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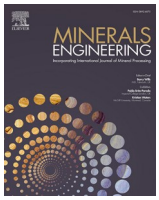

# Experimental, benchmarks and theoretical investigations into the complexation of chalcopyrite and silica with guar gum and beneficiation of a siliceous copper ore using polyethylene oxide as a silica depressant

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ABSTRACT

The application of guar gum (GG) as a selective chalcopyrite flocculant on Mpanda Mineral Field (MMF) ore and flotation of flocculated fraction in presence of polyethylene oxide (PEO) as a silica depressant was investigated. For the first time theoretical simulation of FTIR for GG was conducted and interestingly it was noted to match with the experimental one. Different functionals were used to optmise the complexes and it was noticed that MN15/6-311++gdp/def2-TZVP perfomed best compared to other tested functionals with respect to rev-DSD-PBEP86-D3(BJ), a double hybrid functional as reference, with a mean absolute % deviation in complexation energy of 1.4 %. The complexation energy for GG with Cu species was higher than that of Fe and S species on chalcopyrite surface suggesting that GG adsorbs more on Cu sites compared to others. Further, the complexation energy for Silica-GG dimer was lower relative to chalcopyrite-GG dimer and this is in agreement with experimental results. The resulting nature of interaction in chalcopyrite-GG complex was found to be conventional hydrogen bonding (HB), non-covalent and partial covalent interaction, whereas that for silica-GG dimer was HB only. After selective flocculation, the settled fraction was subjected to flotation in presence of 60 g/t of potassium amyl xanthate and 500 g/t of PEO, as collector and silica depressant, respectively, and yielded Cu grade and recovery of 28.4 % and 93.2 % respectively.

## 1. Introduction

The depletion of high-grade copper ores has necessitated the beneficiation of siliceous lean grade copper ores using low-cost technologies to meet the increasing demands of copper products (Jena et al., 2019). The application of selective flocculation prior to flotation has been reported to increase the separation efficiency of targeted minerals in ores existing in fine fractions (Colombo and Jacobs, 1976). Several studies have been reported on the selective flocculation of oxide minerals in presence of silica (Weissenborn et al., 1994; Su et al., 2016; Arol and Iwasaki, 2003; Chuanbing and Yuhua, 2008). For instance, Nambaje et al. (Nambaje et al., 2022) as well as Saravanan and Subramanian (Loganathan and Sankaran, 2021), reported on the selective flocculation of cassiterite from siliceous Gasambya mine tailings and alumina, respectively, using xanthan gum. Apart from the flocculation of oxide minerals, other workers (Attia, 1977) also investigated the flocculation of copper minerals from their synthetic mixtures such as silica, dolomite, feldspar and calcite using polyacrylamide glyoxal-bis-(2-hydroxyanil). In addition, works on the selective flocculation of sulphides such as pyrite and sphalerite from pyrite-silica and sphalerite-silica systems using separan are well documented (Usoni et al., 1968). The flocculation of chalcopyrite from a chalcopyrite-silica system using hydroxyl propyl cellulose xanthate was studied by Sresty and Somasundaran (Sresty and Somasundaran, 1980). Acar and Somasundaran (Acar and

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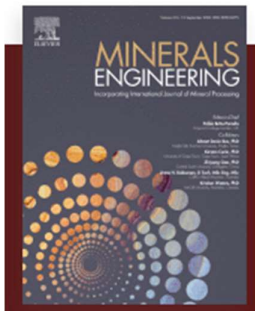
## Highlights

- Adsorption of guar gum and polyethylene oxide onto chalcopyrite and silica.
- Zeta potential of chalcopyrite and silica in presence of guar gum and polyethylene oxide.
- Selective flocculation of Mpanda Mineral Field ore using guar gum.
- Benchmark studies of chalcopyrite and silica with guar gum.

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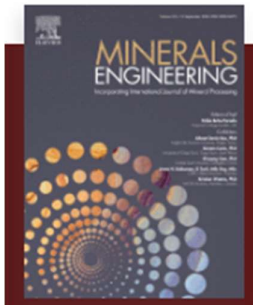


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