

# 陶粒填料生物滴滤塔净化甲苯废气

张书景, 李坚, 金毓荃, 李依丽, 孙丽, 梁文俊

(北京工业大学环境与能源工程学院, 北京, 100022)

## 文摘:

随着工业的迅速发展, 挥发性有机物 (VOCs, Volatile Organic Compounds) 所造成的环境污染问题已受到普遍关注。生物滴滤法处理VOCs具有净化效率高、成本低等特点, 适合处理低浓度、大气量的非亲水性VOCs污染物。通过气相与生物相中污染物、营养物质的传递、生物降解等过程, 微生物以废气中的VOCs作为能量来源, 通过新陈代谢将其转化为简单的无机物 ( $\text{CO}_2$ , 水等) 及细胞组成物质。本论文以陶粒作为生物滴滤塔填料, 采取恶臭假单胞杆菌进行纯培养制备菌悬液挂膜, 采用气液逆流操作方式, 对含甲苯废气进行了净化试验研究。对不同停留时间条件下, 进口气体甲苯浓度、填料床层中水分等对滴滤塔净化性能的影响; 氮源与碳源停止供应后, 生物滤塔的运行与启动情况进行了研究; 根据生化反应动力学, 结合生物膜微观菌落结构的变化以及甲苯浓度沿滤塔高度的分布, 对生物滴滤塔甲苯降解机理与生物降解反应速率常数进行了分析研究。研究表明, 生物滴滤塔在接近于工业应用的非稳定条件下(环境温度、湿度变化), 连续运行 200 多天, 稳定后滤塔在停留时间为 43.2s、36s, 进气甲苯浓度为  $756\text{-}1889\text{mg/m}^3$ , 环境温度为  $19\text{-}28^\circ\text{C}$  的操作条件下, 出口气体甲苯浓度低于检出下限, 最大去除速率为  $1450\text{mg/h}$ , 抗负荷冲击能力以及抗饥饿能力均较强; 同时证明了填料床层中水分的含量在憎水性有机化合物的生物降解过程中起到非常重要的作用。

**关键词:** 陶粒; 生物滴滤塔; 甲苯; 净化性能; 降解机理

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作者简介: 张书景 (1979.11), 女, 汉, 河北

Tel: 010-67392080; Email: shujing@emails.bjut.edu.cn

# Purification of Toluene-polluted Streams in Bio-trickling Filter with Ceramic Pellets

Zhang Shujing, Li Jian, Jin Yuquan, Li Yili, Sun Li, Liang Wenjun

(College of Environmental & Energy Engineering, Beijing University of Technology;  
Beijing, 100022, China)

## **Abstract:**

With the rapid development of industry, the VOCs pollution has gained more and more attention. With the characteristics of high efficiency and low cost, bio-trickling technology is suitable to treat hydrophobic VOCs with high loading and low concentration. Through the transition of pollutants, nutrients and the microorganism degradation between biofilm and gas phase system, the VOCs are degraded to simple inorganics ( $\text{CO}_2$ ,  $\text{H}_2\text{O}$  etc.) and the substance to compose cell by metabolism of microorganism. In this paper, the removal of toluene from an artificial waste gas was investigated in a laboratory scale bio-trickling filter packed with biologic ceramic pellets, which can provide a good biological growth condition. The bio-trickling filter was operated in an up-flow mode and inoculated with pure bacterial culture (Bacilliform *Pseudomonas*). Effects of inlet concentration, water content in the bed under different retention time, periods of nitrogen and carbon starvation on bio-trickling filter performance were studied. According to biochemistry reaction dynamics and combining with micro-community structure of biofilm and the distribution of pollutant along the filter, the kinetic toluene degradation process of bio-trickling filter and biodegradation reaction rate constant were also studied. The results showed that throughout the period of more than 200 days continuous running, the filter was in changing environmental conditions, such as variations in temperature and moisture, which was the typical character of industrial operations. The removal efficiency of toluene was almost 100% at a residence time of 43.2s, 36s, inlet concentration range from  $756 \text{ mg/m}^3$  to  $1889 \text{ mg/m}^3$  and at surrounding temperature ranging between 19 and  $28^\circ\text{C}$ . The maximum removal reaction rate of  $1450 \text{ mg/h}$  was achieved. What's more, the ability of resisting loading impact and starvation are good and the water content in the bed plays an important role on the process of the organic compounds bio-degradation.

**Key words:** ceramic pellets; bio-trickling filter; toluene; purification performance; degradation mechanism