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生物沥浸处理中微生物菌群和胞外聚合物对城市污泥脱水性能的影响

Influence of microbial flora and extracellular plyometric substances on municipal sewage sludge dewaterability enhanced by bioleaching process

关键词：污泥 生物沥浸 微生物菌群 胞外聚合物 结合水 脱水性能

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作 者 单位

霍敏波 南京农业大学资源与环境科学学院环境工程系,南京 210095

郑冠宇 南京农业大学资源与环境科学学院环境工程系,南京 210095

梁剑茹 南京农业大学资源与环境科学学院环境工程系,南京 210095

周立祥 南京农业大学资源与环境科学学院环境工程系,南京 210095

摘要：探讨城市污泥生物沥浸过程中微生物菌群和胞外聚合物（EPS）变化对污泥脱水性能的影响，对进一步揭示生物沥浸法提高污泥脱水性能机理具有重要意义.本研究通过摇瓶试验探讨了硫杆菌和异养微生物菌群数量的变化及EPS在生物沥浸法提高城市污泥脱水性能中的作用.试验结果表明，在生物沥浸处理的前2 d内，由于硫杆菌*A. ferrooxidans* LX5和*A. thiooxidans* TS6的大量生长，导致生物沥浸污泥的pH从初始的4.62显著下降至2.47，进而导致污泥中异养菌数量从初始的2.65×10^{8} CFU·mL^{-1}下降至8.20×10^{6} CFU·mL^{-1}，污泥中EPS含量从初始的28.18 mg·g^{-1}（以VSS计，下同）显著下降为13.53 mg·g^{-1}.*A. ferrooxidans* LX5和*A. thiooxidans* TS6的大量生长、异养微生物细胞的死亡破裂及EPS含量的下降共同促使污泥的结合水含量从初始的37.28%下降至21.10%，最终导致污泥比阻从初始的5.14×10^{12} m·kg^{-1}显著下降至6.92×10^{11} m·kg^{-1}.通过验证试验发现，原始污泥在剥离EPS后其比阻仅为原来的11.23%，其脱水性能与生物沥浸2 d后的污泥在0.05水平上没有显著性差异.因此，污泥中*A. ferrooxidans* LX5、*A. thiooxidans* TS6和异养微生物菌群数量的改变及EPS含量的减少是生物沥浸法提高污泥脱水性能的两个重要因素.

Abstract: To study the effects of microbial count variation and extracellular plyometric substances (EPS) content change on sludge dewaterability is very significant for further revealing mechanisms responsible for the dewaterability enhancement of municipal sewage sludge by bioleaching treatment. In this study, the effect of variation of *Acidithiobacillus* species count, total heterotrophic bacteria count and EPS content on the dewaterability of sludge during bioleaching was investigated in details through batch experiments. Results showed that after 2 days bioleaching the pH value of sludge significantly decreased from initial 4.62 to 2.47, which is resulted from the rapid growth of *A. ferrooxidans* LX5 and *A.thiooxidans* TS6, while the count of total heterotrophic bacteria in sludge significantly decreased from initial 2.65×10^{8} CFU·mL^{-1} to 8.20×10^{6} CFU·mL^{-1}. Meanwhile, EPS content in sludge remarkably decreased from initial 28.18 mg·g^{-1} to 13.53 mg·g^{-1}. Thus, during the bioleaching treatment the growth of *A. ferrooxidans* LX5 and *A.thiooxidans* TS6, the death and lysis of heterotrophic microbial cells and the decrease of sludge EPS content were helpful to reduce the bound water content in bioleached sludge from initial 37.28% to 21.10%. As a result, the specific resistance to filtration (SRF) of bioleached sludge significantly decreased from initial 5.14×10^{12} m·kg^{-1} to 6.92×10^{11} m·kg^{-1}. Furthermore, SRF of original sludge without EPS was only 11.23% of original sludge, which has no significant difference (p>0.05) compared to the sludge being bioleached for 2 days. Therefore, the variation of microbial counts of *A. ferrooxidans* LX5, *A. thiooxidans* TS6 and heterotrophic bacteria in sludge and the content decrease of sludge EPS were two important factors in enhancing the dewaterability of bioleached sludge.

Key words: sludge bioleaching microbial flora extracellular plyometric substances bound water dewaterability

主办单位：中国科学院生态环境研究中心

单位地址：北京市海淀区双清路18号 邮编：100085

服务热线：010-62941073 传真：010-62941073 Email：hjkxxb@rcees.ac.cn

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