Flotation of Clay-Bearing Ores

Flotation of Clay-Containing Ores

BACKGROUND

The presence of clay slime represents a challenging metallurgical problem in sulphide mineral flotation, in particular in the treatment of porphyry copper, copper-molybdenum, copper-gold and gold ores as well as, in some cases, lead-zinc and copper-zinc ores. As a result, metallurgical results are less than optimum in many operating plants that treat clay-containing ores. Moreover, collector consumption is sometimes relatively high.

Until recently, the real effect of clay-like minerals on metallurgical results was difficult to determine, because there was no means of controlling clays during flotation. Therefore, the extent of the problem associated with clays in flotation has never been properly recognised and quantified.

Recent extensive development work on many clay-containing ores from several operating plants, has resulted in the development of a series of highly effective clay dispersant/depressants, which eliminate the harmful effect of many different clay minerals during flotation.

PROBLEMS ASSOCIATED WITH THE TREATMENT OF CLAY-CONTAINING ORES

There are many problems associated with the treatment of clay-containing ores, beginning with grinding and flotation, and continuing to the dewatering circuit. These problems can be summarized as follows:

- In the presence of clay, pulp viscosity is relatively high, which has a negative effect on grind efficiency.
- For instance, flotation performance is reduced, owing to (a) slime coating of the minerals to be floated, (b) poor froth loading due to the high viscosity of the pulp, and (c) poor froth drainage. The flotation of coarse and middling particles is most affected.

These problems are not easily recognized in industrial practice, because there is no practical means of determining the real effect clays have on flotation.

CHEMISTRY OF THE NEW CLAY DISPERSANTS/DEPRESSANTS

The new clay dispersants/depressants are the reaction product of a phosphoric acid salt, an acrylic acid-based polymer and/or a sodium salt of sulps to produce sodium orthophosphate and other compounds with specific structures, and oxygen co-ordination. They can then react with an organic polymer to form new compounds. Likewise, molecules of sodium silicate react by bonding hydrogen in the silicate micelle with the polymer.

These reaction products, known as NQ compounds, are capable of creating a highly dispersed clay-containing slurry, which in turn reduces the pulp viscosity significantly. They also react with clay particles, thus preventing clay coatings on the air bubbles and the particles to be floated.

APPLICATIONS

The new clay dispersants/depressants were studied during the treatment of clay-containing gold, copper, copper/molybdenum and other base metal ores. The major advantages of these clay-controlling reagents are:

- reduce pulp viscosity and consequently, improve grind efficiency
- improve recovery of coarse and middling particles
- reduce collector consumption
- improve concentrate grade

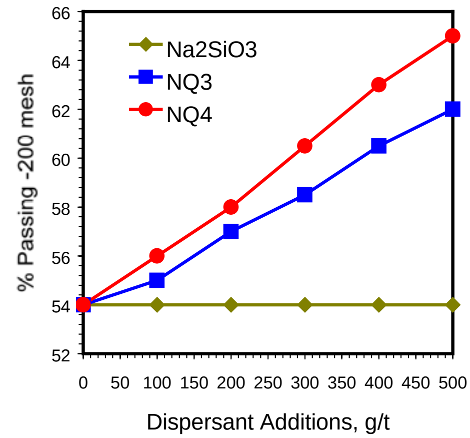
EFFECT OF NEW CLAY DISPERSANTS/DEPRESSANTS FROM THE NQ SERIES

Clay dispersants/depressants were evaluated on clay-containing copper, copper/gold and gold ores. NQ4 was successfully introduced into an industrial plant treating a high clay gold-bearing ore.

EFFECT OF NQ3 AND NQ4 ON THE GRINDABILITY OF HIGH CLAY COPPER ORE

Clay dispersants/depressants NQ3 and NQ4 were evaluated in the laboratory on a copper ore containing high levels of kaolinite and illite, to determine if the grinding efficiency could be improved by reducing the pulp viscosity. Figure 1 shows the effect of different levels of NQ3 and NQ4 on grind fineness at a fixed grind time. The results show a substantial improvement in grinding efficiency in the presence of the new clay dispersant/depressants compared to a conventional sodium silicate dispersant.

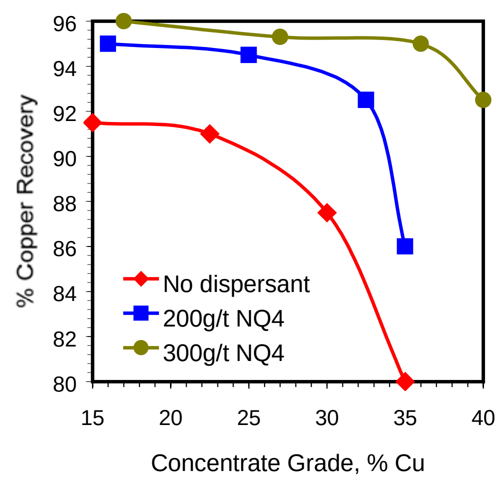
Figure 1. Effect of Different Clay Dispersant/Depressant on Grind Fineness



EFFECT OF NQ4 ON THE FLOTATION OF A CHILEAN COPPER CORE

NQ4 was evaluated on a copper ore from Chile, which contained several types of clay. The metallurgical results obtained in this operating plant at the time were poor. Figure 2 shows the grade-recovery relationship with different levels of NQ4. The results obtained showed a significant improvement in concentrate grade and recovery in the presence of reagent NQ4.

Figure 2. Effect of NQ4 Level on Copper Grade Recovery Relationship



FLOTATION OF COPPER-GOLD ORES

Porphyry and skarn copper-gold ores usually contain a variety of clay minerals which interfere with both copper and gold metallurgy. Gold metallurgy in particular is adversely affected, owing to the fact that clay minerals readily coat the copper auride and electrum, thus reducing their floatability. The following examples illustrate the effectiveness of the clay dispersants/depressants.

Example #1 – Copper-Gold Ore from Australia

Comparative locked cycle tests were carried out on a copper-gold ore from Australia that contained high levels of clay minerals. The results obtained with different levels of NQ3 are shown in Table 1. An improvement in recovery of about 8% for copper and 8.7 % for gold, at 400 g/t depressant addition is indicated.

Table 1. Effect of NQ3 Level on Copper-Gold Flotation (AH Ore)

NQ3 Addition	Product	Weight %	Assays %, g/t		% Distribution	
			Cu	Au	Cu	Au
0 g/t	Cu/Au Conc	3.90	32.2	33.7	86.5	79.2
	Cu/Au Comb Tail	96.10	0.20	0.36	13.5	20.8
	Feed (Calc)	100.00	1.45	1.66	100.0	100.0
200 g/t	Cu/Au Conc	3.79	33.8	33.4	90.2	83.3
	Cu/Au Comb Tail	96.21	0.14	0.25	9.8	16.7
	Feed (Calc)	100.00	1.42	1.52	100.0	100.0
400 g/t	Cu/Au Conc	3.88	35.2	36.1	94.8	87.9
	Cu/Au Comb Tail	96.12	0.08	0.20	5.2	12.1
	Feed (Calc)	100.00	1.44	1.60	100.0	100.0

Example #2 – Copper-Gold Ore from Indonesia

Clay dispersant/depressant NQ4 was assessed for this ore (Table 2). Using NQ4 improved copper and gold recovery significantly.

Table 2. Effect of NQ4 on Copper-Gold Flotation from a Porphyry Cu/Au Ore from Indonesia

NQ4 Addition	Product	Weight %	Assays %, g/t		% Distribution	
			Cu	Au	Cu	Au
0 g/t	Cu/Au Conc	2.09	28.1	40.3	89.1	76.6
	Cu/Au Comb Tail	97.91	0.07	0.26	10.9	23.4
	Feed (Calc)	100.00	0.66	1.10	100.0	100.0
350 g/t	Cu/Au Conc	2.15	29.6	45.4	93.6	84.8
	Cu/Au Comb Tail	97.85	0.04	0.18	6.4	15.2
	Feed (Calc)	100.00	0.68	1.15	100.0	100.0

Example #3 - Copper-Gold Ore from Peru

This is a new deposit with a hypogene ore containing large quantities of various clay minerals, including kaolinite, iron hydroxide and sericite. The results (Table 3) showed that, with a 300 g/t addition of NQ3, significant improvement in copper-gold recovery was achieved.

Table 3. Effect of NQ3 on Copper-Gold Flotation (Peruvian Ore)

NQ3 Addition	Product	Weight %	Assays %, g/t		% Distribution	
			Cu	Au	Cu	Au
0 g/t	Cu/Au Cl Conc	2.45	26.6	43.1	83.5	75.5
	Cu/Au Comb Tail	97.55	0.13	0.35	16.5	24.5
	Feed (Calc)	100.00	0.78	1.40	100.0	100.0
300 g/t	Cu/Au Cl Conc	2.55	28.6	47.3	91.3	84.9
	Cu/Au Comb Tail	97.45	0.07	0.22	8.7	15.1
	Feed (Calc)	100.00	0.80	1.42	100.0	100.0

Example #4 – Industrial Rest on an Oxidized Gold Ore Using NQ4

Industrial Test on an Oxidized Gold Ore Using NQ4
An oxide gold ore containing iron hydroxide and montmorillonite gave poor gold recovery (i.e. 75% Au) at relatively high collector consumption in an operating plant.

After laboratory development testwork was completed, a plant trial was conducted with NQ4. The results obtained over a 2-month trial period are shown in Table 4.

Table 4. Plant Metallurgical Results Obtained on a High Clay Gold Ore Using NQ4

NQ4 Addition	Collector Consumption	Au Concentrate		Au Recovery	
		Au, g/t	Ag, g/t	% Au	% Ag
0 g/t	260 g/t	70	250	75.5	46.7
150 g/t	180 g/t	110	360	81.6	55.0
300 g/t	150 g/t	120	410	86.7	60.1
500 g/t	80 g/t	160	518	92.2	75.5

The improvement in plant metallurgical results was remarkable. At the same time, collector consumption was significantly reduced. This plant is currently using NQ4 and operating with a gold recovery of over 90%.