Depression of pyrite in porphyry copper flotation

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High pyrite recovery in Cu/Mo operation

FEED
4800 tph
µ
Ball Mills

ROUGHER
SCAVENGER

FINAL CON
Polishing Mills

FINAL TAIL

<table>
<thead>
<tr>
<th>grade</th>
<th>recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cp %</td>
<td>Py %</td>
</tr>
<tr>
<td>65-70</td>
<td>10-15</td>
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Case Study
Plant Evidence
Pyrite reports to the Cu concentrate even at high pH

Case Study
Rougher Con, pH = 10.5, Eh = 250 mV SHE

Pyrite should not float at high pH (Gaudin, 1957):

\[ \text{Xanthate adsorp. density} \propto \log \left( \frac{X^-}{OH^-} \right) \]

Maximum pyrite recovery in the intermediate size ranges true flotation
Possible mechanisms for pyrite recovery

1. Insufficient liberation from the copper sulphide

2. Surface Cu activation and genuine flotation

Galvanic interactions in complex sulphide ores (Huang & Grano, 2005)
Pyrite in the Rougher Con is Liberated

Pyrite is not recovered due to mineralogical association with chalcopyrite

QEM-Scan analysis

Case Study
Time-of-Flight Secondary Ion Mass Spectrometry: ToF-SIMS

Ga$^+$ 11 kHz

Mass resolution ~9000 in Bunched Mode

Pulsed electron flood

$t = L \sqrt{\frac{m}{z}} \times \frac{1}{2V}$
Pyrite in the concentrate is Cu activated

- Copper and collector detected on the surface of pyrite
- More Si, Al, K, Ca and O on the slow-floating pyrite
Laboratory Work
Na$_2$SO$_3$ and DETA to depress pyrite

ROC$^{2-}$ + SO$_3^{2-}$ + HSO$_3^-$ + O$_2$ → ROH + 2S$_2$O$_3^{2-}$ + CO$_2$

Decomposition of xanthate

Py[5S$^0$] + 5SO$_3^{2-}$ → Py[S$_2$O$_3^{2-}$] + 4S$_2$O$_3^{2-}$

Reduced surface hydrophobicity

Cu$^{2+}$ complexation with Cu

DETA
Flotation Baseline

Conditioning: $O_2$/air/no gas to control Eh and DO level in the pulp

Rghr Con (Plant)

Ore 1

FEED

$O_2/$

Condit.

SIPX

DETA, $Na_2SO_3$

frother

flotation

Tail

Rghr Feed (Lab grind) +Thio primary coll.

Ore 2

0-30 mins

2 mins

2 mins

1 min

Con 1, 2, 3, 4

Feed H/G

<table>
<thead>
<tr>
<th>Cu %</th>
<th>Fe %</th>
<th>Cp %</th>
<th>Py %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ore 1</td>
<td>0.66</td>
<td>3.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Ore 2</td>
<td>0.44</td>
<td>4.6</td>
<td>1.2</td>
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</table>
Depression of pyrite in the rougher concentrate (ore 1)
Limited depression of pyrite with lime

Flotation tests on plant rougher con (60% Cp, 18% Py) (Ore 1)

Pyrite is Cu and xanthate activated
Depression of pyrite with \( \text{Na}_2\text{SO}_3 \) and DETA

Flotation tests on plant rougher con (60% Cp, 18% Py) (Ore 1)

After intense oxygenation

![Graphs showing pyrite and chalcopyrite recovery over time under different conditions.](image-url)
Depression of pyrite in the rougher feed (ore 2)
Na$_2$SO$_3$ reduces the adsorption of xanthate on pyrite in the feed.

Float tests on rghr feed ground in the lab (1.2% Cp, 10% Py)(Ore 2)

- Na$_2$SO$_3$ reduces the adsorption of xanthate on pyrite in the feed.
- Pyrite re-activates if further SIPX is added after Na$_2$SO$_3$.
- Chalcopyrite is not affected.

Graphs showing the effect of Na$_2$SO$_3$ on pyrite recovery with and without xanthate at pH 10.5.
Conclusions (Case Study)

- Pyrite in the feed was Cu activated, and adsorbed xanthate even at high pH (>10.5), becoming highly floatable.

- Limited pyrite depression was achieved by increasing the pH with lime.

- Na$_2$SO$_3$ and DETA were effective in preventing/reversing the activation of pyrite in the presence of O$_2$, reducing pyrite recovery by 50%.

- However, further addition of xanthate after depression with Na$_2$SO$_3$ re-activated pyrite.
Conclusions (Generic)

• Xanthate collectors appear not to be very selective versus pyrite

• The use of sodium sulphite \((\text{Na}_2\text{SO}_3)\) and similar sulphoxy species \((\text{Na}_2\text{S}_2\text{O}_5, \text{Na}_2\text{S}_2\text{O}_3)\) or sulphur dioxide gas \((\text{SO}_2)\) may significantly reduce/reverse xanthate adsorption on pyrite

• Pyrite may re-activate down the bank if further xanthate is added

• For ores containing highly floatable pyrite, the use of more selective collectors (e.g. thionocarbamates) may be preferable
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Thank you!