

# Recovery of Valuable Metals from Acid Mine Drainage using Aluminum-Iron (Al-Fe) Bimetallic Particles

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## Abstract

Acid mine drainage (AMD) is a mining industry waste that has been identified as a global critical pollutant. Due to its high acidity and high metal content, it poses detrimental effects to the environment and ecosystems. Current approaches to the study of AMD control perceive it as an environmental concern due to its nature; with current mitigation and remediation methods focusing on either controlling its acidity or sequestering the metals present in the waste effluent. The high metallic nature of AMD, however, may be viewed not only as an environmental concern but also as a potential secondary source for valuable metals. This study investigated the viability of utilizing locally sourced recycled Al-scrap to synthesize magnetic Al-Fe bimetallic materials to recover copper (Cu) and zinc (Zn) from synthetic AMD. The effects of varying bimetal dosages (5, 10, and 20 g/L) and contact times (5–120 mins.) were investigated (see Figure 1). The results revealed that Al/Fe bimetallic materials can positively recover Cu and Zn and that both bimetal dosage and contact time were significant factors in metal recovery. For Cu, a maximum recovery of 100% is observed after 10 min using 10 g/L bimetal dosage. A maximum recovery of 98% for Zn was obtained after 120 mins at 20 g/L bimetal dosage. XPS and SEM-EDX results revealed the presence of zero-valent Cu and Zn on the bimetal surface after the recovery process. This suggests that the main mechanism for the metal recovery is electrochemical reduction from three occurrences: (1) direct reduction by Al, (2) direct reduction by Fe, and (3) reduction from the galvanic interaction in the Al/Fe bimetal system. Furthermore, a significant increase in pH from 2.12 to 5.72 was recorded after the process. This suggests that the application of Al-Fe bimetallic materials does not only have potential in metal recovery but also in simultaneously neutralizing the AMD. Hence, the recovery of valuable metals from AMD using scrap-based Al-Fe bimetallic materials shows promise as a metallurgical extraction method which additionally offers a practical approach for possible remediation and sustainable management of waste streams, specifically mining effluents such as AMD.

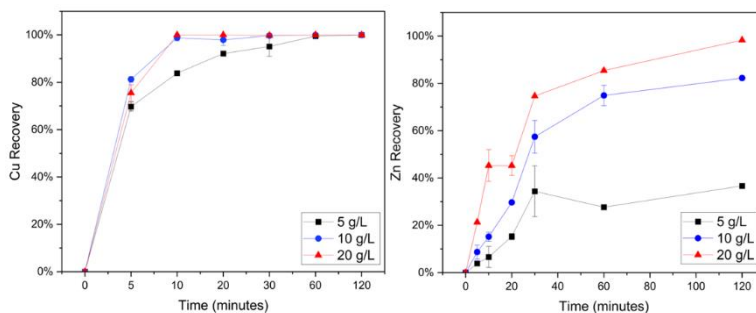


Fig. 1. Metal Recovery of Cu (left) and Zn (right) from AMD.

*Keywords: acid mine drainage; waste recycling; geochemical waste remediation*