环境科学学报
ACTA SCIENTIAE CIRCUMSTANTIAE

研究报告

刘奋武,高诗颖,卜玉山,崔春红,周立祥.培养转速与镁离子对生物合成次生铁矿物的影响研究[J].环境科学学报,2014,34(6):1429-1435

培养转速与镁离子对生物合成次生铁矿物的影响研究

Effect of shaker speed and magnesium ions on the formation of biogenic secondary iron minerals

关键词：转速 镁离子 氧化亚铁硫杆菌 次生铁矿物 矿相

基金项目：国家自然科学基金项目（No.41371476，21277071）；山西农业大学博士科研启动基金项目（No.2012YJ06）；山西农业大学科技创新基金项目（No.201301）

作 者	单位
刘奋武	山西农业大学资源环境学院环境工程实验室, 太谷 030801
高诗颖	山西农业大学资源环境学院环境工程实验室, 太谷 030801
卜玉山	山西农业大学资源环境学院环境工程实验室, 太谷 030801
崔春红	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：探析培养转速与镁离子浓度对氧化亚铁硫杆菌生物合成次生铁矿物的影响对酸性矿山废水（AMD）治理具有一定的工程指导意义.本研究通过摇瓶实验，研究了Mg^{2+}浓度分别为48与4.8 mg•L^{-1}，其它元素组成与富含Fe与SO_4^{2-}的9K液体培养基一致的体系在180 r•min^{-1} 与100 r•min^{-1}转速条件下氧化亚铁硫杆菌催化合成次生铁矿物过程.考察了不同次生铁矿物合成体系pH、Fe^{2+}氧化率、总Fe沉淀率及次生铁矿物矿相等相关指标.研究结果表明，在180 r•min^{-1} 的培养条件下，Mg^{2+}浓度分别为4.8与48 mg•L^{-1}两体系培养48 h后，pH 从原始的2.50 分别降低至2.07与2.12，Fe^{2+}均可在48 h内实现完全氧化.Fe^{2+}完全氧化时，Mg^{2+}浓度为4.8 mg•L^{-1}体系总Fe沉淀率为37.4%，合成的次生铁矿物均匀分散于溶液中，而Mg^{2+}浓度为48 mg•L^{-1}体系中，总铁沉淀率仅为31.7%，且70%的矿物牢固粘附于摇瓶底部.培养转速为100 r•min^{-1}时，Mg^{2+}浓度分别为4.8与48 mg•L^{-1}两体系经过72 h培养后，pH 均从原始的2.50降低至2.21与2.17.Fe^{2+}需要72 h才能被完全氧化，两体系总Fe沉淀率分别仅为21.3%与23.0%，产生的次生铁矿物几乎全部牢固粘附于摇瓶底部.本研究所有体系产生的次生铁矿物均为黄铁矾与施氏矿物的混合物.研究结果可为生物合成次生铁矿物工艺的优化及其在酸性矿山废水治理领域的有效应用提供必要的参数支撑.

Abstract: Understanding the effect of shaker speed and magnesium concentration on the formation of biogenic secondary iron minerals facilitated by *A. ferrooxidans* is of important engineering significance in the field of acid mine drainage (AMD) treatment. In this study, secondary iron minerals was synthesized in acidic Fe and SO_4^{2-}-rich solution through the oxidation of ferrous iron by *A. ferrooxidans* and subsequent hydrolysis in 9K liquid medium containing 48 or 4.8 mg•L^{-1} magnesium ions at shaker speed of 180 r•min^{-1} or 100 r•min^{-1}. The pH, Fe^{2+} oxidation rate, total Fe precipitation rate, secondary iron mineral phase, and mineral morphology in different treatments were investigated. Results showed that solution pH decreased from an initial 2.50 to final 2.07 or 2.12, and Fe^{2+} achieved complete oxidation after 48 h incubation at 180 r•min^{-1} for 4.8 or 48 mg•L^{-1} magnesium ions systems, respectively. When Fe^{2+} was completely oxidized, total Fe precipitation efficiency was 37.4% in 4.8 mg•L^{-1} magnesium ions systems and secondary iron minerals uniformly dispersed in the solution. But in 48 mg•L^{-1} magnesium ions systems, total Fe precipitation efficiency was 31.7%, and 70% of secondary iron minerals were closely adhered to the flask bottom. Solution pH decreased from an initial 2.50 to final 2.21 or 2.17, and the Fe^{2+} achieved complete oxidation after 72 h incubation at 100 r•min^{-1} for 4.8 or 48 mg•L^{-1} magnesium ion systems, respectively. Total Fe precipitation efficiency was 21.3% for 4.8 mg•L^{-1} magnesium ion system and 23.0% for 48 mg•L^{-1} magnesium ion system. Likewise, Fe^{2+} achieved complete oxidation, but secondary iron mineral was closely adhered to the flask bottom in both systems. In this study, mineral phase were identified as the mixture of jarosite and schwertmannite in all treatments. The data obtained from this study were helpful in the engineering application of secondary iron minerals biosynthesis and its use in AMD treatment.

Key words: culture speed magnesium ions *A. ferrooxidans* secondary iron minerals mineral phase

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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