing factors (initial concentration, pH, and temperature) on the bacterial substrate degradation were studied. The results showed that the optimal AO7 degradation occurred at an AO7 concentration of 50 mg•L-1, 30 °C and pH8.0- 9.0. The decolorization of the bioaugmented SBR reactor was successful under long-term operation. This is the first report of AO7-degrading isolate from the genus of Microbacterium. Strain LX-1 could potentially be employed in bioremediation of AO7.

Key word: Acid Orange 7; azo dyes; Microbacterium sp.; Bioaugmentation

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21 Mechanism and effectiveness of Cu/TiO2 composite nano electrode for electrochemical denitrification

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Abstract: Nitrate contamination of water resources not only endangers ecological environment, but also poses a threat to human health, which has become an increasingly problem for all over the world. Electrochemical denitrification with high efficiency, easy operation, low investment and environmental friendliness, has attracted a large of researchers' interest. However, the traditional electrochemical method has some disadvantages such as a large number of by-products and poor electrode surface activity, which restricts its application in practical engineering.

In this study, a novel Cu/TiO_2 composite nano electrode was developed by electrodeposition to improve the efficiency of electroreduction of nitrate. The surface of composite nano electrode has a regular morphology, TiO_2 nanotubes were uniformly distributed and Cu nanoparticles were evenly distributed on the electrode surface. The surface area and active sites of Cu/TiO_2 composite nano electrode were increased. XPS and XRD analysis results showed that Cu loaded on the surface of the electrode with three forms of Cu^0, Cu_2O and CuO, improved the adsorption and reduction activity of nitrate on the electrode surface. The removal efficiency of nitrate reached 83.5%, which was 1.3 times higher than TiO_2 nano electrode, significantly improved the removal efficiency of nitrate.

Keywords: Cu/TiO_2 composite nano electrode; electrochemistry; anodic oxidation; electrodeposition; nitrate reduction

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22 The influence research on nitrogen transport and reaction in the hyporheic zone with an in-stream structure

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Abstract: The hyporheic zone (HZ) is important for river ecological restoration as the main biochemical processes zone, especially for the nitrogen. However, as the river ecological restoration engineering constructed, it can significantly change the hydrodynamic and solute transportation and reaction processes and it is still not fully understood. In this study, the nitrogen transportation and reaction processes are analyzed in HZ with an in-stream weir structure. A HZ model coupled with the surface water and groundwater is built and verified by the indoor flume experiment with NaCl tracer. Four main species and three occurring reactions are considered to discuss the nitrogen transportation and transformation processes in different weir structure design parameters and porous media permeability characteristics. The results show that the structure height increasing on the overlying surface water can make the species breakthrough the deeper porous media. It promotes the spatial mean reaction rates of nitrification and denitrification and results in the increasing net denitrification in most cases. Also, the increasing buried depth of the structure has the same variance trend of the spatial mean reaction rates as the structure height. The larger permeability coefficients in porous media can enhance the flow exchange and three spatial mean reaction rates increase. The results can help deepen the understanding of nitrogen transport and transformation in HZ and optimize the in-stream structure design parameters and location.

Keywords: Hyporheic zone, in-stream weir structure, Nitrogen, Flume experiment, Numerical simulation

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23 Screening, adsorption characterization, and mechanism of potassium modified-biochar for antibiotic and Cu(II) in water

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Abstract: Antibiotics and heavy metals are frequently detected simultaneously in aqueous environment. In this study, the coadsorption process of sulfamethoxazole (SMX) and Cu(II) on biochar modified by potassium were explored, containing crude biochars (CBs) and artificial biochars (ABs). According to the results of orthogonal experiment ($L_9(3^4)$), the CB which was prepared at 450 °C (CB450) and the AB which was prepared by K_2CO_3 with 1:1 of potassium and wood-processing residue ratio at 600 °C (AB600) were the highest efficient adsorbents. Freundlich model fitted the adsorption process better and the K_f values of SMX were 42.147 and 133.391 (mmol/kg) (L/mmol)^n for CB450 and AB600, respectively. The adsorption amounts of SMX and Cu(II) increased with the increasing of pH among 3-6 and decreased at pH>7. The adsorptions of SMX and Cu(II) were slightly influenced by ionic strength. Hydrogen bond, π-π interactions and oxygen-containing functional groups on biochars participated in the adsorption process.

Keywords: Biochar; Sulfamethoxazole; Copper; Adsorption; Potassium

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24 Quality Matters: Pollution Exacerbates Water Scarcity and Sectoral Output Risk in China

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2.

Abstract: Water scarcity induces potential output losses in local water-using sectors and the economic risks can be transmitted to downstream sectors through supply chains. Water pollution further worsens regional water scarcity and reshapes the economic risks of sectoral outputs. In this study, we examined the spatio-temporal patterns of both quantity and quality-based water scarcity and how water scarcity risks are transmitted in Chinese trading systems. We developed a local water scarcity risk (LWSR) index that measures potential sectoral output loss due to both inadequate water quantity and substandard water quality in each province. We then used the Chinese 2017 Multi-regional Input-Out table to quantify the provincial and sectoral imports and exports of the virtual water scarcity risk (VWSR). Our results show that after considering water quality constraints, LWSR in Beijing, Hebei and Tianjin located in the Hai River Basin increases by 1.93, 1.43 and 1.02 times, respectively. The North China Plain is China's main VWSR export region. Hebei, Tianjin, Henan and Shandong have significant impacts on economic activity in other regions through VWSR exports. Guangdong, Zhejiang, Henan, Jiangsu and Shandong are major importers of VWSR, and their economies are highly sensitive to LWSR from upstream suppliers. We have identified hotspots of sectors in trading system that are highly sensitive to local water shortages, for example, the agriculture, forestry, animal husbandry and fishery, and electricity and gas production and supply sectors in Hebei, Shandong and Jiangsu, as well as the chemical products sectors in Zhejiang, Jiangsu and Anhui. Water pollution further exacerbates water scarcity risk in sectoral outputs. For instance, taking account of water quality restrictions in specific water sectors, the VWSR in agriculture and forestry sectors in Hebei province to food and tobacco sectors in Shandong and Tianjin provinces increases 1.43 times. Our findings reveal the need for different regions to conserve water resources and improve water quality simultaneously to mitigate potential sectoral risks.

Keywords: water scarcity risk; input-output analysis; water quality; sectoral risk

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25 Kinetics and efficacy of membrane/DNA damage to Bacillus subtilis and autochthonous bacteria during UV/chlorine treatment under different pH and irradiation wavelengths

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Abstract: The disinfection efficacy and kinetics of *B. subtilis* and autochthonous bacteria during UV/chlorine treatment under different pH and irradiation wavelengths (254 nm Hg lamp vs 275 nm LEDs) were investigated using the flow cytometry analysis. The inactivation efficiency assessed by different cell viability methods was in the order of cultivability > membrane damage > DNA damage. Compared to UV irradiation or chlorination alone, the UV/chlorine showed the enhanced kinetics and efficacy of cell membrane or DNA damage to *B. subtilis*. These enhancements by UV/chlorine might be primarily attributed to the in-situ generation of radical species HO• and Cl• around intracellular DNA. With pH increasing from acidic to alkaline, the UV254/chlorine showed the decreased kinetics of cell membrane or DNA damage to *B. subtilis* due to the pH-induced decreases of [HO•]ss and [Cl•]ss; while the UV275/chlorine exhibited the increased cell membrane and DNA damage kinetics due to the higher chlorine photolysis rates. When the chlorine dose was not excess, the DNA damage of *B. subtilis* were highly depended on the CT_{FAC} values. During UV275/chlorine in the presence of natural organic matter, the cell membrane damage also showed linear correlations with the decreases of UV absorbance at 254 nm (UVA254), and about 20−25% decrease of UVA254 indicates a sufficient cell membrane damage. Using the CT_{FAC} values and decrease of UVA254, this study has provided the surrogate indicators for fast determining the minimal chlorine dose for sufficient inactivation of bacteria by UV/chlorine treatment.

Keywords: disinfection; UV/chlorine; flow cytometry analysis; chlorine dosing strategy

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26 Novel reutilization methods for spent inorganic cementitious adsorbent（ICA）--a contribution to phosphorus recycling

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Abstract: Many studies focus on producing phosphate adsorbents with high adsorption capacity but fewer studies touch on the reusability aspect. ICA (Patent NO.CN107746224A) has been initially applied as phosphate adsorbent based on its advantages of adsorption efficiency, low-cost and easy-recovery. The present study was designed to explore feasible disposal strategies of phosphate loaded ICA. Firstly, the possibility of P reutilization was investigated by using the adsorbed ICA as P-source to cultivate *Ipomoea aquatica Forsk*, the sample plant dry weight using adsorbed ICA as P-source was (0.40~0.41) ± 0.05 g, which was dramatically increased comparing with the non-P source samples (0.19 g ± 0.07 g). The leaves and the fibrous roots of spinach under ICA-P conditions are more and fresher than others. On another hand, the aim is to use ICA-P as ecological reef to provide phosphorus source for marine microalga *Chlorella vulgaris*. It was found that the accumulation of lipids (17%) at ICA-P concentration of 3 g/L was significantly higher than others (5%~13%). The concentration of superoxide dismutase (SOD) and the intracellular malonaldehyde (MDA) decreased with increasing the content of spent ICA, which indicating the stress effects of phosphate deficiency in C. vulgaris was alleviated by addition of spent ICA. Overall, the fate of phosphate after adsorption is investigated in the literature, which provide some new ideas for where spent ICA goes.

Keywords: spent adsorbent；phosphate；fertilizer；reef；reutilization

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27 ZIF-8-incorporated Thin-Film Nanocomposite (TFN) Nanofiltration Membranes: Importance of particle deposition methods on Structure and Performance

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Abstract: The incorporation of functional nanomaterials is a promising technique to enhance or develop novel material properties, such as improvement of permeability and selectivity related to water purification and reuse. Herein, ZIF-8 nanoparticles were used to prepare the thin-film nanocomposite (TFN) membranes via both two-step in situ growth and one-step blending interfacial polymerization (IP) methods. The primary purpose was to investigate specific effects of different preparation methods and ZIF-8 nanoparticles on the structure and properties of TFN membranes. The results show that ZIF-8 nanoparticles increased the negative charge, roughness, and hydrophilicity of the polyamide rejection layer. The effects of one-step blending method on the TFN membrane characteristics were limited as compared to the two-step in situ growth method. The effective incorporation of ZIF-8 nanoparticles into TFN membranes increased the water permeability of TFN-ZIF-0.64 to 20.8±0.62 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$ and enhanced the Na_2SO_4 rejection to 94.2 ± 3.4%, which is approximately 1.3 times increase in water permeability and 8.0% rise in rejection than those of TFC membrane. Comparatively, two-step in situ growth ZIF-8-modified TFN membranes displayed ultrahigh rejection of typical anionic dyes, demonstrating superior NF performance.

Keywords: TFN membrane, membrane structure, water permeability, rejection performance, MOFs

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28 Characteristics of siderophores secretion in Vegetation-Activated Sludge Process under iron-limited condition

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Abstract: Vegetation-activated sludge process (V-ASP) was comprised of activated sludge and installed decontamination plants, which was proved to have high pollutants removal performances, high resistance to influent loading shocking and seasonal temperature fluctuation, and low greenhouse gases emission, which is believed to be a promising environment-friendly technique for decentralized wastewater treatment. The objective of this study was to evaluate the characteristics of siderophores secretion in V-ASP under iron-limited condition. When the total iron content in the influents reduced to 0.03 mg/L, the COD removal efficiency has not changed in the first week, and following gradually decreased to more than 70.00%, which is about 20% lower than that of the unlimited iron control group. Iron-limited condition also has a negative effect on NH_3-N removal, and the average effluent concentration decreased from 0.8 mg/L to 0.2 mg/L. V-ASP could release iron to the system during operation time under iron-limited condition, the total iron content of effluent was 0.035~0.020 mg/L, compared to the 0.08mg/L in the control group. By using UPLC-TOF mass spectrometry, the siderophores in V-ASP were classified into catechol siderophores and hydroxamates siderophores.

Keywords: Vegetation-activated sludge process；iron-limited；COD；NH_3-N；siderophore

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29 Enhanced Self-powered System with Graphene Oxide Modified Electrode for Simultaneous in-situ remediation of Nitrate-Contaminated Groundwater and River Sediment

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Abstract: Simultaneous in situ remediation of malodorous organic sediment and nitrate-contaminated groundwater was achieved with a novel, enhanced, self-driven three-chamber bio-electrochemical system with Graphene Oxide (GO) modified electrodes. It has been successfully improving the electron transfer efficiency and self-purification ability by the special configuration combining surface water, sediment with underground water. The upper part can be regarded as a Sediment Microbial Fuel Cell (SMFC). The organic sediment serves as available carbon source to provide electrons for the microbes coated on the anode instead of potential pollutants. The lower part is the Biofilm Electrode Reactor (BER). Electrons were synchronously obtained from the loaded biofilm to reduce nitrate. The electricity generated from the upper part was applied directly to the lower part as electrical stimulation to enhance bacterial denitrification of the system. The electron conduction efficiency was further improved by graphene oxide modifying. With a maximum power density of 14.21 W/m^2, as well as the voltage outputs ranging from 700 mV to 900 mV, nitrate removal was accelerated with less accumulation of intermediates compared with the controls without graphene oxide. The maximum output power was increased by 1.5 times and the nitrate removal efficiency (in 10 h) was increased from 89.13 ± 1.4% to 99.9 ± 0.1% after the modification. The organic matter in the sediment decreased by 78% after 270 days simultaneously. Sequencing of the microbial community showed that *Geobacter* and *Anaerolinina* were enriched in the anode. And theα-proteobacteria were enriched in the four experimental groups and had a good effect on nitrate removal especially in the C-GO-SSG system (Carbon felt anode-Graphene Oxide Modified cathode equipped Surface-water Sediment and Groundwater System) after 270 days operation. These results demonstrate that the C-GO-SSG system can be further used to remediation of sediment and groundwater with improved efficiency.

Keywords: Self-driven system; Graphene-oxide modified electrode; Nitrate removal; Sediment microbial fuel cells; Groundwater; Organic matter

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30 Enhanced biological treatment of organic dyes with nanoscale zero-valent iron (nZVI)

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Abstract: Biodegradation of recalcitrant organic contaminants such as organic dyes is a fundamental challenge in wastewater treatment. We report herein the integration of nanoscale zero-valent iron (nZVI) with membrane bioreactors (nZVI-bio system) to achieve enhanced degradation of Congo red (CR) in wastewater. nZVI pretreatment converts the large and bio-recalcitrant CR molecules into smaller and more biodegradable organic compounds in continuous flow stirred tank reactors (CFSTR). The decolorization mechanism by nZVI was ascribed to the chromophore groups of –N=N– of CR breaking, and the main reduction products were 4-Amino-1-naphthalenesulfonic acid and 4,4'-diaminodiphenyl proved by liquid chromatography coupled to mass spectrometry, UV–Vis spectrophotometer, infrared spectroscopy. A nZVI-bio system was experimented continuously for 52 d with a color removal efficiency of 99% and a reduction of chemical oxygen demand (COD) from 167 mg/L^{-1} to less than 70 mg/L^{-1}. However, a conventional biotreatment system treating identical wastewater achieved color removal efficiency of just 30-70% and the COD reduction to 116 mg/L^{-1}. This suggests that nZVI technology can enhance the biological treatment of dyes and the integrated nZVI-bio system has potential for the treatment of recalcitrant organic dyes.

Keywords: Nanoscale zero-valent iron; Biodegradation; Congo red; Continuous flow stirred tank reactor

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31 Comparative study of the effect of loading increments on the mesophilic codigestion of waste activated sludge and food waste: Reactor performance, stability analysis, and microbial community

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Abstract: The performance and stability of mesophilic codigestion of waste activated sludge (WAS) and food waste (FW) were compared in two parallel, continuously stirred tank reactors using high- and low-magnitude loading increments for the loading regimes. The results indicated that a high methane (CH_4) production of 6.98 $L \cdot L^{-1} \cdot d^{-1}$ was realized without volatile fatty acid accumulation via low-magnitude loading increments at a high loading of 26.5 $g\text{-}COD \cdot L^{-1} \cdot d^{-1}$, and this system was more stable and achieved a higher efficiency than the codigestion system that used high-magnitude loading increments at similar loading and operating conditions. Furthermore, higher CH_4 yields of 258-334 $mL\text{-}CH_4 \cdot g\text{-}COD^{-1}$, TCOD removal efficiencies of 64-79%, conversion ratios of 62-88%, and methanogenic activities of 0.37-0.40 $g\text{-}CH_4\text{-}COD \cdot g\text{-}VS^{-1} \cdot d^{-1}$ were consistently maintained via the low-magnitude loading increments during the high-rate period. High abundances of the phyla *Firmicutes* (63.3%) and genus *Methanosarcina* (94.5%) contributed to the high rates and stable operating conditions of the mesophilic system for WAS and FW codigestion using low-magnitude loading increments.

Keywords: Codigestion; Food waste; Loading increments; Loading rate; Methanosarcina; Waste activated sludge

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32 Biochar stretched medium-coarse sand media to remove typical sulfonamide antibiotics during groundwater recharge

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Abstract: The strong leakage of medium-coarse sand（MCS）layer in recharge area of groundwater leads to high environmental risk. Sulfamethoxazole (SMX) and trimethoprim (TMP) are two common sulfonamide antibiotics in surface water and have high ability of migrating to groundwater. In this study, four biochar were prepared and the adsorption effects for SMX and TMP were investigated. Due to high specific surface area and total pore volume, the adsorption capacity of biochar for SMX and TMP increased with pyrolysis temperature. With the influence of pH, the adsorption amount for TMP was more than SMX. The maximum adsorption amounts of the biochars prepared at 700 °C were 54.73 and 67.62 mg/g for SMX, 59.3 and 73.38 mg/g for TMP, respectively. The retention factors were related to the adsorption capacity and fast chamber adsorption rate constants of biochar. We constructed the biochar stretched soil aquifer treatment (SAT) column, which showed better retention for SMX and TMP. The removal rates of SMX and TMP in the biochar stretched SAT was up to 96%, while that of MCS SAT was less than 5%. The addition of biochar greatly improved the retention capacity of pollutants in the medium-coarse sand layer in groundwater recharge area and effectively reduce the environmental risk.

Keywords: Biochar; Medium-coarse sand; Sulfonamide antibiotics; Groundwater recharge

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33 Fluoride enrichment mechanisms and related health risks of groundwater in the transition zone of geomorphic units, northern China

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Abstract: Although groundwater is the primary drinking water source in northern of China, little is known about generation mechanisms and related health risks of high fluoride groundwater at the geomorphic transition zones. Thus, 419 groundwater samples were collected from Zhangjiakou region, where is a typically geomorphic transition zone of the North China Plain and the Inner Mongolia Plateau, to conduct the hydrochemical analysis, geochemical modeling, multivariate statistical analysis, and health risks assessment. From the results, F^- concentration in groundwater had a range of 0.05-9.71 mg L^{-1}. About 37.1% and 26.2% of groundwater samples from Bashang region (BSR) and Baxia region (BXR), respectively, were over the 1.50 mg L^{-1}, which were mainly distributed in the groundwater flow retardation area and/or evaporation discharge area. Thermodynamic simulations demonstrated that F-bearing minerals dissolution and Ca^{2+}/Mg^{2+} removal via calcite/dolomite precipitation primarily governed high-F^- groundwater formation in the whole study area. Competitive adsorption, evaporation, evaporites dissolution and salt-effect also affected F^- enrichment in BSR. Desorption in alkaline environment, ion exchange and human activities played a vital role in F^- enrichment at BXR. The multivariate statistical analysis revealed that the origin of F^- contamination was geogenic in BSR; whereas, it was geogenic and anthropogenic in BXR. Besides, more than 71.8%, 51.0%, 36.1% and 25.5% of the study area exceeded the acceptable level (health index>1) for infants, children, adult males, and females, respectively. The health risks for different groups of people varied significantly and ranked: infants> children> males> females, suggesting that younger people were more susceptible to fluoride contamination. Meanwhile, females were more resistant to fluoride contamination than males. These findings are vital to providing insights on high-F^- groundwater formation, investigate the situation of health risks, and conduct the integrated management for high fluoride groundwater in geomorphic transition zones at northern China.

Keywords: High-F^- groundwater; hydrogeochemical analysis; human health risk; geomorphic transition zone

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34 Functional responses of biofilm and hydrophyte to silver nanoparticles varied with exposure duration in constructed wetlands

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Abstract: As widely used in many kinds of products, silver nanoparticles (AgNPs) are inevitably released into the aquatic environment. Constructed wetlands (CWs) are important sinks of AgNPs, while little is known about the responses of biofilm and hydrophyte functions to AgNPs accumulation in CWs. Given that, we conducted a 60-day experiment exposing to 1 and 50 $mg \cdot L^{-1}$ of AgNPs in CWs. Results revealed that AgNPs accumulation obviously decreased the relative abundance of genes involving to biofilm formation and nitrogen metabolism, whereas increased those in glycolysis process; AgNPs also remarkably decreased key enzyme activities corresponding to nutrient removal. In addition, AgNPs accumulation decreased the hydrophyte activity, causing the decline in the uptake ability to C, N, and P elements. Finally, due to the decline in the whole biofilm and hydrophyte functions under AgNPs exposure, the treatment performance of CWs significantly decreased by 40%-56% of TN and 44%-60% of NH_4^+-N, respectively. Overall, our results firstly revealed the functional response of biofilm and hydrophyte to AgNPs exposure and systematically analyzed the changes of key functional modules of microorganisms based on the metagenomic analysis, as well as the functional emergency response of aboveground and underground tissues of hydrophyte in CWs under AgNPs stress.

Keywords: Constructed wetlands; Silver nanoparticles; Nutrient removal; Biofilm function; Plant activity

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35 Investigating the biological stability of drinking water in aged household connection pipes during supply water quality switching

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Abstract: As continual attempts at the operational level have been made to improve drinking water quality by the use of better source water and/or updating water treatment procedures, switching supply water quality has become one of the most popular operations worldwide. While the treated water at the treatment plants is of superior quality, it has been demonstrated that irregular fluctuations in source water quality can cause water quality to deteriorate throughout distribution, providing a significant health risk to consumers. However, our knowledge of the effects of biological stability in drinking water distribution systems (DWDSs), particularly premise plumbing, during supply water quality change is relatively limited. Over the course of 18 weeks, aged HCPs from two sites in a traditionally treated water distribution area were combined into test rigs and fed in three types of water: conventionally treated water (KA), mixed water (MX), and remineralized RO permeate (RE). 16S rRNA amplicon sequencing were applied on influents, effluents after one-week stagnation in HCPs and biofilm samples before and after the pilot experiments. Following high-throughput sequencing, data analyses were conducted, including primer trimming, error model learning, ASV (Amplicon Single Variants) inference, chimera removal and taxonomic classification. The type of influents was found to be the driving force behind the clustering of influent samples. Furthermore, following stagnation, the drinking water microbiota in influents was fundamentally distinct from that in effluents. Moreover, location was the main factor influencing the microbial communities in both effluents and biofilms after experiment, which suggested that the destabilization of microbiome in HCPs exhibits effects on the drinking water delivering in the DWDSs during supply-water quality switching. Additional SourceTracker2 was performed to predict the sources of microbes, which indicates that biofilm made more contribution in the effluents and biofilms after pilot experiment as compared to influents.

Keywords: 16S rRNA amplicon sequencing；Drinking water microbiome；supply water quality switching

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36 Manganese and Iron Deposits and Biofilms on Pipe Surfaces Promote Dissolved Aluminum Accumulation in Drinking Water Distribution Systems

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ABSTRACT: Aluminum deposits are pervasive in drinking water distribution systems (DWDSs) due to the residual of Al-based coagulants in finished water. They deteriorate tap water quality by increasing turbidity and reducing disinfection efficiency. However, the mechanisms driving the transformation of dissolved Al in finished water to pipe deposits are still elusive. This study investigated dissolved Al accumulation in DWDSs by batch experiments using synthesized water and long-term pipe experiments using water produced by a full-scale water treatment plant. The pipe experiments showed that dissolved Al, which hardly deposited on plastic pipe walls at alkaline pH, could be substantially anchored by the pipe surfaces with Mn and Fe deposits formed from Mn(II) oxidation and the hydrolysis and precipitation of Fe^{3+}. Batch experiments revealed that the synthesized Mn and Fe oxides exhibited a strong capacity of dissolved Al uptake at pH 7.7 and 9.0 (dissolved Al was the dominant Al under this condition). Comparing Al accumulation in chlorinated and unchlorinated pipes indicated that biofilms developed on pipe walls also enhanced dissolved Al accumulation. This study disclosed the essential role of Mn and Fe oxides and biofilms in dissolved Al accumulation on pipe surfaces, which promoted the mechanistic understanding of Al deposit formation in DWDSs.

Keywords: Dissolved aluminum, accumulation, deposits, manganese, iron, biofilms, drinking water distribution systems

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37 Water environmental security assessment and coupling coordination analysis in Haihe River Basin

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Abstract: Water environmental security, which is closely related to economic security and social stability, and has become a limiting factor for sustainable development of Haihe River basin. It is of great significance to reasonably evaluate the current situation and development trend of water environmental security and identify the key driving factors. Under the guidance of water environmental security theory, the water environmental security assessment index system was constructed under the framework of Pressure-State-Response model from aspects of economy, population, water resource quantity and water pollution to comprehensively and reasonably assess the water environmental security status of Haihe River basin and grasp its coupling development trend and key driving factors. An improved fuzzy comprehensive evaluation method and coupling coordination degree model were applied to evaluate water environmental security and analyze coupling coordination respectively. Furthermore, the key driving factors affecting water environmental security were further identified. The results show that, from 2009 to 2019, the overall safety degree of water environmental security in Haihe River Basin increased from 2.19 to 3.25. It changed from an endangered disorder status with state-response lagged to the preliminary coordinated development status with state lagged. Among the indicators, some were always at a relatively safe or very safe level, such as the proportion of the value added of the tertiary industry in GDP, which effectively alleviated the pressure of water environment security in the basin, while population density will continue to increase the pressure of water environment in the basin for a period of time. The proportion of river in class I-III was still at a relatively dangerous level, which was an important reason for the lag of state of water environment. The exceeding ratio of ammonia nitrogen and total phosphorus had greatly reduced, which effectively improved the overall water environmental safety degree. In the medium- and long- term, the treatment of ammonia nitrogen and total phosphorus pollutants will be an effective way to continuously improve the water environmental safety degree of Haihe River Basin.

Keywords: water environmental security；assessment；PSR model；coupling coordination degree；Haihe River Basin

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38 Deep investigation on different effects of Cl^- in transformation of reactive species in Fe(II)/NH_2OH/PDS and Fe(II)/NH_2OH/H_2O_2 systems

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Abstract: Hydroxylamine (NH_2OH) has been verified to efficiently strengthen pollutants oxidation in Fe(II)/peroxydisulfate (PDS) and Fe(II)/H_2O_2 systems. However, the different effects of hydroxylamine salts types were rarely recognized. Herein, the effects of two commonly used hydroxylamine salts (i.e. $NH_2OH \cdot HCl$ and $(NH_2OH)_2 \cdot H_2SO_4$) on oxidation kinetics and reactive species composition were compared in Fe(II)/PDS and Fe(II)/H_2O_2 systems for the first time. Pseudo first order kinetics could only describe benzoic acid (BA) oxidation well in Fe(II)/NH_2OH/H_2O_2 system, which was related to the different concentration changes of Fe(III) determined by [Oxidant]/$[NH_3OH^+]^2$. Hydroxylamine salts types influenced not kinetic rules, but reaction rates of target compounds. The empirical reaction rate constant of BA in Fe(II)/$NH_2OH \cdot HCl$/PDS system was 141.5% of that in Fe(II)/$(NH_2OH)_2 \cdot H_2SO_4$/PDS system under the same concentration of NH_2OH (1.4 mM), while the apparent reaction rate constant in Fe(II)/$NH_2OH \cdot HCl$/H_2O_2 system was 68% of that in Fe(II)/$(NH_2OH)_2 \cdot H_2SO_4$/H_2O_2 system. This opposite effect resulted from the differences in primary reactive species compositions and their interactions with Cl^-. Reactive species identification indicated that Cl^- would decrease the contribution of ferryl ion (Fe(IV)) and transform sulfate radical ($SO_4^{\cdot -}$) to hydroxyl radical ($\cdot OH$) in Fe(II)/NH_2OH/PDS system, while it competitively consumed the only reactive species $\cdot OH$ in Fe(II)/NH_2OH/H_2O_2 system. This study highlights the importance of reductants types on strengthening Fenton oxidation and offers a reference for reasonable construction of the relevant systems.

Keywords: Hydroxylamine; Peroxydisulfate; Hydrogen peroxide; Reactive species; Chloride ions

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39 Sustainable modulation of anaerobic malodorous black water: the interactive effect of oxygen-loaded porous material and submerged macrophyte

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Abstract: The depleted oxygen (O_2) in the sediment and overlying water of malodorous black water poses a potential threat to aquatic ecosystems. This study presents a method for sustainable regulation of the dissolved oxygen (DO) levels towards the malodorous black water. Oxygen-loaded natural porous materials were prepared through vacuum degassing to remove air from the pores, then filling with pure O_2. Capping anaerobic sediment with the prepared 6 oxygen-loaded porous materials was effective in prompting DO concentration of the malodorous black water. Despite Granules activate carbon (GAC) displayed the highest oxygen-loading capability, oxygen-loaded volcanic stone additive were more efficient for long-lasting combating of the anaerobic condition, as DO level at sediment-water interface (SWI) and DO penetration depth showed approximately 5.38- and 3.75-fold increase than the untreated systems, respectively. The improvement of DO could be substantially enhanced in the presence of submerged macrophyte (*Vallisneria natans*), during which the releasing of O_2 from oxygen-loaded volcanic stone facilitated the plant growth. Under the joint efforts of O_2 releasing from volcanic stone and photosynthesis by the macrophytes, the DO levels maintained at approximately 6.80 mg/L after 41 days incubation, which farly exceeded ($P<0.05$) the value in only oxygen-loaded volcanic stone or macrophytes added treatments. In addition to the elevated DO level, the combined employment of oxygen-loaded volcanic stone and macrophytes triggered negative NH_4-N flux across SWI and 85.82% reduction of methane (CH_4) production compared to that without treatment, accompanied by the decline of total inorganic carbon and 2.55- fold increasing of submerged macrophyte biomass, presumably attributing from nitrification, remineralisation, and assimilation. The results obtained here shed a degree of light on the sustainable modulation of anaerobic condition in malodorous black water.

Keywords: Anaerobic, Sediment, Black water, Submerged macrophyte, Capping, Microelectrode

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40 Evidence of phosphorus release from sediments controlled by the reductive dissolution of iron-bound phosphorus in seasonal hypoxic reservoir

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Abstract: Reservoirs in southwest China are encountering the challenge of emerging eutrophication which attribute to increase loading of phosphorus (P). However, high-resolution studies of release mechanisms of P in sediment are lack in those reservoirs until now. Here, monthly monitoring (Nov 2017 to Oct 2018) using diffusive gradient in thin films (DGT) was conducted to determine the distributions of DGT-P (Fe) in Hongfeng Reservoir sediment. Results showed that the mean concentrations of the DGT-P (Fe) in surface sediments were 0.63±0.24 mg/L and 4.61±1.12 mg/L, respectively, with significantly higher concentrations during summer hypoxic period than that during winter aerobic period. Significant positive correlation (r^2>0.70, $p<0.001$) between DGT-P and DGT-Fe suggesting that the simultaneous release of P and Fe from sediments and P release is controlled by the reductive dissolution of Fe-bound P. Release rates of P ranged from 0.01 to 0.83 mg/(m^2·d) (mean: 0.22 mg/(m^2·d)) in Hongfeng Reservoir are higher than that in severely eutrophic shallow lakes in eastern China, such as Lake Taihu. Taken together, higher loading, stronger reactivity, faster release rates and higher pollution potential of P in seasonal hypoxic reservoirs of southwest China than that in natural shallow lakes of eastern China highlighting the importance and urgency of treating internal P pollution. Further studies should be paid on the transport and controlling factors of coupled Fe-P-S cycle in sediments for reducing eutrophication in seasonal hypoxic reservoirs in southwest China.

Key words: Eutrophication, Phosphorus, Diffusive gradients in thin films (DGT), Seasonal hypoxic reservoirs, Southwest China

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41 Fuel from Within: Can Suspended Phosphorus Maintain Algal Blooms in Lake Dianchi

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Abstract: Extensive algal blooms in surface water are a pressing issue in Lake Dianchi because lake restoration is very difficult due to complex and variable phosphorus (P) sources in the water column. P released from algae, suspended particles (SS), and sediment may provide sustainable P sources for algal blooms. However, there is little information on P speciation in these substances from different sources. Here, chemical sequential extraction and solution ^{31}P Nuclear Magnetic Resonance (^{31}P NMR) were employed to identify P speciation in algae, SS, and sediment, along with differences among them. The results showed that dissolved inorganic P (P_i) could be directly accumulated in algae in form of orthophosphate (Ortho-P) and pyrophosphate (Pyro-P). P_i was preferentially utilized by algae during growth and reproduction, followed by organic P (P_o) in the water column. Ortho-P, orthophosphate monoesters (Mono-P), orthophosphate diesters (Diester-P), and Pyro-P in all samples were identified by using ^{31}P NMR. The average amounts of Ortho-P, Mono-P, Diester-P, and Pyro-P released from SS during or after SS sedimentation were 4.5 t, 10.4 t, 0.8 t, and 3.6 t, respectively. H_2O-P_i, $NaHCO_3$-P_i, and P_o were the main P species from algae and SS, which cumulatively accounted for 93% and 86% of total P (TP), respectively. NaOH-P_i and HCl-P_i were the main P species from sediment, which cumulatively accounted for 63% of TP. P released from SS (including H_2O-P_i + $NaHCO_3$-P_i + P_o) during or after sedimentation was 49.8 t, which would increase the concentrations of dissolved P_i by 0.03 mg L^{-1} in the water column. The above results provide far-reaching insights into P transformation and degradation in algae, SS, and sediment. Particularly, released labile P_i and remineralization of P_o from SS play an irreplaceable role in sustaining algal blooms in surface water.

Keywords: Solution phosphorus-31 nuclear magnetic resonance; Chemical extraction; Organic phosphorus; Phosphorus cycling

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42 Niche and interspecific associations of *Pseudoanabaena limnetica* - exploring the influencing factors of its succession stage

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Abstract： In aquatic ecosystems, the dynamics of ecological parameters play an important role in community organization. To understand the changes in the phytoplankton community structure in karstic reservoirs, the Hongfeng reservoir in Guizhou plateau was monitored monthly from 2016 to 2019. The results showed that the dominant organisms in phytoplankton comprised five phyla and twelve species during 4 years, among which the proportion of abundance of *Pseudoanabaena limnetica* begin to rise in 2018 and reached 46.57% in 2019 (the highest during the study period). The niche breadth (0.259–0.925) and overlap value (0–0.991) of *P. limnetica* have an obvious seasonal trend and are significantly affected by environmental factors such as water temperature, nutrients, and interspecific competition. This is primarily reflected in the high adaptability of the dominant species to changes in the N:P concentration ratio in water. Variance Partitioning Analysis (VPN) results show that the diffusion degree of *P. limnetica* is the result of the interaction between internal (*i.e.* interspecific competition, with a contribution rate of 13.4%) and external (*i.e.* environmental factors, with a contribution rate of 86.6%). The greater the external influence, the higher the diffusion degree. The results of niche-based theories and neutral-based theories showed that the stable community structure (variance rate (VR > 1)) and the excessive fast diffusion rate of dominant species (migration rate (m = 0.84)) may lead to the risk of *P. limnetica* and other toxic filamentous cyanobacteria blooms. The results provide basic data for the study of early warnings regarding phytoplankton community succession and cyanobacteria blooms in large reservoirs in the karst areas.

Keywords: Phytoplankton; *Pseudoanabaena limnetica*; Niche; Interspecific associations; Hongfeng Reservoir

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43 Effect of cascade damming on microplastics transport in rivers: a large-scale investigation in Wujiang River, Southwest China

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Abstract: Rivers are the important channels for transporting microplastics into the ocean from land. Prosperous dam construction significantly changed the hydrodynamic conditions and connectivity of rivers, thereby reducing the flux of microplastics to the ocean. However, this process currently lacks verification for the large-scale watersheds. In this study, we investigated the Wujiang River, a tributary of the Yangtze River that spans a total length of 1037 km, to evaluate the interception of cascade dams on microplastics. The results are as follows: 1) The temporal and spatial distribution of microplastics in the Wujiang River Basin is uneven. The middle reach (606.6-1046.2/kg) exhibits a high pollution level while the upper and lower reach exhibits relatively low pollution levels. Under the influence of cascade reservoirs, the small-sized microplastics of 0-0.5 mm are easily migrated downstream while the large-sized microplastics of 0.5-5 mm tend to settle. 2) The earliest microplastics in the Wujiang River Basin were found in the sediments of 1962. The abundance of microplastics in the sediments in seven reservoirs increased over time, impling the contribution of increasing human activities to microplastic pollution in the watershed. 3) Positive correlations between the abundance of microplastics in sediments and local gross domestic product (GDP) ($n=33$, $R^2=0.894$, $p<0.05$) and negative correlations between microplastics abundance and reservoir basin area ($n=33$, $R^2=0.422$, $p<0.05$) revealed that GDP and watershed area are the key factors that control the spatial distribution of microplastics in the watershed. The flourishing artificial dams all over the world are likely to form a large number of hot spots of microplastics in the cascade reservoirs along the rivers. Our results are helpful to understand the migration of microplastics between terrestrial and marine ecosystems.

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