

METHOD OF COPPER CONCENTRATE LEACHING AND SULFATION

[0001] The present application relates one or more hydrometallurgical methods of treating metal-containing sulphide ores and concentrates. Particularly, the application
5 also relate to one or more methods of copper concentrate leaching and sulfation. The one or more methods are alternatively known as process or processes.

[0002] Sulfide (i.e. Sulphide) ores are either treated as such, concentrated or leached to recover the valuable metals. Roasting, sintering, and smelting of these ores or
10 concentrates of these ores are known treatment methods or processes. In known chalcopyrite leaching or Sulfation process, the passivation of the process is typically a problem in the dissolution of copper contained in the sulfide ores. More efficient and cost effective treatment methods are always desired.

[0003] The present application aims to provide one or more new and useful methods. The application also intends to provide new and useful methods for processing copper concentrate. Essential features of the application are provided by one or more independent claims, whilst advantageous features of the application are presented by their dependent claims respectively.
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[0004] Copper concentrate leaching process normally refers to the flow of components contained in a solid material into another phase, which is typically a liquid phase. The present application provides a Sulfation process or a dissolution-Sulfation process, which is related to the leaching process. The Sulfation process of present application
25 can achieve extractions of above 90% copper or higher from copper concentrates. The method also requires very low residence times, which may range between 60 and 120 minutes. The method utilizes a high concentration of sulfuric acid (e.g. over 90% concentration level) and maintains the sulfuric acid at this high concentration level in a glass-lined reactor for obtaining high copper extraction with short residence times. The
30 present method requires the injection of oxygen gas in order to regenerate the acid by reaction with sulfur dioxide SO_2 and water H_2O generated during the Sulfation process. Accordingly, the method maintains high concentrations of sulfuric acid in the reactor. The method introduces vigorous agitation and appropriate agitation (e.g. using of Rushton impeller) in order to avoid passivation by interference of sulphates/sulfates
35 (copper and iron based), which may be formed during the Sulfation process.

Accordingly, oxygen gas is more efficiently used in the regeneration of sulfuric acid with high permanence and short residence time in the reactor gas. The method can further increase the efficiency of oxygen gas by using a large reactor with characteristics L/D (e.g., greater than 2) for the gaseous oxygen interacting more with the other reactants.

- 5 The method requires lower temperature of about 130 degree Celsius ($^{\circ}\text{C}$) for keeping the elemental sulfur formed in the solution (MP 120°C), which allows the solution to oxidize firstly to SO_2 and later to form sulfuric acid. The method can be carried out in one or more reactors at atmospheric pressure, which is safe, cheap and simple. The concentrates used in this method does not require regrinding as the concentrates are
- 10 obtained directly from a flotation process, which only requires drying. To ensure that all chalcopyrite has reacted, the method proposes a flotation process for recycling the chalcopyrite. In subsequent tests, reflux of the method is minimized by increasing efficiency of the reactors. The method requires addition of certain reagents as catalysts (e.g. Ag) or oxidants (e.g. ferric sulfate $\text{Fe}_2(\text{SO}_4)_3$ or halogen (e.g. chlorine, bromine).

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[0005] The accompanying figures (Figs.) illustrate embodiments and serve to explain principles of the disclosed embodiments. It is to be understood, however, that these figures are presented for purposes of illustration only, and not for defining limits of the present invention.

- 20 Fig. 1 illustrates an exploded view of basic components for building fillers of diverse shapes.

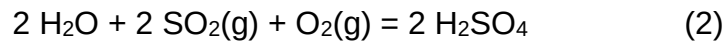
- [0006] Exemplary, non-limiting embodiments of the present application will now be described with references to the above-mentioned figures. Particularly, embodiments
- 25 of the application comprise parts or method steps that are similar or identical to each other. These parts or method steps are thus denoted with similar or identical names or reference numerals. Description of these relevant parts of method steps is hereby incorporated by reference, wherever relevant or appropriate.

- 30 [0007] The hydrometallurgical method of treating metal-containing sulphide ores and concentrates is known as a global process, which comprises some individual process. Particularly, the Sulfation process is most important because the Sulfation process provides the elements that receive kinetic strength, and makes the elements different to other processes or their variants. The proposed Sulfation process and its operating
- 35 conditions associated with the dissolution process substitute a leaching process.

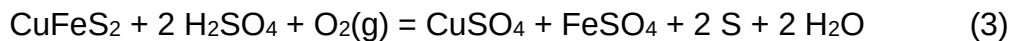
[0008] During the Sulfation process, sulfuric acid and chalcopryrite vigorously react resulting firstly to the following anaerobic reaction.



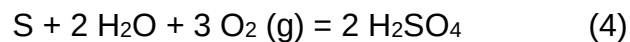
[0009] Because the medium is completely acidic, sulfates formed (e.g. CuSO_4 and FeSO_4) are almost completely insoluble. Subsequently, due to the simultaneous and adequate injection of oxygen gas (O_2), water (H_2O) and sulfur dioxide (SO_2), the
 10 medium reacts with the oxygen gas (O_2), water (H_2O) and sulfur dioxide (SO_2) to regenerate about half of the sulfuric acid fed according to the following reaction.



15 [0010] Thus, combining reactions (1) and (2) results in the overall reaction (3) below



[0011] The water generated evaporates of the system and tends to leave the acid free
 20 of moisture. In preliminary tests, it has been observed that some sulfur also tends to oxidize and form sulfuric acid according to reaction (4), making the overall reaction more self-sufficient with respect to that reagent.



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[0012] After Sulfation process, upon the S/L separation, this mixture of sulphates and leaching residue is subjected to water washing where sulphates dissolve and a residue leach based chalcopryrite (CuFeS_2) remains (unreacted), sulfur (S), pyrite (FeS_2), silica (SiO_2) and some presence of precious metals (Au and Ag).

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[0013] In a solvent extraction and electro-winning process, after the Dissolution process of sulphates, the liquid stream obtained from the filtration of the pulp, which contains a minimal amount of acidity and a high concentration of copper and iron is processed in a system of solvent extraction and electro-winning for copper recovery. Pure copper is
 35 thus obtained electrolytically. In this process, remaining iron in the solution is removed

for provision or sale. Washed solid obtained after sulfate filtration is subjected to a chalcopryrite flotation process to recover any small fraction of this unreacted. The material recovered is recycled to the Sulfation process. Tailings obtained in this first flotation are floated again to separate pyrite (FeS_2) and the remaining elemental sulfur in order to serve as a possible acid production. The pyrite in final tailings are removed for preventing acid drainage formation.

[0014] The Sulfation step is an important part of the method which replaces Leaching process. The method has succeeded in reducing copper content of slag from 27.98% to 0.65% by a single operation, which is significantly more effective than the pyro metallurgical process.

[0015] Following this, further experiments have been performed by achieving the leaching efficiencies of about 85% in copper recovery. Additional copper may be recovered from unreacted chalcopryrite by flotation process. Moreover, the method requires residence times about 02 hours, which is very low for this type of process in view of the problem of passivation posing in most cases. The S/L ratio managed to simulate industrial operation must be equal to or greater than 20%. Sulfation temperature of the method is about 130°C whilst residence times of the method is less than 2 hour. Copper recovery efficiencies of 90% or higher can possibly be achieved by the method.

[0016] Table 1 provides contents of various elements in copper concentrate and copper concentrate residue after using the method.

Elements	Copper Concentrate	Copper Concentrate Residue
%As	0.179	0.091
%Bi	0.018	0.001
%Sb	0.045	0
%Fe	27.66	25.89
%Cu	27.98	0.65
%S	35.80	58.61
%SiO ₄	3.26	4.2

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[0017] It will be apparent that various other modifications and adaptations of the embodiments or application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all such modifications and adaptations come within the scope of

5 the appended claims.

Claims

1. Method of recovering copper from sulfide ores with copper and iron, the method comprising:

- 5 (a) reacting the sulfide ore with sulfur dioxide gas at a temperature of at least about 130°C., thereby forming elemental sulfur, magnetite and a copper sulfide;
- (b) condensing and removing the elemental sulfur from the reaction mixture;
- 10 (c) reacting the residual solids with concentrated sulfuric acid at a temperature of about 180°C to 500°C, thereby forming copper sulfate and sulfur dioxide gas;
- (d) recycling the sulfur dioxide gas to the step (a);
- (e) separating the solids comprising magnetite and copper sulfate from the liquid phase,
- 15 (f) roasting the separated solids at a temperature of about 400°C to 900°C,
- (g) leaching the roasted solids with an aqueous solution comprising water or dilute sulfuric acid, thereby solubilizing the copper sulfate,
- (h) separating the solids comprising magnetite and gangue from the liquid phase; and
- 20 (i). recovering copper from the solubilized copper sulfate.

2. A hydrometallurgical method of treating metal-containing sulphide ores and concentrate substantially as hereinbefore described with reference to any one of the examples and/or the accompanying drawing.

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