

Design and simulation-based evaluation of a two-axis sliding robotic scrap charging system for electric induction furnaces

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Abstract

Manual and mechanized charging of scrap into electric induction furnaces can slow production and expose workers to serious hazards in steel plants. In addition to decreasing furnace production, delays and erratic charging rates expose personnel to toxic fumes, high temperatures, molten metal splashes, and ergonomic hazards. This paper presents a two-axis sliding robotic scrap charging system for electric induction furnaces. The system integrates an industrial robot arm mounted on an xy-axis sliding base with interchangeable end effectors for handling different scrap types. Data obtained from three actual steel manufacturing plants was used to establish the system requirements. The work then covered mathematical calculations, mechanical design, development of the control architecture, finite element analysis, and simulation-based evaluation. The designed charging capacity was estimated at 87 kg/min, compared with 73 kg/min for the existing process. This would increase the amount of scrap charged during a 2.5-hour production period from approximately 11 to 13 tons. Structural and thermal analyses were conducted under the specified mechanical loads and temperature boundary conditions.

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