JOM
https://doi.org/10.1007/s11837-025-07782-5

Recovery and Beneficiation of Talc Particles from the Gol-Gohar Iron Ore Processing Tailings

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Talc is one of the main gangue minerals that coextract with magnetite in pit #1 of the Gol-Gohar iron ore mines. This valuable industrial mineral accompanies iron ore through comminution, pulp-making, and low-intensity magnetic separation, and is finally introduced into the tailing thickeners. Mineralogical and chemical analyses on a mixed sample obtained from the underflows of three thickeners of the company indicated that talc constitutes more than 30% (17% MgO) of the process waste. Wet low-intensity magnetic separation (WLIMS) experiments (1500 G) using 20% solid contents reduced total Fe from 12 to 6.7%, and increased the MgO grade from 17 to 18% in the non-magnetic product. Successive flotation experiments performed after WLIMS did not lead to an acceptable product. Individual rougher flotation tests using methyl isobutyl carbinol (MIBC) and sodium hexametaphosphate as frother and dispersant agents, respectively, improved the MgO content to more than 28%, and, after cleaner and recleaner stages, it was augmented to 32% while the Fe grade fell to 3%. To further reduce iron impurity, reductive leaching tests were carried out on the recleaner concentrate and optimized using the Box–Benken design. Oxalic acid and sodium dithionite were employed as reductants. A leaching temperature of 80°C, solid content of 7.5%, oxalic acid concentration of 1.0 M, and pH = 2 reduced the iron content to less than 1% in a 2-h leaching period. Considering the ~ 4 Mt/annum of the tailings disposed of by the Gol-Gohar iron ore processing plants, the production of ~ 300 Kt/annum of the talc concentrate is feasible.

INTRODUCTION

In the last few decades, due to the decrease in the grade of minerals, it is necessary to pay attention to low-grade sources and wastes. Most of the ore extraction and mineral processing activities are associated with waste production and tailing disposal issues.[1] Mining and metallurgical wastes lead to irreparable damage to the environment and agricultural and forest lands, and augment the risk of landslides. Sometimes, even after the restoration of the land, their effects persist for a long time. The development of industries, the growth of the economy, and the increase in the amount of mineral and metallurgical activities lead to the production of huge amounts of waste materials, which have unfortunately become the origin of various environmental problems.[2] Nevertheless, industrial residues usually contain valuable entities, whose recovery can create added value for the related companies. Every metric ton of iron ore concentrate generates approximately 2.5–3 tons of tailings, and, annually, 130 million tons of this type of waste are produced.[3] Also, storing tailings without recovering all the valuable minerals and extracting mines to obtain raw materials can be considered a loss of primary resources, which conflicts with sustainable development.

(Received September 18, 2024; accepted September 2, 2025)

Published online: 06 October 2025