Ke   d : Solvent extraction; Contamination; Performance optimisation; Diluent treatment; Copper; Cobalt

I ⬚ d c⬚

In recent years, liquid-liquid extraction has established itself as a technique in its own right in modern hydrometallurgy, for the enrichment, separation and puri cation of metal ions. From a technical point of view, managing a solvent extraction plant involves ensuring that it operates e ciently, taking into account the objectives set down [1]. any cause likely to lead to a reduction in the e ciency of the circuit requires special attention from informed industrialists. Currently,

in order to eliminate dissolved silica and the quantity of solids was initiated, through the metallurgical studies department [6], e is to get the solvent extraction plant at the Shituru plants running smoothly with good organic continuity and to improve the metallurgical performance of this circuit, while studying the impact of the Pregnant Leach Solution treatment operation by advancing our understanding of the phenomena linked to the e ciency of the process and selectivity for the element or elements to be eliminated.

Ma e a a d e h d

Sa e ce

is study focused on the sample of leach solutions from the Shituru plants. Shituru has several sources of leaching solutions that feed its solvent extraction unit: solutions from agitated tank leaching, solutions from the large Panda heap and solutions from Kambove heap leaching. We focused on the solutions from the large Panda heap, where heap leaching is applied to Kamatanda ores. In order to demonstrate the origin of the silica in the Pregnant Leach Solution, a sample of Kamatanda ore was subjected to mineralogical characterization. Identi cation of the valuable minerals and gangue minerals of sample was carried out at the School of Resource and Safety Engineering central south university, using a Wild Heerbrugg binocular stereoscopic microscope.

Chemical characterization of our sample of Grand Heap Panda leaches solutions to determine the concentration of chemical elements and chemical properties. e instruments used for chemical analysis of the samples in the laboratory are:

- Perkins Elmer AA400 atomic absorption spectrometer;

- Pinacle 500 atomic absorption spectrometer;

- Perkins Elmer Optima 8300 inductively coupled plasma optical emission spectrometer.

e physical characterization of the Grand Heap Panda leach solution sample is aimed at determining the suspended solids content.

D e Wa h Te

Various items of equipment were used to carry out washing tests on the Pregnant Leach Solution with Massimo Sol diluent, including: 250-mL, 500-mL, 800-mL and 1000-mL beakers; 500-mL test tubes; 500-mL separating funnels; a Hanna (HI 2221 pH meter). e reagents used in these tests were the diluent, Pregnant Leach Solution and NaOH to regulate the working pH. e NaOH was prepared at a concentration of 10N as follows: weigh 200 g of NaOH; take 500 mL and place in an 800 mL beaker; adjust the mechanical stirrer to its centre; start the stirrer and adjust its speed to 800 rpm; add the NaOH until it is completely dissolved in the water; keep the NaOH solution in a at-bottomed ask. Washing the Pregnant Leach Solution with the diluent consists of a liquid-liquid dispersion in which the two liquids are nothing.

$$\eta = \frac{[SiO_2]_{alimentée} - [SiO_2]_{résiduelle}}{[SiO_2]} \times 100$$

With: _(SiO_2): dissolved silica removal e ciency (en%); m[SiO_2] alimentééfeed: concentration (in ppm) of dissolved silica in the PLS before treatment with diluent; [SiO_2] résiduelle: concentration (in ppm) of dissolved silica in the PLS a er treatment with diluent. e TSS removal yield is the ratio of the quantity of TSS removed from the liquor a er treatment to the TSS in the PLS liquor before treatment. is ratio is expressed as a percentage (%).

$$\eta_{TSS} = \frac{TSS_{alimenté} - TSS_{résiduel}}{TSS} \times 100$$

With: _TSS: suspended solids removal e ciency (TSS) expressed in %:TSS_alimenté: the quantity of suspended solids in the PLS liquor before treatment with the diluent, expressed in ppm; TSS_résiduel: this is the quantity of suspended solids that could not be eliminated from the liquor a er treatment with the diluent, also expressed in ppm.

is is the phase separation time for solvent extraction of the leaching solutions a er treatment with the diluent [7]. So we can assess the impact of this solvent extraction treatment.

E e e a de g

To investigate the in uence of the various physicochemical parameters on the e ciency of the solvent extraction and diluent washing processes studied, we opted for a statistical approach using Taguchi's methodology coupled with analysis of variance. According to the literature, this approach o ers many advantages due to the robustness of Taguchi's methodology, because it takes into account the e ects of uncontrollable parameters grouped together in what is known as "noise". We therefore describe Taguchi's methodology and the concept of analysis of variance. Experimental designs are in fact a series

percentage extactant (D). Table 2 summarises all these parameters and their quantitative values (Table 1).

A series of 16 trials were carried out following the experimental design with the aim of determining the levels of controlled operating parameters that optimise copper extraction yield and phase separation time, and analyzing the in uence and relative interactions of these parameters. e order of the experiments was obtained by inserting the parameters into the columns of the orthogonal matrix chosen as the experimental design. An orthogonal matrix is simply an integration table of integers whose columns represent the levels of the factors. Each row represents a trial, which is in fact a set of the speci c levels of each factor. Table 2-3 describes the orthogonal matrix chosen for our experiments (Table 2).

To carry out the tests for the solvent extraction study with the diluent alone in order to eliminate silica and TSS, ve parameters were selected, namely: Agitation (A), Ratio (B), Contact Time (C), pH (D) and Continuity (E) (Table 3).

e identi cation of valuable and gangue minerals in the Kamatanda ore sample that feeds the Grand Heap, the solutions of which were used in our microscopic study, revealed the presence of the elements listed in Table 6: Mineralogical characterisation of Kamatanda ore (Table 4).

A series of 16 runs were carried out following the L16 experimental design (54) in order to determine the levels of controlled operating parameters that optimise dissolved silica and TSS removal yields, and SX phase separation time, and to analyse the in uence and relative interactions of these parameters. e order of the tests was obtained by inserting the parameters into the columns of the L16 orthogonal matrix chosen as the experimental design. An orthogonal matrix is simply an integration table of integers whose columns represent the levels of the factors. Each row represents a trial, which is in fact a set of speci c levels for each factor. Table 2-5 describes the L16 (54) orthogonal matrix chosen for our experiments (Table 5).

Re   K

most influential or most important parameter and the contact time is the least influential or least important parameter.

We will analyse the graph in (Figure 1), which shows the main effects of the signal-to-noise ratio of the copper extraction yield on solvent extraction. The most important parameter is the one with the greatest difference between the lowest and highest points. We will use the highest points for each factor in the graph as the optimum conditions. Looking at in Figure 3-1, we can see, while confirming the results in Table 3-4, that the ratio is the most influential parameter and time is the least influential. The optimum conditions are A3B4C1D4, i.e. stirring at 1400 rpm, a ratio of 1.4, a contact time of 120 seconds and a percentage of extactant of 30%. Under these optimum operating conditions for solvent extraction copper extraction yield, the predictive model gives a copper extraction yield and phase separation time of 93.65% and 105.25 seconds respectively.

Analysis of the phase disengagement time

Unlike the extraction yield, which has been maximized, the phase separation time should be minimized; hence it is preferred to be smaller. The analysis will be carried out in the same way as for the copper extraction yield

The most important parameter is % extactant (D), followed by agitation (A), then the ratio (B) and finally contact time (C), which is the least important. Figure 3-1 below is a graph representing the effects of the controllable factors with their levels on the statistical performance (S/N) for the Phase disengagement time during Solvent extraction (Figure 2).

It appears from Figure 2 that the optimum for phase disengagement time corresponds to levels A3B2C3D2. The values of 1400 rpm for agitation, 1.0 for the ratio, 180 seconds for contact time and 20% for the extactant percentage. Under the operating conditions which optimize the phase separation time, the predictive model gives us extraction efficiency and a phase disengagement time of 87.14% and 92.50 seconds respectively.

Optimization of the feedstock

Having separately obtained optimal conditions for the extraction yield and the phase separation time, we do not know how to choose
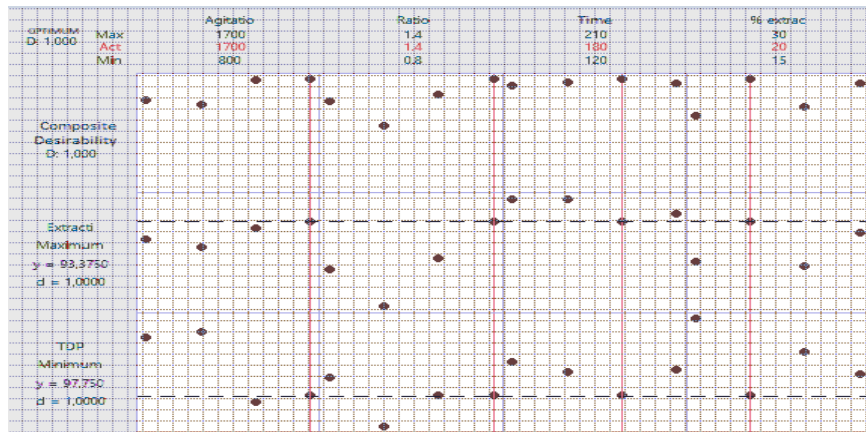
Citation: Ezona B (2024) The Analysis of Leach Solution Treatment By Liquid-Liquid Dispersion With Diluent. J Powder Metall Min 13: 414.

Figure 3: Solvent extraction optimisation diagram.

Table 10: The results of the confirmation tests are.

Designation	Answer	
	Extraction efficiency (%)	**Phase disengagement time (seconds)**
Optimal conditions for extraction field	92,99	103,25
Optimal conditions for the time of the phases	87,89	91,73
Optimal overall condition	92,34	95,17

Number tests	Wash Parameters					/5shdlrTj2- 458.445504.6662 262.9641

C   aℕ   ℝe ℕ

We conducted three confirmation tests regarding the experimental results for the solvent extraction: the operating conditions that optimise the copper extraction yield, then those that optimise the Phase disengagement time and finish with the operating conditions that optimise both the copper extraction yield and the Phase disengagement time (Table 10).

We will retain as operating conditions for the Solvent extraction the conditions that optimise both the copper extraction efficiency and the phase engagement time and therefore the overall optimal conditions.

C a caℕ   ℝe ℕ

Tests to clarify the liquor by washing with diluent were carried out on the sample of the leaching solution from the large heap of the Shituru factories with MasimoSol diluent, these tests aimed to eliminate silica dissolved and Performance of removal of suspended solids removal to improve metallurgical performance in solvent extraction. To achieve this, we used the Taguchi experimental design methodology to be able to study the robustness of the Pregnant Leach Solution clarification and an analysis of variance was carried out for each factor. As shown in Table 3-7, for this study we selected as responses the silica removal efficiency, the removal efficiency of the rate of suspended solids in the Pregnant Leach Solution and phase separation time (TDT) at solvent extraction after Pregnant Leach Solution treatment (Table 11).

A a   f   ca ed cℕ

The S/N ratio calculation was performed to maximize the reduction of silica from the leaching solution, in the liquid-liquid liquor-diluent system. We can rank the parameters in increasing order of influence

where stirring speed is the most important factor followed by contact time, O/A ratio, and pH ending with continuity the least important factor (Figure 4).

Analyzing Figure 3-4, we clearly notice that the optimal conditions are A4B4C4D2E1 corresponding to a stirring speed of 1900 rpm, an ratio of 2.2, a contact time of 300 seconds, a potential of hydrogen pH of 1.4 and according to organic continuity. In these diluent washing conditions, with the help of the predictive model, we say the removal efficiencies of 73.88% for silica and 65.38% for Suspended solids removal efficiency (TSS) and a disengagement time of 53.50 seconds.

D c

e elimination of dissolved silica is due to the polymerization of the silica which rst forms the colloidal then the silica salt. In this way the silica is removed from the leaching solution because we will have three distinct phases, two of which are liquid diluent and Pregnant Leach Solution and the third phase is a solid: silica gel. It also emerges from the above that the polymerization of silica occurs well both in organic continuity and in aqueous continuity. is is explained by the fact that the polymerization is dictated by the frank and intense contact between the aqueous phases Pregnant Leach Solution and the organic phase (diluent) whatever the continuity. e speed of agitation of the dispersion is the most in uential parameter because it is the latter

which allows contact without which there is no dispersion and without dispersion there is no there is no emulsion therefore no polymerization [14]. is is why for the gelation of silica it is recommended to have a very high speed or even greater than 1900 rpm. e Pareto chart of normalized e ects also tells us about the statistical importance of factors on silica removal. By observing Figure 4, we clearly realize that we have three factors which are statistically signi cant because they exceed the red reference line: the most signi cant stirring speed, the contact time and the ratio. e latter have an e ect greater than [15], (Figure 5).

Below is Table 4-1 containing the analysis of variance results for dissolved silica removal (Table 12).

In view of what is presented in the analysis of variance in Table 4-1 the control factors can be classi ed according to their importance and/or the in uence on the elimination of dissolved silica according to the contribution. We see that the stirring speed is the most in uential parameter with a contribution of 63.533%, followed by the contact time with 14.735%, the ratio with 12.674%, the pH with 5.504%, to nish with the continuity whose contribution of almost 0.005% means that regardless of the continuity of work, OC or AC, the elimination of dissolved silica would happen in the same way. e error is estimated at 3.550% contribution to the process of removing dissolved silica, which means errors due to the operator, equipment, climate, etc. can 3.550%
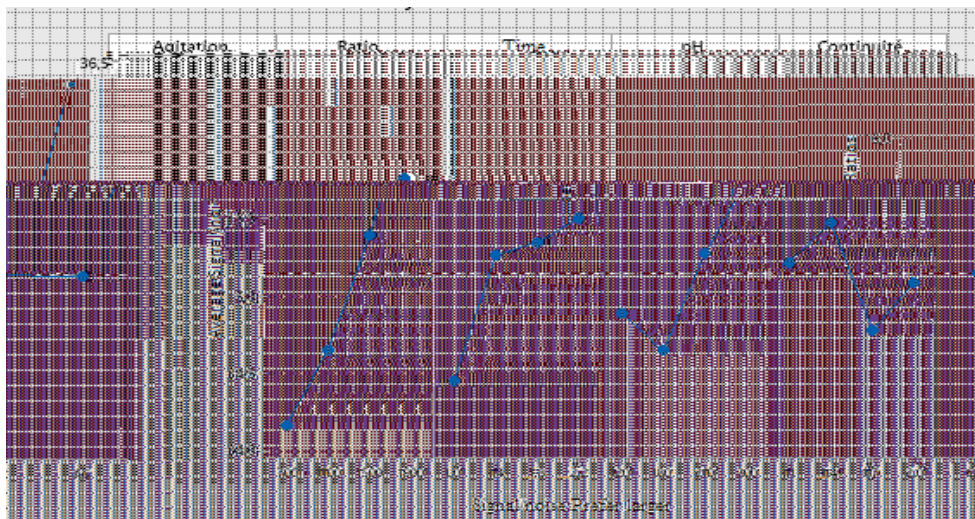
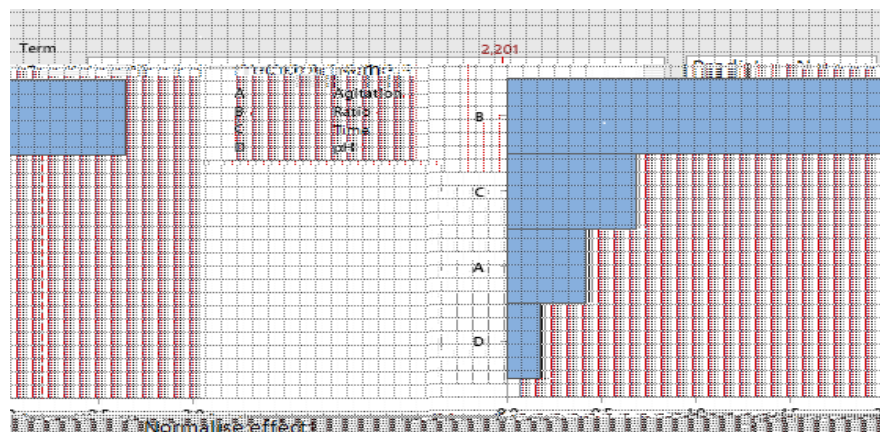

Figure 4: Silica Removal Signal-to-Noise Ratio Chart.

Figure 5: Pareto chart of dissolved silica removal Rend (Sio-2): =0.05.

in uence the e ciency of the removal of dissolved silica.

e dec ea e S e ded d e a e c e c (TSS)

e analysis of the elimination rate of suspended solids is based on the removal performance of TSS. We will do a Taguchi analysis and variance analysis. We will identify the classi cation of the factors according to their in uence of which the rank depends then the most in uential parameter in this case is the O/A ratio which has the highest delta value, followed by contact time, pH, and continuity to nish with the agitation speed which has the smallest delta value (Figure 6).

e analysis in Figure 6 above, being a graph of the e ects of signal-to-noise ratios, will shed light on the conditions that optimise the elimination of Performance of removal of suspended solids. It is A2B4C2D3C1 corresponding to an agitation speed of 1100 rpm, an ratio of 2.2, a contact time of 180 seconds, a pH of 1.7 in organic continuity . ank to the predictive model, under these operating conditions of diluent clari cation, the elimination yields are 51.17% for silica and 83.00% for Performance of removal of suspended solids and a phase disengagement time of 57.15 seconds. e decrease in suspended

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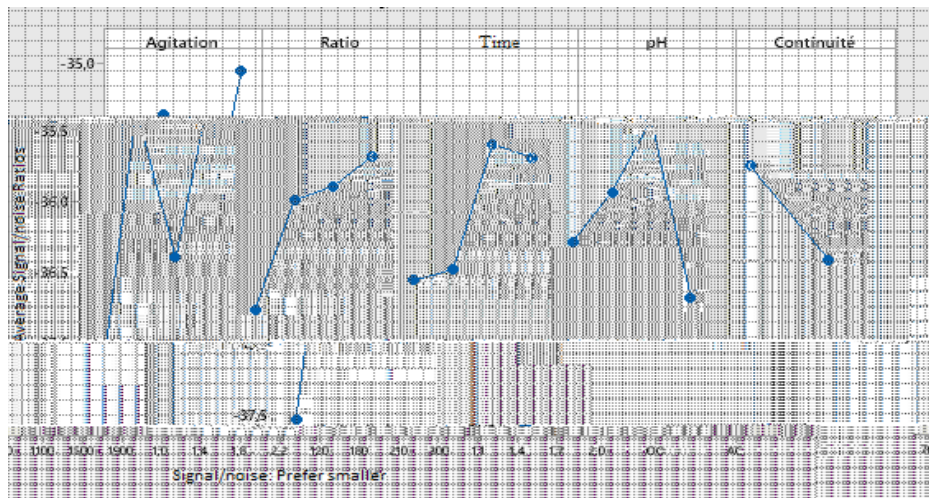
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Figure 8: Main effects plot for signal-to-noise ratios on Phase decommitment time.
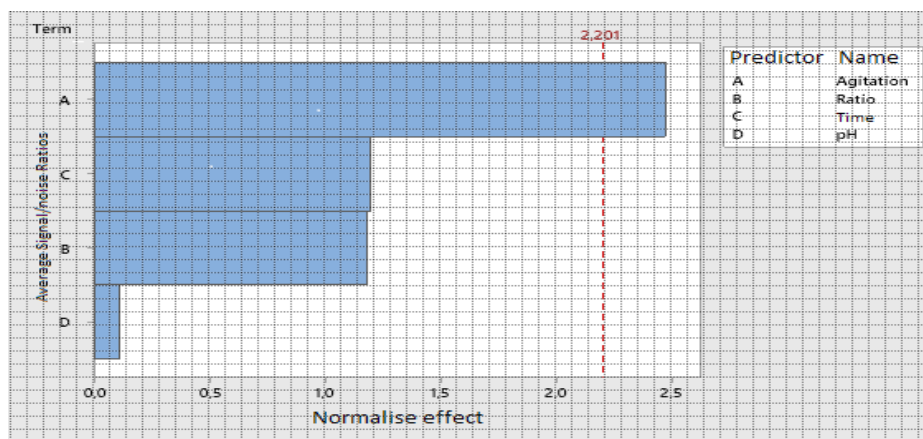

Figure 9: Pareto chart of standardized effects on Phase decommitment time: =0.05.

Table 14: Analysis of variance for phase separation time.

Source	DL	SomCar ajust	CM ajust	Value F	Value P	Contribution (%)
Agitation	3	879,69	293,23	4,20	0,198	54,506
Ratio	3	153,69	51,23	0,73	0,621	9,523
Time	3	186,69	62,23	0,89	0,567	11,567
pH	3	186,19	62,06	0,89	0,568	9,523
Continuity	1	68,06	68,06	0,97	0,428	4,217
Mistic	2	139,62	69,81			8,651
Total	15	1613,94				100

Table 15: The test results are Table 15 Confirmation tests for clarification.

Designation	Residual concentration		For clarification For SX		Pour le SX	
	Silica (ppm)	TSS (ppm)	Silica removal (%)	Solids removal (%)	Copper extraction (%)	PDT (seconde)
Optimal conditions for silica removal	263	311	69,07	70,35	95,89	52,34
Optimal conditions for solids removal	405	177	52,11	83,11	95,44	55,65
Optimal conditions for phase disengagement time	30	263	63,37	74,98	96,33	46,56
Optimal overall conditions	270	252	66,02	75,99	96,77	50,02

conditions for the entire system studied. e conditions that optimize the removal of dissolved silica and Performance of removal of suspended solids and Phase decommitment time are: agitation of 1900 rpm, an ratio of 2.2, a contact time of 300 seconds, a pH of 1.7 and organic continuity. Under optimal conditions, the predictive model estimates the phase disengagement time at 45 seconds with removal of suspensions and dissolved silica of 80.67% and 69.38% respectively. We will discuss the results of multiple optimization; we will focus on the most important factor, agitation. e stirring speed chosen is 1900 rpm. For a stirring speed higher than this value, but difficult to bring

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