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Treatment of Low-Grade Iron Ore Using Two Stage Wet High-Intensity Magnetic Separation Technique

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Abstract : This study investigates the removal of silica, alumina and phosphorus as impurities from Sanje iron ore using wet high-intensity magnetic separation (WHIMS). Sanje iron ore contains low-grade hematite ore found in Nampundwe area of Zambia from which iron is to be used as the feed in the steelmaking process. The chemical composition analysis using X-ray Florence spectrometer showed that Sanje low-grade ore contains 48.90 mass% of hematite (Fe₂O₃) with 34.18 mass% as an iron grade. The ore also contains silica (SiO₂) and alumina (Al₂O₃) of 31.10 mass% and 7.65 mass% respectively. The mineralogical analysis using X-ray diffraction spectrometer showed hematite and silica as the major mineral components of the ore while magnetite and alumina exist as minor mineral components. Mineral particle distribution analysis was done using scanning electron microscope with an X-ray energy dispersion spectrometry (SEM-EDS) and images showed that the average mineral size distribution of alumina-silicate gangue particles is in order of 100 μm and exists as iron-bearing interlocked particles. Magnetic separation was done using series L model 4 Magnetic Separator. The effect of various magnetic separation parameters such as magnetic flux density, particle size, and pulp density of the feed was studied during magnetic separation experiments. The ore with average particle size of 25 µm and pulp density of 2.5% was concentrated using pulp flow of 7 L/min. The results showed that 10 T was optimal magnetic flux density which enhanced the recovery of 93.08% of iron with 53.22 mass% grade. The gangue mineral particles containing 12 mass% silica and 3.94 mass% alumna remained in the concentrate, therefore the concentrate was further treated in the second stage WHIMS using the same parameters from the first stage. The second stage process recovered 83.41% of iron with 67.07 mass% grade. Silica was reduced to 2.14 mass% and alumina to 1.30 mass%. Accordingly, phosphorus was also reduced to 0.02 mass%. Therefore, the two stage magnetic separation process was established using these results.

Keywords : Sanje iron ore, magnetic separation, silica, alumina, recovery
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