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EFFECT OF COARSE QUARTZ SCALPING ON THE REVERSE CATIONIC FLOTATION OF IRON ORE

M. M. Braga Junior[1], A. E. C. Peres[2]

[1]Metallurgical Engineer, M.Sc., Senior Engineer, VALE
manoel.braga@vale.com
[2]Metallurgical Engineer, PhD, Associate Professor, Universidade Federal de Minas Gerais
aecperes@demet.ufmg.br

ABSTRACT

The size of the mineral particles present in the pulp is a relevant variable in the sequence of events resulting in flotation and affects significantly the process performance. The kinetic behaviour of coarse particles is slower and they require longer residence time in the reactor, while fine particles interfere with the selectivity in the system. The effect of scalping the coarse quartz particles prior to flotation and its impact on the reduction of reagents specific consumption was investigated. Samples of the flotation feed at ITM-D (VALE-PICO) under different industrial operation conditions were collected. Flotation experiments were performed aiming at achieving enhanced conditions for a high recovery of coarse quartz particles. The comparison among the results of flotation tests in the presence and absence of coarse quartz particles in the pulp was positive, for the efficiency of coarse quartz scalping was observed (sample screened at 0,150mm). The results achieved with the previously screened sample were superior to those obtained with the global sample, namely: lower silica content in the concentrate, higher separation efficiency, higher selectivity index values, higher mass recoveries, lower iron grades in the tailings, and faster flotation kinetics.

Keywords: Quartz, reverse cationic flotation, iron ore.

1. INTRODUCTION

The reverse cationic flotation is a conventional concentration process applied to iron ores. Quartz particles are collected in the froth after adsorption of ether amines, the iron oxides being depressed by starch. The removal of the fine quartz particles (< 0.150 mm) is adequate even in the presence of low amine dosages. Nevertheless, eliminating coarse quartz particles (>0.150 mm) in the concentrate represents a major challenge for Brazilian mineral processors [1, 2]. Hydrodynamic forces prevent the adequate adhesion between coarse particles and bubbles [3]. The large difference in density between quartz and hematite impairs the efficiency of classification in hydrocyclones and spiral classifiers prior to flotation. The use of high frequency screens, despite its high cost, is an option for cleaning iron ore concentrates aiming at the production of the so-called super concentrates, SiO_2 content < 1% [4].
An alternative process route is the elimination of coarse quartz particles from the flotation feed via scalping in high frequency screens, addressed in this laboratory scale investigation.

2. MATERIALS AND METHODS

The slurry sample (400 L) was collected at Vale´s ITM-D Mina do Pico concentrator and was representative of the two desliming stages underflow. Sampling was performed during stable operation periods, consisting of friable low and high grade itabirites. The preparation stages were dewatering (pressure filter), disaggregation, homogenizing, and quartering. Samples were prepared for size and chemical analyses. The global sample was split in two fractions. Fraction 1 was used in laboratory scale experiments for the definition of the best conditions (standard test): pH and collector and depressant dosages. The responses yielded by the standard test were silica content in the concentrate, Gaudin´s selectivity index, weight recovery, iron content in the reject fraction, and separation efficiency. Flotation kinetics was also assessed. Fraction 2 was screened at 0,150 mm and the undersize was submitted to the same tests sequence of fraction 1 to provide a performance comparison between the scalped and non scalped flotation feed.
Etheramine acetate (EDA 3B) was used as quartz collector and gelatinized corn starch was the iron oxides depressant. Gelatinization was performed with NaOH solution at starch/NaOH weight ratio 4:1.
A conventional Denver laboratory flotation machine was used in the experiments.
The reagents schemes aiming at the definition of the test conditions for the kinetic study are illustrated in table 1.

Variable	Scheme 1	Scheme 2	Scheme 3
Collector dosage	25 g/t	35 g/t	45 g/t
Depressant dosage	500 g/t	700 g/t	900 g/t
pH	9,5	10,5	11,0

Table 1. Reagents schemes for the definition of the flotation kinetics study

3. RESULTS AND DISCUSSION

The size distribution of the global sample (fraction 1), illustrated in table 2, indicates that the contents of slimes (< 0,009 mm) 2,70% and coarse particles (> 0,150 mm) 2,57% are not significant.

Table 2. Size analysis of the global sample, desliming hydrocyclones underflow (screening and cyclosizer)

Sample	Density for global sample (g/cm³):		4.25
	% moisture:		11.74
Size (mm)	**% Retained**	**% Cumulated**	**% Passing**
0.300	0.03	0.03	99.67
0.210	0.62	0.65	99.35
0.150	1.92	2.57	97.43
0.106	8.78	11.35	88.65
0.075	13.96	25.31	74.69
0.053	22.52	47.83	52.17
0.045	11.79	59.62	40.38
0.038	15.36	74.98	25.02
0.0300	2.48	77.46	22.54
0.0217	10.76	88.22	11.78
0.0164	6.73	94.95	5.05
0.0113	2.00	96.95	3.05
0.009	0.35	97.30	2.70
-0.009	2.70	100.00	0.00

The silica content of the fraction retained in 0,150 mm (2,57% in weight) is very high 82,85%. Considering a concentrator receiving as feed 4 Mt/year, 102.000 t of material with silica content 82,85% would be entering the circuit. The silica distribution in the fraction > 0,150 mm is 8,6%, while the iron distribution increases in the fraction < 0,075 mm.

The size distribution of the scalped sample (fraction 2), illustrated in table 3, indicates that the slimes content (< 0,009 mm), as expected, is low 2,46%.

Table 3. Size analysis of the scalped fraction (screening and cyclosizer)

Sample	Density for global sample (g/cm³):		4.29
	% moisture:		6.50
Size (mm)	**% Retained**	**% Cumulated**	**% Passing**
0.300	0.00	0.00	100.00
0.210	0.00	0.00	100.00
0.150	0.00	0.00	100.00
0.106	9.01	9.01	90.99
0.075	14.33	23.34	76.66
0.053	23.11	46.45	53.55
0.045	12.10	58.55	41.45
0.038	15.77	74.32	25.68
0.0300	2.54	76.86	23.14
0.0217	11.05	87.91	12.09
0.0164	6.91	94.82	5.18
0.0113	2.05	96.87	3.13
0.009	0.36	97.23	2.77
-0.009	2.77	100.00	0.00

Again the silica distribution is higher in the coarser fractions.

The oversize of the screening at 0,150 mm contains only 10,8% iron and may be discarded.

Figures 1, 2, 3, 4, and 5 provide a comparison between the flotation performances of the scalped and non scalped samples, regarding, respectively, silica content in the concentrate, separation efficiency, Gaudin´s selectivity index, weight recovery, and iron content in the reject fraction.

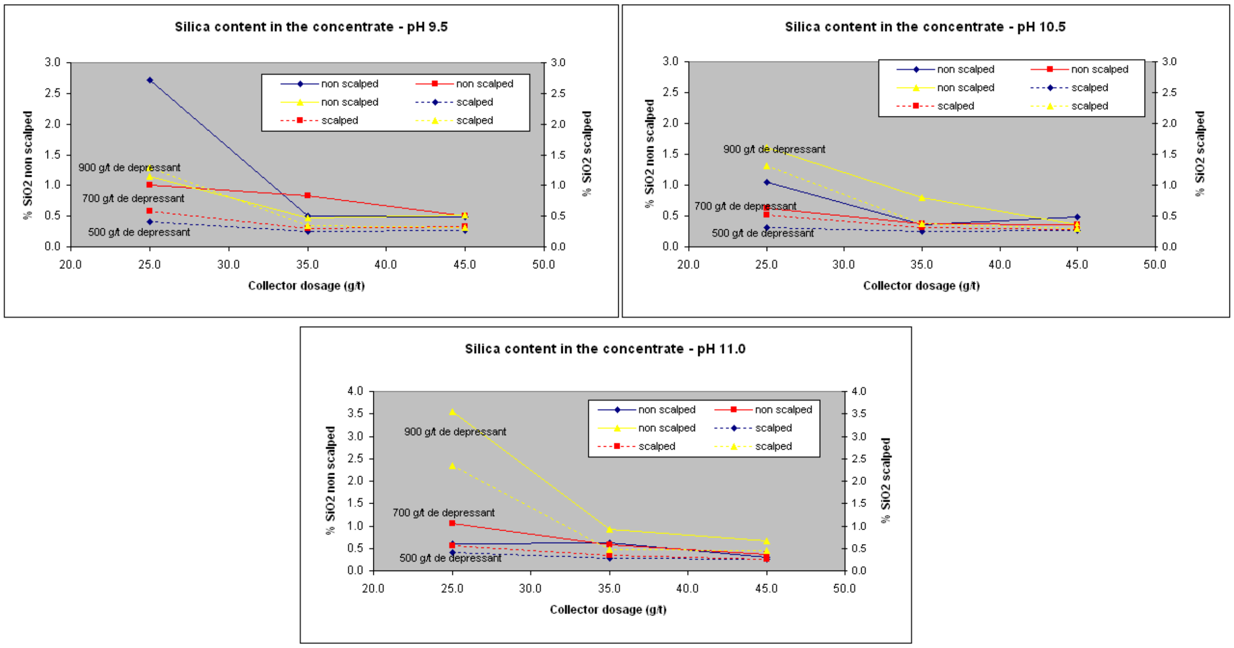

Figure 1. Silica content in the concentrate: scalped at 0,0150 mm and non scalped samples.

The scalped sample yielded lower silica contents in the concentrate than the non scalped sample. Even the lowest amine dosage was sufficient to produce high quality concentrate.

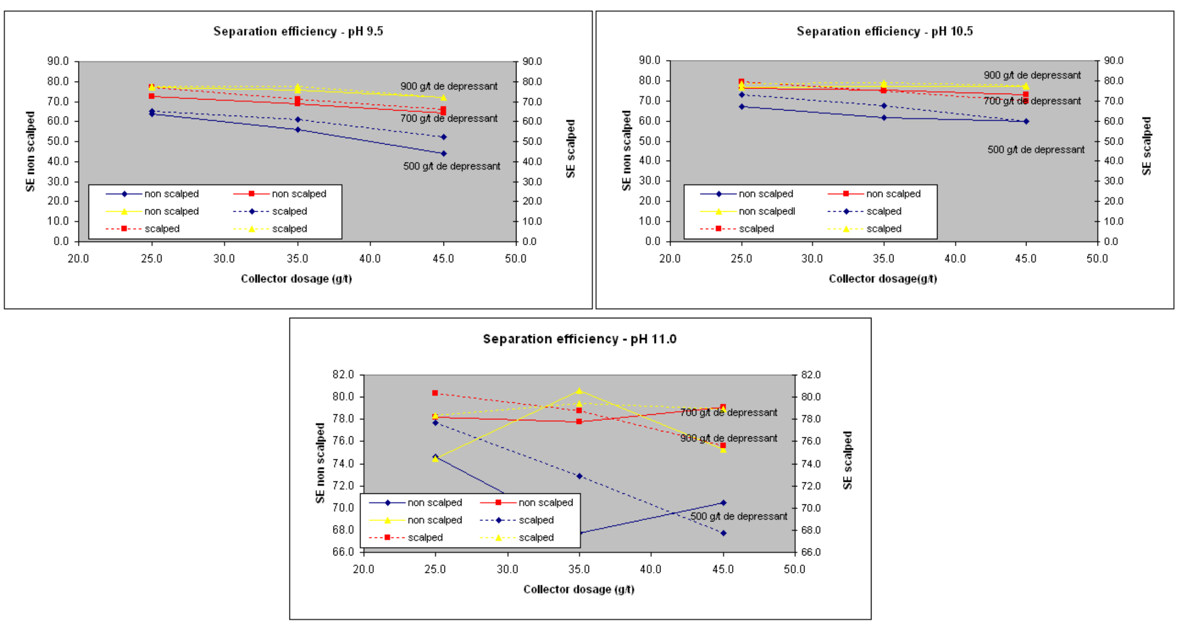

Figure 2. Separation efficiency (SE): scalped at 0,0150 mm and non scalped samples.

Higher separation efficiencies were achieved with the scalped sample.

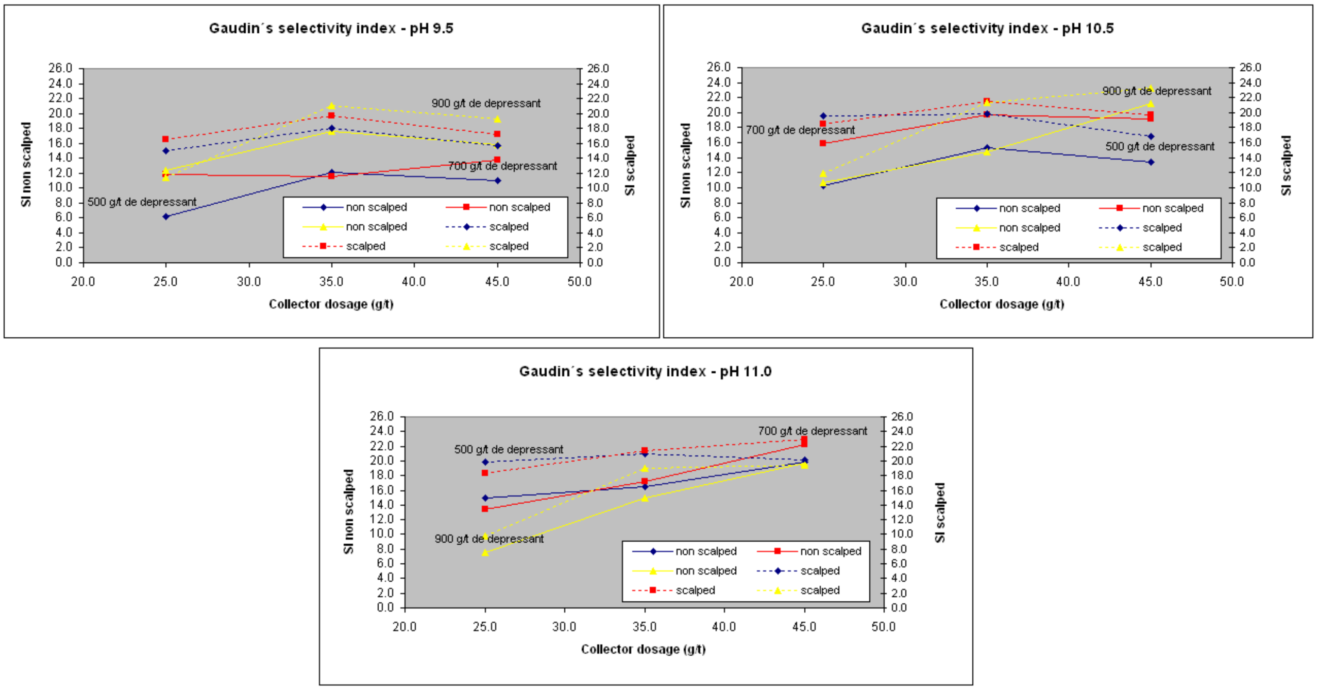

Figure 3. Gaudin´s selectivity index (SI): scalped at 0,0150 mm and non scalped samples.

Higher Gaudin´s selectivity indexes were achieved with the scalped sample.

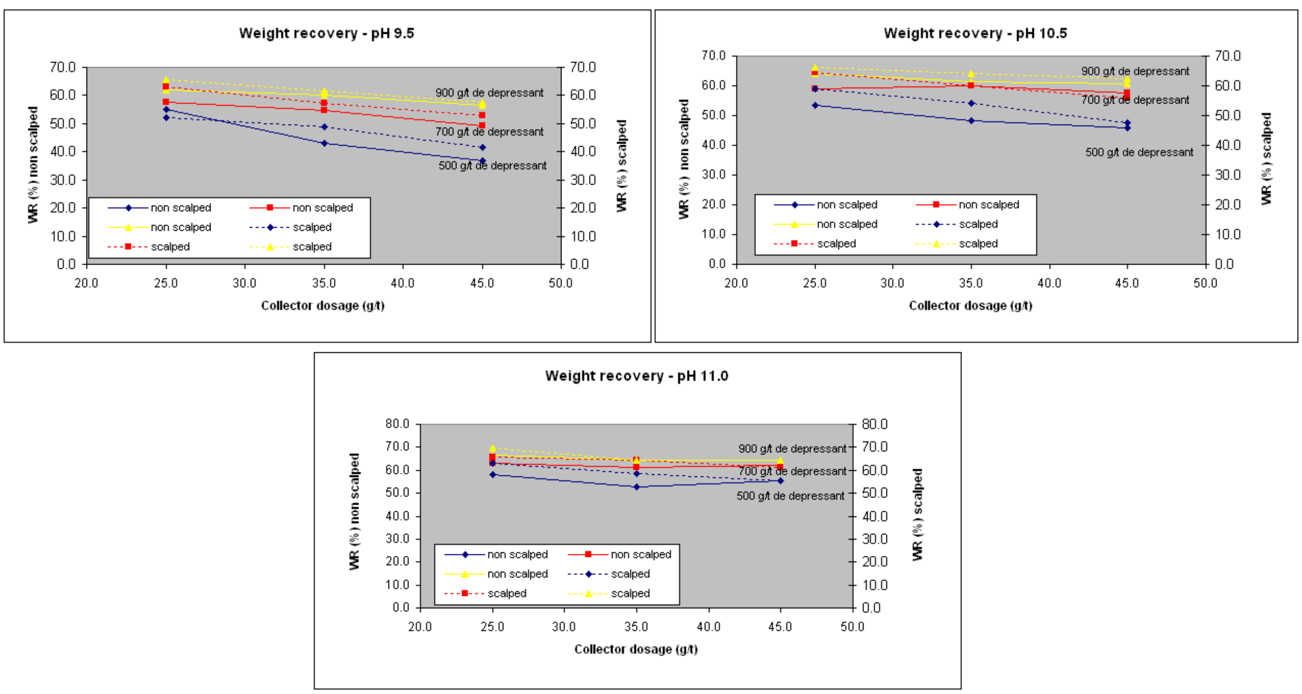

Figure 4. Weight recovery: scalped at 0,0150 mm and non scalped samples.

Slightly higher weight recoveries were achieved with the scalped sample.

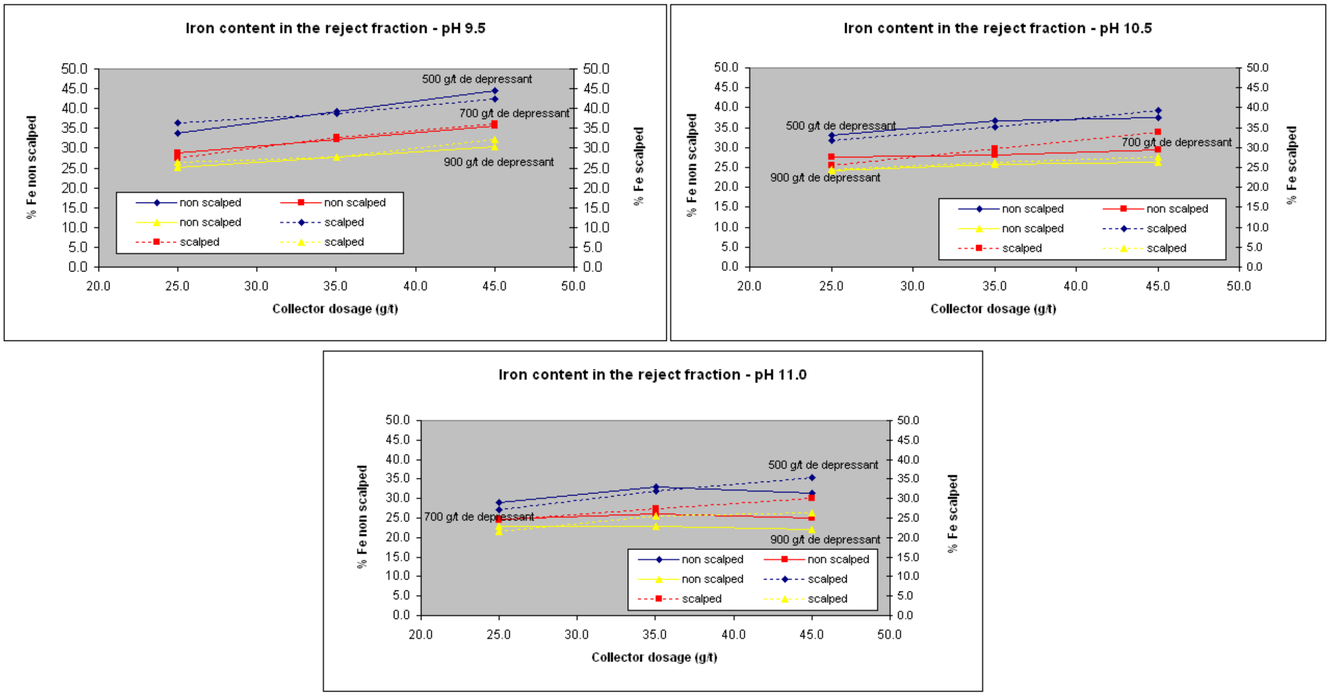

Figure 5. Iron content in the reject fraction: scalped at 0,0150 mm and non scalped samples.

Both, scalped and non scalped samples, yielded similar iron contents in the reject fraction, for the iron distribution is higher in the fine fractions, suggesting the need of a scavenger stage to enhance the iron recovery.

For the kinetic studies the depressant dosage was set at 900 g/t, the pH at 10,5, and the collector was dosage was set at 35 g/t and 45 g/t. The lower silica content in the concentrate was achieved for 35 g/t. The high depressant dosage, 900 g/t, was necessary in order that a high weight recovery and a low iron content in the reject fraction were achieved. The enhanced flotation performance at pH 10,5 is in agreement with the industrial practice.

The flotation process kinetics may be represented by the classic first order model. The results for the non scalped and scalped samples are presented, respectively, in figures 6 and 7, for the collector dosage 35 g/t and pH 10,5. In both cases the quartz flotation kinetics is represented by two straight lines indicating the presence of fast and slow floating particles. The values of both kinetic constants are larger for the scalped fraction.

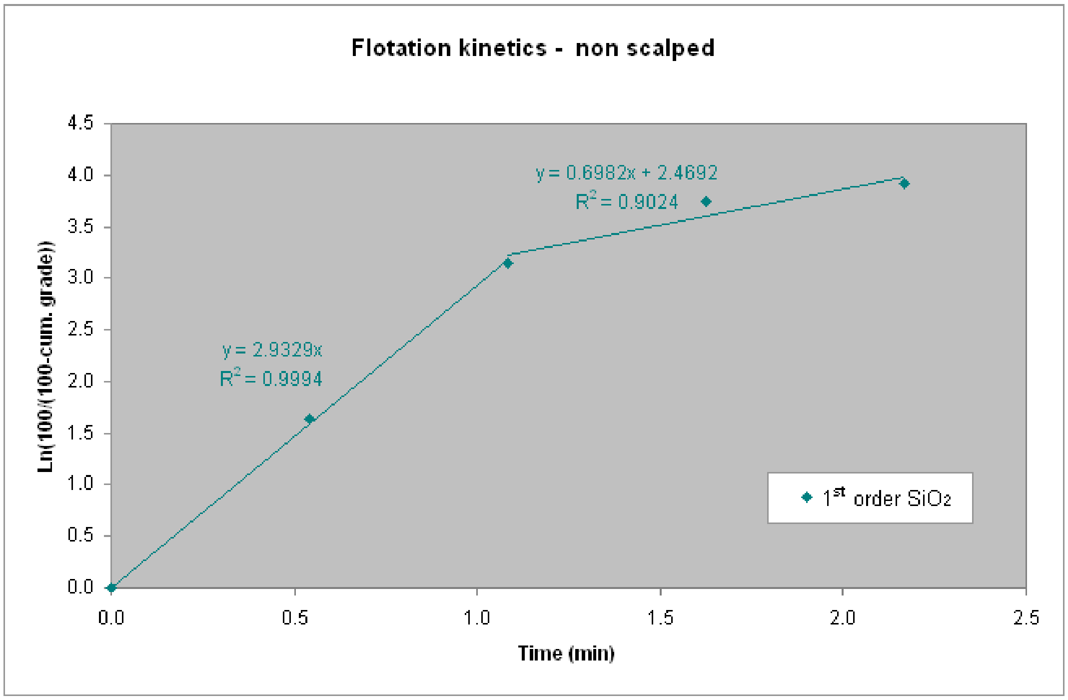

Figure 6. Flotation kinetics non scalped sample at collector dosage 35 g/t.

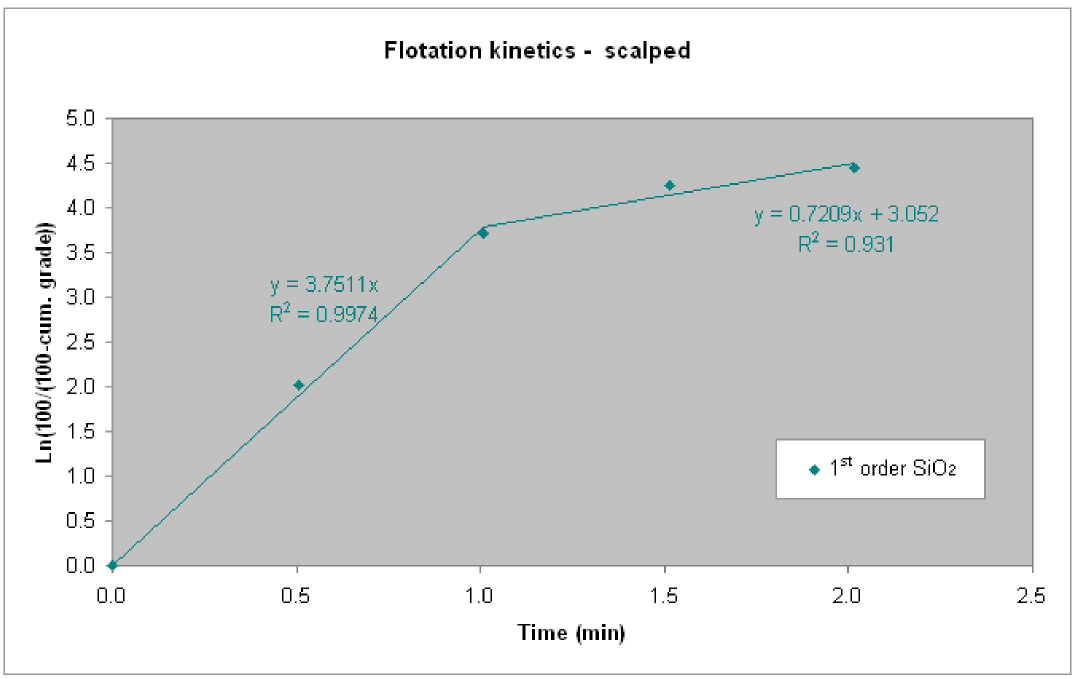

Figure 7. Flotation kinetics scalped sample at collector dosage 35 g/t.

The flotation kinetics results for the non scalped and scalped samples are presented, respectively, in figures 8 and 9, for the collector dosage 45 g/t and pH 10,5. The fast flotation rate constant is slightly larger for the scalped fraction but, for this higher collector dosage, the slow flotation rate is larger for the non scalped fraction.

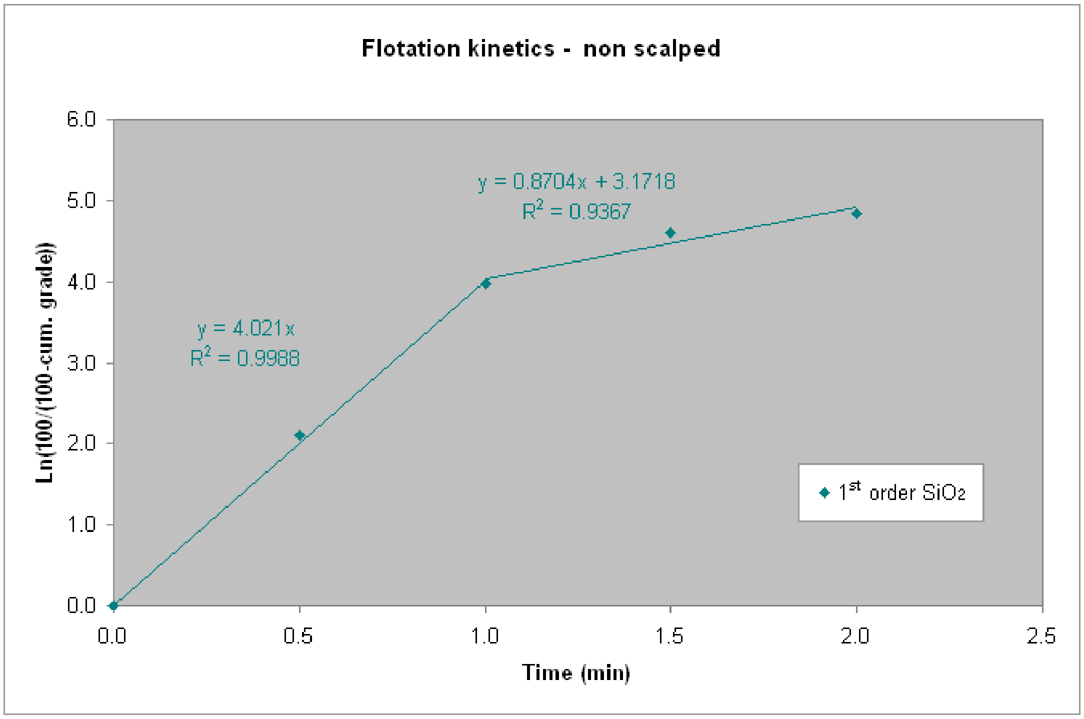

Figure 8. Flotation kinetics non scalped sample at collector dosage 45 g/t.

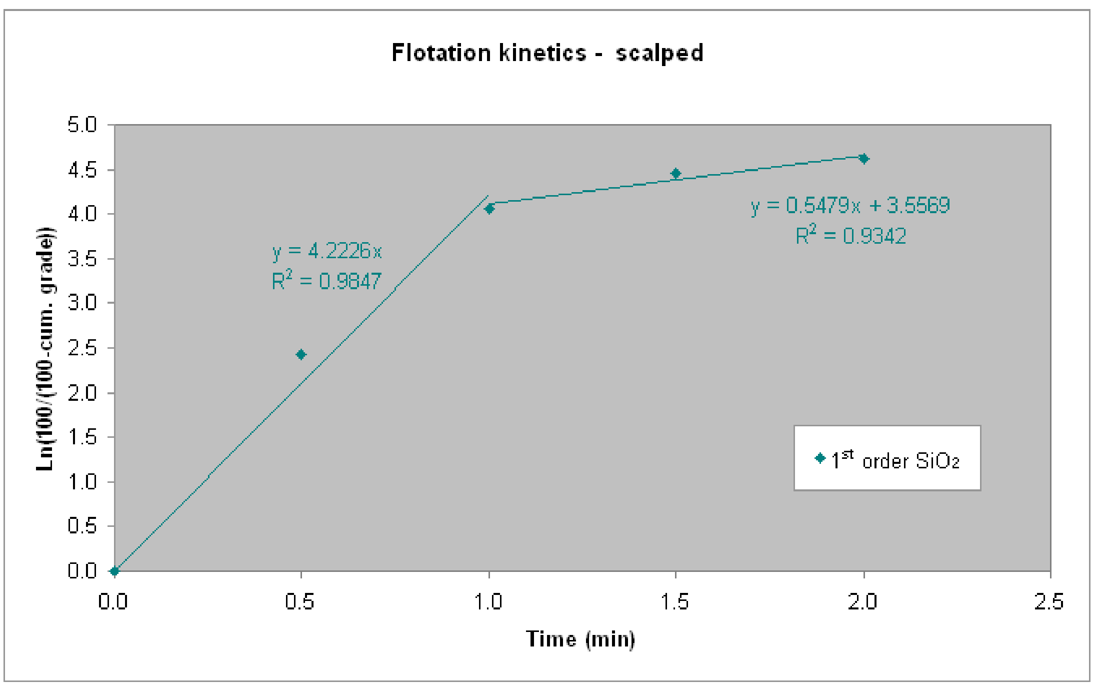

Figure 9. Flotation kinetics scalped sample at collector dosage 45 g/t.

4. CONCLUSIONS

Scalping the feed by screening improves the flotation performance. A small proportion of the feed, 2,57%, is retained in the 0,150 mm screen and presents a very high silica content, 82,85%. The presence of this fraction increases the collector consumption and the flotation residence time.

The silica content in the concentrate was lower for the scalped sample, even for low amine dosage.
The separation efficiency was higher for the scalped sample.
The Gaudin´s selectivity index was higher for the scalped sample.
The iron content in the reject product was similar for the scalped and non scalped samples.
The flotation rate constant was larger in the case of the scalped sample for the conditions: collector dosage 35 g/t, depressant dosage 900 g/t, pH 10.5.

5. REFERENCES

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