

Title : Recovery of Bismuth from Anode Sludge in Sn-Bi Electroplating Processes from Industry

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## ABSTRACT

This research aimed to investigate the recovery of bismuth from anodic sludge generated during industrial-scale electroplating of tin–bismuth (Sn–Bi) alloy coatings. The anodic sludge, classified as industrial waste, primarily consists of bismuth, tin, and electrolyte-derived impurities. Inadequate management of this waste may lead to environmental concerns and the loss of valuable metal resources. Accordingly, this study focused on the development of a selective leaching process to separate bismuth from tin and other associated components. The effects of key parameters influencing leaching efficiency including leachant concentration, temperature, leaching time, agitation speed, and solid to liquid ratio were systematically evaluated.

The anodic sludge was characterized for elemental composition using Inductively Coupled Plasma (ICP) analysis and for crystalline structure using X-ray diffraction (XRD). The results revealed that the sludge contained 53.19 wt.% bismuth, predominantly present as bismuth oxide ( $\text{Bi}_2\text{O}_3$ ). Selective leaching was subsequently performed using methanesulfonic acid under controlled operating conditions. A total of 175 g of bismuth oxide sludge was treated to obtain high-purity bismuth products. The optimal leaching

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conditions were determined to be a methanesulfonic acid concentration of 400 g/L, temperature of 21 °C, leaching time of 160 min, agitation speed of 530 rpm, and a solid to liquid ratio of 175/600 g/mL. Under these conditions, a leaching efficiency of 39.23% was achieved, significantly enhancing bismuth recovery.

The recovered bismuth exhibited a purity level suitable for reuse in the manufacturing process. This study demonstrates the potential for valorizing anodic sludge generated from Sn–Bi electroplating operations, thereby promoting efficient resource utilization, minimizing environmental impacts, and supporting circular economy principles in industrial sectors.

## Title name guide.

ADVISOR title name / แปลไทย	
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Zoology	สัตววิทยา
Biochemistry and Biochemical Technology or Biochemistry and Biochemical Innovation	ชีวเคมีและชีวเคมีเทคโนโลยี หรือ ชีวเคมีและชีวเคมีนวัตกรรม
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Industrial Chemistry	เคมีอุตสาหกรรม
Materials Science	วัสดุศาสตร์
Physics	ฟิสิกส์
Computer Science	วิทยาการคอมพิวเตอร์
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