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Implications in sulphide mineral processing with new insights into metal sulphides oxidation during grinding by H₂O₂ generation

Hanumantha Rao Kota¹ and Alireza Javadi²

¹Norwegian University of Science and Technology, Norway

²Luleå University of Technology, Sweden

Recent studies reveal the formation of reactive, oxidizing oxygen species and H₂O₂ by sulfides interacting with water due to the catalytic activity of sulfide surfaces. The formation of hydrogen peroxide (H₂O₂) by sulfide minerals during grinding was investigated by us1-5. It was found that pyrite (FeS₂), chalcopyrite (CuFeS₂), sphalerite (ZnS), and galena (PbS), which are the most abundant sulfide minerals on Earth, generated H₂O₂ in pulp liquid during wet grinding in the presence and absence of dissolved oxygen in water and also when the freshly ground solids were placed in water immediately after dry grinding. Pyrite generated more H₂O₂ than the other sulfide minerals and the order of H₂O₂ production by the minerals was found to be pyrite > chalcopyrite > sphalerite > galena. The amount of H₂O₂ formed also increases with increasing sulfide mineral loading and grinding time due to increased surface area and its interaction with water. The sulfide surfaces are highly catalytically active due to surface defects capable of breaking down the water molecule leading to hydroxyl free radicals. The type of grinding medium on formation of hydrogen peroxide by pyrite revealed that the mild steel produced more H₂O₂ than stainless steel grinding medium, where Fe²⁺ and/or Fe³⁺ ions played a key role in producing higher amounts of H₂O₂. The results of the amount of H₂O₂ production corroborate with the rest potential of the sulfide minerals; higher the rest potential, more is the formation of H₂O₂. Most likely H₂O₂ is responsible for the oxidation of sulfide minerals and dissolution of non-ferrous metal sulfides in the presence of ferrous sulfide besides the galvanic interactions reported in the literature. Studies have also been carried out to build correlation between percentage of pyrite in the concentrate, grinding conditions and concentration of OH•/ H₂O₂ in the pulp and as well of controlling the formation of these species through known chemical means for depressing the generation of the oxidant. The results demonstrate that the selectivity of metal sulphides against pyrite increases with increasing generation of H₂O₂ in the pulp liquid. These studies highlight the necessity of revisiting the electrochemical and/or galvanic interactions between the grinding medium and sulphide minerals, and interaction mechanisms between pyrite and other sulphide minerals in terms of their flotation behaviour, leaching and environmental degradation in the context of inevitable H₂O₂ existence in the pulp liquid.

Biography

Hanumantha Rao Kota obtained his BSc in 1971 from Andhra Christian College, Guntur, at Andhra University and his MSc and PhD degrees in Applied Chemistry from the Faculty of Engineering at Jabalpur University, in 1974 and 1980, respectively. He worked at Indian School of Mines, Dhanbad; Government Engineering College, Rewa; Regional Research Laboratory, Bhubaneswar, before joining the Division of Mineral Processing of Luleå University of Technology in Sweden in 1985. He became Docent and Full Professor in Mineral Processing at the Luleå University of Technology in 1992 and 2003, respectively. He has authored more than 165 scientific papers published in various international peer-reviewed high-impact journals and conference proceedings.

hanumantha.rao.kota@ntnu.no

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