

城市污水处理厂中内分泌干扰物的检测、迁移转化与去除特性

强志民*, 朱楦, 贾伟伟

中国科学院生态环境研究中心, 北京市海淀区双清路 18 号, 100085

*Email: qiangz@rcees.ac.cn

城市污水厂是内分泌干扰物 (Endocrine disrupting chemicals, EDCs) 进入环境的主要渠道和重要控制节点。由于对结合态物质的忽略, 已有调查研究数据呈现出较大的波动, 对于 EDCs 去除的主要影响因素的分析仍莫衷一是。本研究针对城市污水厂污水、污泥的复杂基质, 开发了可同步检测自由态雌激素 (FEs)、结合态雌激素 (CEs) 和酚类 EDCs (PEs) 的高灵敏度检测方法。在此基础上, 以某典型城市污水处理厂为研究对象, 通过为期一年的连续监测, 考察了影响 EDCs 去除的主要因素, 并分析了 EDCs 在各工艺段中的迁移转化及归趋。结果显示, 影响 CEs、FEs 与 PEs 去除的主要因素分别为温度、HRT 与 SRT, 根据各类 EDCs 的沿程转化和归趋, 推断其主要去除方式分别为酶促水解、共代谢降解与污泥吸附。同时, 研究发现 CEs 占雌激素总摩尔浓度的比率沿处理流程持续上升, 在总出水中可达到 13.5–100.0%, 证明 CEs 更难被生物处理去除。本研究明晰了多类自由态、结合态 EDCs 在城市污水厂中的主要去除途径和影响因素, 为控制城市污水厂 EDCs 的排放风险提供了重要的理论参考。

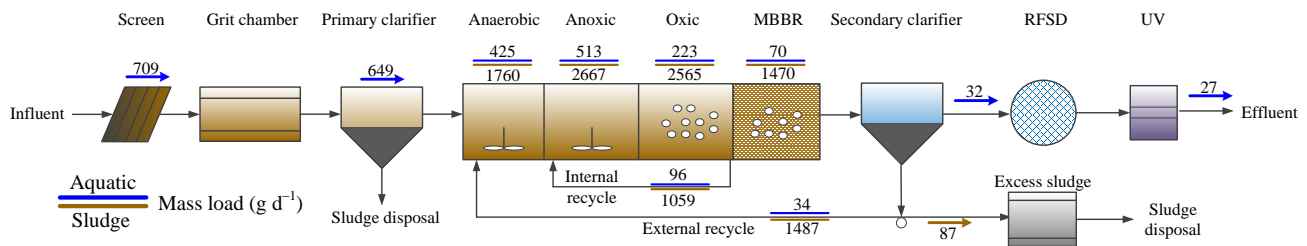


Fig. 1 Total mass flows of target EDCs along the treatment processes.

关键词: 城市污水处理厂; 内分泌干扰物; 检测; 迁移转化; 去除

Detection, fate and removal of endocrine disrupting chemicals in a municipal wastewater treatment plant

Zhimin Qiang*, Bing Zhu, Weiwei Ben

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, 18 Shuang-qing Road, Beijing, 100085

Municipal wastewater treatment plants (WWTPs) are the major pollution source and key control point of endocrine disrupting chemicals (EDCs) to the environment. However, the real removal efficiencies of EDCs and key influential factors still remain largely unknown. In this work, a sensitive and selective detection method was developed for simultaneous detection of three typical categories of EDCs, including free estrogens (FEs), conjugated estrogens (CEs), and phenolic estrogenic compounds (PEs) in both wastewater and sludge of WWTPs. The operational parameters mainly responsible for EDC removal were determined through long-term monitoring in a typical WWTP. Results show that the removal efficiencies of CE, FE and PE were significantly correlated with temperature, sludge retention time and hydraulic retention time, respectively, which corresponded to the respective removal pathways of enzyme hydrolysis, bio-degradation and sludge sorption. The CE proportion in the total estrogen concentration kept increasing along the treatment processes and reached 13.5–100.0% in the effluent, indicating that the conjugates were resistant to bio-treatment.