STUDY ON FLOTATION OF SILLIMANITE USING PLANT-BASED COLLECTOR

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Keywords: *Beach sand minerals; Sillimanite; Froth flotation; Oleic acid; Plant-based collector.*

1. Introduction

The beach and dune sands in India contain heavy minerals like ilmenite, rutile, garnet, zircon, monazite and sillimanite. Ilmenite-rich major beach and dune sand deposits occur in the coastal stretches of Kerala (Chavara), Tamil Nadu (Manavalakurichi, Midalam, Vayakallur), Andhra Pradesh, Odisha and Maharashtra. The Indian ilmenite commonly contains 50-60% TiO_2 and is suitable for various beneficiation processes. Zircon, Monazite and Sillimanite are ubiquitous in both the beach and inland red Teri sands, and constitute potential co-products. Indian resources constitute about 35% of world resources of Ilmenite, 10% of Rutile, 14% of Zircon and 71.4% of Monazite. India meets about 10% of the world requirement of garnet. Heavy-mineral sands, which are sedimentary deposits of dense minerals that accumulate with sand, silt, and clay in coastal environments, locally forming economic concentrations of the heavy minerals [1–4].

The coastal lines of India are rich in placer deposits of valuable heavy minerals such as ilmenite, garnet, rutile, zircon and sillimanite. The conducting and magnetic minerals are separated first, leaving behind the non-conducting and non-magnetic sillimanite along with quartz in the processing of heavies in beach sand. Sillimanite, an important mineral for refractory application is mainly recovered by flotation technique from its associated major gangue mineral, quartz by imparting selective surface hydrophobicity on sillimanite using a suitable collector.

2. Material and Methods

2.1 Materials

In this study, a placer sample after the removal of heavies from western coast of southern India containing 55.4% sillimanite along with 33.9% quartz, 1.7% magnetics, 1.4% rutile, 2.4% zircon, 5.6% kynite was subjected to froth flotation for enriching the sillimanite content.

A representative head sample was drawn and the remaining material was used for flotation studies. A laboratory synthesized plant-based reagent SFA and oleic acid (LR grade) were used as collectors. Sodium silicate was used as depressant for quartz and soda ash as pH regulator.

2.2 Methods

Bench scale flotation experiments were carried out in a standard Denver laboratory D12 type flotation machine. Representative feed and concentrate samples were subjected to X-ray diffraction (XRD) using PANalytical (X'pert) powder diffractometer to identify the mineral phases. Fourier transform infrared (FTIR) was used to detect various functional groups present using Bruker Alpha II compact FTIR Spectrometer-ATR module.

3. Results and Discussion

3.1 Characterization studies

The characterization of the plant-based reagent for sillimanite flotation was evaluated using FTIR in order to study the functional groups that enhance the selective sillimanite flotation. The peaks at 3200 to 3500 cm^{-1} and 1636 cm^{-1} confirm the presence of -COOH in the natural source based collector.

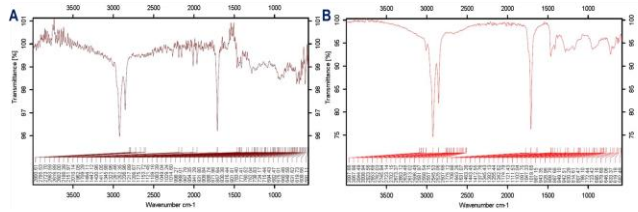

Figure 1: FTIR images sillimanite sample coated with (A) oleic acid (B) plant-based reagent SFA

The adsorption of new reagent on sillimanite surface was examined by FTIR spectroscopy. The peak shifts in FTIR spectrum of reagent-coated sillimanite indicates the chemisorption of new reagent on sillimanite surface.

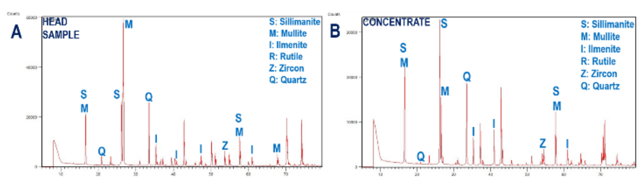

Figure 2: XRD spectra of (A) feed to flotation (B) concentrate obtained at optimized flotation conditions

XRD pattern indicates the presence of sillimanite, ilmenite, rutile along with quartz as mineral phases.

3.2 Beneficiation studies using froth flotation

The flotation process optimization and the effect of variation of process parameters such as pH, depressant and both the collectors were evaluated.

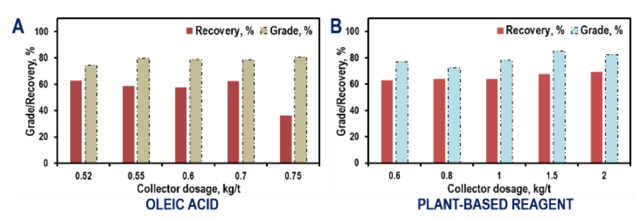

Figure 3: Grade and recovery of sillimanite obtained at various collector dosage of (A) oleic acid and (B) plant-based reagent SFA

It can be seen from Figure 3 that grade and recovery is higher in case of plant source based collector than that of the conventional oleic acid.

4. Conclusion

Flotation process was optimized by varying process parameters such as pH, depressant dosage and dosages of both the collectors. It was observed that flotation performance of the natural source based collector has better selectivity and improved recovery as compared to that of oleic acid as collector. An improved weight recovery of 67.8% with 85.1% sillimanite was obtained using the newly developed natural source based collector while a weight recovery of 55.5% with 84.9% sillimanite was obtained using oleic acid. The improved sillimanite recovery by using this new plant source based collector than that of the conventional oleic acid would be more economical in industrial scale sillimanite recovery in beach sand processing industries.

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