Contribution ID: **155** Type: **Poster Presentation**

Mitigation of Copper Redeposition in Acid Pickling of EAF Flat Steels through Bath Chemistry Control

Monday 11 May 2026 17:55 (2 minutes)

One of the major challenges in scrap-based steel production is the retention of residual elements within the steel matrix, among which copper (Cu) is particularly critical. The inability to remove copper during steelmaking not only degrades mechanical and surface properties, but also causes significant operational problems in downstream processing stages.
Following hot rolling, oxide scale formed on the steel surface is removed by (HCl) acid pickling. During the pickling of flat steel coils produced via the electric arc furnace (EAF) route, copper present in the steel may dissolve into the acid solution. As copper accumulates in the pickling bath, it can subsequently redeposit onto the steel surface, leading to copper-plated surface layers. This phenomenon adversely affects surface quality and represents a serious concern for subsequent processes such as coating and forming.
In this study, the influence of Cu, Fe^{2+}, Fe^{3+} ion concentrations and inhibitor content in the acid pickling bath on copper deposition behavior was systematically investigated. Pickling baths with varying concentrations of Cu, Fe^{2+}, Fe^{3+} and inhibitor were prepared. C67 grade high-carbon steel was selected as the substrate material in order to clearly observe copper deposition tendencies.
During the experiments, Cu and total Fe were quantified by ICP analysis, while Fe^{2+} concentrations were determined by chemical titration and Fe^{3+} levels were calculated by difference. The redox potential of the acid bath was measured by the open circuit potential (OCP) method using a platinum working electrode and an Ag/AgCl reference electrode with a Gamry electrochemical measurement system. In addition, the effect of copper deposition on surface characteristics was evaluated through contact angle measurements to assess changes in wettability.
The results showed that copper deposition on steel surfaces is strongly governed by the redox state of the pickling bath, particularly the Fe^{3+}/Fe^{2+} ratio and overall redox potential. Higher Cu ion concentrations and more oxidizing bath conditions promoted copper redeposition, whereas appropriate inhibitor additions significantly suppressed this behavior. Copper-plated surfaces exhibited noticeable changes in wettability, indicating potential negative impacts on downstream coating and forming operations. These findings emphasize the importance of effective pickling bath chemistry control to mitigate copper-related surface defects in scrap-based flat steel production.

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Session Classification: Poster session

Track Classification: EEC 2 - Process Optimization: EEC 2.C Process control and quality improvement techniques