

III. RESULTS AND DISCUSSION

Fig. 3a summarizes the dissolution recovery for Cu and Fe at the investigated pH value (1.0) the 12 hours leaching test. Figure 3b shows the mineral phase content of the solid residue after the dissolution test. Cu dissolution curve (Fig 3a) obeyed the parabolic nature of the mineral and was characterized by rapid withdrawal of Cu at the early stage of the dissolution. The mineral's Fe dissolved was obtained after subtracting the initial Fe portion used as oxidant (leaching solution) from the total Fe reporting under the AAFS (i.e., Fe mineral = Fe Total (AAFS) - Fe used as oxidant (ferric sulfate)). In addition to that, it could be seen that the Cu dissolution took place in different stage. The first stage was the rapid Cu withdrawal at the earlier stage (20 min of dissolution), followed by a slow dissolution rate (from 20 to 600 min) and lastly the plateau stage (after 600 min of dissolution). This could suggest that during the dissolution chalcopyrite undergoes mineral mutation or conversion. This tends to agree with the XRD results (Fig 3b) were new phases, initially absent in the feed samples (Fig 1) were identified in the residual solid leached sample (Fig 3b). These phases were chalcocite (Cx) and covelite (Co).

The media Fe initial speciation is shown in Fig 2 and it revealed that the solution is composed of various Fe compounds which could be categorized as anions, cations and neutral complexes (free Fe^{2+} and Fe^{3+}), complexed ions ($\text{Fe}(\text{HSO}_4)^+$, $\text{Fe}(\text{HSO}_4)^{2+}$, $\text{Fe}(\text{SO}_4)^{2-}$, FeSO_4^+ , FeSO_4^0) [29]. free Fe^{3+} only constitutes a small portion of the media which is mainly composed of Fe^{2+} and $\text{Fe}(\text{HSO}_4)^+$. It therefore appeared that accurate solution speciation could assist with explanation in regard to dissolution mechanism and pinpoint responsible Fe compound responsible for Cu dissolution from the CuFeS_2 . The evolution of Fe speciation showed a decrease in all Fe species content (Fig 4 a, b, c and d) suggesting that all these species played a vital role during Cu withdrawal from the CuFeS_2 . 90% decrease was observed for Fe^{3+} , 8% decrease for FeSO_4^+ , 2% decrease for $\text{Fe}(\text{SO}_4)_2^-$, 17% decrease for $\text{Fe}(\text{HSO}_4)^{2+}$ at pH 1.0 at 25°C . The relatively high decrease in content identified for Fe^{3+} and $\text{Fe}(\text{HSO}_4)^{2+}$ agrees with the earlier study reporting that both these ions play a major role during Cu dissolution. The results confirm that Fe^{3+} is the principal specie followed by $\text{Fe}(\text{HSO}_4)^{2+}$ [30]. However, the small decrease in regards to FeSO_4^+ and $\text{Fe}(\text{SO}_4)_2^-$ should not be ruled out for Cu withdrawal rather could suggest that these ions oxidizing strength could be much less than the two previous one at the investigated parameters (pH and T0).

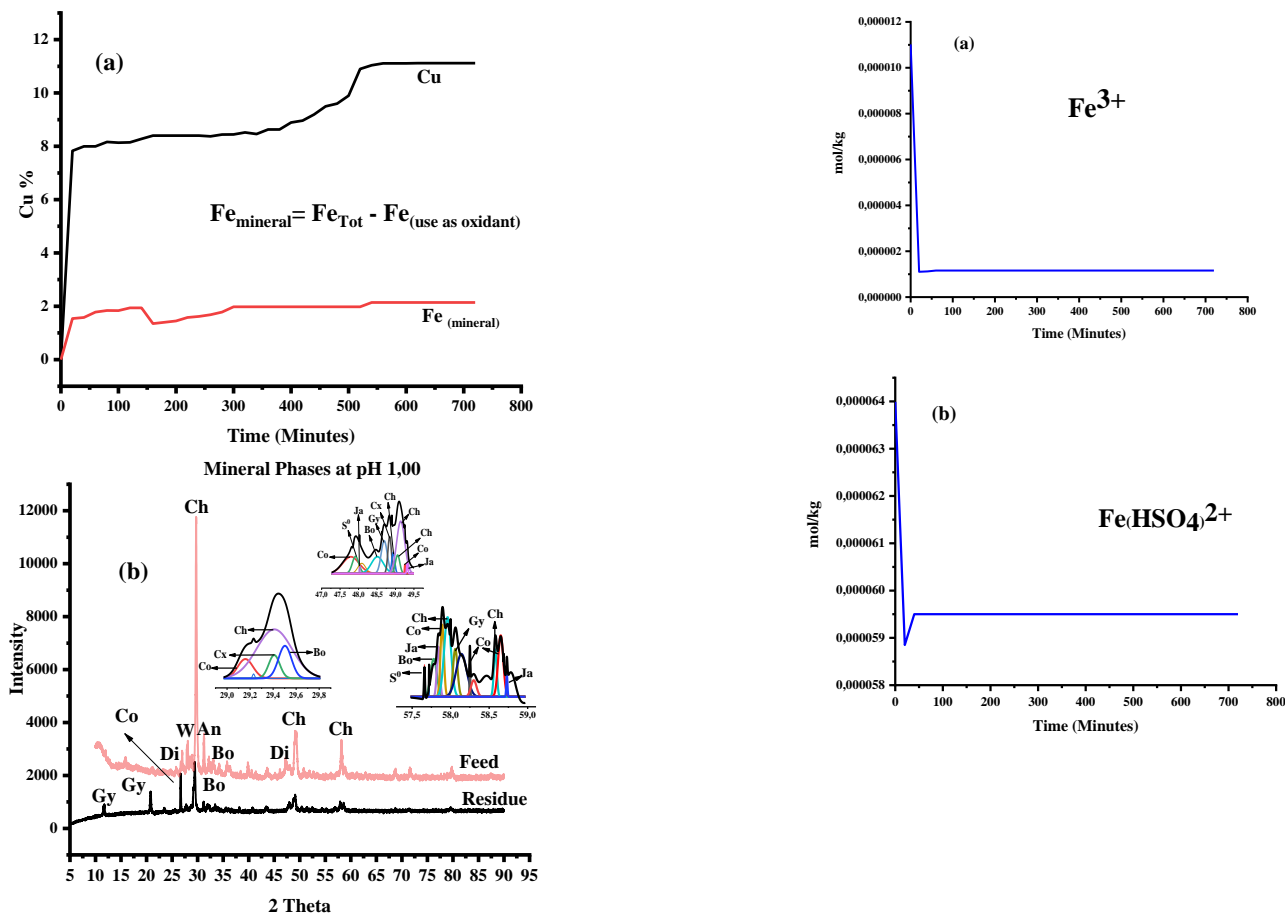


Fig. 3. CuFeS_2 dissolution curve and solid residue mineral content characterisation

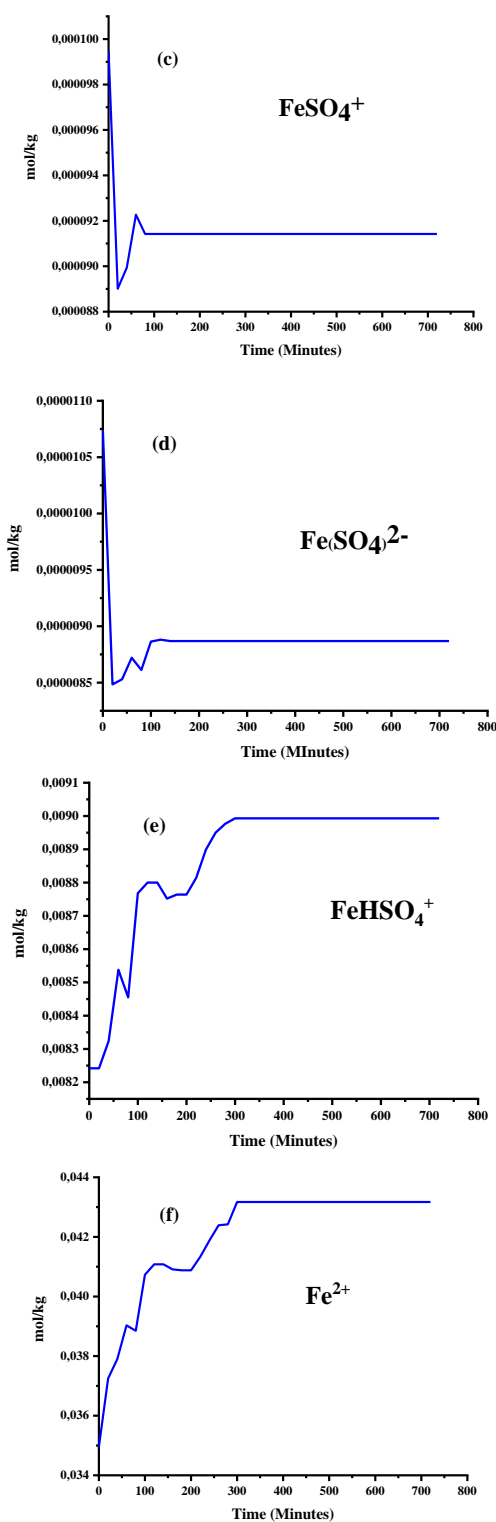


Fig. 4. Evolution of speciation of various Fe species during CuFeS₂ at pH of 1.0 at 25^o C

The increase in the content of Fe²⁺ and FeHSO₄⁺ (Fig 4 e and f) support the mineral dissolution reaction (Eq1), producing and produces elemental sulphur (S⁰) and both copper and ferrous sulphate [31]. It could be said that during the dissolution of CuFeS₂, the first step could be regarded as the ferric attack, taking place at the mineral surface and causing the

reduction of the oxidant (all ferric species including Fe³⁺, FeSO₄⁺, Fe(SO₄)₂⁻ and Fe(HSO₄)₂⁺) thus promoting the withdrawal of Fe and Cu.



IV. CONCLUSION

In this study CuFeS₂ was dissolved in acidic ferric sulfate (Fe₂(SO₄)₃+H₂SO₄+H₂O) at a solution pH of 1.0 and 250C. only 12% of the Cu were recovered from the dissolution test. The results showed that both free Fe³⁺ and Fe(HSO₄)₂⁺ are the major species for Cu withdrawal. Fe³⁺ was found as the main responsible ion and complete Cu dissolution was not attained due to the completion of this ion. Cu leaching curve displayed a stage wise dissolution process characterized by a rapid rate at the earlier stage, decreasing with time until the plateau stage is reached. The solid leached residue showed the presence of new copper sulphide phases including bornite, chalcocite and covelite mineral and suggested that CuFeS₂ undergoes mutation during Cu dissolution.

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