中文摘要集

固定化生物炭基强化低温环境下人工湿地反硝化效能研究

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摘 要 针对人工湿地低温脱氮效能差的问题，构建了四种不同基质（砾石、砾石+海藻酸钙颗粒、砾石+海藻酸钙固定化生物炭颗粒、砾石+粉末生物炭）的人工湿地，研究低温环境下（6-8°C）添加固定化生物炭颗粒对反硝化效能的影响。结果表明，以固定化生物炭颗粒为基质，可以显著强化氮的去除，其中反硝化速率提高了 76.8%，N_2O 释放量降低了 83.2%。通过机理分析可知，固定化生物炭颗粒可以促进糖酵解过程，增加电子传递系统的活性与微生物反硝化的关键性酶活。微生物群落分析表明 *Pseudomonas* 和 *Flavobacterium* 是最主要的反硝化菌属，且以固定化生物炭颗粒为基质可分别增加相对丰度 28.3%和 31.7%。该研究表明，以湿地衰亡植物制备成的生物炭作为人工湿地新型碳基填料，可显著提升低温环境下湿地系统的反硝化脱氮能力并抑制强温室气体 N_2O 排放，研究成果可广泛应用于寒冷地区强化脱氮。

关键字 人工湿地；低温脱氮；固定化生物炭；反硝化；酶活性

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生物接触氧化法处理雨水径流污染方案研究

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摘　要：暴雨冲刷城市地表而产生的初期雨水被认为是影响城市河道水质的重要因素之一，但由于其具有污染负荷较大、随机性较强、有明显季节性等特点，需要选择适合的方式处理后排放河道。作为一种成熟的好氧处理工艺，生物接触氧化法已经普遍应用于污水处理中，并取得良好效果。本文以安徽省合肥市十五里河上游市区河段为例，通过分析初期雨水水质情况及生物接触氧化法处理原理，研究了生物接触氧化法处理初期雨水的适用性，并针对初期雨水的特点制定相应方案，以保证处理效果，维持微生物在晴天活性，旨在为河道面源污染处理提供指导，拓展生物接触氧化法的应用范围。

关键词　接触氧化法；初期雨水；十五里河；河道治理

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多巴胺改性环糊精材料吸附及抑菌性研究

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摘　要　在吸附去除水中污染物的过程中，吸附材料疏松多孔的结构可能会成为微生物的生长繁殖的载体，进而产生出水微生物超标的风险。本研究采用酯化交联反应制备出环糊精柠檬酸聚合物 CD-CA,通过多巴胺单体在有氧、避光的环境下自聚，生成多巴胺改性环糊精材料 CD-CA/PDA，以材料表面还原性的酚羟基团还原银离子，原位生成纳米银颗粒（Ag NPs），构筑出一种兼具吸附-抗菌功能的环境材料。

通过红外分析（FT-IR），X 射线光电子能谱（XPS）分析了材料改性前后的表面基团及元素变化；通过扫描电子显微镜（SEM）、场发射电镜（FESEM）等观察了材料的形貌变化。结果证明，在银含量较低的情况下，聚多巴胺较好地分散作用解决了 Ag NPs 的团聚现象。该材料对水中染料亚甲基蓝（MB）吸附性能优异，但随着银含量的提升，该吸附剂对 MB 的吸附性能(吸附容量和吸附速率)有所下降。这是由于 CD-CA/PDA 表面的邻苯二酚基团对 Ag^{+}进行了还原反应，从而自身被氧化为苯醌基团，丧失了部分吸附位点。

选择大肠杆菌（E.coli）及金黄色葡萄球菌（S.aureus）两种模式菌，进行了抑菌圈实验和菌落形成单位实验。抑菌圈形成实验表明，随着银含量的逐渐提升，抑菌圈逐渐变大，材料的抑菌效果随着银含量的提升而提升。吸附抗菌材料的菌落形成单位抑菌实验表明，在溶液中该材料的抑菌效果由银离子的释放情况、材料的颗粒度以及材料本体银的含量共同决定，其中材料本身银含量是决定性因素。银含量较低的吸附抗菌材料（CD-CA/2PDA 0.5gAg）既保留了 CD-CA/PDA 较强的吸附性能，又有对 E.coli 和 S.aureus 较强的抗菌性能，可以应用于染料、重金属及微生物废水的实际处理。其吸附效果如图 1 所示。

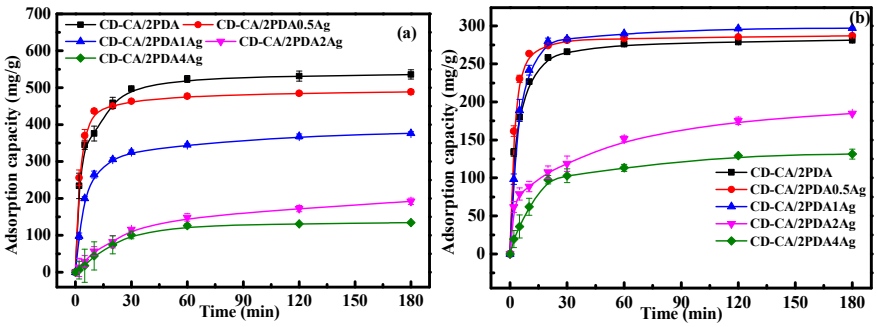

图 1 CD-CA/PDA 及不同载银量的改性材料处理 (a) 600 mg/L 及(b) 300mg/L 的 MB 溶液时吸附量随时间的变化

抗菌机理分析得出，主要有三个抗菌机制在发生作用：1.微生物在含银材料表面附着，表面银颗粒直接破化了细胞壁结构以及影响了细胞膜的通透性。2.材料颗粒在溶液中释放银离子直接进入细胞内部与细胞内蛋白质等重要物质结合使细菌失活。3.材料颗粒内的 Ag NPs 在氧化过程中释放 ROS 直接破化细胞壁和细胞膜进入细胞内氧化不饱和脂肪酸和蛋白质等。

关键词　环糊精；吸附；纳米银；聚多巴胺；抗菌

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常州市永安河小流域生态适宜性评价

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摘　要：基于生态修复目标，为期 3 年对江苏省常州市永安河小流域污染河流向自然状态河流演替过程中水质、生物多样性、生物完整性和水生态服务功能方面进行监测并筛选指标，对河流进行综合评价。结果表明，研究区域恢复过程中水质显著提高（从黑臭到劣五类），鱼类多样性 2018 年较 2017 年有明显的增加，并与污染物浓度呈现负相关。底栖动物从无到有，浮游植物及微生物的群落丰富度、群落结构及功能都得到改善。同时水体臭味减轻，水体不再浑浊。以上指标较好地反映出永安河小流域河道的恢复状况。综上，依此构建适用于研究区域的易于获取、便于操作的城市河流生态适宜性评价体系以及评价标准，以此来反映河流的恢复能力、水体的自净能力及生态修复效果，从河流生态适宜性的视角力求为城市河流的生态恢复奠定基础，为污染河流的综合治理提供数据支撑。

关键词：水质；生物完整性；水生态服务功能；生物多样性；生态适宜性评价体系

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水处理无机膜的功能化设计及抗污染策略

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摘　要：近年来，随着我国工业化规模的扩大和人口的激增，水资源短缺和水污染问题已经成为制约我国生态环境与人类健康的重要因素之一。为减轻水污染和满足纯水供应，发展新型水处理及资源化技术用来分离纯化传统的废水资源如高盐废水、含油废水、新兴微污染物废水等十分有必要。膜技术作为一种高效节能、环境友好的新型分离纯化技术，在水处理领域得到了广泛的应用。无机陶瓷膜或金属膜在环境工程领域目前所面临的关键瓶颈问题有高制备和使用成本、膜分离性能衰减、膜污染加剧等，研制高性能抗污染分离膜，实现分离过程污染物的降解消除、废水资源的深度处理已成为大势所趋。针对工业过程高温及常温含油废水难处理等技术瓶颈，设计了特殊结构陶瓷基复合膜，重点关注膜表面化学、膜结构模型、膜污染机制，实现了对油的截留率保持在 99.9%以上。针对废水中新兴微污染物难处理等问题，提出了新型陶瓷膜结构设计构筑，在陶瓷载体上原位负载纳米催化剂，实现废水中有机微污染物的高效降解，并阐明了污染物降解机理模型；针对现有分离膜长期热稳定性和疏水性差，膜污染、通量和脱盐率性能衰减严重等问题，提出了一种耐热超疏水新型结构陶瓷复合膜设计思想，从微观层面上重点研究了陶瓷-碳纳米管复合膜的结构与模型、复合膜的表面化学及电化学辅助强化膜抗有机污染的微观机制；针对高含盐、高有机质工业废水的特征及水处理应用过程中陶瓷膜的脆性和较差的加工处理能力，充分利用不锈钢基质膜的高强度、高通量、良好的韧性及导电特性，在不锈钢载体上原位生长碳纳米管功能层，构筑形成超疏水（水接触角 171°）不锈钢碳纳米管复合膜。通过负极化微电场（-2.0 V）辅助强化膜蒸馏过程，进而提出通过静电排斥和电子供应机制共同实现抗污染和抗腐蚀功能。最后，利用纳米复合中间层构造正渗透无机膜，实现了低能耗低污染的高性能脱盐应用。以上工作期望被推广到其他无机载体体系和更多的水处理应用领域。

关键词：水处理；无机膜；结构调控；功能化；抗污染策略

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饮用水 UV-LED 消毒技术的应用与展望

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摘　要　紫外/氯组合工艺可高效去除水中新兴污染物和快速灭活致病微生物，且容易在净水工艺中实现，是本领域新近颇为关注的高级氧化技术。然而，现有工艺低压汞灯激发波长单一、自由氯光解效率低、可调控性差、卤代消毒副产物产量高，难以发挥工艺最佳效能。紫外发光二极管（UV-LED）具有发射波长任意可调、运行方式多样、光电转化率高等独特优势，有望解决现有工艺存在的问题。本文以基于 UV-LED 的紫外/氯组合工艺调控理论和应用方法为研究重点，通过可调 UV-LED 与 HOCl/OCl⁻耦合光解，系统性探究了多波长 UV-LED /氯组合工艺中污染物腐殖酸（HA）降解动力学特征和安全风险。结果发现，与低压汞灯相比，以 275 和 310 nm 等波长的 UV-LED 作为光源在中性及碱性条件下可促进自由氯光解产生更多的活性自由基，从而有效提高紫外/氯高级氧化工艺在实际水体碱性环境中对有机污染物的降解效能。同时，275 nm UV-LED 较 254 nm 低压汞灯实现了自由基产生比例提升，通过增强对前体物的矿化效果，有效削减各类高致毒性消毒副产物（DBPs）及其前体物，保障了组合消毒工艺的安全运行。综上所述，UV-LED 作为新型紫外光源具有很好的应用前景。

关键词　饮用水处理；UV-LED；消毒方法；消毒副产物；毒性

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基于模型的低负荷运行村镇污水厂问题诊断分析

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摘　要： 我国村镇污水处理厂普遍存在进水量和进水浓度偏低的问题，导致村镇污水厂运行稳定性差。为防止低负荷运行影响污水处理厂处理效能的发挥，以临太湖村镇污水厂多点进水倒置 AAO 工艺为研究对象，以数学模型为基础，建立污水厂水质水量动态响应模型。以数学模拟为主要研究手段，以试验作为补充方法，通过模型诊断发现，该厂夏季曝气过剩，活性污泥 MLVSS/MLSS=0.37。试验结果表明，该厂进水 ISS 浓度 57~92 mg/L，ISS/SS 为 0.71~0.82，ISS/COD 为 0.50~0.84。进入 AAO 系统的 ISS 粒径范围在 36 μm～52 μm，小粒径的 ISS 组分是导致活性污泥 MLVSS/MLSS 偏低的主要原因。通过优化泥龄、污泥回流比、曝气量，结果表明，出水水质稳定达到一级 A 标准，污泥活性提高到 0.7，全年曝气可节省约 10%。

关键词 村镇污水厂；低负荷；模型；诊断分析

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漓江流域饮用水源地水体重金属污染特征及健康风险评价

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摘　要　为了解漓江流域饮用水源地水体重金属污染水平，在2019年5月对漓江干流采集62个表层水样，对水样中As、Cd、Cr、Mn、Cu、Zn、Hg、Co和Sb 9种重金属的浓度进行了分析检测，运用美国环境保护署(US EPA)推荐的健康风险评价模型对其引起的健康风险进行了初步评价。结果表明：水样中重金属平均浓度顺序为：Mn＞Zn＞As＞Cr＞Cu＞Sb＞Co＞Cd＞Hg，其均值都未超过《生活饮用水卫生标准(GB 5749-2006)》规定的标准限值，且符合《地表水环境质量标准(GB 3838-2002)》I类水质标准。从空间分布来看，As、Cr、Zn和Sb的高含量区主要分布在漓江下游,而Cd、Cu、Hg、Co和Mn高含量区主要分布在漓江上游。多元统计分析结果显示，Cd、Mn、Cu和Co主要来源于农业生产；Cr、Zn、Sb主要来源于旅游交通运输；As主要来源于岩石母质风化和土壤侵蚀；Hg主要来源于大气汞污染物的干湿沉降。健康风险评价结果表明，儿童比成人更易于受到重金属污染的威胁，化学致癌物重金属通过饮水途径对人体健康危害的个人年均风险远远超过非致癌物的年均风险，Cr的个人年均风险最大值大于国际辐射防护委员会(ICRP)推荐的最大可接受风险水平(5.0×10^{-5} a^{-1})；非致癌重金属个人年均风险(10^{-14}~10^{-9} a^{-1})呈现出Co＞Cu＞Hg＞Zn＞Sb＞Mn，均远低于ICRP推荐的最大可接受水平。

关键词　漓江流域；饮用水源地；重金属；来源解析；健康风险评价

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体积排阻色谱联用型有机氮检测器的研制与应用研究

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摘　要　测定溶解性有机氮（DON）和无机氮（DIN）是探究天然生态水体中氮循环转化和控制工程水中与氮相关水质指标的重要基础。根据国家标准《GB 11894-89》，水与废水中溶解性有机氮测定方法主要基于差减法，即在溶解性总氮（TDN）测定的基础上减去溶解性无机氮（NH_4^+、NO_3^-和NO_2^-），间接推算出 DON 浓度。然而根据误差传播规律，即使每次测量误差均能控制在可接受范围内，但在加减的过程中依旧累积 TDN、NH_4^+、NO_3^-和NO_2^-多方面测量误差，导致基于差减法测定的有机氮始终存在准确度低的问题，在一定程度上限制了溶解性有机氮的分析研究。

为提高有机氮测定准确性，德国 DOC-Labor 公司 Huber 博士研制了直接测定 DON 的色谱联用型有机氮-有机碳（LC-OND/OCD）检测系统，系统的技术实现主要取决于三大关键基础：（1）基于体积排阻色谱（SEC）的尺寸排阻效应分离 DON 与 DIN；（2）采用石英微流控技术，紫外氧化含氮物质形成硝酸盐；（3）搭配紫外吸收检测器在 λ =220 nm 处定量硝酸盐浓度。然而 LC-OND/OCD 系统中氧化模块流速低和石英螺旋管内径大（1.0 mm），导致色谱峰峰宽过大，难以分离低分子量有机氮与硝态氮/亚硝态氮。为此 Chon 提出对于高 DIN/TDN 的污水水样，采用电渗析作为预处理方法去除 DIN 以解决色谱峰重叠严重的问题，但电渗析预处理法操作繁琐、耗时且复杂，同时存在低分子量化合物的吸附、渗透或生物降解，造成 DON 损失。

本研究采用了三种新方法提高 DON 与 DIN 分离度：（1）增长体积排阻色谱柱长度；（2）选用低排阻极限和渗透极限体积排阻色谱柱填料；（3）缩小氧化模块石英螺旋管内径，控制氧化停留时间，减小色谱峰扩散。本研究中开发了一套可与实验室液相色谱联用的紫外氧化独立装置，评价了氮回收率与氧化停留时间的关系，提升了体积排阻色谱中有机氮与无机氮的分离度。基于体积排阻色谱和石英螺旋管的改进应用，本文成功建立了基于体积排阻色谱联用型有机氮检测器，实现了高 DIN/TDN 比值污水和地表水样中有机氮的准确测定，还可同步直接测定亚硝氮、硝氮、氨氮以及溶解性总氮。

关键词　体积排阻色谱；氮检测器；溶解性有机氮；硝态氮；亚硝态氮；氨氮

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无光环境下三碘甲烷降解行为研究

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摘　要　本研究聚焦三碘甲烷在无光环境中（如输水管网、热水器等）的降解行为。通过考察无光环境下，液氯浓度、初始浓度、温度和 pH 等因素对 48 小时内三碘甲烷降解的影响，发现在缺少光源照射和自由基存在的情况下，随着液氯浓度从 0mg/L 增加到 4 mg/L，三碘甲烷降解速率常数从 0.00356 h^{-1} 增大 0.03439 h^{-1}；当三碘甲烷的初始浓度从 20 μg/L 增加到 100 μg/L 时，其降解速率常数从 0.0021 h^{-1} 增大 0.00356 h^{-1}；同一 pH 条件下，50°C 时的三碘甲烷降解速率常数比 20°C 时要高，说明温度的升高能一定程度促进三碘甲烷降解；pH 分别为 6.5、7.0、7.5 和 8.0 时，三碘甲烷的降解趋势为：中性环境 > 弱碱性环境 > 弱酸性环境，降解速率常数的变化表明 pH 对三碘甲烷的降解是存在一定影响的。从三碘甲烷在 48 小时的降解情况来看，上述几种影响因素在无光环境下对三碘甲烷的降解有影响，但这种影响相比于有光环境的降解来说并不显著。鉴于三碘甲烷在无光环境下的稳定性，建议日常生活中，在使用自来水时可在光下放置一段时间再使用，尽量减少或避免三碘甲烷可能带来的健康风险。

关键词　碘代消毒副产物；无光环境；三碘甲烷降解

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电诱导臭氧气浮准 IV 类水提质增效特性研究

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摘　要　针对污水处理厂尾水水质提升至准 IV 类地表水环境质量标准的要求，本文以城市污水处理厂二级出水为研究对象，基于臭氧混凝耦合机理，构建了电诱导臭氧气浮一体化中试工艺系统(Electro-hybrid Dissolved Ozone Flotation, EDOF)，探究了不同极板材料、进水流量、电流密度和臭氧投加量条件下，EDOF 一体化工艺系统对二级出水中 COD 和 TP 的去除效果。结果表明，EDOF 系统采用铁阳极与阴极的处理效果最佳，对 COD 和 TP 的去除率可分别达 60%和 71%，工艺运行最佳条件为：最大允许进水流量 1.0 m^3/h、电流密度 3.66 mA/cm^2、臭氧投加量 6.8 mg/L。处理后出水 COD 和 TP 可以达到准 IV 类标准，其中 COD 和 TP 最佳承载负荷分别为 82.9 mgCOD/cm^2•d 和 1.72 mgTP/cm^2•d。此外，三维荧光和分子量分析结果表明，EDOF 工艺对类富里酸和溶解性微生物代谢产物等溶解性有机物去除效果显著。

关键词　二级出水；地表准 IV 类标准；电诱导臭氧气浮；电絮凝；臭氧氧化

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絮状-颗粒耦合自养脱氮系统代谢机理及其低温影响机制研究

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摘　要 近年来，自养脱氮工艺在污水生物脱氮领域越来越受到重视。研究者们常用培养颗粒污泥的方式保持污泥持留并增强其活性。但在低温等工况下，颗粒污泥容易发生解体产生絮状污泥，将这部分絮状污泥排出系统，可能导致大量功能菌的流失，从而致使反应器出现脱氮效率下降、运行不稳定等问题。本课题组研究发现，通过发展絮状-颗粒污泥耦合自养脱氮系统能有效维持系统在低温下的稳定性。针对絮状-颗粒耦合自养脱氮系统，本课题组从多方面进行了研究并得出如下结论：**（1）研究了耦合系统中厌氧氨氧化菌（AAOB）和异养反硝化菌（HDB）对系统脱氮的贡献**：AAOB 主要在颗粒污泥中发挥作用，而 HDB 主要在絮状污泥中对脱氮效率做出贡献。耦合系统的最大总氮去除效率（NRE）高达 92%，高于理论值 88%，这是因为 HDB 在絮状污泥中将部分通过自养脱氮反应产生的硝酸盐还原为氮气，最高时有 46.2%的硝酸盐被还原；**（2）研究了污泥比例对耦合系统脱氮效率的影响**：随着絮状污泥比例的降低（35%→10%），反应器的 NRE 和总氮去除速率（NRR）分别从 81.4%降低到 67.2%和从 0.225 kg N/(m^3·d)降低到 0.174 kg N/(m^3·d)。其中 HDB 对总氮去除的贡献从 13.5%降至 1%，导致耦合系统的脱氮途径发生变化（短程硝化-厌氧氨氧化-反硝化→短程硝化-厌氧氨氧化）。而好氧氨氧化菌（AOB）在絮状污泥和颗粒污泥中都发挥重要作用，AOB 可以将部分氨氮转换为亚硝氮，为 AAOB 提供基质，而颗粒表面的 AOB 能够缓解溶液中氧气对 AAOB 的毒害作用。因此，保留合适比例的絮状污泥有助于提高反应器效率；**（3）研究了耦合系统在降温过程（30℃→20℃→15℃）中脱氮表现**：随着温度的下降，反应器 NRE 呈现先下降后上升的趋势，而 AOB 和 AAOB 的相对丰度以及关键酶（HDH、AMO）的活性并不总是降低。20℃是一个温度阈值，在 30℃→20℃的过程中，主要功能菌（AAOB 和 AOB）的相对丰度反而上升，反应器脱氮效率的下降是由于酶活性下降引起的。而在 20℃→15℃过程中，酶活性逐渐提高，反应器脱氮效率的下降是由于功能菌相对丰度下降引起的。最终反应器在 15℃下 NRE 高达 83%。通过这些实验，我们发现发展耦合系统并对不同形态污泥的菌群组成及反应活性进行主动调节，可保证基质合理分配利用，加快构建平衡的菌群结构，从而大大提高系统快速响应低温工况动态变化的能力，实现低温下的高效稳定运行。

关键词 厌氧氨氧化；自养脱氮；絮状-颗粒污泥耦合系统；低温

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联合活化过硫酸盐高级氧化工艺深度去除污水中微量有机污染物研究进展

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摘　要　难降解有机微污染物在传统的污水二级生化处理过程去除效果较差，高级氧化工艺（Advanced oxidation process，AOPS）是深度去除二级出水中微量有机污染物的有效方法。基于 $SO_4^{\cdot-}$的高级氧化工艺，是以过硫酸盐（Persulfate，PS）作为氧化剂，在近年来方兴未艾。为了促进污染物的降解，PS 需要在应用中活化产生具有高反应活性的自由基 $SO_4^{\cdot-}$。随着对 PS 活化方式的研究进行，发展出了如超声、紫外、热、过渡金属等多种活化方式。在近年来，学者们研究发现，不同活化方式相互联合具有一定的协同作用，能够表现出超越单一活化简单加和的污染物去除效果。本文综述了近年来对 PS 活化方式的研究，对包括对活化方式的选取、对 PS 活化机制特别是联合活化的机制研究的总结、以及联合活化 PS 在去除微量污染物中应用现状进行了阐述。对当前 PS 活化方式及在污水中微污染物去除方面的研究总结如下：

1. PS 活化方式的选取。PS 的活化方式有超声、紫外、热等，都是能量输入，由此又开发了微波加热、伽马射线等活化方式。此外还有过渡金属、碳材料活化等方式。目前学者们对联合活化开展了很多研究，主要有过渡金属之间的联合（如 Cu^{2+}和 Co^{2+}）、非金属与过渡金属的联合（如超声和零价铜）、非金属之间的联合（如热和超声）等方式。目前降解污染物时活化方式并的选取依据没有统一标准，以前的研究多是根据已有的某种活化方式具有优越活化性能的结论而选取的，对活化方式可能对污染物的影响缺乏考虑。

2. 联合活化 PS 机制的研究。传统活化方式基本已有定论，而联合活化方式的机制则需要更多探索。传统活化方式如热、紫外、超声等，主要是通过能量输入断键。领域内的研究热点如过渡金属活化，其基础机制是金属价键变化引起的电子转移导致 PS 活化。此外，近年来开始的联合活化在活化 PS 方面显示出协同效应，其机制根据活化方式不同组合而变。过渡金属之间的联合，主要机制是过渡金属自身电负性差异引起的电子转移，进而促进活化 PS 的过渡金属离子的再生；非金属与过渡金属的联合，如超声与过渡金属的联合，主要协同机制是超声促进对过渡金属表面的腐蚀和消除钝化，但是部分联合方式如热和过渡金属之间的联合活化协同机制尚不明确。

3. 联合活化 PS 的应用。目前应用 PS 去除的污染物对象多样，既有氯霉素、磺胺类药物等抗生素类污染物，也有双氯芬酸等非甾体抗炎药以及橙 G 等染料污染物，主要是针对传统生化处理难以除尽的微量污染物。目前对污水中 PS 去除污染的研究开展多是针对模拟废水，但是已有部分学者研究实际废水（如纺织废水等）中 PS 高级氧化工艺的应用。

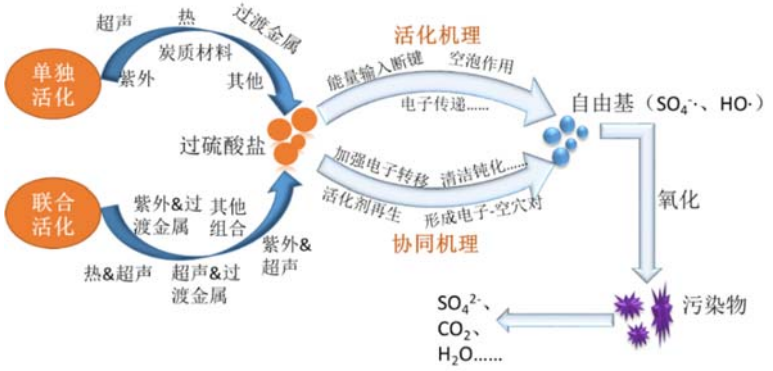

图 1　不同活化方式活化过硫酸盐去除污染物机理

关键词　过硫酸盐；活化；联合活化；协同效应；微污染物

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市政污水 DOM 亲疏水性对固相萃取小柱选择的影响

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摘　要　市政污水溶解性有机物（DOM）组成复杂，核磁共振和高分辨质谱是对其进行深入分析的有效手段，但需提前进行固相萃取（SPE）以浓缩除杂，而有机物亲疏水性是影响 SPE 小柱填料吸附、解吸有机物的重要因素。本文以我国 8 个省会城市市政污水 DOM 为研究对象，考察 DOM 亲疏水性，结果显示 DOM 以疏水组分为主，进水和二级出水疏水组分占比分别为 54%~97%和 34%~67%（图 1）。在此基础上，以 DOM 含量（以 DOC 计）和荧光组分（FDOM）的保留情况为评估指标，进一步探究不同 SPE 小柱对 DOM 的处理效果，结果显示，相比混合型阴离子交换（MAX）、混合型阳离子交换（MCX）、十八烷基-硅醇基（C18OH）和亲水亲脂平衡反相吸附剂（HLB）小柱，苯乙烯-二乙烯基苯聚合物（PPL）小柱适合用于分析污水处理过程 DOM 的变化，对市政污水进出水 DOC 回收率为 44%~56%（图 2）；适合保留市政污水整体 DOM，对三种 FDOM（微生物源腐殖质、色氨酸和疏水性大分子类腐殖质）的回收率基本一致，分别为 45%，57%，43%（图 3）。相比其他四种小柱，C18OH 小柱更适合保留疏水性大分子类腐殖质（图 3），对三种 FDOM（微生物源腐殖质、色氨酸和疏水性大分子类腐殖质）回收率分别为 69.2%，77.7%，140.5%。

关键词　市政污水；溶解性有机物；亲疏水性；回收率；固相萃取小柱选择

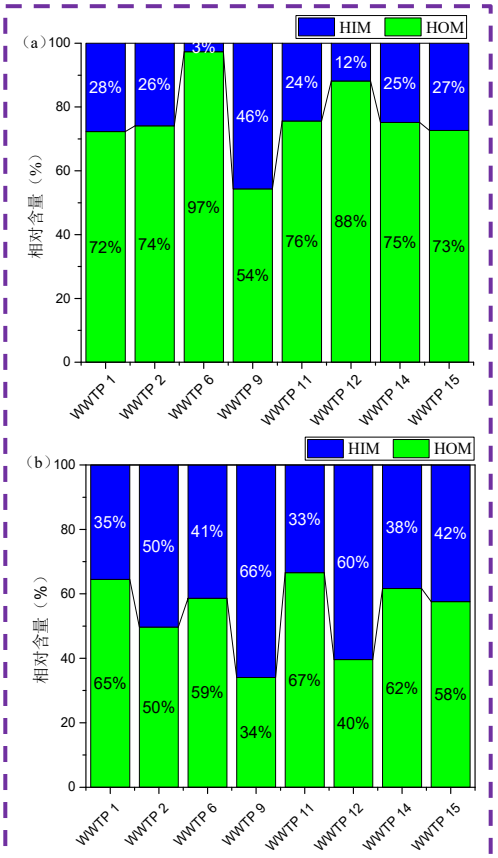

图 1 进水（a）和二级出水（b）亲疏水组成相对含量

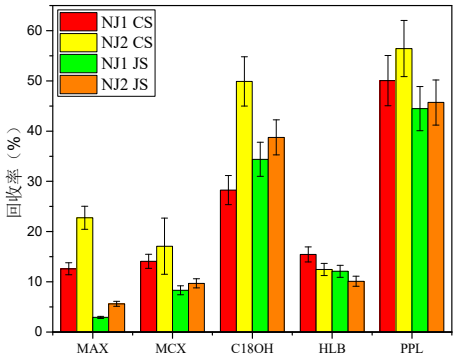

图 2 不同极性小柱对 DOC 回收率

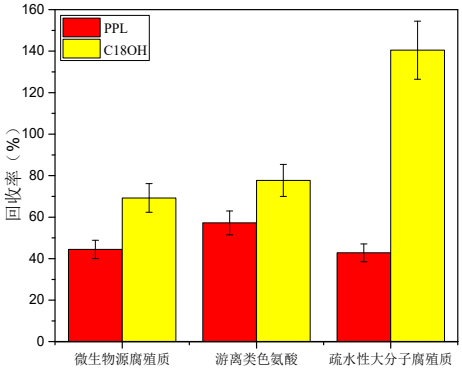

图 3 PPL 和 C18OH 小柱对荧光组分回收率

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活性污泥和生物膜模型预测污水中药品及个人护理品去除的研究进展

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摘　要：药品及个人护理用品(Pharmaceutical and Personal Care Products, PPCPs)是各国水环境普遍存在的有机微污染物。污水处理厂出水是 PPCPs 排放到环境中的主要途径之一。活性污泥和生物膜工艺是目前污水处理厂最常用的污染物去除工艺，由于 PPCPs 的生物转化机制尚未确定，且去除效果与污水处理厂的运行参数密切相关，利用活性污泥法和生物膜法降解 PPCPs 的效果难以准确预测和调控。由国际水协会推出的活性污泥和生物膜模型已广泛应用于碳氮磷等传统水质指标的去除，如何将这两种数学模型应用于 PPCPs 等新型污染物的去除已受到越来越多的关注。目前与 PPCPs 去除相关的数学模型研究主要有以下三个方面：

1. 模型框架的改建。将PPCPs引入活性污泥和生物膜模型会导致微生物和物质间的生化反应发生变化，原有模型结构无法准确预测PPCPs去除，因此必须对模型进行改建。首先确定PPCPs去除过程中所涉及的污水组分和微生物，以及与PPCPs去除相关的各个生化反应过程，构建过程与组分间的矩阵网络。其次通过呼吸速率法等手段对进水组分和微生物浓度进行定量，确立初始值。

2. 模型动力学表达式和系数的选择校验。在模型的基本框架建立后，合适的动力学表达式和化学计量系数是准确描述 PPCPs 去除的关键。目前可选择一阶动力学、Monod 动力学、Logistic 动力学等表达式来描述 PPCPs 的去除，不同表达式会对预测结果产生不同的影响。另外对模型所包含的系数需要根据敏感性分析结果，通过拟合各项水质指标的实测值和模拟值对关键系数就行校准（图 1）。除此之外，活性污泥和生物膜模型的建立在反应区域、物质扩散、生物量分离等方面的表达均存在不同，不同模型对 PPCPs 去除预测能力的比较也值得研究。

3. 模型在 PPCPs 去除方面发挥的作用。两种数学模型已被证明可以解决污水处理厂中 PPCPs 及其产物浓度难以预测的问题。目前与 PPCPs 去除相关的模型应用主要关注两个方面，一是解释 PPCPs 的生物降解机制，包括识别功能菌和主要降解途径；二是探究 PPCPs 不完全生物转化的原因，包括基质抑制效应、产物逆转化效应等。如何利用这两种模型优化污水处理厂运行参数从而强化 PPCPs 去除是未来研究的重要方向。关键在于利用模型筛选出对 PPCPs 去除影响最大的运行参数，优化关键参数组合，为调控污水处理厂中 PPCPs 的强化去除提供支撑。

图 1 数学模型建立与研究思路

关键词：药品及个人护理品；活性污泥；生物膜；数学模型

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基于宽禁带半导体光电器件的溶解性有机物光谱法快速检测技术及其在水处理智慧调控中的应用

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摘　要　本研究建立了体积排阻色谱结合紫外吸收光谱、荧光光谱、有机氮和有机碳多种检测器的联用分析方法，对扬子江水样及其入江河流以及太湖水样进行了分子量特征、光谱特征和碳氮丰度分析，与南京段水样相比，苏锡常南通段长江及其入江河流水样的三维荧光光谱中频繁出现发射波长在 460 nm 处的具有三重激发波长的特殊荧光峰，经污染溯源解析判断该类荧光团来自于印染废水生化处理出水中萘酚萘胺类物质对环境水体的排放输入；研究还发现太湖水样中由于蓝藻爆发所增加的腐殖质类荧光团同样具有三重激发荧光峰，其发射波长在 450 nm，经高分辨质谱鉴定该物质源自于藻类所合成的一种小分子含氮杂环辅酶物质。

通过对溶解性有机物的紫外吸收光谱和荧光光谱特征解析，选取了紫外吸光度 UVA275、蛋白类荧光（Ex275/Em340）和腐殖质类荧光（Ex275/Em450）三种光谱指标作为化学需氧量、溶解性有机碳以及特征污染物的替代性指标，研制了基于氮化镓铝第三代半导体光电器件的紫外荧光双光谱溶解性有机物快速检测技术和装置，设计了便携手持式、在线探头式和流通池式等形式，具有灵敏、快速、低成本、低功耗和微型化等优点，为智慧水务系统的分布式底层传感提供了新型技术手段。

在线水质监测是实现水处理工艺参数动态优化调整的重要基础，然而对水体中各类化学和生物污染指标的频繁检测存在较大困难。一方面，微污染物种类繁多，难以逐一检测；另一方面，许多水质指标的分析检测方法费时费力，成本高昂。在臭氧-生物滤池工艺中，溶解性有机物是 O_3 分子或·OH 自由基的主要氧化对象，在有机碳的降解转化、微污染物的去除、溴酸盐的生成以及病原菌灭活等过程中均有重要影响。本研究阐明了臭氧工艺中溶解性有机物光谱指标和分子量分布的变化规律，揭示了微污染物去除、消毒副产物生成、病原菌灭活等与光谱指标变化之间的响应关系，明确了臭氧投加量的优化目标是实现 70%-90% 的荧光强度削减，为 LED 水质检测技术在水处理智慧调控系统中逻辑应用层的设计提供了关键数据和理论支撑。

关键词　溶解性有机质；深紫外 LED；腐殖质荧光；臭氧；氯消毒

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两段式纳滤工艺膜污染中有机/无机/生物贡献率的空间演变规律研究

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摘　要：纳滤（NF）技术作为一种重要的高压膜分离技术，被广泛运用于城市污水深度处理与回用中。然而，膜污染是其运行中最大的问题，有机污染、无机污染和生物污染之间的复合作用使得膜污染机理更加复杂。目前，对于处理城市污水二级出水的纳滤工艺不同空间位置的主要膜污染类型及特征还不明晰。本文通过采用实际 NF 水厂中的 NF 进水（MBR 出水）、一段浓液、NF 出水进行膜污染试验和污染膜样品的剖析表征，分别探究两段式纳滤工艺中一段始端、二段始端及二段末端的膜污染特征。随后，建立了一套评价膜污染的统计学分析方法，基于污染膜样品的表征数据，采用冗余分析（RDA）揭示膜污染要素、膜的理化性质以及膜污染进程的关系（图 1）；采用基于多重线性回归的方差分解分析（VPA）定量计算有机污染、无机污染、生物污染以及复合污染对于纳滤不同空间位置的膜污染的贡献率。

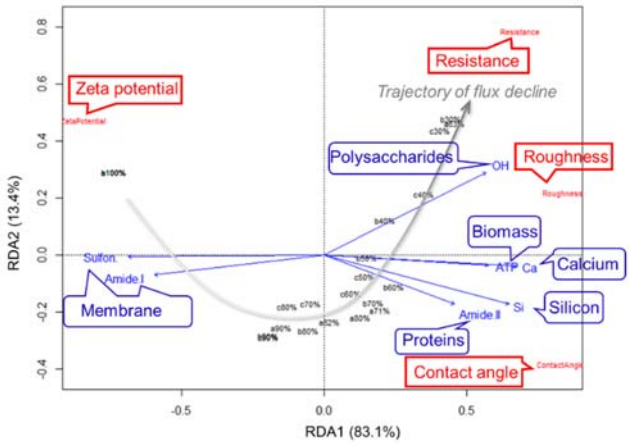

图 1. 冗余分析（RDA）揭示膜污染要素、膜的理化性质以及膜污染进程的关系。百分比表示污染后膜通量相比初始膜通量的比例，百分比前的“a”、“b”、“c”分别代表一段始端、二段始端和二段末端。

RDA 结果表明，从膜污染发展过程来看，污染前中期以硅和蛋白质的吸附为主，污染后期生物污染、钙离子与多糖的相互作用更加突出。VPA 结果表明，在最终的膜污染中，一段始端以生物污染（26.5%）和有机-生物复合污染（27.9%）为主；二段始端有机污染（34.2%）和有机-生物复合污染（27.6%）的贡献较为突出；二段末端的主要污染类型则转变为有机-无机复合污染（39.7%）和无机-生物复合污染（11.0%）。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有机污染，再向无机污染转变。该研究有望为实际水厂的纳滤膜污染的精细化控制提供思路，例如在一段前端的预处理中提高微生物消毒处理的效率，在二段始端注重有机污染的控制，在二段末端注意有机-无机复合污染的控制等。

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污水处理系统中弱酸低氧环境富集 Comammox 并降低 N2O 的释放

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摘 要：完全氨氧化细菌（complete ammonia oxidizer, comammox）的发现，颠覆了长期以来硝化反应需要由两种不同微生物协调催化完成的认识。然而，现有研究对 comammox 生存环境及其对硝化作用和 N_2O 释放的影响仍不充足。本研究运行了两个弱酸膜生物反应器（pH=6.3-6.8），对比分析了两个反应器在弱酸高氧（>2 mg/L）和弱酸低氧(~0.5mg/L)下的硝化行为、氨氧化菌菌群（包括 comammox）和 N_2O 的释放特征及机制。结果表明，在弱酸低氧的环境下仍能实现良好的完全氨氧化。长期弱酸性条件培育了具有耐酸性的氨氧化微生物。通过 qPCR 以及宏基因组学分析，我们确认了两个系统中 comammox 在数量上均显著多于保守的 AOB，说明弱酸条件仍能富集 comammox。基于对 amoA 功能基因的分析，我们发现在两个反应器中的 comammox 组成存在显著差异。弱酸高氧反应器中，comammox 以目前尚未获得纯培养的 clade A.2 为主，而弱酸低氧反应器中 comammox 主要由污水处理系统中常见的 clade A.1 组成（图 1）。此外，在长期的弱酸低氧环境下，强温室气体 N_2O 的转化率反而比高氧系统更低，这可能与 comammox 的富集和更强的反硝化作用有关。

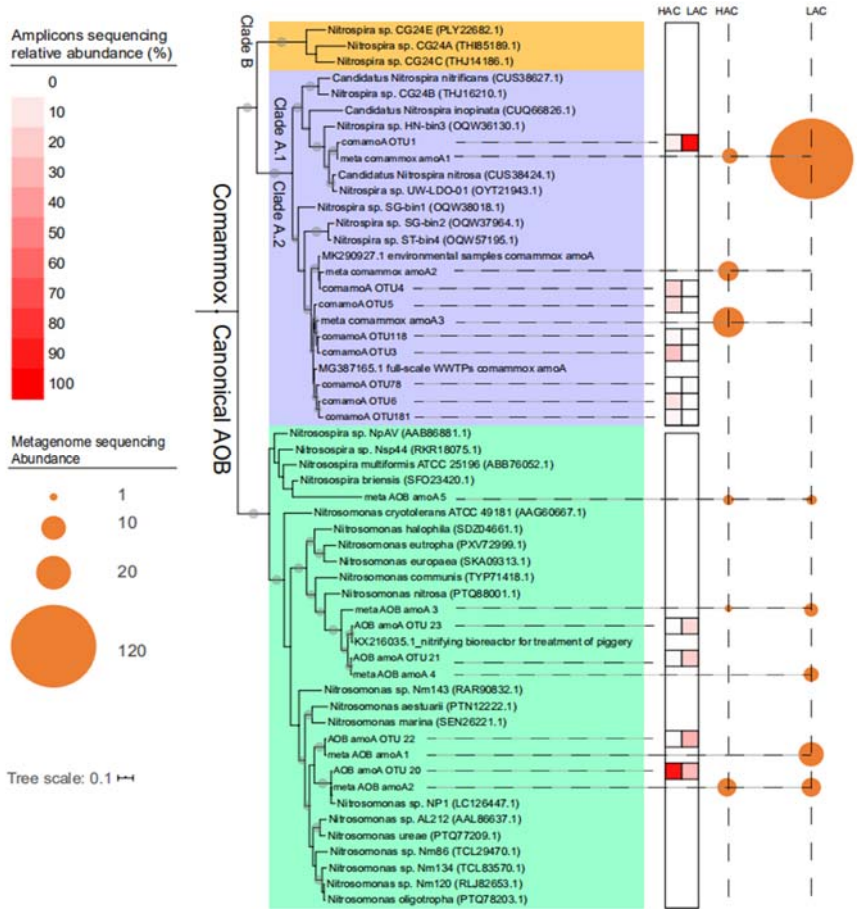

图 1 弱酸高氧和弱酸低氧系统中的 AOB 和完全氨氧化菌（comammox）

关键词：污水生物处理；硝化反应；*Comammox*；N_2O；温室气体

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“4 20”雅安地震前后生活饮用水水质健康风险评价

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摘 要 为了解“4 20”雅安地震对当地生活饮用水水质的影响，研究建立了基于区间模糊数法的健康风险评价模型。运用方差分析方法，从时间和空间角度研究了地震对当地生活饮用水水质健康风险的影响。研究表明：相较于饮水途径的的非致癌风险、致癌风险，皮肤接触途径造成的非致癌物风险、致癌风险可以忽略；雅安市宝兴县、芦山县、汉源县 2012—2016 年生活饮用水中的非致癌风险较小，五年内各项非致癌物通过两种途径对成人的平均健康风险比例为 $As > F^- > Pb > NO_3^- > Cr > Cd > Fe > Mn > NH_3 - N$；雅安市宝兴县、芦山县、汉源县 2012—2016 年生活饮用水可能具有一定的致癌风险，其中铬的贡献度较大，五年内各项致癌物通过两种途径对成人的平均健康风险比例为 Cr>As>Cd。方差分析结果表明雅安地震前后相近几年宝兴县生活饮用水健康风险无较大差异，2013 年雅安地震对宝兴县和汉源县生活饮用水健康风险的差异没有较大影响。最后针对生活饮用水水质健康风险评价结果，给出如下建议：有关部门应高度重视，环保部门应该改进监测方法，提高检测精度以彻底掌握生活饮用水中铬的浓度，必要时采取相关措施减少或除去雅安市生活饮用水中的铬。

关键词 生活饮用水；地震；健康风险评估；区间模糊数评价法

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丝状真菌 Galactomyces 对活性污泥中 N-酰基高丝氨酸内酯的响应机制

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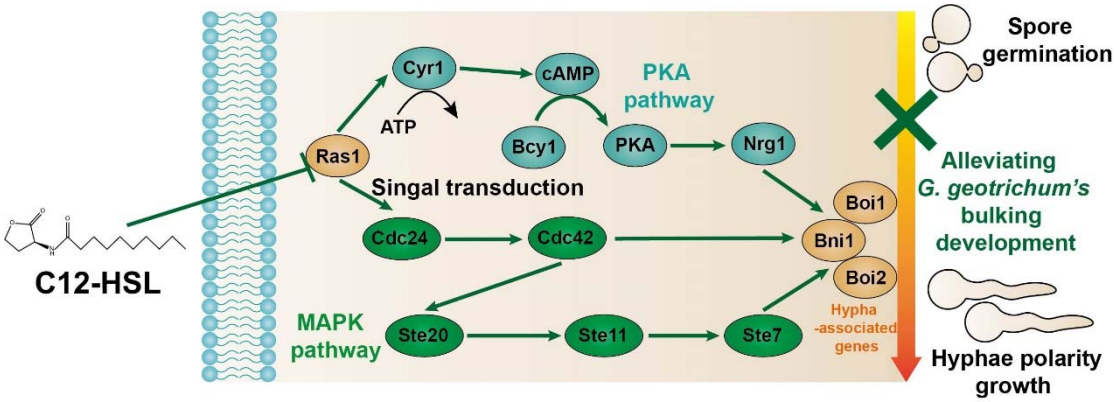
摘 要 *Galactomyces* 是活性污泥菌胶团中常见的丝状真菌，是诱发丝状菌性污泥膨胀的丝状真菌菌种之一。实质上，丝状真菌性污泥膨胀的是丝状真菌与胶团菌之间恶性竞争的结果。胞间通讯是微生物之间相互作用的核心方式。然而，目前尚鲜见以丝状真菌-胶团细菌胞间通讯为切入点的丝状菌性污泥膨胀致因机制研究。本研究探讨了胶团菌释放的 3 类 N-酰基高丝氨酸内酯（AHLs）对 *Galactomyces* 孢子萌发和菌丝极性生长的影响，揭示了丝状真菌与胶团细菌之间跨界胞间通讯的行为与机制。研究结果表明，*Galactomyces* 性污泥膨胀发生时检测到了 C4-HSL、C6-HSL 和 C12-HSL，其中 C12-HSL 与污泥沉降性显著负相关（R=-0.91, P<0.05）。*Galactomyces* 能够接收 C12-HSL 并作出响应：在孢子萌发的初期、中期和末期时，孢子萌发率分别减缓 19.60%，17.95%和 8.94%，随后的菌丝生长延缓 15.01%。转录基因水平分析揭示了 C12-HSL 通过抑制 Ras1 的表达，调控 Cyr1-cAMP-PKA-Nrg1 路径表达下调，从而抑制 *Galactomyces* 丝状生长相关群体感应响应系统。此外，菌丝生长 MAPK 路径表达也下调，控制菌丝极性延伸相关基因 Bni1、Boi1 及 Boi2 的表达。综上所述，C12-HSL 对抑制 *Galactomyces* 性污泥膨胀具有关键作用，研究结果对丝状真菌性污泥膨胀具有重要启示意义。

关键词 污泥膨胀；丝状真菌；胞间通讯；*Galactomyces*；N-酰基高丝氨酸内酯



活性污泥菌胶团中 *Galactomyces* 对 C12-HSL 感知和响应路径

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浓差驱动反向电渗析与电催化耦合废水处理研究

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摘要：不同领域排放的废水中蕴含着大量的盐差能。反向电渗析技术（Reverse electrodialysis RED）是一种通过选择性离子交换膜装置将高盐溶液与低盐溶液分离在膜两侧，在两电极板之间选择性输送溶液中含有的盐离子而产生连续的流动系统进而产生电能的过程。近年来我国大部分地区开始建立大型的工业园区将各类化工企业集中管理，各厂排放的废水被集中收集，这就使得在同一工业园区产生的高低盐废水可以被收集并应用于反向电渗析系统内，可利用不同废水中的盐度梯度产生电能，在不同极板材料的作用下使用适宜的电化学工艺来降解废水中存在的污染物质。本研究使用自制反向电渗析反应器，模拟实际石油废水中存在的盐度梯度，通过选择适当的氧化还原工艺，研究了利用 RED 工艺同时进行发电和处理受有机污染物（甲酸）污染废水的可能性。这种耦合过程可以有效的提高 RED 反应过程以及对电化学废水处理技术的研究和应用前景，实现了在无外加电场作用下对高盐废水高效稳定的去除目标，彻底解决电化学废水处理工艺面临的能耗问题。

表 1 使用 60 组膜和单膜系统处理高盐甲酸废水的技术性和经济性比较

膜数	高盐水 (g L^{-1} NaCl)	低盐水(g L^{-1}NaCl)	去除率/ %	能耗 kW·h $gTOC^{-1}$	能耗 kW·h m^{-3}
60 组阴阳离子膜（反向电渗析体系）	143	0.07877	68	0	0
	143	2.6	55	0	0
	143	8	34	0	0
	143	16	8	0	0
单膜（普通电化学体系）	143	143	34	0.1	2.1
			57	0.11	4
			78	0.12	5.85
			85	0.15	7.8

关键词 反向电渗析；有机污染物物；电化学；废水处理；零能耗

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会仙岩溶湿地流域地表河流中氮和磷的时空变化

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摘　要：地表水富营养化可能会对脆弱的岩溶区水生态系统带来严重影响。岩溶区河流氮(N)和磷(P)养分的时空变化特征与集水区的水文条件、人类活动和岩溶特征密切相关，完整水文周期的河流氮磷野外监测结果分析有助于探求岩溶区河流中氮磷养分的时空变化特征及主要影响因素。根据 2017.10-2019.09 会仙岩溶湿地 11 个空间尺度范围介于 21.00-373.37km^{2}之间集水区的出水口每月流量及总氮(TN)和总磷(TP)的浓度与组分监测资料，分析干季和雨季氮磷养分从上游到下游、支流（睦洞河和会仙河）到干流（相思江）输出的空间变化特征。本研究发现了监测期内会仙岩溶湿地流域河流氮磷养分输出在水文条件、人类活动和岩溶特征影响下的三个重要特征：1)河流氮磷养分输出在水文条件控制下呈季节性差异，干季 TN 以 NO_3^--N 为主要形态，雨季 NH_4^+-N 贡献比升高，TP 以 TDP 为主，二者相关关系干季较雨季显著；氮磷浓度在低流量条件下较高，输出通量在雨季高流量条件下最大且在不同时段都与流量保持幂函数相关关系。2) 河流氮磷养分输出在人类活动影响下呈局部空间差异性，以农业面源污染为主的支流小流域同一监测点在不同季节相同流量条件下氮磷浓度、组分以及输出通量不同，以城镇点源污染为主的干流相思江上游集水区氮磷浓度较高，输出通量贡献率较高；人类对支流河道水利用量的增加导致面积较小的低阶支流集水区氮磷输出的变异性大于面积较大的高阶干流集水区。3) 河流氮磷养分输出在岩溶特征制约下呈空间尺度相似性，各集水区内覆盖型岩溶面积份额与氮磷养分输出系数均值呈显著性正相关关系；同时段不同河流集水区出水口的氮磷浓度均值向下游方向有朝同一浓度范围值收敛的趋势，雨季尤为明显。会仙湿地流域河流氮磷养分输送的时空变化特征与水文条件、人类活动、岩溶特征的耦合分析对岩溶区河流氮磷污染控制具有一定的科学指导意义。

关键词　河流氮磷养分；岩溶特征；集水区；水文；会仙湿地

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白洋淀夏季入淀区沉积物间隙水-上覆水水质特征及交换通量分析

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摘 要：为揭示白洋淀夏季入淀区间隙水-上覆水氮磷营养盐相互作用，本研究于 2019 年 7 月对白洋淀主要六条入淀河流取样，通过分析间隙水、上覆水水质特征及应用营养盐在沉积物-水界面的扩散通量，评估了营养盐扩散对沉积物与上覆水的影响。结果表明：间隙水氨氮（NH_3-N）含量在 5.24-10.64mg·L^{-1} 间，是上覆水体的 10 倍，内源污染严重；硝氮（NO_3^--N）含量在 0.36-0.79mg·L^{-1} 间；溶解性总氮（TDN）含量在 5.36-10.67mg·L^{-1} 间，是上覆水体的 5 倍；溶解性总磷（TDP）在 0.03-0.3mg·L^{-1} 间。上覆水分析显示白洋淀水质呈弱碱性；溶解氧（DO）含量较低，为沉积物内源污染物的释放提供了厌氧环境；淀区水环境呈现为还原状态，高锰酸盐指数污染较高；氨氮范围在 0.35-1.76mg·L^{-1} 间，作为主要给水来源的潴笼河淀区最高；硝氮含量在 0.75-1.97mg·L^{-1} 间；溶解性总氮（TDN）在 0.99-2.70mg·L^{-1} 间，纳污河流府河的含量最高；溶解性总磷（TDP）含量在 0.03-0.15mg·L^{-1} 间，靠近居民区的白沟引河含量最高。应用综合污染指数法对水质进行评价发现间隙水污染程度远高于上覆水，各采样点呈现出重度污染状态。对 NH_3-N、TDN、TDP 进行交换通量分析显示，NH_3-N 的扩散通量在 1.71-7.43mg·（m^2·d）$^{-1}$ 间，污染最严重的保定市纳污河流府河内源氨氮向上覆水扩散速率最快；溶解性总氮（TDN）的扩散通量除白沟引河较低，其余五个采样点均值达到 9.11mg·（m^2·d）$^{-1}$，夏季水体中溶解氧含量较低且水界面-沉积物 TDN 浓度差较大，导致沉积物中含氮营养盐在厌氧条件下大量释放到上覆水中，对水质造成严重污染；溶解性总磷（TDP）扩散通量显示萍河采样点呈现出汇集的状态，剩余五个采样点的的扩散通量范围在 0.03-0.16mg·（m^2·d）$^{-1}$ 间，表现出磷营养盐向上覆水释放的状态；扩散通量显示内源污染物是上覆水污染物的重要来源，为有效治理入淀区水质，沉积物氮磷营养盐的清淤处理迫在眉睫。

关键词 白洋淀　入淀区　间隙水-上覆水　水质特征　氮磷营养盐　扩散通量

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人工湿地对抗生素复合污染的净化效果及微生物群落响应

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摘 要:为研究人工湿地对氟喹诺酮类(FQs)、磺胺类(SFs)、四环素类(TCs)抗生素的净化性能及微生物结构响应，以运行多年的单层基质结构及多层基质结构的水平潜流人工湿地为对象，采用固相萃取-高效液相色谱法和高通量测序分别对抗生素和微生物群落进行研究，分析对比湿地系统中三类 8 种抗生素去除规律及其对常规污染物去除的影响，明确抗生素净化效果与湿地基质结构相关性，并对比抗生素投加前后系统微生物群落结构的变化。结果表明：人工湿地对 FQs、磺胺噻唑、磺胺二甲基嘧啶、氧四环素表现出较好的去除效果（＞95%），相同条件下，对磺胺嘧啶和四环素去除效果较差（＞61.93%）。多层结构湿地系统对抗生素的净化效果较单层湿地结构提高（3.16±4）%。抗生素的加入使湿地系统对 COD、NH_4^+-N 的去除效果略有增加，去除率分别提高了（18.56±4.50）%、（16.56±16.76）%，却使 TP 的去除率有所下降，降低了（28.67±18.82）%。FQs、SFs 和 TCs 抗生素加入后，Shannon 指数由 5.80±0.35 降到 4.66±0.53，Simpson 指数由 0.017±0.01 升到 0.063±0.036。添加抗生素前后主要优势门 *Proteobacteria* 和 *Bacteroidetes* 不变，其余优势门（*Chloroflexi* 、*Firmicutes*、 *Verrucomicrobia* 和 *Acidobacteria*)主次位置发生改变。优势属结构出现明显差异，反硝化菌 *Acinetobacter*、*Aquabacterium* 和 *Pseudomonas* 丰度显著升高，且取代除磷菌 *Dechloromonas* 和 *Flavobacterium* 成为主要优势菌属。

关键词：水平潜流人工湿地，抗生素，微生物

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纳米花层状二硫化钼改性聚醚砜混合基质膜及分离性能研究

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摘 要: 聚醚砜（PES）由于其良好的热稳定性，抗氧化以及耐酸耐碱性质被广泛应用到超滤膜技术中，但由于其固有疏水性，在实际应用中存在不可避免的膜污染问题。在本研究中，首先通过简单的水热法一步制得纳米花层状二硫化钼(HF-MoS2 NSs)，并首次将其引入到 PES 混合基质膜中得到纳米复合膜。系统的研究了复合膜的渗透性，分离性，防污性以及抗菌性，实验结果表明，在 HF-MoS2 NSs 含量为 0.4 wt%时得到的 M-0.4 复合膜具有最佳膜性能，纯水通量可达到 286 LMH/bar，相比于空白 PES 膜提高了 1.8 倍，M-0.4 同时对牛血清蛋白 BSA 和腐殖酸 HA 的截留率可以高达 98.2% 和 96.9%，对刚果红，直接红，甲基蓝和普鲁士蓝等染料的截留率大于 96%。使用 BSA 和 HA 两种模型污染物研究了膜的防污性能，结果表明复合膜的通量回复率 FRR 分别为 88% 和 93%，远高于空白膜的 69% 和 84%，同时抗菌实验结果表明由于添加二硫化钼纳米材料，复合膜的抗菌性能得到显著提升，对大肠杆菌 E. coli 和枯草杆菌 B. subtilis 的抑菌率为 67.8% 和 82.5%。本研究结果表明引入 PES 混合基质膜可以有效的提升膜性能，有望在实际水处理中得到应用。

关键词： 纳米花层状二硫化钼；复合膜；染料截留；防污性能；抗菌活性

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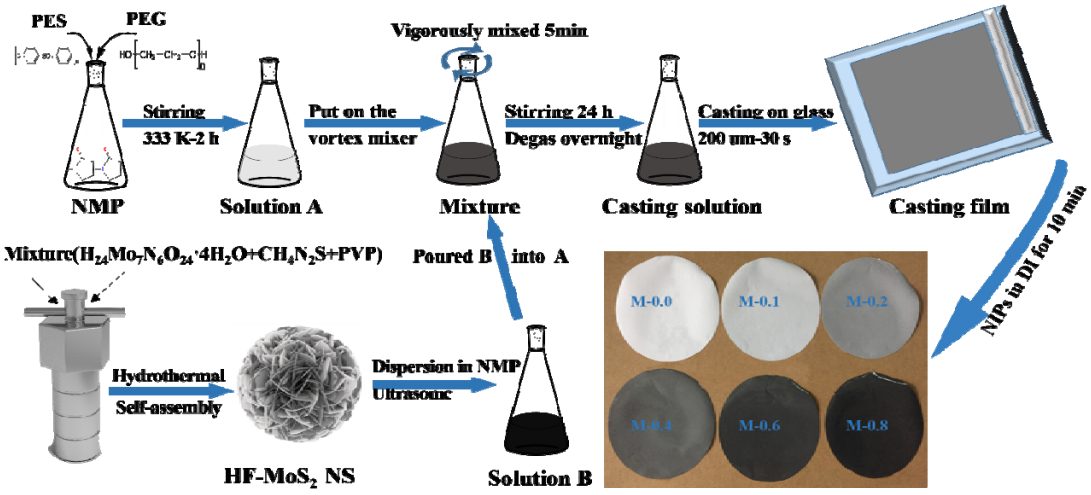

两种浮床植物及其组合对岩溶地区富营养化水体净化效能的试验研究

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摘　要　会仙喀斯特国家湿地公园位于桂林市临桂县会仙镇境内，主要有睦洞湖、分水塘与古桂柳运河等湿地，构成以“湖泊-沼泽-库塘-河流-人工运河”为主的复合湿地生态系统，是典型的喀斯特岩溶湿地。随着经济社会的快速发展和人类生活水平不断提高，工农业废水和农村生活污水的排放量逐年增加，湿地面积萎缩、水质逐步恶化。近年来虽然政府对会仙湿地日益重视，但是目前的保护措施仍然无法抑制湿地水环境恶化的趋势。因此，采取具有针对性的岩溶湿地治理技术措施，形成具有代表性、适用性的岩溶湿地生态修复模式，是保护会仙湿地生态环境的迫切工作。

生态浮床技是植物修复技术与浮床技术的结合体，主要由水生植物、种植床体、浮床框体和固定装置构成。它既能有效地去除水体中的污染物、净化水质，又能保持良好的景观效果，增加生物多样性，越来越受国内外研究者的青睐。目前对单一植物的生态浮床影响研究较多，而对不同植物混合种植模式生态浮床的研究甚少。单一植物生态浮岛对污染水体的净化效果能力有限，难以克服众多净化效果影响因子的影响。本文选取美人蕉、大藻两种会仙湿地常见的优势植物，构建岩溶地区富营养化水体的生态浮床修复系统，通过静态水培试验，对两种植物及其组合在岩溶地区富营养化水体中的生长特性、水质净化能力进行比较研究，综合比较不同植物的生长状况及不同植物浮床的净化效能，筛选有较好净化能力和较高生态景观观赏价值的浮床植物组合模式，为富营养化水体的生态修复提供试验依据。

结果表明，冬夏季试验各浮床植物对污染物均具有较好的去除效果，冬夏季浮床系统对 COD_{Cr}、NH_4^+-N 和 TN 的去除效果为混种>大藻>美人蕉，冬季，TP 去除效果为大藻>混种>美人蕉；夏季，TP 去除效果为混种>美人蕉>大藻。同单一的植物相比，两种植物混种系统对污染物有较好的去除效果，且生长良好，认为最适合作为浮床系统的是美人蕉和大藻混合种植系统。该浮床植物组合模式对于南方岩溶地区富营养化水体修复有着良好的适用性。

关键词　美人蕉；大藻；生态浮床；富营养化；岩溶湿地

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会仙湿地沉积物中磷和重金属的形态及分布特征研究

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摘　要 本研究以会仙湿地水体表层沉积物为研究对象，对会仙湿地 10 个点（S1-S10）进行采样，分别通过分光光度法和原子吸收分光光度法测定其磷形态（总磷 TP、有机磷 OP、无机磷 IP）和几种主要重金属（铜 Cu、锌 Zn、铅 Pb、镉 Cd、铬 Cr）及其赋存形态（离子交换态 F1、碳酸盐结合态 F2、铁锰氧化态 F3、有机结合态 F4 和残渣态 F5）的含量，从而研究会仙湿地表层沉积物中磷和重金属形态及其分布特征，推测磷和重金属的污染来源、影响因素，通过单项污染指数评价、内梅罗综合污染指数评价、地积累指数（Igeo）评价和土壤污染累积指数评价等对会仙湿地磷和重金属进行生态风险评价，并分析了会仙湿地沉积物中磷形态和重金属不同形态与总量间的相关性。结果表明：

（1）会仙湿地水体和沉积物中磷含量在 S7 号采样点（七星码头处）含量最高，S7 号采样点水质总磷 0.2332mg/L，为地表水水环境质量标准IV类水质标准，其余采样点为地表水II类水标准；沉积物总磷含量为 92.413~451.212 mg/kg，均小于 600 mg/kg，生态风险评价属于安全级别；根据单项污染指数法，S7 号采样点为轻度污染状态，其余采样点均为无污染状态。

（2）会仙湿地水质重金属 Zn 为地表水环境质量标准II类水质标准，其他重金属元素均属于地表水环境质量标准I类水质标准；沉积物重金属 Cu、Zn、Pb 在 S7 号采样点最高，Cd、Cr 在 S1 号采样点最高，这两个点均为码头，推测重金属主要来源于生活污水排放，通过生态风险评估，结果表明各点位的 Cu、Zn、Pb、Cr 元素生态危害等级均为无污染或轻微生态危害，而重金属 Cd 为强生态危害至很强生态危害等级。

（3）沉积物中磷形态以无机磷为主，无机磷和有机磷与总磷的含量及分布特征存在显著的相关性。沉积物中，重金属以残渣态为主，稳定性高，不易释放到上覆水中；除 Pb 外，Cu、Zn、Cd、Cr 金属的残渣态 F5 与总量之间均呈现出极强相关性，表明会仙湿地沉积物中重金属残渣态与总量含量及分布规律基本相同。

（4）会仙湿地磷和重金属污染主要来源于居民生活污水未经处理直接排放和农业污染，其中七星码头处受污染最为严重，而污染最严重的重金属是 Cd，建议对居民生活排放污水进行处理，然后再排放到水体中，并采取措施对湿地中的 Cd 进行治理，并防止其继续造成污染，保证湿地良好的生态功能。

关键词 会仙湿地；沉积物；磷；重金属；污染源

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水力停留时间对高负荷短程硝化反应器的影响

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摘 要：在高负荷短程硝化反应器中，水力停留时间（HRT）是运行过程中的关键因素。采用保持进水 NH_4^+-N 浓度不变，逐渐缩短 HRT 的策略，观察不同 HRT 下反应器的运行情况。利用微生物群落分析技术对不同 HRT 的污泥进行分析，探讨反应器中的优势菌种。结果表明，HRT 为 12h 和 6h 时，NH_4^+-N 转化率和 NO_2^--N 积累率都维持在较高值，随着 HRT 的不断降低，氨氮负荷逐渐上升，NH_4^+-N 转化率和 NO_2^--N 积累率降低。PCR-DGGE 结果表明，HRT 实验中优势门和属分别为 *Proteobacteria* 和 *Nitrosomonas*，*Nitrosomonas* 相对浓度从 15%上升到 40%， *Nitrosomonas* 丰度与 HRT 相关。高通量测序表明反应器在进水容积负荷降低的过程中，微生物群落数大幅度降低减少，系统微生物群落结构的多样性和丰度不断减少。改变短程硝化反应器的进水氨氮负荷，能够影响到反应器内微生物群落结构的变化，从而影响短程硝化反应器的功能。

关键词：短程硝化；水力停留时间；高负荷；*Nitrosomonas*

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基于分子网络的污水中双氯芬酸转化产物识别研究

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摘　要 双氯芬酸（Diclofenac，DCF）在污水中会生成转化产物，对产物的识别有助于全面了解污水处理系统中 DCF 的去除规律及生态风险。污水基质复杂，这使得其质谱数据解析困难。本文结合分子网络的质谱数据处理方式对其转化产物进行识别。根据结构类似的化合物具有类似二级质谱碎片这一原理，对所有一级 MS 下的二级碎片进行两两余弦类似性打分，并根据得分值大小将一级 MS 进行分子网络处理（图 1）。分子网络图将原始质谱数据分成 11 个具有类似结构的化合物区域。根据 DCF 母体及已知产物（4-OH-DCF，TP325）的质荷比代表的节点所在位置，可以确定 3 块带有蓝色阴影区域的节点为可疑的转化产物质荷比。进一步对这 3 块节点的质荷比及二级谱图进行分析，识别出污水中 DCF 的 14 个转化产物及转化途径（图 2）。污水处理过程中，DCF 主要发生羟基化、硝化、氧化、酰胺化、硫螯合、甲基化、脱羧反应，其中羟基化反应尤为关键，羟基化产物（4-OH-DCF、5-OH-DCF）可以进一步转化成其他 9 个产物（DCF-BA、DCF-lactam、TP392、TP275、TP268、TP328、TP392b、TP310a、TP310b）。分子网络可以极大简化污水样品质谱数据复杂程度，有利于污水中 DCF 转化产物的识别及转化途径的解析。

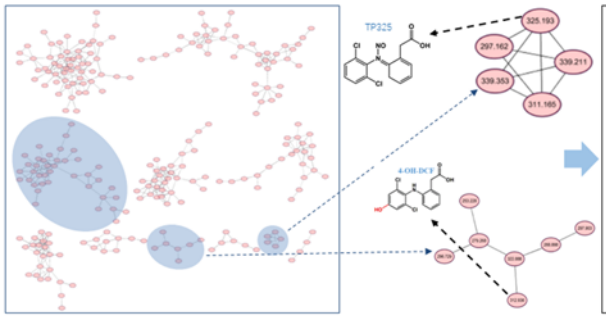

图 1 DCF 转化产物的分子网络图

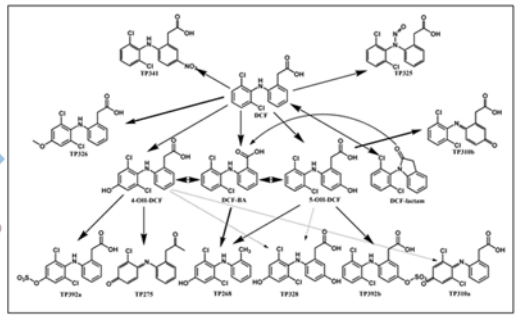

图 2 DCF 在污水中的转化途径

关键词 双氯芬酸，转化产物，污水，分子网络，识别

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厌氧膜生物反应器耦联部分亚硝化/厌氧氨氧化用于污水处理研究

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摘　要　近年来，污水处理的目标从达标排放向节能降耗、低碳运行和资源化迈进。本研究构建了厌氧膜生物反应器（AnMBR）-部分亚硝化/厌氧氨氧化反应器（PN/A）污水处理系统，以探究系统的甲烷回收和氮去除性能，以及微生物动力学。结果表明：系统化学需氧量（COD）去除率稳定在 97%以上，其中超过 80%的 COD 转化为 CH_4，TIN 平均去除率为 78%，系统出水 COD 和 TIN 浓度分别低于 13 和 11 $mg·L^{-1}$。AnMBR 段 COD 去除率达到 95%，最高甲烷产率为 0.38 $L·L^{-1}·d^{-1}$。PN 段实现了 AnMBR 出水中 NH_4^+-N 的稳定转化以及 NO_2^--N 的高效积累，其出水中 NO_2^-/NH_4^+和 $NO_2^-/(NO_2^-+NO_3^-)$平均值分别为 0.96±0.11 和 0.83±0.04。Anammox 段几乎完全利用 PN 段出水中的 NO_2^--N，出水 NH_4^+-N 和 NO_3^--N 浓度分别低于 5.02 和 5.62 $mg·L^{-1}$。高通量测序结果表明 PN 段氨氧化菌主要为 *Nitrosomonas*，丰度为 7.09%，亚硝酸盐氧化菌主要为 *Nitrospira*（0.16%）。Anammox 段主要微生物为 *Candidatus Brocadia*，丰度高达 21.01%，且通过荧光原位杂交（FISH）观察到 anammox 菌主要分布在污泥内部。本研究构建的 AnMBR-PN/A 系统实现了同步能源回收、自养脱氮以及低碳氮排放的污水处理模式，研究成果为工程应用提供了技术支撑。

关键词　厌氧膜生物反应器；厌氧氨氧化；甲烷回收；自养脱氮

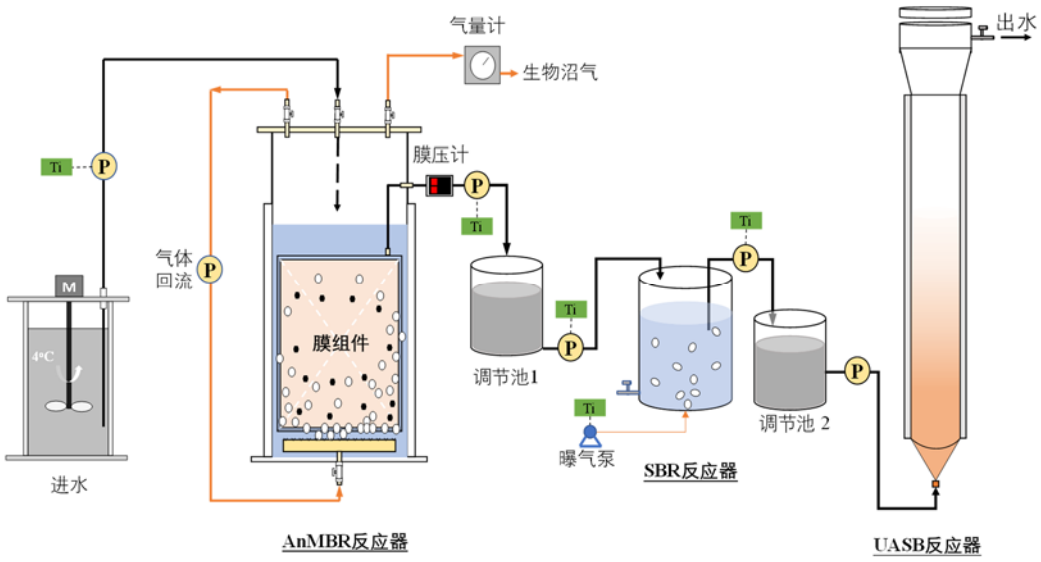

图 1.　系统原理图

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介质阻挡等离子体降解酚类化合物：工艺优化和酚类的取代基影响

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摘 要 酚类化合物是一类具有高毒性、难降解、生物累积性和强烈气味排放的污染物，对环境和人类构成了极大的威胁。由于其在塑料、染料、药物、杀虫剂和纸张的制造工艺中的广泛应用，迫切需要开发生态友好的方法来消除工业废水中的这些污染物。介质阻挡放电（DBD）等离子体技术作为一种新兴的水处理高级技术，通过电极间高压放电来生成大量活性物种（如 O_3、H_2O_2 和•OH）以及紫外光、冲击波等，共同作用于水中各类有机污染物，达到降解的目的。

本文基于自主设计的瀑布式介质阻挡放电等离子体对一系列酚类化合物进行降解，探究了外加电压、放电区水流流速、有机物初始浓度、溶液电导率和 pH 值等多个参数对酚类化合物去除效果的影响（图 1）。在最优参数条件下，p-CH_3 可在 32 分钟内实现完全降解，最高能量产率约为 3.5g/kW h。电子顺磁共振分析和自由基猝灭实验表明，臭氧分子和•OH 是酚类化合物降解的主要原因，而•O_2^-和 $^1O_2$ 也在酚类污染物降解过程中扮演重要角色。本文同时考虑了取代基团的差异对酚类化合物降解的影响（图 1）。在仪器最优参数条件下，取代酚类化合物更易降解，尤其是具有强吸电子基团的硝基苯酚，主要源于•OH 和•O_2^-的攻击。用质谱法（MS）对降解过程中产生的酚类化合物的中间体进行了鉴定，并提出了相应的降解路径及机理。

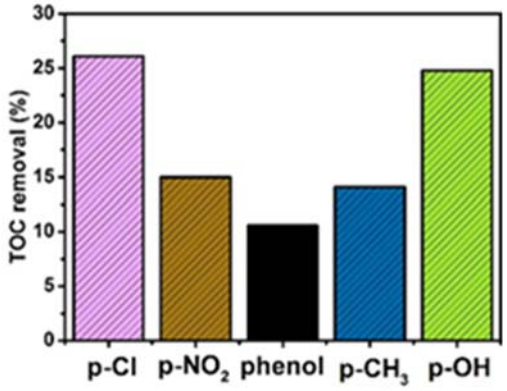

图 1. 等离子体降解含不同取代基酚类污染物的 TOC 去除效果

本文最后进一步提出了 DBD 等离子体-活性炭联用技术和 DBD 等离子体-碳电极-气液混合柱联用技术，以促进氧气向活性氧的转化，提高取代酚类化合物的矿化率。

关键词 介质阻挡放电；等离子体；酚类污染物；操作参数

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三江源地区沉积物磷赋存形态及其释放潜力研究

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摘　要　沉积物既是污染物的汇集地，又是内源营养的重要来源，其磷形态特征及释放潜力常作为反映河流生态环境状况的重要指示。近年来，随着气候变化与人类活动的影响，三江源地区生态环境受到进一步的威胁与挑战。为了研究三江源地区河流生态环境状况，2019 年 5 月，本研究共采集长江、黄河和澜沧江等源头地区 20 个断面沉积物样品，分析沉积物铁结合态磷（铁磷）、钙结合态磷（钙磷）、酸提取有机磷（酸磷）、热碱提取有机磷（碱磷）等不同磷形态含量及沉积物磷释放潜力。研究结果表明：（1）三江源地区沉积物磷形态以酸磷和钙磷为主，不同沉积物磷形态含量排序为酸磷＞钙磷＞碱磷＞铁磷；（2）按照不同河流源头分类，酸磷含量排序为澜沧江源＞长江源＞黄河源，钙磷含量排序为长江源＞黄河源＞澜沧江源，碱磷含量排序为澜沧江源＞黄河源＞长江源，铁磷含量排序为澜沧江源＞黄河源＞长江源；（3）利用 Langmuir、Freundlic 等吸附动力学模型研究沉积物磷释放潜力，研究结果显示三江源地区沉积物磷平衡浓度（EPC0）变化范围为 0.001~0.335mg/L（平均值为 0.087mg/L），按照 ECPC0 含量排序为黄河源（0.171mg/L）＞澜沧江源（0.078mg/L）＞长江源（0.049mg/L）；（4）虽然三江源地区沉积物铁磷含量（平均含量为 16.29mg/L）较低，然而 EPC0 浓度显著高于上覆水磷酸盐浓度，从而表现出磷源的特征，即三江源地区沉积物具有较高的磷释放风险，其中黄河源地区磷释放风险最高。

关键词　三江源；沉积物；磷赋存形态；磷平衡浓度；释放风险

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单宁酸功能化三维掺钛石墨烯气凝胶的制备及光催化降解有机物的研究

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摘　要　随着工业化与城市化的不断推进，世界范围内的环境问题日益严重。目前，三维石墨烯基复合光催化剂因其兼具吸附与光催化降解能力，且易回收与重复利用，而受到研究者们的广泛关注。本文采用简单的一步水热合成法成功自组装三维石墨烯基二氧化钛复合光催化剂（3D TA-TiO_2-GA），并应用于水体污染物的光催化降解。其中单宁酸（TA）在三维网状石墨烯结构的形成和 TiO_2 纳米颗粒（TiO_2 NP）原位生长在石墨烯结构上起到连接剂和分散剂的重要作用。通过扫描电镜和透射电镜的形态表征证明，TA-TiO_2-GA 具有 3D 多孔网状石墨烯结构，其表面均匀分散 TiO_2 NP（平均粒径为 9.03 ± 2.45 nm）。通过能量分散光谱仪、傅立叶变换红外光谱、拉曼光谱、X 射线衍射和 X 射线光电子能谱进一步分析了 TA-TiO_2-GA 的化学组成与成分。TA-TiO_2-GA 对于光催化消除典型的水溶性有机污染物（如：四环素（TC）、亚甲基蓝（MB）、RhB）表现出良好的去除效率和可重复使用性：在模拟太阳辐射 3 h 下，对 TC、MB 和 RhB 的总去除率分别达到 43.2%，77.8%和 91.9%。机理研究表明，TA-TiO_2-GA 对 RhB 的去除主要是吸附和光催化的协同作用，且·O_2^-和·OH 是主要的活性氧化物质。总而言之，这项研究为制造 3D TiO_2-GA 提供了一种新颖的替代方法，它在太阳能驱动的环境应用中具有巨大的潜力。

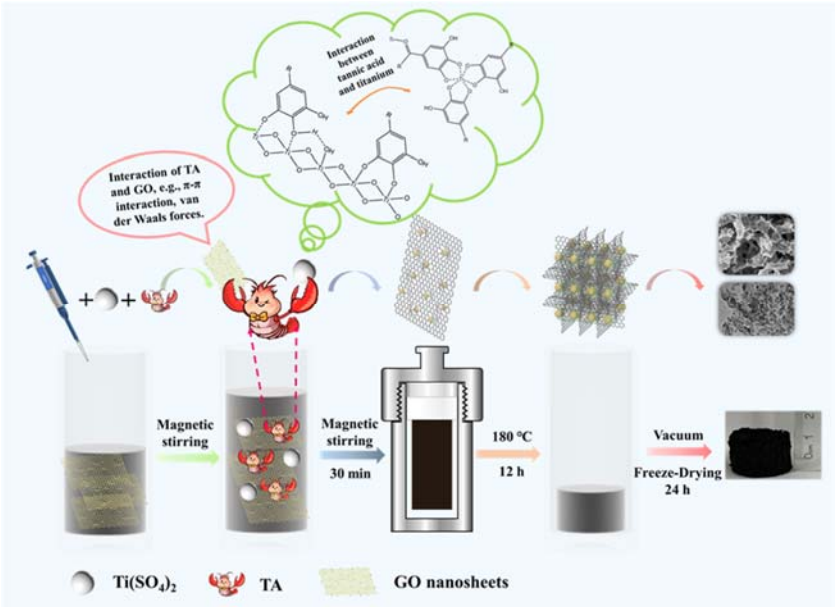

图 1 TA-TiO_2-GA 材料的制备流程示意图

关键词　光催化；三维石墨烯；TiO_2 NP；气凝胶；水体污染物

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四环素类抗生素在碳质填料人工湿地中的降解特征

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摘 要　为研究四环素类抗生素(TCs)，即土霉素、四环素、强力霉素和金霉素在碳质填料人工湿地中降解特征及其受植物的影响，以焦炭为填料，构建有植物和无植物 2 个垂直上流人工湿地实验系统(CW1 和 CW2)，研究对比系统对四种 TCs 在不同浓度下(无、低、中、高)的去除，TCs 在碳质填料中的累积，以及在植物(根、茎、叶)中的分布，并通过物料衡算探讨四种 TCs 在湿地系统中的净化机制。实验结果表明：相同运行条件下，碳质填料人工湿地对土霉素及四环素的去除率较高(平均去除率分别为(91.6±2.6) %和(89.9±4.1) %)，优于强力霉素和金霉素(平均去除率分别为(79.9±8.2) %和(75.4±7.7) %)，植物的存在有利于四环素类抗生素的去除，有植物的 CW1 湿地对土霉素、四环素、强力霉素和金霉素的平均去除率比无植物的 CW2 分别高 10.5 %、4.8 %、15.8 %及 4.0 %。湿地系统中植物对去除 TCs 的贡献要高于填料，CW1 系统中植物体内累积 TCs 总量为 3 635.0 ug，碳质填料中的累积总量为 2 211.5 ug，而 CW2 填料的累积总量为 11 541.1 ug。CW1 物料衡算结果显示，TCs 在系统中的分解、植物摄取及填料吸附贡献分别为 81.4 %，7.6 %和 4.6 %，其中土霉素和四环素更易在系统分解去除，强力霉素和金霉素更容易被植物和填料固定。

关键词　碳质填料；四环素；降解特征；人工湿地

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BP-1 生物降解群落结构解析及关键功能菌的降解效能评估

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摘　要：2,4-二羟基二苯甲酮（2,4-dihydroxybenzophenone, BP-1）作为一种典型的二苯甲酮类紫外线吸收剂，同时也是其它紫外吸收剂（BP-2、BP-3）的主要降解转化产物，广泛存在于地表水、沉积物及废水中，由于其潜在的内分泌干扰效应，已引起研究者的广泛关注。生物降解是有机污染物去除的重要途径，为探究环境中微生物对 BP-1 的降解能力，本文以 BP-1 为唯一碳源，设置好氧和厌氧条件分别驯化富集功能菌群，通过高通量测序技术深度解析群落多样性及功能菌群，在此基础上筛选关键功能菌，并评估其降解效能。结果显示，好氧处理系统是降解 BP-1 的主要途径，降解速率是厌氧体系的 2.74 倍。好氧体系中微生物群落多样性显著高于厌氧体系，厚壁菌门（Firmicutes, 59.58%）是厌氧体系中的优势菌门，梭菌目（Clostridiales, 52.58%），苏黎世杆菌目（Turicibacterales, 5.47%），芽孢杆菌目（Bacillales, 1.53%）是厚壁菌门中占优势地位的菌目；变形菌门（Proteobacteria, 40.66%）是好氧体系中的优势菌门，红环菌目（Rhodocyclales, 28.15%），假单胞菌目（Pseudomonadales, 3.11%），鞘氨醇菌目（Sphingomonadales, 2.22%）是变形菌门中占优势地位的菌目。采用选择性培养基从好氧体系污泥中筛选获得 4 株 BP-1 降解菌，经鉴定分别为甲基营养型芽孢杆菌（*Bacillus methylotrophicus* BP1.1），解淀粉酶芽孢杆菌（*Bacillus amyloliquefaciens* BP1.2），红球菌（*Rhodococcus sp*. BP1.3）和鞘氨醇单胞菌（*Sphingomonas sp*. BP1.4），其中甲基营养型芽孢杆菌 BP1.1 降解速率最快，在 6 h 内对 BP-1 的降解率高达 99.9%，为高效去除废水中 BP-1 提供了微生物种质资源。

关键词：2,4-二羟基二苯甲酮；好氧处理；厌氧处理；高通量测序；降解菌

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不同土壤团聚体中微塑料对土壤胞外酶活性的抑制作用：通过改变土壤性质和直接吸附作用

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摘　要　微塑料作为一种新型的环境污染物，对土壤生态系统构成了严重威胁。微生物产生的土壤胞外酶的活性是潜在的土壤质量敏感指标。但是，关于酶活性对微塑料的长期反应机制知之甚少，而且缺乏关于不同土壤团聚体中酶活性异质性响应。在本研究中，长期土壤培养实验与土壤团聚体分组相结合，以评估微塑料对土壤胞外酶活性的影响。研究结果表明，微塑料通过吸附作用减少对酶活性有重要作用的基质，或与土壤微生物竞争理化生态位减少微生物活动，从而降低土壤酶活性。此外，微塑料还可以通过改变土壤理化性质而对酶活性产生影响，溶解性有机碳和速效磷是影响酶活性的主要因子。不同土壤团聚体组分中酶活性对微塑料的响应不同。大团聚组分（2000μm-250μm）中过氧化氢酶和微团聚体组分（250μm-53μm）中苯酚氧化酶和 β-葡萄糖苷酶对微塑料的响应最大，而非团聚体组分（<53μm）中脲酶、锰过氧化物酶和漆酶活性对微塑料的响应最大。这可能是微塑料进入土壤后，在不同团聚体中的分配比例不同，以及不同团聚体对土壤有机质的保护机制不同，导致不同团聚体中酶活性对微塑料的响应不同。我们关于微塑料对不同团聚体中土壤理化性质和酶活性影响的研究有利于探明塑料污染对土壤养分循环和土壤健康的影响，从而优化微塑料污染背景下对土壤环境质量的最佳管理。

关键词　微塑料；土壤团聚体；胞外酶活性；理化性质；长期培养

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菌群 WZ-7 降解菲的机理研究

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摘　要　从涠洲终端污水处理系统中分离出以菲为主要碳源和能源的耐盐菌群 WZ-7，对其代谢产物、功能基因和生物降解途径进行了研究。在 35℃、pH= 7.0、盐度为 30‰、菲浓度为 100 mg/L 条件下，连续培养 7 d，菲的降解率为 87.76%；1，2-二羟基萘、1-羟基-2-萘甲酸、7，8-苯并香豆素和邻苯二甲酸是主要代谢产物。根据 KEGG 功能注释，在 WZ-7 菌群中注释到 19 个编码多环芳烃降解酶的基因。结合 NCBI 数据库检索，鉴定出参与上游降解途径的基因，为 3，4-二氢二羟基菲脱氢酶基因（phdE）、3，4-二羟基菲双加氧酶基因（phdF）、1-羟基-2-萘甲酸水解酶基因（phdG）和 4-羧基粘康酸脱羧酶基因（pcaL）。基于 GC-MS 检测到的代谢物和通过 BLAST 搜索鉴定出的潜在菲降解基因，提出了 WZ-7 对菲的生物降解途径。即，菲首先于 C3 和 C4 碳位发生双羟基化，3，4-二羟基菲于间位开环裂解生成 1-羟基 2-萘酸，随后脱羧转化为 1，2-二羟基萘，并于邻位开环生成邻苯二甲酸。经双加氧酶和脱羧酶的作用，邻苯二甲酸转化为原儿茶酸，原儿茶酸在双加氧酶的作用下开环裂解转化为丙酮酸，最终进入三羧酸循环完成降解。

关键词　多环芳烃；菲；微生物；降解机理

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含氨污染在不同形态及介质中处理的经济价值分析

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摘要：氨是化学工业的主要原料，广泛应用于化肥，炼焦、塑料、石油精炼、制药等行业。氨氮现已超过化学需氧量成为影响我国地表水水环境质量最主要的污染物，是“水十条”、“十三五”环保规划等重点防治污染物。多介质过程产生的氨排放也成为我国区域水体黑臭、灰霾污染、土壤生境恶化的重要成因。近年来，我国对含氨废水及废气排放的监督和管理越来越严格，并制定了一些严格的排放标准，而氨作为资源可进行重新利用，其存在形态及浓度对资源化成本影响较大。本文揭示了氨污染处理的成本效益，提出氨作为废物与资源的临界点浓度与氨的资源价值模型，并探讨了不同形态及介质中氨污染的处理成本差异。结果表明，在废水中氨氮浓度接近于 10%时，通过资源化利用基本能够达到净现值为 0，即收支平衡。相同进水浓度时，氨氮在碱性条件下单位处理成本最低，为 0.19~0.41 元/kg NH_3，在酸性离子态、重金属络合态及有机物络合形态下，会分别平均增加 2、8 及 13 倍左右的单位处理成本。在气态介质中，氨的处理成本约为-0.5~6 元/kg NH_3，但实际工艺中加热浓缩等过程会进一步增加成本。含氨污染在实际工艺中多为气态液态并存以及与其他杂质共存状态，存在污染的跨介质转移风险。今后应进行全过程统筹，关注氨污染的多介质协同管控及治理，实现经济成本最小化的同时，降低环境风险。

关键词：含氨污染；成本；资源价值模型；介质；形态

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成都平原典型混合用地区域地下水污染风险评价研究

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摘 要 针对目前地下水污染风险评价指标不够全面和指标权重确定较主观等问题，本文综合考虑含水层脆弱性、污染荷载和功能价值三方面因素，以成都平原某典型混合用地区为对象进行地下水污染风险评价研究。在传统地下水脆弱性 7 项指标基础上添加土地利用类型指标进行含水层脆弱性评价，结合地下水污染程度进行污染荷载评价，并以研究区地下水赋存量为主要因素，考虑地下水生态敏感性、地下水水质等次要因素进行地下水功能价值评价，构建地下水污染风险评价模型，采用熵权法确定评价指标权重。借助 ArcGIS 加权叠加揭示研究区地下水污染风险空间分布特征，并通过区域内 36 处地下水水质监测井，运用污染综合指标 F 值法获取地下水水质综合指数空间分布，检验地下水污染风险评价模型的合理性。结果显示研究区地下水污染风险低、较高、高的区域分别占研究区总面积 24%、15% 和 10%。地下水水质污染综合实测值与污染风险模型预测值空间分布基本一致，反映出本文构建的地下水污染风险评价模型能够客观指示研究区污染风险程度，为区域地下水污染风险评价提供准确可靠的指标体系和参考模型。

关键词 成都平原；地下水污染；风险评价；熵权法；土地利用

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新型组合工艺深度去除 DOM 及其对低温运行的响应特征

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摘　要：我国城镇污水处理厂进水具有碳氮比低、可生化性差等特性，显著增加了污水处理厂稳定达标运行的难度。为应对逐渐提高的污水处理排放标准，研发了基于生物吸附-多级 AO-活性焦吸附的高效污水处理组合工艺，并探索了其运行参数对脱氮除磷的影响，分析了各工艺段溶解性有机物（Dissolved Organic Matter，DOM）和总磷的去除特性，最后对低温条件下组合工艺的响应特征进行解析，为该组合工艺的工程应用提供理论依据和技术支撑。

围绕组合工艺不同功能段的运行效果，确定了组合工艺的最优运行参数。经过 80 d 的连续运行，TN 和 TP 出水平均浓度分别为 8.5 和 0.25 mg/L，平均去除率分别高达 80.5%和 84.6%，其中活性焦吸附工艺段对聚磷酸盐和有机磷的去除率高达 84.6%和 58.8%，实现了超低营养盐指标排放目标。此外，活性焦中孔结构发达，对大分子芳香族类和环烷烃类 DOM 的去除效果较好，多级 AO 出水中芳香族类、环烷烃类和卤代烃类 DOM 的比例由 50.23%降至 10.24%，使工艺出水 COD 浓度降低至 20 mg/L 以下，达成了污水 COD 超低排放的目的。

生物吸附工艺段和多级 AO 工艺段均含有大量脱氮除磷功能微生物。生物吸附工艺富集了适应原水的多种微生物，菌群多样性较高，具有快速富集有机物能力的 *Acidobacteria* 菌门相对丰度达到 10.23%。多级 AO 工艺菌群丰度和多样性略低，其中相对丰度较高的微生物为具有脱氮除磷功能的 *Proteobacteria* 菌门（79.39%）和 *Nitrospirae* 菌门（6.5%）。微生物多样性及群落结构分析从微观角度揭示了生物吸附和多级 AO 工艺段对污染物的不同作用方式，为工艺调控提供了理论依据。

在 5 ℃低温条件下，组合工艺出水 TN、TP 和 COD 等主要水质指标未出现显著波动，系统仍获得了较高的污染物去除率，表明组合工艺具有良好的抗低温影响能力。多级 AO 工艺污泥中仍然保有大量脱氮除磷功能菌，但主要脱氮除磷功能菌门 *Proteobacteria* 相对丰度由 66.22%降至 54.27%，生物吸附段 *Proteobacteria* 菌门相对丰度由 60.35%降至 56.46%。具有降解有机化合物能力的 *Bacteroidetes* 菌门相对丰度由 5.27%降至 2.56%，但该工艺段仍然保有大量具备降解有机物功能的 *Acidobacteria* 菌门，有效缓冲了后段工艺处理负荷，使组合工艺具有良好的抗外界干扰能力。

关键词：生物吸附，多级 AO，活性焦，溶解性有机物，聚磷酸盐，低温，微生物菌群结构

预偶联-氧化耦合工艺强化制药废水特征污染物去除研究

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摘 要 制药废水中含有大量特征污染物，包括药物中间体、残留抗生素、有机溶剂等，导致制药废水具有难降解、去除效率低等特点。2-巯基-5-甲基-1,3,4-噻二唑（MMTD）是常用感冒药头孢类抗生素（头孢唑啉钠、头孢唑酮等）的典型药物中间体，也是头孢类抗生素制药废水的特征污染物。前期研究发现，MMTD中的噻二唑环很难在常规生化与氧化（如臭氧）下发生破环降解，导致该制药废水的总有机物去除效率很低，难以达到废水排放标准。

本研究提出预偶联-氧化耦合新工艺，通过MMTD预偶联过程改变MMTD中噻二唑环电子结构，促进MMTD在氧化过程的开环降解。腐殖酸（HS）作为预偶联剂加入体系，不仅可有效实现>95%的MMTD与富含醌类结构HS发生偶联，而且显著促进MnO_2氧化对MMTD的去除（>98%）。（中间）产物的ToF质谱分析结果表明，MMTD与HS预偶联后形成中间产物MMTD-HS，在后续氧化过程中噻二唑环进一步被开环氧化形成磺化HS；对比直接氧化过程，MMTD容易产生二聚体中间产物，并进一步氧化形成磺化MMTD。DFT理论计算表明，预偶联和氧化过程会显著改变MMTD及中间产物的电子结构特性，决定了继续发生破环降解反应的能力；MMTD中间产物的亲核指数Nu呈现$Nu_{HS\text{-}MMTD}$> $Nu_{MMTD\ 二聚体}$> $Nu_{磺化\ MMTD}$的趋势, Nu越高表明越容易继续发生氧化；且其开环能垒E呈现$E_{HS\text{-}MMTD}$ (274 kJ/mol) < $E_{MMTD\ 二聚体}$ (286 kJ/mol) < E_{MMTD} (338k J/mol) 的趋势，E越低表明越容易发生开环降解。因此，由于腐殖酸的预偶联作用，MMTD与腐殖酸形成的偶联中间产物比直接氧化MMTD形成的二聚体中间产物更容易继续被氧化发生噻二唑环的开环降解反应。由于HS环境友好并且容易分离实现资源化利用，预偶联-氧化新工艺且更有可能实现废水中噻二唑环的完全去除，为抗生素废水的绿色可持续处理提供了新的思路和策略。

关键词 制药废水特征污染物；预偶联-氧化耦合；腐殖酸；开环降解

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环糊精改性钛纳米管对 BPA 等污染物的光催化去除

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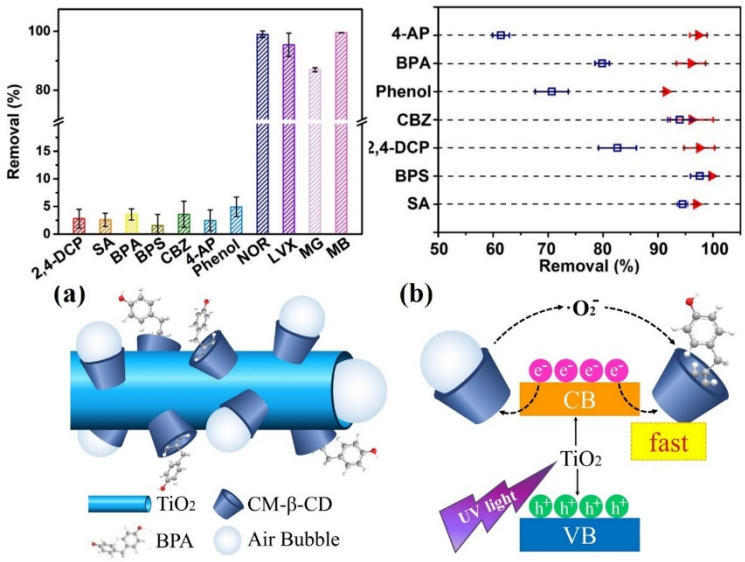
摘　要　水中的药物、抗生素、环境干扰素等有机污染物对人类生活的影响日益增加，迫切需要对其进行高效去除。相较于传统的物理法和生物法处理技术，化学法在去除水中有机污染物方面具有显著的优势，这其中，光催化技术在水环境治理方面表现出巨大潜力。但由于 TiO_2 的电子-空穴复合率高、纳米级 TiO_2 粒径过小不易分离等缺陷，导致 TiO_2 光催化法在水处理中的实际应用受到了制约。环糊精（CD），作为一种环境友好、可生物降解的多糖，其用于修饰 TiO_2 半导体时，具有优于贵金属 Au 纳米颗粒的助催化性能。本文针对 TiO_2 存在的问题，以工业纳米级 TiO_2 (P25)为基础材料，采用水热法制备了 TiO_2 纳米管（TNT）材料，并考察了环糊精改性 TiO_2 材料(CM-β-CD-TNT)对 BPA 等污染物光催化效果的影响。发现 CM-β-CD-TNT 对诺氟沙星(NOR)、左氧氟沙星(LVX)、亚甲基蓝(MB)和孔雀石绿(MG)均有一定吸附效果，对初始浓度为 20 mg/L 的上述污染物，30 min 内均可以去除 90%以上。在 2.5 h 内，CM-β-CD-TNT 可以将初始浓度为 20 mg/L 的双酚 A(BPA)、双酚 S(BPS)、卡马西平(CBZ)、2,4-二氯酚(2,4-DCP)、扑热息痛(4-AP)、苯酚(Phenol)、磺胺(SA)，分别去除 96.0%、99.7%、96.1%、97.5%、97.3%、91.4%以及 97.0%。对比改性前后的材料光电流、材料电阻抗等，发现 CD 对 TNT 表面电子传输速率具有明显的提升作用。另外，通过自由基捕获、电子顺磁等方法，并辅以低溶解氧条件下、改性 TNT 材料的自由基捕获实验，提出 TNT 光催化作用机理：在 TNT 光氧化系统中，紫外激发 TNT 产生的电子会优先攻击材料介孔及材料表面的气泡，产生·O2-用以攻击污染物。在 TNT 体系中，CD 不仅可以加速电子传输速率，捕获有机污染物，还起到了包结疏水性气泡的作用。

关键词　环糊精；钛纳米管；光催化；双酚 A



(a) CM-β-CD-TNT 吸附去除单一体系水中污染物(time=30 min)；(b)两种催化剂对不同污染物的降解去除效果对比；(c) CM-β-CD-TNT 的分子结构；(d) CM-β-CD-TNT 的电子迁移示意图

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纳米锰氧化物改性生物质炭协同作用去除水体中柠檬酸铜的研究

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摘　要　水体中 90%以上的金属均以络合态形式存在，危害大且去除困难。常规去除途径（单纯的沉淀法、膜分离、电解）难以满足环境要求。由简单合成手段制备的纳米锰氧化物改性生物质炭（BC-MnOx）可高效去除柠檬酸铜（CuCA），在较短时间内去除率可达 99%且该材料在宽 pH 范围内（4-10）高效、稳定，在真实水体中依然保持稳定的去除性能。去除机理为纳米锰氧化物对柠檬酸铜的氧化以及改性材料的吸附作用，同步实现金属铜吸附及有机质降解和吸附。具有低成本、高效和无二次污染等优点的复合生物质炭材料展现了良好的稳定性和优异的吸附性能，应用于水体金属去除实现了“以废治废”的目的。

关键词　生物质炭；锰氧化物；柠檬酸铜；吸附；氧化

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抗干扰型钴@碳铠甲催化剂高效催化降解水中有机污染物

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摘　要　以核壳结构 ZIF-8@ZIF-67 为前驱体，通过热解和酸洗制得表面长有碳纳米管的氮掺杂中空碳多面体，其壳层中包裹尺寸约 15 nm 的单质钴纳米颗粒。碳壳类似铠甲可保护钴颗粒不受外界酸性和强氧化性环境侵蚀，而钴颗粒可将电子传递至碳壳形成高反应活性表面。该催化剂可高效活化过一硫酸氢钾降解水中双酚 A，一级反应动力学常数达 9.29 min^{-1}，比同等条件下已报道催化剂高 1-2 个数量级，同时无钴离子泄露，并可通过外加磁场实现简易回收。更为重要的是，该催化剂在广泛 pH 和低温条件下、无机盐和 NOM 共存时仍保持高效，体现出优异的抗干扰性能。自由基淬灭实验和固液表征表明污染物通过直接电子转移的非自由基方式被降解。本工作为实际水体中有机污染物的高效稳定去除提供了一类新型可全季节使用的铠甲催化剂，有利于推动基于过硫酸盐的高级氧化技术落地。

关键词　过一硫酸氢钾；钴-碳铠甲催化剂；双酚 A；电子转移；抗干扰

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Abstracts of English Manuscripts

Spatial effect on the microbial community in chlorinated drinking water distribution systems: an Integral Study of Particle-Associated and Free-Living Bacteria

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Abstract: Risk control in the pipeline transportation could be an important and the final barrier for the security of drinking water. Previously, it was believed that all bacteria in DWDSs exist only in the following two forms: wall biofilm and bulk water bacteria. In contrast, recent studies generated fresh insights that bulk water bacteria consisted of particle-associated (PAB) and free-living bacteria (FLB), two significant components with different communities. And the characteristics of bacterial communities in transition regions, where different drinking water distribution systems (DWDSs) are connected, have not been revealed.

For comprehensive insights into the potential risks on the microbial community during pipeline transportation, this study utilized 16s rRNA approaches and conventional microbial methods to observe the potential subtle variation and characterize the spatial effect on PAB and FLB in DWDSs, especially the microbial risks in transition regions.

Based on heterotrophic plate count, flow cytometry, q-PCR, and 16s rRNA approaches, our research has shown that the characterization of bacterial concentration, relative abundance of opportunistic pathogens, and microbial communities did not allow to a spatial variation pattern that was appropriate to all different DWDSs. Nevertheless, according to the distance-decay relationship both in FLB ($r = -0.476$, $P < 0.01$) and PAB ($r = -0.352$, $P < 0.01$), transportation distance appeared as a potential driver of bacterial variation in DWDSs. In addition, the higher alpha diversity and relative abundance of *Pseudomonas* in PAB from the transition region highlighted that transition regions may be of great microbial risk. This could be explained by the detachment of biofilm induced by hydraulic disturbances. These spatial patterns indicated that different DWDSs, especially the transition region, might need specific security strategies.

Meanwhile, the beta diversity based on PCoA indicated the significant difference (PERMANOVA, $R^2=0.14$, $P_{value} < 0.001$) between FLB and PAB in DWDSs. Compared to FLB, the extremely higher abundance of *Pseudomonas* in PAB suggested that PAB are potential reservoirs for pathogens. Notably, the potential resistance of PAB to disinfection may decrease the disinfection efficiency of pathogens and bring potential risks of drinking water. Thus, PAB in drinking water deserves more public health concerns.

Furthermore, the distribution distance showed a significant influence on pipe water PAB and FLB based on SourceTracker analysis. This was revealed by the 66.9%~92.5% decline in contribution of treated water to pipe water during transportation from proximal to distal regions. Therefore, although source water and purification processes shape the original bacterial community, the distribution process is also of great impact on drinking water.

Consequently, our findings indicated that variation in pipeline distribution could be responsible for the degree of impact on tap water, and sufficient microbial control strategies should be implemented considering different microbial components and transition regions.

Keywords: drinking water, distribution system, bacterial community, spatial effect, high-throughput sequencing

Urban water security of the mega cities in the Yangtze River basin: Comparative assessment on city and basin level

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Abstract: Current urban water security studies have seldom incorporated urban water management targets and sustainability topics, nor considered the connection of the cities and their corresponding basins. To address the challenges, this study employed the indicator framework integrating the targets of urban water management transitions (achieving towards the water supply city, the sewered city, the drained city, the waterways city, the water cycle city and the water sensitive city) and sustainability topics (encompassing environmental, economic, social and institutional dimensions) to evaluate the water security condition of the mega cities in the Yangtze River basin, namely Shanghai, Nanjing, Wuhan, Chongqing and Chengdu, during 2011-2017. To lower the subjectivity, the Criteria Importance Through Inter-criteria Correlation (CRITIC) method was applied to detect an indicator weighting scheme by considering data divergence and indicator interdependencies. The results showed that Chongqing had the best water security condition in 2017, followed by Shanghai, Chengdu, Wuhan and Nanjing. Shanghai has had the largest improvement of the water security condition while Chengdu has showed the least. At the river basin level, the upstream mega cities have the superiority of water resources endowment, advancement of drainage system, river quality, wastewater discharge, water use, urban greening and government's support of water affairs. The middle- and downstream ones have shown the better performance of water affordability, the density of water supply and sewage network, water intensity of economic activities and government's expenditure of environmental protection. This study contributes to the comparative assessment of water security condition on city and river basin level, and assists tailoring policy measurements to the mega cities to enhance water management practice.

Keywords: Urban water security; Urban water management transitions; Sustainability; Mega cities; The Yangtze River basin

Robustness of granular activated carbon-synergized anaerobic membrane bioreactor for pilot-scale application over a wide seasonal temperature fluctuation

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Abstract: Novel granular activated carbon-anaerobic membrane bioreactor (GAC-AnMBR), which consisted of expanded bed anaerobic bioreactor combined with GAC as carriers for microbial growth and biogas-sparged membrane tank, was developed in pilot-scale for the treatment of real municipal wastewater (MWW) at ambient temperature seasonally fluctuating from 35 ℃ to 5 °C. It showed sound organic removal over 86% and permeate COD was found less than 50 mg/L at all times, despite the operation at extremely low temperature of 5-10 °C. A high methane yield over 0.24 L $CH_{4\ (STP)}$/g $COD_{removed}$ was achieved at mesophilic temperature, and decreased slightly to 0.21 L $CH_{4\ (STP)}$/g $COD_{removed}$ at 5-15 °C. COD pathway analysis indicated membrane rejection of organics (nearly 20%) compensated more for the decreased biological removal at lower temperature. Methanogenic activity of GAC attached biomass was higher and more stable than that of the suspended biomass when witnessing temperature drop, ensuring stable anaerobic treatment performance. Pyrosequencing of microbial communities suggested that temperature affected the functional bacteria for methane production, and GAC addition enhanced methane production by enriching *Methanosaeta*, syntrophic bacteria and exoelectrogenic *Geobacter* on GAC. Compared with other pilot scale AnMBRs, GAC-AnMBR showed superior overall performance, and high stability in a wide temperature range. The results indicated future potential of GAC-AnMBR for practical operation, especially in cold and temperate climate regions where MWW temperatures are quite low during part of the year.

Keywords: Granular activated carbon; Membrane; Municipal wastewater; Ambient temperature; Methane yield

Microbial community assembly and metabolic function in top layers of slow sand filters in two full-scale drinking water treatment plants

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Abstract: Slow sand filters (SSFs) are widely applied for degrading organic matter and producing biologically stable drinking water, the function of which lies mainly in the "golden" top layer. However, the development of microbial community and its metabolic function is still poorly understood. In the present study, we analyzed microbial quantity and community of the influents, effluents, and the top layers of SSFs (schmutzdeke, 0-2 cm, 4-6 cm, 8-10 cm) in two full scale drinking water treatment plants (DWTPs) that using the same artificial recharged groundwater source. As quantified by flow cytometric cell count and adenosine triphosphate (ATP), the biomass decreased rapidly along the depth (>75% ATP; >1 log TCC), which sharply occurred at the first 6 cm and gradually stabilized while going deeper. Remarkably, beta diversity showed that the same depth SSFs in two DWTPs clustered together, demonstrated the insignificant effects of lateral spatial factors (e.g. filter ages, filtration rates and locations) but key role of the influent water on shaping microbial communities in SSFs. Using an island biogeography model, we found that microbial communities in SSFs were strongly assembled by selection (25 OTUs, 22% sequences) rather than neutral processes mitigating from the microbial communities in the influents (65 OTUs, 18% sequences). The alpha diversity indices followed the same trend with biomass, suggested more active and diverse community on the top layers. PICRUSt based function prediction revealed the significant overrepresented of membrane transport, amino acid and carbon hydrate metabolism in the top layers, the functional importance of which was confirmed by the co-occurrence patterns of the dominant taxa and metabolic functions. Our finding shed new lights on understanding microbial community assembly and metabolic function in the top layers of SSFs, which are valuable for optimizing the design and operation of biofilters in full-scale DWTP.

Keywords: Slow sand filters, top layers, microbial community assembly, predicted metabolic capacities, neutral community model

Performance and functional microbial communities of denitrification process of a novel MFC-granular sludge coupling system

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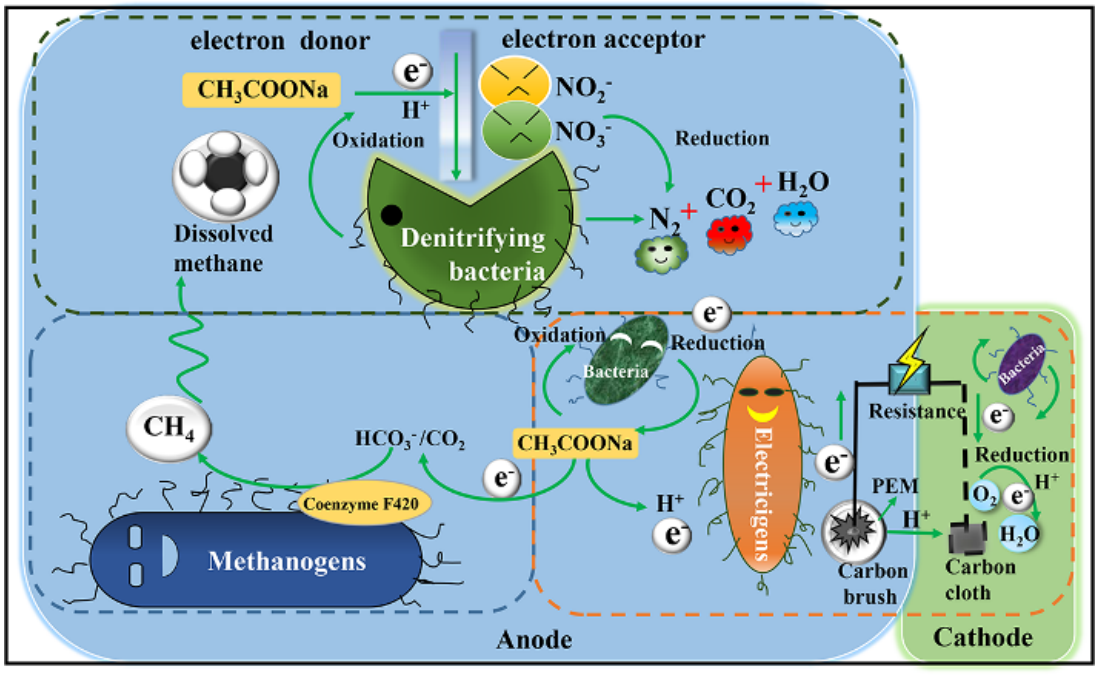
Abstract: The performance, microbial communities and functional gene metabolism of the novel microbial fuel cell (MFC)-granular sludge coupling system was investigated. The results showed that COD and nitrogen removal can be up to 1.3-2.0 kg COD/L, 20-30 mg NO_2^--N/L, and 60-70 mg NO_3^--N/L, respectively. Proteobacteria, Chloroflexi, and Firmicutes were the dominant bacterial phyla, and the denitrification process was mainly consisted of the dominant denitrifying bacteria: *Thauera* (26.21%) and *Pseudomonas* (14.79%) in the first compartment, combining with denitrifying anaerobic methane oxidation bacteria: NC10 phylum of 0.072% (the first compartment) and 0.089% (the fourth compartment), *Candidatus Methylomirabilis oxyfera* of 0.044% (the first compartment) and 0.048% (the fourth compartment). According to functional gene classification for Kyoto Encyclopedia of Genes and Genomes (KEGG) analysis, metabolism was the main cluster for the whole sequence in the KEGG (7.17-11.41%), indicating that the dominant metabolic pathway played an important role in the degradation of pollutants.

Keywords: MFC-granular sludge coupling system; Denitrification process; DAMO; Dissolved methane; Electron transport system; Microbial community

Graphical abstract



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Evaluating the seasonal wastewater quality before and after aerobic-anoxic treatment for irrigation purpose

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Abstract: Agricultural sector requires large volume of water (~70% of global water), which makes this sector difficult to produce enough food for the growing demand with the existing scare available freshwater source. As a viable alternative water source, urban wastewater reuse is a potential candidate. Using untreated domestic wastewater to grow different vegetables is a common practice in most part of the world. However, wastewater reuse and disposal before treatment poses a significant threat to human health and ecological systems. In the study area (Arba Minch town, Ethiopia), there is a critical shortage of urban wastewater quality information and no wastewater treatment plant so far in the town. This study was designed to evaluate the seasonal wastewater quality before and after aerobic-anoxic treatment for irrigation purposes. Wastewater samples were collected in summer and winter seasons at nine sites of Arba Minch town and subjected for aerobic-anoxic treatment. The effect of treated and untreated effluents was used to irrigate different vegetables and results compared with control. The results showed that most of the untreated wastewater quality indexes exceeded the standards limits recommended by FAO, WHO and EEPA, mainly higher during winter season than summer. Statistically significant ($p<0.05$) seasonal variations were observed for temperature, NH_4-N, NO_2-N, K, Ca, Fe and sodium adsorption ratio (SAR). Although the COD (471.0-636.8 mg/L) and BOD_5 (300.9-402.4 mg/L) results were significantly fluctuated in both seasons (BOD5/COD>0.6), it has been found biodegradable. The performance of aerobic-anoxic treatment for COD, BOD_5 and TSS were found to be 91-94, 92-95 and >96% with the effluent concentration 23.5-46.6, 19.7-34.2, and <30.0 mg/L for both seasons, respectively. The removal efficiency of NH_4-N, TN and TP were also found to be greater than 92, 88 and 58%, respectively. The aerobic-anoxic removal efficiency of microbial load such as helminths egg (100%), fecal coliform (>82%) and total coliform (>65%) were also significant. The order of heavy metals concentration in raw wastewater were Fe>Pb>Zn>Mn>Cu> Cd, which substantially reduced after aerobic-anoxic treatment [Cd (>98%) > Cu (60-85%) > Zn (40-84%) > Mn (51-69%) > Fe (42-64%) > Pb (19-33%)]. The relative phytotoxicity effect of untreated wastewater was significantly higher (cabbage> lettuce> tomato) than treated effluent and the control. Overall, the results confirmed that aerobic-anoxic treated wastewater fulfill the WHO and FAO guideline water that can be used for irrigating crops.

Keywords: wastewater; aerobic-anoxic; irrigation purpose; Arba Minch town, coliform

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Novel Fenton-like system for the efficient cleaning of fouled ultrafiltration membrane by simultaneous generation of free radicals and oxygen

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Abstract: The novel fenton-like system is developed to achieve highly efficient membrane cleaning for both fouled PVDF and PES membranes in this study. Compared with conventional chemical cleaning process in which the whole membrane module has to be soaked in highly concentrated solution of chemical reagent for long period of time, the developed cleaning process conducting for only 5 min in 0.5 wt% H_2O_2 solution can achieve more than 95% recovery of permeate flux and almost total removal of the irreversible foulants. More importantly, the permeate flux and filtration effificiency of the membrane can be still kept stable after 6 runs of consecutive fouling and cleaning. The outstanding performance of developed system is attributed to the generation of both free radicals and abundant oxygen simultaneously, leading to the physico-chemical membrane cleaning. The effects of typical cations on membrane fouling and cleaning, as well as the related mechanisms are further investigated systemically, with K^+ and Ca^{2+} chosen as the representative cations, and humic acid (HA) as the membrane foulants. The results demonstrate Ca^{2+} promotes the formation of reversible fouling, meanwhile higher removal efficiency of HA can also be achieved with the assistance of filtration cake containing HA+Ca^{2+}. However, K^+ leads to the formation of more recalcitrant irreversible fouling. By comparing the concentration of cations in feed and permeate, analyzing the influence of cations on size of HA flocs, and the detailed SEM, AFM and TEM observation, it can be found that different mechanisms dominate the interaction between cations and HA. The bridging effect induced by Ca^{2+} attributes to the extension of HA molecules, while the electrostatic shielding effect induced by K^+ leads to the compression of them. Moreover, the different characteristics of hydrated Ca^{2+} and K^+ also contribute to the different structures of foulant layers formed by HA+Ca^{2+} and HA+K^+. Conclusively, the newly developed Fenton-like system demonstrates noteworthy advantages on efficient membrane cleaning, and exhibits highly potential for the wide application in practical water treatment process.

Keywords membrane cleaning, Fenton-like system, ultrafiltration membrane, membrane fouling

Statement: The related results are newly published in *Water Research (2019, 2020).*

Insight into the synthesis and electrocatalytic performance of *in-situ* fabricated electroactive biofilm-Pd

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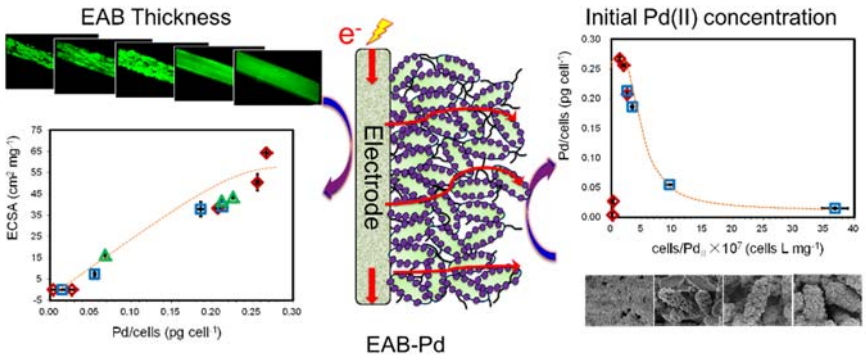
Abstract Biogenic palladium (bio-Pd) nanoparticle has been considered as a promising biocatalyst for energy generation and contaminants remediation in water and sediment. Recently, a novel procedure that relied on electroactive biofilm (EAB) to generate an EAB-Pd network, which could be used directly as electrocatalyst and provide with enhanced electrocatalytic performance, has exhibited tremendous application potential. However, the information regarding to the controllable biosynthetic process and corresponding catalytic properties is scarce. This study proposed that the factors affect the catalytic performance of EAB-Pd could be summarized as Pd loading on bacteria cells (Pd/cells), which was crucial to determine the final distribution characteristic of Pd nanocrystal on EAB skeleton. The high Pd/cells (over 0.18 pg cell^{-1}) indicated high coverage and densely distributed nanoparticles on bacteria surface, which could form an effective electron transfer pathway to accelerate electrons transport through conductive structure and enhance the electrocatalytic performance. In addition, the Pd/cells was further affected by the synthesis factors, the ratio of biomass to initial Pd(II) concentration (cells/PdII) and the exposure time of EAB to Pd(II) precursor solution. The Pd/cells increased significantly as cell/Pd_{II} ratio decrease from ~5.5×10^7 to ~1.3×10^7 cells L mg^{-1} and increased with the prolongation of exposure time from 3 h to 24 h. The findings developed in this work extensively expend our knowledge for the *in-situ* designing biogenic electrocatalyst and provide important information for the development of its utilizing property in the degradation of pollutants.

Keywords Biogenic Pd nanoparticles; Electroactive biofilm; EAB thickness; Electrocatalytic performance



Novel strategy to stimulate the food wastes anaerobic fermentation performance by eggshell wastes conditioning and the underlying mechanisms[1]

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Abstract: A novel strategy of utilizing eggshell wastes to condition food wastes (FW) anaerobic fermentation for efficient volatile fatty acids (VFAs) production was proposed. The VFAs production, especially acetic and butyric acids, was significantly accelerated and enhanced by eggshell conditioning. The enhanced effects were dose-dependent and improved by approximate 13-folds with optimal dose when compared with that in control. Eggshell conditioning synchronously enhanced the FW solubilization, hydrolysis and acidification steps, resulting in high VFAs production. Further analysis found that the environmental conditions (*i.e.,* pH, ORP, trace elements, *etc.*) were significantly improved by eggshell conditioning. Hence, the microbial activities (*i.e.,* hydrolases, acidogenic enzymes and ATP) and functional fermentative bacteria related with VFAs generation were enhanced and enriched. The massive accumulation of H_2 and CO_2 in eggshell conditioning reactors stimulated the homoacetogenesis, which also contributed to the VFAs promotion. Metatranscriptomic analysis indicated that 3 carbohydrate-active enzymes (Glycoside hydrolases, carbohydrate esterases and carbohydrate binding modules), which participate in carbohydrates and energy metabolisms, were improved. Moreover, 10 kinds of synthetase, hydrolase and oxidoreductase genes, and 4 kinds of acetyl-CoA carboxylase genes that distributed throughout the fatty acid biosynthesis pathway (especially the acetic and butyric acids generation) were all enhanced. It was the highly expressed genes and metabolic enzymes that contributed to high microbial activities and subsequent efficient VFAs production in eggshell conditioning reactors. Besides, the improvement of dewaterability and phosphorus fixation in fermentation residues further increased the added-value of conditioning FW fermentation by eggshell wastes.

Keywords: Food wastes (FW); Anaerobic fermentation; Volatile fatty acids (VFAs); Eggshell conditioning; Metatranscriptomic analysis; Fatty acid biosynthesis pathway

[1] This work has just accepted by chemical Engineering Journal (https://doi.org/10.1016/j.cej.2020.125560)

LiCl-CN nanotubes ceramic films with highly efficient visible light - driven photocatalytic active for bisphenol A degradation and efficient regeneration process

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Abstract: In this research, well-crystallized lithium chloride (LiCl) intercalated graphite carbonitride (g-C_3N_4) nanotubes(LiCl-CN) as ceramic films have been rationally designed and fabricated through the molten salt preparation. The as-synthetic material exhibited nanotube morphology and showed significantly enhanced photocatalytic performance on the degradation of bisphenol A (BPA) compared with g-C_3N_4 in the presence of simulated solar light. The catalytic performance of LiCl-CN was remarkably improved due to the structural alteration of g-C_3N_4. The results demonstrated 100% BPA could be effectively removed with 0.3 g/L LiCl-CN at pH 5.0 in this investigated reactive system, and the degradation behavior was consistent with pseudo first order reaction kinetic model. Besides, LiCl-CN photocatalyst exhibited excellent photostability and recyclability for BPA photolysis. Mechanistic study revealed that both superoxide radicals ($\cdot O_2^-$) and photogenerated holes (h^+) were the dominant activated species for the degradation of BPA by LiCl-CN. The findings of this work further open an avenue for the application of g-C_3N_4 based ceramics materials for organic pollutant removal from wastewater.

Keywords LiCl-CN; Visible-light; Photodegradation; BPA.

Characteristics of nitrogen and phosphorus adsorption by Mg-loaded biochar from diffffferent feedstocks

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Abstract: Herein, biochars from 6 diffffferent feedstocks (taro straw, corn straw, cassava straw, Chinese fifir straw, banana straw, and Camellia oleifera shell) were produced using magnesium chloride ($MgCl_2$) as a modififier due to their sorption behavior toward NH_4^+-N and phosphorus in an aqueous solution. The biochar characteristics were evaluated, including pH, pH_{PZC}, biochar magnesium content, and total pore volume (PV_{tot}). The experimental results in terms of the kinetics and equilibrium isotherms showed that the cassava straw and banana straw biochars exhibited the theoretical maximum saturated adsorption capacities of 24.04 $mg \cdot g^{-1}$ (NH_4^+-N) and 31.15 $mg \cdot g^{-1}$ (TP), respectively. Biochar produced from these feedstocks had higher magnesium contents and greater total pore volumes, reflflecting the signifificant contributions from magnesium and steric effffects. FTIR, XRD, and SEM/EDS analyses demonstrated that NH_4^+-N and TP sorption mechanisms predominantly involved surface electrostatic attraction, Mg^{2+} precipitates and complexation with surface hydroxyl functional groups.

Keywords Magnesium-loaded biochar； Nitrogen；Phosphorus；Adsorption；Diffffferent crop straws

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Goldfish Growth Inhibition and Gut Microbial Community Shift Induced by Exposure to Carboxylated Multi-Walled Carbon Nanotubes

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Abstract: Exposure to carbon nanotubes can affect animal growth and gut microbiota are closely related with lipid metabolism of animals, but the roles of gut microbiota in the adverse effects of carbon nanotubes on fish growth remain unknown. In this study, juvenile goldfish (*Carassius auratus*) was exposed to 0-1000 μg/L carboxylated multi-walled carbon nanotubes (MWCNT-COOH) for 28 d to investigate the correlations of fish gut microbial community shift with the induced toxicities. MWCNT-COOH was found to induce histopathological and oxidative damages to liver. Fish body weight and liver weight decreased after the MWCNT-COOH exposure at any dose for 14 d or longer time ($p < 0.05$). Pyrosequencing of 16S rRNA gene amplicon showed that the MWCNT-COOH exposure greatly disturbed gut microbial community structure of the fish by increasing the relative abundance of Bacteroidetes phylum and *Bacteroides* genus and inhibiting Proteobacteria and Firmicutes phyla and *Vibrio* genus. Correlation and network analyses consistently indicated that the liver weight and body weight changes were positively correlated with the alterations of Firmicutes/Bacteroidetes ratio and negatively correlated with the increase of Bacteroidetes and *Bacteroides* abundance. Our results suggested that MWCNT-COOH inhibited fish growth by modulating the intestinal microbiota and subsequently disturbing the lipid metabolism.

Keywords: goldfish; gut microbial community; MWCNT-COOH; lipid metabolism; pyrosequencing

On-site prediction of micro-pollutant removal by UV/H_2O_2 in practical water by the combination of simulation models and portable measurements

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Abstract: Micro-pollutants (MPs) in water treatment have raised growing attentions recently. Ultraviolet (UV) based advanced oxidation processes (UV-AOPs) were proved to be an effective technique for removing micro-pollutants because of the formation of hydroxyl radicals ($HO^{\bullet}$). The bench-scale tests for the target MP removal by various UV-AOPs in practical waters is significant for the evaluation of a practical project, as well as the sequential selection of appropriate technologies, UV light sources, optimal operation conditions etc. However, these bench-scale tests have always been limited by the transportation and storage of the practical water samples with unknown water matrixes.

In this study, we proposed a new "simulation models & portable measurements (SM&PM)" method to predict photon fluence-based degradation rate constants of target MPs (k'_p) of UV-AOPs on-site without the transportation and storage of the practical water samples. The portable measurements were conducted on a mini-fluidic UV photoreaction system (MUPS) and a portable spectrometer to determine the $HO^{\bullet}$ scavenging capacities of practical waters on-site, while the simulation models consisted of steady-state $HO^{\bullet}$, photochemical, and quantitative structure-activity relationship (QSAR) models. The $HO^{\bullet}$ scavenging capacity represents the $HO^{\bullet}$ competition ability of a practical water sample with unknown water matrix, which could be inputted into the model to obtain k'_p. The external standard method for the measurement of $HO^{\bullet}$ scavenging capacity was proposed with different external standard components like isopropyl alcohol (IPA) and *p*-chlorobenzoic acid (*p*-CBA). In addition, QSAR model was used to predict the second order reaction rate constants between MPs and $HO^{\bullet}$ ($k'_{HO^{\bullet},MP}$).

The degradation of a model MP, sulfamethazine (SMN) by UV/H_2O_2 was predicted by the developed SM&PM method in five kinds of real waters (Milli-Q, synthetic, activated carbon + ultrafiltration, iron coagulation + ultrafiltration water and secondary effluent) with various unknown water matrixes. The $HO^{\bullet}$ scavenging capacities of these five water samples were determined, and the results showed that the lowest $HO^{\bullet}$ scavenging capacity could be found in Milli-Q water, while the highest was found in synthetic water because of strong $HO^{\bullet}$ and photon competition of humic acid (5.0 mg/L). Then the $HO^{\bullet}$ scavenging capacity parameter was coupled as an input into steady-state $HO^{\bullet}$ model to predict the k'_p values of various water samples. In additions, the k'_p of SMN degradation by UV/H_2O_2 was also measured experimentally to verify the predicted results. The $k'_{p,SMN}$ predicted results agreed well with experimental results in general and the detailed differences were analyzed. This study provided a new method to acquire the k'_p of UV-AOPs on-site, which is of great significance for the preliminary evaluation of practical projects involving the MPs removal in water and wastewater treatment.

Keywords: Micro-pollutant; UV-AOPs; model; portable measurement; mini-fluidic UV photoreaction system

Changes in physicochemical characteristics of microplastics in wastewater pipeline networks and treatment processes

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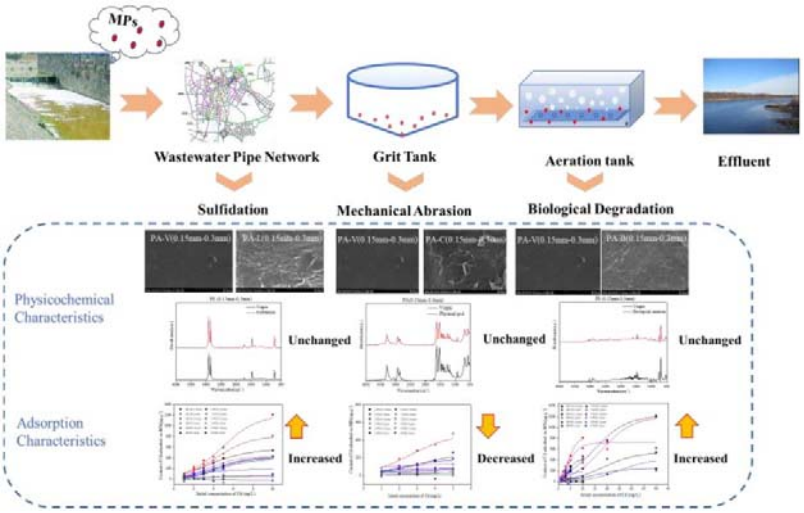
Abstract: Wastewater treatment plants (WWTPs) composed of physical, chemical, and biological processes are microplastic (MP) receptors. Despite a wealth of information on removal efficiency of MPs during wastewater treatment processes, little attention has been paid to their effects on the MP physicochemical characteristics. Changes in physicochemical properties of three MPs i.e. polyamide (PA), polyethylene (PE) and polystyrene (PS) in the wastewater pipeline, grit and biological aeration tanks were investigated in this study. Results showed that sulfidation in the pipeline made MP surface wavier, and more holes were found on the PA surface after biological aeration, but the variation was negligible after the physical grit, compared to the pristine MPs. The MP zeta-potentials decreased after pipeline sulfidation and biological aeration, implying the enhancement of negative charge on the MP surface. Meanwhile, pipeline sulfidation and biological aeration led to an increase in the MP adsorption potentials to cadmium, in accord with the zeta potential. However, the adsorption of cadmium on MPs decreased after physical grit. Tow dimensional FTIR correlation spectra implied that the N-H bond in the PA played more important role in the adsorption to cadmium, compared with the C-H bond. In terms of the adsorption potentials, the influence of the biological aeration on the MP physicochemical characteristics was higher than that of pipeline sulfidation, followed by the physical grit. The findings supply new insights into the effect of wastewater treatments on MP characteristics.

Keywords: microplastics; wastewater treatment plant; pipeline networks; physicochemical characteristics; adsorption potential



Rapid start-up of anammox reactor using granular sludge supported on activated carbon

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Abstract: The long start-up time and high demand of anaerobic ammonium oxidation (anammox) limit the practical applications of the anammox process. In this study, granular sludge supported on activated carbon (AC) was used as seed sludge. The operation mode of gradually increasing the matrix concentration and shortening the hydraulic retention time was adopted. The start-up time of the reactor was substantially shortened, and the expanded granular sludge bed (EGSB) reactor could be started quickly (in only 17 days). The nitrogen load rate (NLR) reached 1.58 kg/(m^3·d), the removal rate of total nitrogen (TN) was 78.24%, and the ratio NH_4^+: NO_2^-: NO_3^- was 1:1.38:0.27. Moreover, the reactor load could be further improved and increased to 1.80 kg/(m^3·d) from the 18^{th}–22^{nd} day, and the reactor run stably. During this period, N_2O and CO_2 production was 0.8% and 0.02%, respectively. According to the analysis of microorganisms, the main functional microorganism in the reactor was *Candidatus Kuenenia*. The content of *Candidatus Kuenenia* increased by 5.45% after the reactor was started successfully. The color of sludge was brick red. This showed that the operation mode and inoculated sludge employed in this study are highly effective for the fast start-up of an EGSB reactor.

Keywords activated carbon; anaerobic ammonium oxidation; nitrogen removal; EGSB reactor

Note: This paper has been submitted in water science and technology. It is under review.

Insights into the comparative roles of biochar and GAC on the enhanced anaerobic phenol degradation by clarifying the adsorption and conductive properties

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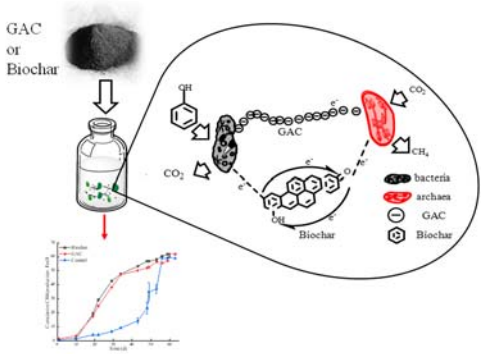
Abstract: To distinguish the comparative roles of biochar and granular activated carbon (GAC) on the enhanced anaerobic phenol degradation, batch tests were conducted at different phenol concentrations combining with the adsorption kinetics, microbial community and in-situ electrochemical analysis. Results showed that both biochar and GAC (15 g/L) remarkably shortened the lag time (t_0) by adsorbing dissolved phenol and accelerated maximum CH_4 production rate (Rmax) by triggering direct interspecies electron transfer (DIET) during anaerobic phenol degradation. The stronger adsorption capacity of GAC helped to achieve a shorter t0 only when phenol concentration was higher than 800 mg/L (threshold of adsorption capacity of biochar), while the distinct conductive properties of biochar determined the higher R_{max} of subsequent phenol degradation. Although *Syntrophorhabdus* and *Methanosaeta* were dominant on both biochar and GAC, the IET via hydrogentrophic methanogensis was still the main pathway for syntrophic phenol degradation in suspended sludge. Compared with GAC (higher conductivity but non redox activity), biochar exhibited higher electron exchange capacity (6.57 μmol e-/g) due to the diverse redox active moieties, it probably triggered the more efficiently DIET by forming the wire-like appendages which could linked the enriched DIET partners on biochar, than that triggered by conductivity. The in-situ analysis also confirmed that biochar and GAC acted as a geobattery and geoconductor, respectively, and the stimulation on DIET was persistent even they were enveloped by biofilm.

Keywords biochar; GAC; phenol; methanogenesis; direct interspecies electron transfer



Microscopic analysis towards rhamnolipid-mediated adhesion of *Thiobacillus denitrificans*: a QCM-D study

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Abstract: Rhamnolipid was proved to increase the abundance of *Thiobacillus denitrificans* in the mixotrophic denitrification biofilm while its microscopic mechanism remains to be explored. Effect of rhamnolipids on deposition of macromolecular substances and adhesion of *Thiobacillus denitrificans* at room (20°C) and low temperature (10°C) were systematically investigated by the quartz crystal microbalance with dissipation monitoring (QCM-D) for the first time. Results showed that low concentration of rhamnolipids (20 ~ 80 mg/L) could promote the deposition of macromolecular substances by reducing hydraulic repulsion force, with the maximum deposition amount increased by 4.28 times than that of the control at room temperature. Deposition amount of microorganisms could be improved by increasing its concentration at room temperature while it didn't work at low temperature. Meanwhile, low temperature could significantly inhibit adhesion of *Thiobacillus denitrificans* ($p < 0.05$) and deposited layers under low concentration of rhamnolipids were generally rigid, resulting in the negative feedback effect on the microorganisms' adhesion. While high concentration of rhamnolipids (120 ~ 200 mg/L) could regulate the biofilm from rigid to viscoelastic and significantly promote the initial adhesion of *Thiobacillus denitrificans* on SiO_2 surface ($p < 0.05$). This study demonstrated the microscopic mechanism of rhamnolipids on the initial biofilm formation, that is, the reduction of hydration repulsion force was responsible for the enhanced deposition of macromolecules while the regulation of biofilm properties was account for the promoted adhesion of *Thiobacillus denitrificans*.

Keywords: *Thiobacillus denitrificans*; Rhamnolipid; Biofilm formation; microscopic mechanism; QCM-D

Differentiated effect of anaerobic digestion on gaseous products from sequential pyrolysis of three organic wastes

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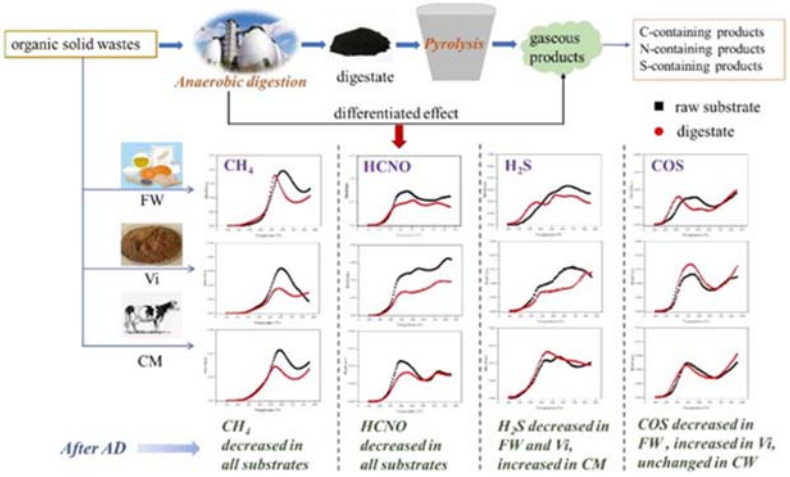
Abstract: Pyrolysis is often used to treat the digestate, but there is little information about the effect of anaerobic digestion (AD) on the sequential pyrolysis. In this study, thermogravimetric analysis and Fourier transform infrared spectroscopy (FTIR) were used to investigate the AD influence on gaseous products from sequential pyrolysis of three common organic wastes, i.e. food waste (FW), vinasse (Vi) and cow manure (CM). The weight loss of the organic wastes and their digestates mainly occurred in the second stage with the temperature range of 180-550oC, which was mainly related to the degradation of organic macromolecules. Weight loss of the digestate was less than that of the corresponding raw substrate in this stage. AD caused a decrease in the generation of gaseous small-molecule products and the temperature of maximum concentration of Vi and CM, but an increase in that of FW. After AD, the emissions of some C-containing products such as CH4 , CO2 and C6H6 , and some N-containing products HCNO and NO decreased, but other products such as CH3COOH, CH3OH, CH3CHO, NH3 and HCN increased. AD reduced the emissions of S-containing gaseous products in FW, while increased the emissions of H2S in CM and carbonyl sulfide (COS) in Vi. The findings supply theoretical support for the N- and S-containing pollution controls during thermochemical conversion of the digestates.

Keywords: anaerobic digestion; digestate; pyrolysis; organic wastes; gaseous products



GRAPHICALABSTRACT

Anti-inflammatory drugs degradation during LED-UV_{365} photolysis of persulfate: roles of reactive oxygen species

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Abstract: This study investigated the non-steroidal anti-inflammatory drugs (NSAIDs) removal during light-emitting diode (LED)-UV(365 nm) photolysis of persulfate (PS). Degradation of phenacetin (PNT) and acetaminophen (ACT) at pH 5.5-8.5 followed the pseudo-first order kinetics. At pH 8.5, the pseudo-first order rate constants (k_{obs}) of PNT and ACT degradation were obtained at the highest values of 1.8×10^{-1} and 1.2×10^{-1} min^{-1}, respectively. The presence of hydroxyl radicals (·OH), sulfate radicals ($SO_4{\cdot}^-$), superoxide radicals ($O_2{\cdot}^-$), and singlet oxygen ($^1O_2$) were firstly determined in situ electron paramagnetic resonance (EPR) tests and alcohol inhibition tests in photolysis of persulfate. The average contributions of ·OH and $SO_4{\cdot}^-$ were 23.5% and 53.0% for PNT removal, and 15.9% and 53.0% for ACT removal at pH ranges of 5.5-8.5. The total concentration of five CX_3R-type disinfection by-products (DBPs) was comparatively small at pH 5.5 (90.9 μg·L^{-1}) and 7.0 (126.7 μg·L^{-1}) in LED-UV_{365}/PS pre-oxidation system, which is 58.5% and 30.2% lower than that in system without LED-UV_{365}/PS pre-oxidation. However, a higher maximum value of total DBP concentration was achieved at pH 8.5 (445.6 μg·L^{-1}) with LED-UV_{365}/PS pre-oxidation. The electrical energy per order (EE/O) of the LED-UV_{365} system has a range of 0.383-0.589 and 0.089-0.137 kWh/m^3/order, for electric and adsorbed power, respectively. The results showed that UV_{365} would be more cost-effective in application for pollutant degradation compared with UV_{254}.

Keywords: Persulfate; non-steroidal anti-inflammatory drugs; Reactive oxygen species, Disinfection by-products.

Spectral characteristics and pollution implications of dissolved organic matter in the water of rivers accepting the Chinese medicine hospital

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Abstract: Waste water were collected from Nan River and Tujia River locating in Ningbo city hospital of traditional Chinese medicine. The physicochemical characteristics and fluorescence components distribution of dissolved organic matter were analyzed, and its composition, evolution and containment distribution were revealed by using UV-Vis, ion chromatography and fluorescence spectra combined with PARAFAC analysis. The results showed that two black stunk rivers were both identified as the water of worse V level. The highest COD of water in Tujia River and Nan River was 90 mg L^{-1} and 1100 mg L^{-1}, respectively. Humic-like and protein-like substances were both detected from two rivers. The two rivers had both the endogenous pollution caused by the microorganisms in the water, and the exogenous pollution was ascribed to the terrestrial humic acid. Furthermore, heavy metals were not detected, which indicated that sanitary sewage was the main pollution source of the two rivers accepting the hospital of traditional Chinese medicine.

Keywords: Dissolved organic matter; Fluorescence characteristics; PARAFAC; Chinese medicine hospital

Effect of *Rhodococcus equi* Rq-001 bio-enhanced activated sludge on microbial community structure and function

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Abstract: Estrogen contamination has had a serious impact on the ecological balance, and has been classified as a Class 1 carcinogen by the World Health Organization. However, most wastewater treatment plants can only achieve an estrogen removal rate of 58.1-84.2% for urban sewage, and residual estrogen is discharged into the natural environment. The recognized estrogen-degrading microorganisms such as *Rhodococcus* are low in the activated sludge system of municipal wastewater sewage treatment plants, which may be the main reason for the low estrogen degradation efficiency of activated sludge. *Rhodococcus* is an ancient steroid-degrading metabolic bacterium, which is widely distributed all over the world, and its plays an important role in the C and N cycles involved in steroids. Therefore, this study used *Rhodococcus equi* Rq-001 to bio-enhanced activated sludge to remove E2 and reveal the changes in the structure and function of the bio-enhanced activated sludge community. We believe that bio-enhanced activated sludge technology is an important technical method to remove emerging contaminants.

The activated sludge was bio-enhanced for 30 days using Rq-001. The sequence results showed that the abundance of *Rhodococcus* was gradually reduced after the addition. At the level of the bacterium, the abundance of *Proteobacteria* was consistent with that of *Rhodococcus*; the abundance of *Verrucomicrobia* and *Bacteroidetes* was opposite to that of *Rhodococcus* . At the genus level, *Paracoccus*, *Lysobacter*, *Methylobacillus*, *Roseimicrobium* and *Rhodococcus* abundance have the same trend; *Prosthecobacter*, *Haliscomenobacter*, *Methylophilus*, *Methyloversatilis*, *Elstera*, *Zoogloea* abundance changes contrary to *Rhodococcus*. The results showed that *Rhodococcus* bio-enhanced activated sludge caused significant changes in the structure of the original flora and could not be restored to its original state in the short term. Functional predictions indicate that a large number of sequences are annotated to carbohydrate metabolism and amino acid metabolism. Functional differences caused by biofortification were only found on the sample of 10 day and 20 day, indicating that the bioaugmentation with *Rhodococcus* has caused significant changes in microbial community function. E2 was degraded by using the enhanced sludge within 3 h. It was found that bioaugmentation could increase the E2 degradation rate from 90% to 94% in a short time, but with the gradual decrease of the abundance of *Rhodococcus*, the removal rate of E2 by activated sludge that was bio-enhanced for different days is also gradually reduced.

Keywords: *Rhodococcus* ;17β-estradiol; microbial diversity

Spatial distribution of microbial community in a single-stage expanded granular sludge bed capable of simultaneous anammox and denitrification under optimal organic loading

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Abstract: A simultaneous anammox and denitrification (SAD) system was established for enhanced nitrogen removal in a single-stage expanded granular sludge bed (EGSB) bioreactor, and the spatial distribution of microbial community was investigated under different organic substance conditions. Results showed that organic substance changed the effluent concentration of ammonia and nitrate, and the optimal total nitrogen removal efficiency was 93.4%. Meanwhile, *Candidatus Brocadia* (3.9%), *Denitratisoma* (1.6%), *Dokdonella* (4.4%) and *Thauera* (4.6%) dominated in the EGSB bioreactor. The incongruous organic substance inhibited both anammox and denitrifying bacteria, while appropriate organic substance improved their synergy. Anammox bacteria were mainly enriched at the middle part and appeared high expressing activity at both the bottom and middle of the EGSB bioreactor. Denitrifying bacteria were concentrated at the bottom due to the organic substance, while nitrate and nitrite reduction were highly activated at the bottom and middle of the EGSB bioreactor, respectively. The spatial distribution difference between anammox and denitrifying bacteria facilitated their synergy in the SAD system.

Keywords: Anammox; Denitrification; Spatial distribution; Microbial community; Functional genes

Characteristics and Risk Assessment of Seven Typical Antibiotic Residues in Fish Pond from Lingui District, Guilin

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Abstract: Seven typical antibiotics including three Sulfonamides((Sulfadiazine, SDZ), (Sulfamethazine, SM2), (Sulfamethoxazole, SMX)) and four Quinolones((Ciprofloxacin, CIP), (Enrofloxacin, ENR), (Norfloxacin, NOR), (Ofloxacin, OFL)) in water, sediment and fish of fish pond from Lingui District, Guilin, Guangxi Zhuang Autonomous Region were tested in this study, aimint to clarify the antibiotic residues in the aquaculture environment in the region, and to evaluate the risks of the ecological environment and human health. The results are as follows:

1. The seven typical antibiotics in fish pond water were detected, and the detection frequencies of SDZ, SMX, CIP and ENR were 100%. The Pearson correlation analysis indicated that the concentrations of seven typical antibiotics were related to total nitrogen (TN), total phosphorus (TP), total organic carbon (TOC).

2. The average antibiotics contents of the two group antibiotics in fish pond sediment from Lingui District shows the following rules: OFL > SMX > SM2 > SDZ > NOR > ENR > CIP, with the 100% detection frequencies of SM2, SMX, ENR and NOR. In addition, the contents of antibiotics were related to TN, TP in the sediment.

3. A total of 66 fish individuals were collected in fish pond from Lingui District, which were identified to be 11 species, belonging to 11 genera, 4 families and 2 orders.. The antibiotics contents in *Cyprinus carpio*, *Pelteobagrus fulvidraco* and *Cyprinus carpio specularis* were higher than other fish. Some antibiotics were detected in the feed which the content ranged from 0 ~ 1351.03 μg/kg.

4. The human health risk quotient (HQ) of each antibiotic in the fish is less than 1. It can be considered that the antibiotic exposure has subtle impact on the dietary safety of the human, and the fish can be eaten with guarantee.

Keywords: Antibiotics; Fish pond; Sediment; Fish; Risk assessment

Diagnostic and optimization strategy for enhancing stable operation of wastewater treatment plant: A case study in Taihu Basin

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Abstract： The newly issued wastewater discharge standard in China becomes more stringent, and leads to a rising challenge to the stable and energy-saving operation of wastewater treatment plant (WWTP). Currently, with the increasing upgradation and establishment of WWTP, it is significant to discover suitable and feasible strategy to the operation of WWTP, which is further conducive to achieve resource recovery and ecological risks elimination. The diagnostic and optimization strategy was proposed as followed: 1) wastewater quality analysis to determine the preliminary reason for poor operation of WWTP; 2) performance analysis and microbial activity in function niche; 3) process analysis and variations of contaminants; 4) identification and analysis of contaminants removal, and the selection of key issues for stable operation of wastewater treatment process; 5) simulation of wastewater treatment process, and preliminary proposed optimization operation of WWTP; 6) verification and optimization, inspection and calibration of wastewater treatment process based on Biowin model; and 7) determination of optimal method to support the stable operation of WWTP. Aiming at the WWTP in Taihu Basin that employed cyclic activated sludge technology (CAST) process, the diagnostic and optimization strategy obtained good performance. The influent BOD_5/TN and BOD_5/TP were relatively low over the years, resulted in poor TN and TP removal capacity, and the rates of denitrification and anaerobic phosphorus release were comparatively slow due to the short operational time of anaerobic and anoxic tank. Therefore, the transformation of operation mode and the replacement of phosphorus removal chemicals were verified through Biowin simulation and finally proposed. TN removal increased by a factor of 16.5%, and the effluent TP decreased to below 0.27 mg/L, which the operation cost of chemical phosphorus removal was reduced by 0.008 yuan/t. The application proved that the diagnostic and optimization strategy was effective to the stable and energy-saving operation of WWTP, which could further facilitate to enhance the contaminants removal capability and reduce energy consumption.

Keywords: wastewater treatment plant (WWTP), operation diagnosis, operation optimization, nitrogen and phosphorus removal, Biowin mode, operation strategy

Aqueous Cu(II) ion adsorption by amino-functionalized mesoporous silica KIT-6

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Abstract: To find an alternative adsorbent with high adsorption performance, KIT-6 was prepared by hydrothermal crystallization synthesis using tetraethyl orthosilicate as a silicon source and triblock copolymer P123 as a template. Then the silane coupling agent (3-chloropropyl)trimethoxysilane was first grafted onto KIT-6 mesoporous material and then the polyethyleneimine (PEI) was further grafted through the substitution reaction between amino groups and chlorine atoms. The functionalized KIT-6 was denoted as PEI/KIT-6. The samples were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), N_2 adsorption–desorption, elemental analysis (EA), Fourier transform infrared spectroscopy (FT-IR) and thermal gravimetric analysis (TGA). The Cu^{2+} adsorption performance was determined by inductively coupled plasma (ICP). The results showed that the average loading of the amino groups was 3.74 mmol·g^{-1}, and the modified KIT-6 still has a stable mesoporous structure without pore blockage. With the dosage of 1 g·L^{-1} PEI/KIT-6 and at room temperature, the optimum pH value for adsorption of 100 mg·L^{-1} Cu^{2+} was 6.0. The adsorption capacity of PEI/KIT-6 for Cu^{2+} increased with the increase of reaction temperature, and the maximum adsorption capacity of Cu^{2+} was 36.43 mg·g^{-1}. The adsorption capacity tends to reach equilibrium after 120 min, and the optimum adsorption temperature was 35 ℃. The pseudo-second-order kinetic model was found to be well suited for the adsorption process of Cu^{2+}. Adsorption equilibrium data could also be described well by the classical Langmuir and Freundlich isotherm models. The adsorption tends to be the chemisorption of a monolayer.

Keywords: Functionalized KIT-6; Cu^{2+}; adsorption; PEI; two steps grafting method

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Biopolymeric ferric sulfate modified diatomite as a novel adsorbent for organic dye removal: Adsorption performance and mechanism studies

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Abstract: Diatomite (DE) is widely used as adsorption material in wastewater treatment because of its cheap lost, high porosity and stability. The adsorption properties of DE can be improved by compositing with other chemical substances. Biopolymeric ferric sulfate (BPFS) was prepared by biocatalytic oxidation and it could remove efficiently organic compounds. In this study, biopolymeric ferric sulfate modified diatomite (BPFS-DE) was prepared as a novel adsorbent when DE was modified by BPFS. The DE and BPFS-DE were characterized by various methods including Scanning electron microscopy (SEM), N_2 adsorption-desorption and X-ray diffraction (XRD) to analyze their physical and chemical properties before and after modification. The adsorption performance of BPFS-DE for acid chrome blue K (ACBK) was investigated and adsorption mechanisms were analyzed. The results indicated that the porosity and specific surface area of DE increased after it was modified. BPFS-DE showed high adsorbent activities (98.6%) for ACBK under pH 6.0, 30℃ and adsorption time of 30 min. Langmuir adsorption isothermal models presented better correspondence (R=0.9896) with adsorption data. Pseudo-second reaction kinetics was more suitable than pseudo-first model in reflecting adsorption process (R=0.9075). The adsorption process was spontaneous and exothermic. The adsorption efficiency of BPFS-DE was higher than that of DE. The synthesized BPFS-DE was a promising adsorbent in the treatment of dye industrial wastewater.

Keywords: composite modified diatomite; acid chrome blue K; adsorption property

Occurrence of COVID-19 in air and ground confluence in Wuhan, China: Risk assessment, the role of water environmental parameters and control approaches

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Abstract: In recent months, SARS-CoV-2 as a serious infectious pathogenic respiratory virus causing new coronary pneumonia (COVID-19) threats worldwide. Up to now, limited information has been obtained concerning the assessment of the risk of COVID-19 in the air and ground confluence. In the current study, a modified dose-response model was employed to quantitatively assess the risk of COVID-19 under different environmental parameters including rainfall, temperature (T), absolute humidity (AH) and relative humidity (RH). Results showed that the risk in the air exhibits an "S" trend rising from January 20th to February 29th, 2020. The risk of COVID-19 showed a significant correlation with the number of patients diagnosed (P <0.01), RH (P <0.01), AH (P <0.05) and temperature. A negative correlation was observed with rainfall, where AH and rainfall reduced the risk about 16.7% and 66.7% respectively compared to the theoretical risk. Besides, the risk is reduced by 90%-40%, when increasing temperature from 0 ℃ to 25 ℃. Furthermore, the risk of ground confluence presents a trend of rapidly increasing and then decreasing due to the dilution of rainfall. Three approaches (*Mask-out*, *Disinfection*, and *Mask-in/wash*) play a critical role in preventing the risk of air and ground confluence, which can reduce risk about 4×10^3 times.

Keywords: COVID-19, risk assessment, air, ground confluence, infection control

Efficient simultaneous removal and enrichment of phosphorus from wastewater by biofilm process

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Abstract Phosphorus (P) recovery from domestic wastewater is an important way to solve the lack of phosphate rock resource. Current processes cannot simultaneously remove and recover P efficiently from wastewater in mainstreams. A biofilm sequencing batch process could realize synchronous removal and enrichment of P efficiently when conditions included a 40% packing ratio for the synthetic fiber carriers and 6 h hydraulic retention time (3 h for the aerobic phase and 3 h for the anaerobic phase). P removal efficiency was up to 80% and the P concentration of aerobic effluent was under 0.5 mg/L in aerobic at the later stage of biofilm culture. The highest P concentration of recirculated solution was 82 mg/L in anaerobic during the P enrichment stage. The results of polymerase chain reaction-denaturing gradient gel electrophoresis (PCR–DGGE) revealed that the similarity coefficient of microorganisms decreased to 54.1% in the biofilm and microbial community selection occurred in the culture stage. The decline of Shannon and the Berger–Parker index showed that the diversity of microorganisms decreased and phosphorus accumulating organisms (PAOs) proliferated. Compared with the GenBank data, the PCR–DGGE sequencing data indicated that *Acinetobacter sp.* was the dominant PAOs, the structural morphology of which was matched with the scanning electron microscope (SEM) results.

Keywords biofilm; phosphorus recovery; PAOs; PCR-DGGE;

Biological removal of Se and Cd(II) in acidic selenite- and cadmium-containing wastewater with limited carbon availability

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Abstract: Selenium (Se) is vital for all living organisms. However, it can contaminate the environment at moderate concentrations. Se oxyanion contamination is often accompanied by cadmium [Cd(II)] in acid mine drainage (AMD) which has low pH and limited carbon availability. However, there are few reports on selenium removal with limited accessible carbon in AMD wastewater. Thus, the present study investigated the removal of Se and Cd(II) in acidic selenite- and cadmium-containing wastewater under limited carbon in a sequencing batch reactor (SBR). Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS), high-resolution transmission electron microscopy (HRTEM) and X-ray photoelectron spectroscopy (XPS) were used for micromorphology, element composition and valence measurements. The microbial community of the activated sludge was determined by 16S rRNA gene high-throughput sequencing on the Illumina MiSeq PE300 platform.

The removal efficiencies of total Se and Cd(II) were above 90% during phase I (cycles 1 to 40) with a COD influent concentration of 100 mg/L. However, when the influent COD concentration decreased to 50 mg/L during phase II (cycles 41 to 66), the total Se and Cd(II) removal performance correspondingly decreased to 55.20 (±8.40)% and 72.57 (±13.79)%. When the influent COD concentration increased again to 100 mg/L during phase III (cycles 47 to 106), the removal efficiencies of total Se and Cd(II) slightly improved to 72.65 (±10.05)% and 75.16 (±4.85)%, respectively. Thus, treatment of the biological acidic selenite- and cadmium-containing wastewater via SBR was successful with a low carbon source of 100 mg/L COD. The content of proteins and polysaccharides increased from 6.78 mg/(g VSS) and 3.67 mg/(g VSS), in the inoculum to 7.11 mg/(g VSS) and 4.44 mg/(g VSS), respectively, at the end of phase I. SEM-EDS results confirmed the buildup of nanoparticles inside the sludge. HRTEM and XPS analysis further verified the formation of elemental Se and CdSe. A gradual shift at the genus level with the exposure of Se (IV) and Cd(II) from phases I to III in the SBR occurred based on the results of microbial community analysis. Compared with the inoculum, the proportions of the taxa *Proteiniclasticum* (14.89%), *Clostridium_sensu_stricto_12* (5.71%), *Longilinea* (4.11%) and *Mycobacterium* (3.01%) increased obviously at the end of phase I, which are assumed to contribute to selenite and cadmium removal. Redundancy analysis (RDA) indicates that COD concentrations had the greatest impact on *Zoogloea* and *Pseudomonas* by promoting increase of abundance and decrease of abundance, respectively. RDA results also showed COD had a positive impact on the abundance of *Proteiniclasticum*. These findings help explain the Se and Cd(II) removal mechanisms and microbial community succession in terms of limited carbon availability in acidic selenite- and cadmium-containing wastewater.

Keywords: selenium; limited carbon; acidic wastewater; cadmium; microbial community

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Simultaneous elimination of amoxicillin and antibiotic resistance genes in activated sludge process: contributions of easy-to-biodegrade food

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Abstract Antibiotics are continuously released into aquatic environments and ecosystems where they accumulate, which increases risks from the transmission of antibiotic resistance genes (ARGs). However, it is difficult to completely remove antibiotics by conventional biological methods, and during such treatment, ARGs may spread via the activated sludge process. Easy-to-biodegrade food have been reported to improve the removal of toxic pollutants, and therefore, this study investigated whether such co-substrates may also decrease the abundance of ARGs and their transferal. This study investigated amoxicillin (AMO) degradation using 0-100 mg/L acetate sodium as co-substrate in a sequencing biological reactor. Proteobacteria, Bacteroidetes, and Actinobacteria were identified as dominant phyla for AMO removal and mineralization. Furthermore, acetate addition increased the abundances of *adeF* and *mdsC* as efflux resistance genes, which improved microbial resistance, the coping ability of AMO toxicity, and the repair of the damage from AMO. As a result, acetate addition contributed to almost 100% AMO removal and stabilized the chemical oxygen demand (~20 mg/L) in effluents when the influent AMO fluctuated from 20-100 mg/L. Moreover, the total abundance of ARGs decreased by approximately ~30%, and the proportion of the most dominant antibiotic resistance bacteria Proteobacteria decreased by ~9%. The total abundance of plasmids that encode ARGs decreased by as much as ~30%, implying that the ARG spreading risks were alleviated. In summary, easy-to-biodegrade food contributed to the simultaneous elimination of antibiotics and ARGs in an activated sludge process.

Keywords co-substrate; antibiotics; biodegradation; ARGs; metagenomics

Enhanced removal of phosphorus under the influence of Fe^{3+}

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Abstract： Excessive discharge of phosphate can cause eutrophication of a water body. Effluent total phosphorus (TP) of a traditional activated sludge process often does not meet first-class A of Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant in China (GB18918-2002). In this study, Fe^{3+} was added into influent of an A^2O process to enhance removal of COD and TP. Sludge surface morphology and valence transformation of major elements were analyzed. Results showed that a low concentration of Fe^{3+} (<10 mg/L) could increase COD removal and promote microbial activity, whereas this was not the case with a high concentration of Fe^{3+} (>10 mg/L). TP removal efficiency always increased with increasing Fe^{3+} concentration. Enhancement of phosphorus removal was achieved by both biological and chemical mechanisms. Fe^{3+} increased surface roughness of the sludge and promoted chemical adsorption of phosphorus. Fe^{2+} and Fe^{3+} coexisted in the supernatant, with Fe^{3+} as the dominant form. Species of iron in the pellet included Fe-O-Fe, FeOOH, $FePO_4$, and $Fe(OH)_x$-P. This study shows removal efficiencies of pollutants can be increased by regulating influent Fe^{3+} concentration.

Keywords: Iron ions; Biological and chemical phosphorus removal; Sludge micro-morphology; Surface and porous characteristics; A^2O process

Nitrogen fixation using electrons produced from photoelectrocatalytic organics degradation

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Abstract: Ambient electrocatalytic (EC) N_2 reduction reaction (NRR) offered a promising alternative to Haber-Bosch reaction, but the high overpotential of oxygen evolution reaction (OER) and large electrical energy input hindered its wider application. Here, we substituted photoelectrocatalytic (PEC) bisphenol A (BPA) degradation (~99.6% in 180 min) for OER and thus sustainably provided abundant electrons for NRR (NH_3 yield: ~37.4 μg h^{-1} $mg^{-1}_{cat.}$, Faradaic efficiency: ~17.1%). The reasons were that the overpotential of hydroxyl radical production was lower, and the electric energy input used to drive entire cell also could be partially or even completely eliminated depending on the extra photovoltage and Fermi level of the photoanode in light irradiation. As expected, the integrated PEC system reduced the electric energy consumptions by a factor of ~24.1% and ~51.8%, compared with individual PEC BPA degradation and EC NRR, respectively. In contrast, the impacts of present process on economy, and ecosystems were also relatively minimal. More importantly, the issue of the effective utilization for cathode electrons in PEC water treatment process also has been well solved in this way. This work provided a sustainable and economic viable insight to simultaneously tackle the energy crunch and water scarcity.

Keywords: ammonia production; organics removal; simultaneously; sustainability; water-energy nexus

Enhanced Bioremediation of Hydraulic Fracturing Flowback and Produced Water Using an Indigenous Biosurfactant-Producing Bacteria *Acinetobacter* sp. Y2

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Abstract: In this study, a biosurfactant-producing strain Y2 was isolated from hydraulic fracturing flowback and produced water (HF-FPW) and identified as *Acinetobacter* sp.. The biosurfactant produced by Y2 could reduce surface tension of water from 72.2 mN/m to 30.2 mN/m with a CMC value of 187.5 mg/L and showed strong tolerance against wide ranges of pH (2–12), temperatures (4–100 °C), and salinity (0–100 g/L). Through thin layer chromatography, Fourier transform infrared spectroscopy, and gas chromatography–mass spectrometry analysis, the biosurfactant was characterized as lipopeptide. Inoculation of *Acinetobacter* sp. Y2 into HF-FPW greatly increased the activity and growth of the microcosm. Meanwhile, it significantly (P<0.05) promoted the removal of chemical oxygen demand (reduction from 6646.7 mg/L to 1546.7 mg/L), and the degradation of *n*-alkanes (reduction from 2635.4 mg/L to 159.7 mg/L) and polycyclic aromatic hydrocarbons (reduction from 918.6 μg/L to 209.6 μg/L) in 7 days. High-throughput sequencing analysis revealed that the inoculation of indigenous biosurfactant producer modified the bacterial community structure and enriched the hydrocarbon-degrading microorganisms including *Pseudomonas* sp. and *Rhizobium* sp. The real-time quantitative PCR results showed that the expression of several key functional genes was greatly enhanced by Y2 addition and was significantly correlated with *Acinetobacter* sp. This study proved the introduction of native biosurfactant-producing microorganisms as a promising in situ strategy for HF-FPW bioremediation and the underlying mechanisms were proposed.

Keywords: Hydraulic fracturing wastewater, Enhanced bioremediation, *Acinetobacter*, Biosurfactant, Indigenous microorganisms, Functional genes

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Evaluation of CDOM sources, spectral characteristics, and their links with water quality in Baiyangdian lake from different molecular weight based on EEM and UV–vis

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Abstract: The sources, spatial-temporal distribution characteristics and the interactions with water quality for the different DOM molecular weight fractions in Baiyangdian lake were investigated based on UV–Vis, EEM-FRI, and EEM-PARAFAC in Baiyangdian Lake. The results showed that the environmental parameters and relative concentration of CDOM exhibited significant season difference among the typical zones in Baiyangdian Lake (P<0.001). The α_{254} and α_{355} for winter and spring exhibited similar trend, while the variations of summer and autumn were similar. The E3/E4 values were all > 3.5, indicating DOM exhibited low humification characteristics. The results of E2/E3 ratio, E4/E6 ratio, $S_{275\text{-}295}$, and S_R showed that the MW and humification degree for summer and autumn were higher than those for winter and spring. The high FI values, BIX values and low HIX values indicated CDOM raised from microbial sources. Meanwhile, these fluorescence indices exhibited significantly difference for different function area, and no significant difference for different DOM MW fractions. The results of EEM-FRI and EEM-PARAFAC showed the relative abundance exhibited significantly season difference among the different function areas (P<0.001), while was no significant difference (P>0.05) for MW DOM fractions. Furthermore, the protein-like components (Q1+Q2+Q4) accounted for main proportion of CDOM (61.61%~97.11%), and exhibited significantly spatial difference. The correlations between fluorescent PARAFAC components with water quality exhibited the similar trend among different molecular weight (MW) DOM fractions, while presented significant seasonal difference in Baiyangdian Lake. The results of PCA showed CDOM exhibited significant difference for different seasons, functional zones, and MW DOM fractions (P < 0.001) based on UV-Vis, while only exhibited significant difference for different seasons, and functional zones (P < 0.001) based on EEM (FRI and PARAFAC). Furthermore, the results of RDA and RF analysis showed the environmental driving factors exhibited significant difference for different seasons and MW DOM fractions, and SpCond, T, ORP, TP and TDS played important predictors of the variations of CDOM based on UV-Vis and EEM. These findings provided important implications for manager to understand the DOM characteristics and interaction between DOM and water quality for the different DOM MW fractions in Baiyangdian Lake.

Keywords: Chromophoric dissolved organic matter (CDOM); ultraviolet–visible light spectroscopy (UV–Vis); Excitation-emission matrix-fluorescence regional integration (EEM-FRI); Excitation-emission matrix-parallel factor analysis (EEM-PARAFAC); Molecular weight; Baiyangdian Lake

High-throughput absolute abundance quantification sequencing reveals the spatial-temporal characteristics and key driving factors of microbial community evolution in Gangnan Reservoir

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Abstract: Here, we propose the high-throughput absolute abundance quantification method to simultaneously obtain both the relative and absolute abundances in the microbial community of Gangnan Reservoir. The results showed that the environment factors exhibited significant seasonal and vertical difference (P<0.05). The α-diversity of microbial community presented significant seasonal difference (P<0.05) based on absolute abundance, while there was not difference based on relative abundance. the α-diversity of absolute abundance were higher than those of relative abundance. EC (21.1%) and COD_{Mn} (29.1%) were the key environment factor for the variation of α-diversity. Significant seasonal difference for microbial community, indicator OTUs community, and keystone OTUs community were found based on Adonis (P<0.001), MRPP (P<0.001) and Anosim (P<0.001), respectively. Furthermore, Veen plot showed the number of cores OTUs of absolute abundance was higher than that of relative abundance. The LEfSe results for relative abundance and absolute abundance were different, and the number of biomarkers based on absolute abundance was higher than that based on relative abundance. OTU-OTU association network showed the positive edges accounted for 91.9% based on absolute abundance, which was higher than that based on absolute abundance and indicated that symbiotic relationship accounted for the major proportion among microbial network. And most OTUs related to T, NO_3^-, pH, TDP and EC, respectively. Moreover, the keystone OTU included 168 OTU, and *Bacillariophyta*, *Chlorophyta*, *Cryptomonadaceae*, *Flavobacterium*, *Hyphomonas*, *Ilumatobacte*, *Rhodoluna*, *Rhizobacter*, and unclassied were the main genera. In addition, redundancy analysis (RF), network analysis, correlation analysis, and random forest (RF) analysis showed T, DO, NO_3^-, COD_{Mn}, and ORP were the most important environment driving factors for microbial and functional community (P<0.05). From all the results, the variation and environment factors of microbial and functional community exhibited significant difference between absolute abundance and relative abundance. Therefore, high-throughput absolute abundance quantification could provide an accurate understanding of microbial structures and functional potentials.

Keywords: high-throughput absolute abundance quantification; 16S rRNA; microbial community; RDA, network analysis; reservoir

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Flocculation benefits subsequent biomanipulation in controlling *Microcystis* blooms: A laboratory study

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Abstract: The frequent occurrence and long-term duration of *Microcystis* harmful algal blooms (HABs) are of great concern. Chemical flocculation is thought to be an effective way to deal with the HABs, while the application of the flocculants at a high dosage pose potential adverse impacts to the aquatic ecosystems. In this study, an alternative approach is proposed that involves the employment of polyaluminum chloride (PAC) combined with the *Daphnia magna* (*D. magna*) to achieve sustainable HABs removal efficiency with an acceptable ecological risk. It was found that under a dense *Microcystis* HABs (algal density of 1.5×10^7 cells/ml), a PAC dosage of 30 mg/l triggered >95% algae removal, but the released Al^{3+} caused 90% mortality of planktonic *D. magna*. Reducing the PAC dosage to 15 mg/l resulted in a slightly lower algal removal efficiency (>90%). In addition the reduced PAC dosage benefited the proliferation of the remaining unicellular algal cells, which tended to form a large colony during the 25-day experiment. Incubation of *D. magna* following flocculation with 15 mg/l PAC effectively grazed the remaining algal cells, meanwhile increasing the *D. magna* density by approximately 40-folds, and enlarging the body size by 1.37-1.50 times. This result implied that the released Al^{3+} was not detrimental to the *D. magna*. Flocculation with a reduced dosage is sufficient for colonial and large algal cells mitigation, which creates a window time for the biomanipulation of the residual tiny algae. Hence, the subsequent addition of *D. magna* triggered the sustainable removal of the HABs cells. The present study provides an environmentally friendly strategy for cleaning up the green tides without obvious detrimental effects on the aquatic ecosystem.

Key words: HABs, *Microcystis*, flocculation, *Daphnia*, biomanipulation

Pollution status of sediments and pollutant release potential of four drinking water reservoirs in China

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Abstract: Reservoir sediments sometimes act as sources of pollutants, owing to changes in microbial activity, salinity, and redox conditions. To investigate sediment pollution status and potential water pollution risk, four drinking water reservoirs were selected from different regions in China. Our results showed that ion-exchangeable nitrogen in all four sediment samples accounted for 44.0%, 45.9%, 51.8%, and 44.1% of the total nitrogen. Bioavailable phosphorus also accounted for a large percentage. Assessment of Fe and Mn showed that they were at medium-to-high risk in all four reservoir sediments. Bioavailability factors for both Fe and Mn were >0.43, indicating high bioavailability and mobility. Experiment results from the laboratory indicated that total phosphorus concentrations increased by ten times in all the four reservoirs compared with the initial concentrations. Moreover, Fe, Mn, and total organic carbon concentrations increased significantly during the laboratory experiments. The findings of this study highlight that the four drinking water reservoirs pose health risks due to contamination of the sediments, and N, P, Fe, and Mn exhibit high bioavailability and mobility. The maximum release potential of phosphorus can increase up to ten times compared with the concentrations in the raw water.

Keywords: drinking water reservoir; sediment; pollutant fraction; sediment release