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FLOTTABILITY OF COBALT MINERALS APPLICATION TO MUKONDO MINERALS FROM THE NORTH CENTER AND SOUTH EAST.

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ABSTRACT

The classic problem of an Industrial Mining for a mineral Cell Co fromMukondo flank North-Center and Southeast (NCSE) buoyancy curiously difficult in threshold on attack, a preliminary study of grindability comparing this ore and another cell equivalent supposed to easy flotation, fed to the KAKANDA Concentrator (KDC) in acronym Gécamines en joint venture with BM Mining / ERGAFRICA multinational operating. Then, the flotation tests orientation were initiated in two parts, the first of which, using a mixture of Rinkalore 840 and the second, the Rinkalore R10 mixture. We also did some finishing tests but this time trying to study the release by varying the particle size in the range after two minutes of flotation for finishing. During the variation of the granulometry, impressive observations have been made on the recovery of cobalt metals Copper. We found that it is with the Granulometry of 30% of refusal on + 75 µm that we get the best results. An application in real time context of the Enterprise,the economic aspect was studied by determining the operational cost of the transposed finishing test on an industrial scale working in conditions like ours, our cost is slightly lower than the typical current operating cost of the plant for a quality of 7.8% Co in the concentrate, the operating cost is 14372.22 USD / t Cobalt for the NCSE flank ore in our Test, while at the factory, the cost is 14990.32 USD / t of cobalt at the same yield of 72%, an accomplishment of a usual practical management that accompanied our touch in the buoyancy of this ore and the figures of the Industrial BM Mining via an approach of his annual budget and the operating cost of industrial management on a daily basis. The dynamics of BM Mixed Gecamines executives updated time in the appendices of this work.

Key words: Mukondo NCSE, Cobalt, µm, yield, cost.

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RESUME

La problématique classique d'un Industriel Mining pour un minerai Cellulaire Co de Mukondo flanc Nord-Centre et Sud-Est (NCSE) de flottabilitécurieusement difficileen seuil on attaque, une étude préalable de broyabilité comparant ce minerai et un autre équivalent Cellulaire supposé à flottation facile, alimenté au Concentrateurde KAKANDA (KDC) en sigle Gécamines en joint-venture avec BM Mining /ERGAFRICA multinational en exploitant. Puis, les essais de flottation d'orientation ont été initiés en deux volets dont le premier, utilisant une mixture au Rinkalore 840 et le deuxième, la mixture au Rinkalore R10.Nous avons aussi procédé à des essais de finissage mais cette fois-ci en essayant d'étudier la libération par variation de la granulométrie dans la gamme après deux minutes de flottation pour le finissage. Lors de la variation de la granulométrie, des observations impressionnantes ont été faites sur la récupération des métaux du Cobalt que celle du Cuivre. Nous avons constaté que c'est à la Granulométrie de 30 % de refus sur + 75 µm que nous obtenons les meilleurs résultats. Une application en réel du contexte du moment de l'Entreprise,l'aspect économique a été étudié en déterminant le cout opératoire del'essai de finissage transposé à l'échelle industrielle en travaillant dans les conditions comme les nôtres, notre coût est légèrement inférieur au classique coût opératoire actuel de l'usine pour une qualité de 7,8 % Co dans le concentré, le coût opératoire est de 14372,22 USD/t de Cobalt pour le minerai du flanc NCSE dans notre Essai, alors qu'à l'usine, le coût est de 14990,32 USD/t de cobalt au même rendement de 72 %, un accomplissement d'un management habituel pratique qui a accompagné notre touche dans la flottabilité de ce minerai et les chiffres de l'Industriel BM Mining via une approche de son budget annuel et le coût opératoiredu management industrielau quotidien. La dynamique des dirigeants BM Mixte Gécamines un temps actualisé dans les annexes de ce travail.

Mots Clefs : Mukondo NCSE, Cobalt, µm, rendement, coût.

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I.GENERAL

I.1. MUKONDO Mining Situation.

MUKONDO Mining is at 9Km from KAKANDA mining town and 65Km from LIKASI town. It is under the management ofthe company BOSSMINING Sas in ERGAFRICA multinational joint venture with theGécamines RD Congo. Geographically, the mine has its deposits located at 10 46 South latitude,26 28 East longitude and 1300m average altitude. These are of sedimentary typeCuprocobaltifere whose mineralization is on a set of 'SDB' Basic Schists andCellular Silicone Rocks' RSC'Mukondo Mining one of the reserves of quality and quantity of theGecamines.

These days, the Mukondo ores including Cell by Flotation at KDC Concentrator

Kakanda gecamines and another part of the 'Particulates' Cobalt Silicates 'PCS' by the process

DMS (concentration in dense media) getting around 15% Cobalt on average after initiallyraw laundering of ore by simply washing rich ores around 2% cobalt from the minefor production around more than 25% Cobalt. At a given time, this ore was sentin Luita where the Boss Mining hydro-metallurgical plant is located for the extraction of copper andcobalt. Copper being extracted pure electrolysis after heap leaching of ores, and Cobaltrecovered as salt after precipitation. A small progressive story of Mukondo aftermining production in the factories in total of 5,000 TCo per year resumed in the annual budget aroundthe years 2008-2009 respectively to a total return of 75% discounted (budget 500TCototal KDC + DMS the month).

The Kababamkolé Mining Company journey, KMC in acronym, is aprivate company born from a partnership contract signed on January 11, 2001 with Kambove-Kakanda to Kakanda in early 2002 and Congo Cobalt Corporation 'C.C.C' Electrolysis Plant with Heap leaching then the two in common became Savannah Mining with a buyback at the end of 2006 by eurasian Natural Resources Corporation 'ENRC' naming Boss Mining B.M Mining in acronym joint venture with Gécamines de Dynamique a multinational ERGAFRICA now we have

also talked about 'CAMEC' a multinational partner a moment before ENRC. In addition already too

solvent extraction of PLS (Pignan Leach Solution) in the circuit before electrolysis at Luita.

I.2. PROBLEM

The Gecamines concentrator of KAKANDA under BM Mining in partnership, section

Flotation Concentration Company BOSS MINING, among others feeds into minerals from deposits of the MUKONDO Mine Cellular. The height of a classic hunting concentrator and the agreed metallurgical performance of the Industrial for a Cobalt is valued at 8.5% and achieves a recovery yield of 75% of this Cobalt in an economical way. Cellular ore from the North Central and South flank East proved to be difficult to navigate. Hence a comparative flotation study between this ore

Cellular and that of easy flotation as well a determination of operational costs practices day-to-day management always relate to so-called Cellulars.

I.3. MINERALOGICAL ANALYSIS OF MUKONDO ORE NORTH CENTER SOUTH-EAST FLANK

The mineralogical analysis of the MUKONDO Cellular ore flank North Center South East, performed by X-ray diffraction in the Laboratory of Matter and Materials Service of the University

Brussels, shows that copper is in the form of malachite and cobalt in the form of

heterogenite. The main elements of gangue are in large part in the form of:

- Quartz : SiO_2 ;
- Dolomite : $CaMg(CO_3)_2$;
- Minerals containing clinichore aluminum (Mg, Al)$4O_{10}(OH)_8$, Muscovite ; ($Kal_2(AlSi3O_{10})(OH)_8$, Microcline $KAlSi_3O_3$ and basanite $CaSO_4.O._5H_2O$ table 0:

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Table 0: MUKONDO Minerals containing.

Element	Content (%)
Cu tot	2,44
Co tot	1,46
CaO	2,18
MgO	6,92
Fe_2O_3	1,14
Al_2O_3	3,45
P_2O_5	0,15
SiO_2	27,66

II. BROKETNESS OF MUKONDO ORE NORTH CENTER SOUTH EAST

II.1. Grindability.

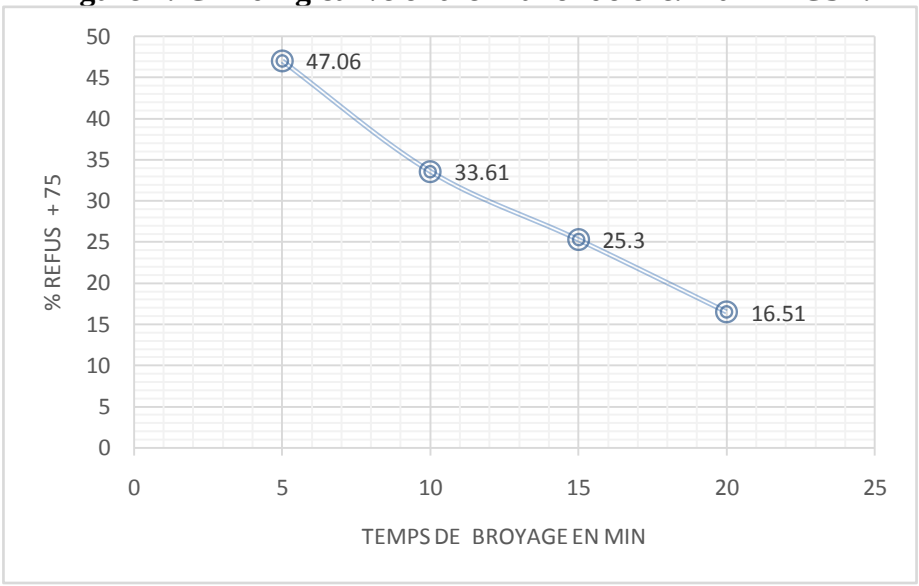
The concentrator is fed with pulp of granulometric characteristic of 30%of refusal d70 + 75 µm. a millability test of the MUKONDO Flanc NCSE ore gave the results below:

Table 1: MUKONDO ore grindability test NCSE Flank.

Grinding time	**Weight of refusal + 75 µm(g)**	**% refusal + 75 µm**
5 min	564,80	47,06
10 min	403,30	33,61
15 min	304,10	25,30
20 min	198,20	16,51

From the table above, the grinding curve representing the% refusal + 75 µm depends ongrinding time. (Figure 1)

Figure 1: Grinding curve of the Mukondo ore. Flank NCSE.



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II.2. Granulochemical analysis.

Mining time in min the results of this analysis are illustrated in the table below: It appears from the examination of this curve that the particle size of 30% rejection + 75 µm for the ore of MUKONDO FLANC NCSE is reached at 12 minutes while that ofthe concentrator power supply is usually reached at 13.50 minutes.

Table 2: Granulochemical analysis of the MUKONDO FLANC NCSE ore.

Sieve (µm)	Refusalg (g)	% refus	% refusa accrued	% passing accrued	% Cu	% Cu Distribution on Cu (g)	% Co	% Co Distribution on Co (g)
212	57,40	4,81	4,81	95,19	1,38	0,79	1,25	0,72
150	76,90	6,44	11,25	88,75	2,00	1,54	1,72	1,32
+106	26,40	2,21	13,46	86,54	2,28	0,60	1,82	0,48
+75	200,00	16,83	30,29	69,71	2,70	5,43	1,92	3,86
+53	47,80	4,00	34,30	65,70	2,50	1,20	1,7	0,81
+45	8,10	0,68	34,97	65,03	2,56	0,21	1,67	0,13
-45 slimes	261,30	21,88	56,86	43,14	1,83	4,78	1,26	3,29
- 45 sables	515,10	43,14	100,00	0,00	2,12	10,92	1,37	7,06
	1194,00		100,00		2,23	25,46	1,48	17,68

In addition, for the supply of the Kakanda concentrator, the analysis discontinued particle size is given in the conventional similar table of the Concentrator.

III. FLOTATION TESTS

These tests were carried out at the Kambove control laboratory, the reagents used for this purpose are:

- Sodium silicate (Na_2SiO_3) as depressant gangue and providing slimes;
- the mixture composed of 42% of NaHS, 41% of Rinkalore 840 and 17% of Rinkalore 10 as

main collector;

- Rinkalore Booster as Rinkalore activator;
- Sodium sulphhydrate as sulphurizing agent;
- KAX as secondary collector.

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III.1. Flotation comparison tests.

Under the same factory conditions, two flotation tests were carried out to report the difficult concentration of MUKONDO FLANC NCSE ore, namely:

- Granulometry: 30% of refusal on the sieve of 75 µm; 600 g / t NaHS;
- 1400 g / t of Rinkalore 840 mixture;
- 600 sodium silicate;
- 250 g / t of Rinkalore Booster.

The flotation results of the difficult flotation ore are given in the tablefollowingConcentrated rough :

Table 3: MUKONDO Flank NCSE ore flotation test under factory conditions.

Designation	**Contents**		**Yield**	
	%Cu	%Co	N Cu (%)	N Co(%)
Head concentrate	6,3	4,4	30,0	22,2
Concentrate rough	2,3	1,8	68,7	57,0
Rejection	0,6	0,8	-	-

The analysis of the results in the table confirms that the buoyancy of the ore MUKONDO FLANC North Central South East is difficult: the head concentrate title 4.39% Co for arecovery yield of 57.01% Co in the concentrated blank while the rejects comprise 0.79% of Cu.

The results of the Kakanda feeding flotation test are, for their part, given in the table below:

Table 4: Metallurgical Results of the KDC Feed Flotation Test.

Designation	Contents		Yield	
	% Cu	% Co	N Cu (%)	N Co (%)
Head concentrate	5,6	6,1	59,9	69, 8
Concentrate rough	0,6	0,8	84,0	84,5
Rejection	0,4	0,4	-	-

This ore floats just as well compared to the difficult flotation of the problematic.The results of these two tests show a difficult buoyancy of ore from MUKONDO FLANK NCSE.

The rest of our work will be geared towards improving, if possible, the metallurgical performance.

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III.2. Flotation orientation tests.

In the first place, flotation tests under the conditions of the concentrator ofkakanda, that is to say using a Rinkalore 840 mixture (42% NaHS, 41% R840 and 17%R10) for better flotation.

Second, the classical flotation tests using the conditions of the .Kambove concentrator: a mixture of Rinkalore 10 (90% gas oil and 10% Rinkalore 10)

III.2.1. Flotation tests with variation of the NaHS dose.

Tests at respective doses 600, 1200 and 1200 g / t NaHS the other reagents were used at the following respective doses:

- The mixture: 1400 g / t;
- The Rinkalore Booster: 250 g / t;
- Sodium silicate: 600 g / t.

The results of the NaHS dose variation flotation tests and the curves see the curves of copper and cobalt recovery yields related there to are given below ,recovery rejection.

Table 5: Metallurgical results of flotation tests with NaHS dose variation.

N° Trial	Dose (g/t)	Concentrated head		Concentrated draft		Yield of Recovery		rejection	
		% Cu	% Co	%Cu	%Co	%Cu	%Co	%Cu	%Co
1	600	7,2	4,4	4,8	3,1	82,7	74,4	0,5	0,6
2	1200	7,8	6,5	4,7	3,0	81,9	82,1	0,7	0,5
3	1800	7	5,8	4,5	2,8	84,9	82,8	1,6	0,4

These results show that good recovery yields are achieved atthe 1800 g / t dose of NaHS (84.9% Cu and 82.9% Co). But as they are close to those found at the dose of 1200 g / t (81.9% Cu and 82.1% Cu) and that at this dose we notice high levels in Cu and Co is 7.8% Cu and 6.5% Co and also for economic reasons, we retained the 1200 g / t dose as the optimal NaHS dose that we will use in the rest of our tests.

III.2.3. Flotation tests with variation of the mixture dose.

The tests were carried out at respective doses of 400, 800, 1000 and 1200 g / t of mixture. the other reagents were used at the following respective doses:

- NaHS: 1200 g / t;
- Na_2SiO_3: 600 g / t;

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- Rinkalore Booster: 250 g / t.

The results of the flotation tests as well as the yield curves of Copper and cobalt recoveries are given below:

Table 6: Results of flotation tests with variation of the mixture dose at Rinkalore 840.

N° Trial	Dose (g/t)	Concentrated head		Concentrated draft		Yield of Recovery		rejection	
		% Cu	% Co	%Cu	%Co	%Cu	%Co	%Cu	%Co
1	400	6,5	4,8	3,9	2,8	77,8	79,3	0,8	0,5
2	800	4,4	6,1	4,0	2,7	76,9	80,1	0,9	0,5
3	1000	7,1	5,4	4,3	3,1	74,5	77,9	1,0	0,6
4	1400	7,9	6,9	4,8	3,1	77,2	75,3	1,0	0,7

The yield - Cu content for flotation tests with variation of the R mixture dose 840 are under the magnifying glass.

The addition of sodium silicate in the pulp has helped increase the quality of the concentrates and the optimal dose retained is 800 g / t Na2SiO3at this dose, the performances are relatively promising for obtaining a quality of 8.5% Co and a yield of 75% Co recovery when we see that the 9.0 Cu head head concentrate and a yield of recovery 79.3% Cu.

III.2.4. Classic flotation tests.

The simple variation of the doses of the reagents used at the Kakanda concentratornot enough to deduce the difficult buoyancy of this oxidized Cupro-Cobalifère ore from Mukondo NCSE flank. To do this, we proposed to try with the reagents used in the ecamines in the Kambove Concentrator using the applied doses as applied currently in this flotation plant, namelyGécamines does not base its flotation on the recovery of Co but copper.

Only the mixture of 90% gasoline and 10% Rinkalore R10 is influential to its variation. Reason why our classical tests have been done by varying the dose of the latter.

At Flotation test with variation of the R10 mixture dose. We did this flotation test using the mixture doses respectively 200, 400 and 800 g / t.

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The metallurgical results of these classical tests as well as the curves of yields of copper and cobalt recoveries are given below: Well number the tables.

Table 7: Typical flotation tests with variation of the R10 mixture dose for the copper.

N° trial	Dose (g/t)	Concentrated head		Concentrated draft		Yield of recovery		rejection	
		% Cu	% Co	%Cu	%Co	%Cu	%Co	%Cu	%Co
1	200	7,4	4,5	4,1	2,4	73,1	65,3	1,0	0,8
2	400	6,6	4,5	4,2	2,4	77,0	83,7	0,9	0,7
3	800	7,9	5,1	4,6	2,7	78,9	78,2	0,7	0,5

.

The evolution of the content as a function of copper recovery in the test of Flotation classic with variation of the mixture with R10 is in sight.

Co-recovery efficiency Co content in the classical flotation test with variation of the dose of the mixture at R 10 is important.

These results show that the 800 g / t dose for the R10 mixture provides the best performance. Indeed, at this dose, we have 5.1% Co, a yield Co recovery of 78.2% and a rejection that takes 0.5% of Co. And even for copper, the resultsthe same dose: 7.9% Cu in the head concentrate and 78.9% recovered.

In addition, we note that the highest cobalt content in concentrates is obtained at the dose of 1200 g / t of R840 mixture, ie 6.9% Co. In the testsusing the R10 mixture, we proposed to use dextrin as depressing. We offered to experiment with and without the use of dextrin.

b. Classical flotation tests with or without the use of the dextrin dose.

For this flotation test, the doses of the reagents are as follows:

- 500 g / t of sodium silicate;
  800 g / t of R10 mixture;
- 5000 g / t NaHS;
- 50 g / t of G41;
- 30 g / t dextrin;

The results of the tests as well as the recovery yield curves Copper and cobalt are given below:

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Table 8 : The classical flotation tests with / without dextrin for Copper and Cobalt.

N° essai	Dose (g/t)	Concentré de tête		Concentré ébauché		Rendement de récupération		Rejet	
		% Cu	% Co	%Cu	%Co	% Cu	%Co	% Cu	%Co
1	sans dextrine	7,7	5	4,4	2,6	82	74,3	0,7	0,6
2	avec Dextrine	6,5	4,4	3,9	2,5	80,6	74,9	0,8	0,7

The above results show that using dextrin at the dose of 30 g / t at the head has 4.4% of cobalt instead of 5% Co that we had without the use of this reagent.

Similarly, we have 2.6% Co vs. 2.4% Co in the blank concentrate. In both cases, recovery yields are below the bar (74.3% Co without dextrin and 74.9% Co with dextrin at 30 g / t).

Therefore, we will neglect the introduction of dextrin in our classical tests using the mixture of R10 because its action causes a dilution of the cobalt content in the concentrated.

Of all the classical tests carried out, we retain for finishing teststhat carried out with the 800 g / t dose of R10 mixture giving 5.1% Co in the concentrate and one Co recovery yield of 78.2%.

C. Finishing tests.

1. Test condition.

Simple orientation flotation tests did not yield directly the expected content (8.5% Co) while from the recovery recovery point of view of the concentrate

sketched we have at least 74% cobalt.

That being the case, we went to the finishing stage in order to meet thequalitative and quantitative requirements of Boss Mining.two components of finishing tests were initiated using respectively:

- The Rinkalore 840 mixture as well as the Kakanda concentrator;
- the Rinkalore 10 mixture as well as the Kambove concentrator.

The optimal doses retained during the tests with the R840 mixture are:

- 600 g / t Na_2SiO_3;
- - 1200 g / t of mixture;
- 1200d g / t NaHS;

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- - 5000 g / t KAX;
- - 250 g / t of Rinkalore Booster.

And the performance of these doses of reagents on the
- 6.9% cobalt in the concentrate;
- 75.3% of cobalt recovered in the concentrated blank;
- 0.7% cobalt in the rejects.

And the performance of these doses of reagents on the

- 6.9% cobalt in the concentrate;
- 75.3% of cobalt recovered in the concentrated blank;
- 0.7% cobalt in the rejects.

For tests with an R10 mixture, the doses stopped are:
- 500 g / t Na_2SiO_3;
- - 800 g / t of mixture;
- 5000 g / t NaHS- 5.1% Co in the head concentrate,
- 78.2% Co recovered in the prepared concentrate,
- - 0.5% Co in the rejects.

1. ***Presentation and interpretation of the results of the finishing tests.***

   Rinkalore 840 mixture test in this case, the tests were carried out according to the following flow sheet:

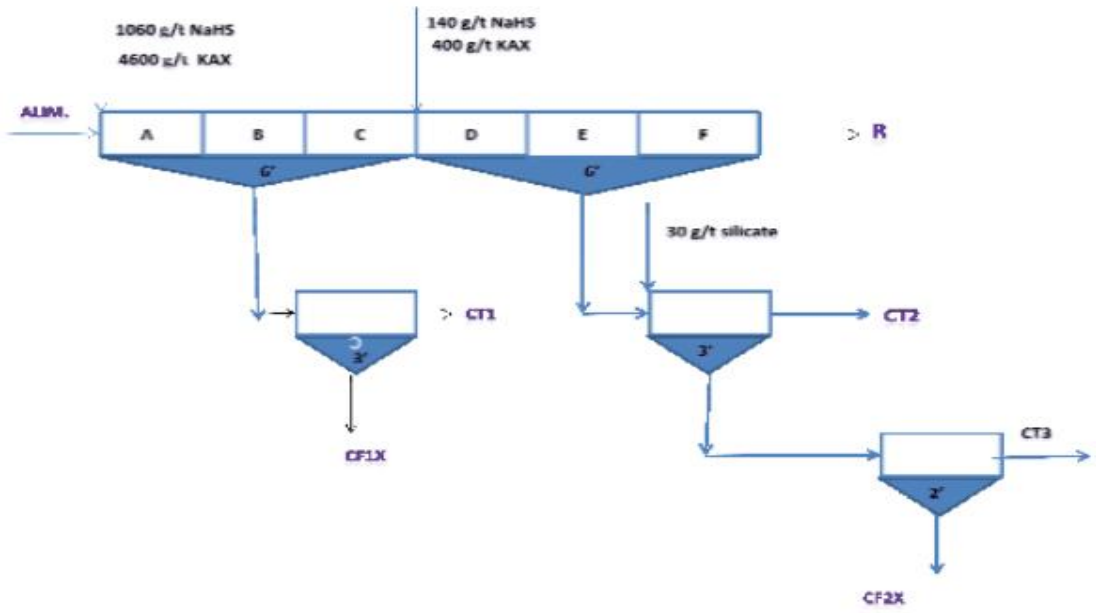

Figure 2: flow -sheet of the finishing test of the first three cells with a mixture at R840

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In order to maximize both recovery performance and Cobalt contentin the concentrate, we decided to take the first 3 fractions (A, B and C) for which one does a finishing. Are:

CF_{1x} : concentrate from the finishing of the first 3 fractions;

CT_1 : the depleted discharge;

CF_{2X}, CT_2 et CT_3 the other finite fractions.

the metallurgical results obtained in this test are required in the table 9 below:

Table 9: Content Co in the concentrate with recovery yield

Fractions	Cobalt (%)	
	Content	Yield
CF_{1x}	5,6	69,9
CF_{2x}	2,3	0,4
CE	2,8	80,9
R	0,5	19,1

Only reach 5.6% Co in the concentrate with a Co recovery yield of 69.9%. At the second finishing, we have 2.3% Co at a very low recovery efficiency Co in the concentrate is 80.9% Co. The discharge carries 19.1% Co. Clearly only spring to get to reach 8.5% Co recovery will significantly decrease.

In short, we have abandoned the pursuit of our goal of quality and quantity based on this flow sheet for fear of not going round in circles, because in these conditions, we will never do anything.

- Test with R10 mixture

The metallurgical performances achieved in this classic finishing test are shown in the following table 10:

Table 10 :Finishing the fractions of concentrate has a content of Co

Fractions	Cobalt (%)	
	Content	Yield
CF_{1x}	5,6	42,6
CF_{2x}	4,6	2,1
CT_3	1,7	69,8
R	1,0	36,2

These results show that by finishing the fractions of concentrate has a content of 5.6% Co and a recovery yield Co of 42.6%. What is bad. The concert drafted title 2.7% Co with a recovery yield of 69.8% Co while 36% cobalt are washed away. Comparing

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the Co content obtained during the tests classics with R10c mixture and that obtained after finishing, we clearly see that this finishing does not help anything. And it is likely that this behavior was the one that hindered the factory Metallurgical results expected and we can not therefore tackle these two tests of finishing for the improvement of the results.

c. Finishing tests with varying particle size.

In view of the results of the orientation tests, the optimum test is 1200 g / t of R840 mixture which gives the cobalt content of 6.8% in the head concentrate and a 75% recovery yield in the blank concentrate. It is based on these tests that we have a study of the impact of particle size on the buoyancy of the ore.

The granulometries chosen for these tests were:

- 20% rejection + 75 µm;
- 25% rejection + 75 µm;
- 30% of refusal + 75 microns.

Thus these tests were made according to the flow sheet below: Diagram of finishing tests with variation of particle size. the analysis of the samples of flotation tests with variation of the particle size in the range of 20%, 25% and 30% rejection on the 75 µm sieve gives the results shown in the following tables for copper and cobalt. Table 11 Metallurgical results of finishing tests wit variation in particle size for Cobalt.

Table 11: Metallurgical results of finishing tests with variation in particle size for Cobalt.

Fractions	Co at 20 % + 75 µm		Co at 25 % + 75 µm		Co at 30 % + 75 µm	
	Contentgrade (%)	η (%)	Contentgrade (%)	η (%)	Contentgrade (%)	η (%)
CF_{1X}	3,0	29,5	5,4	40,0	7,8	47,3
CF_{2X}	1,9	9,3	3,3	11	1,8	4,5
CT_3	1,3	5,7	1,4	6,3	0,8	12,1
CT_2	0,7	12,2	0,6	5,2	0,5	4,5
CT_1	1,9	34,8	2,0	23,4	1,9	3,7
CE	1,7	91,6	2,4	85,8	2,6	72,1
R	0,5	8,5	0,4	14,2	0,5	27,9

From the table above follows the milling curve representing the% refusal + 75µm depending grinding time. (Figure 2)

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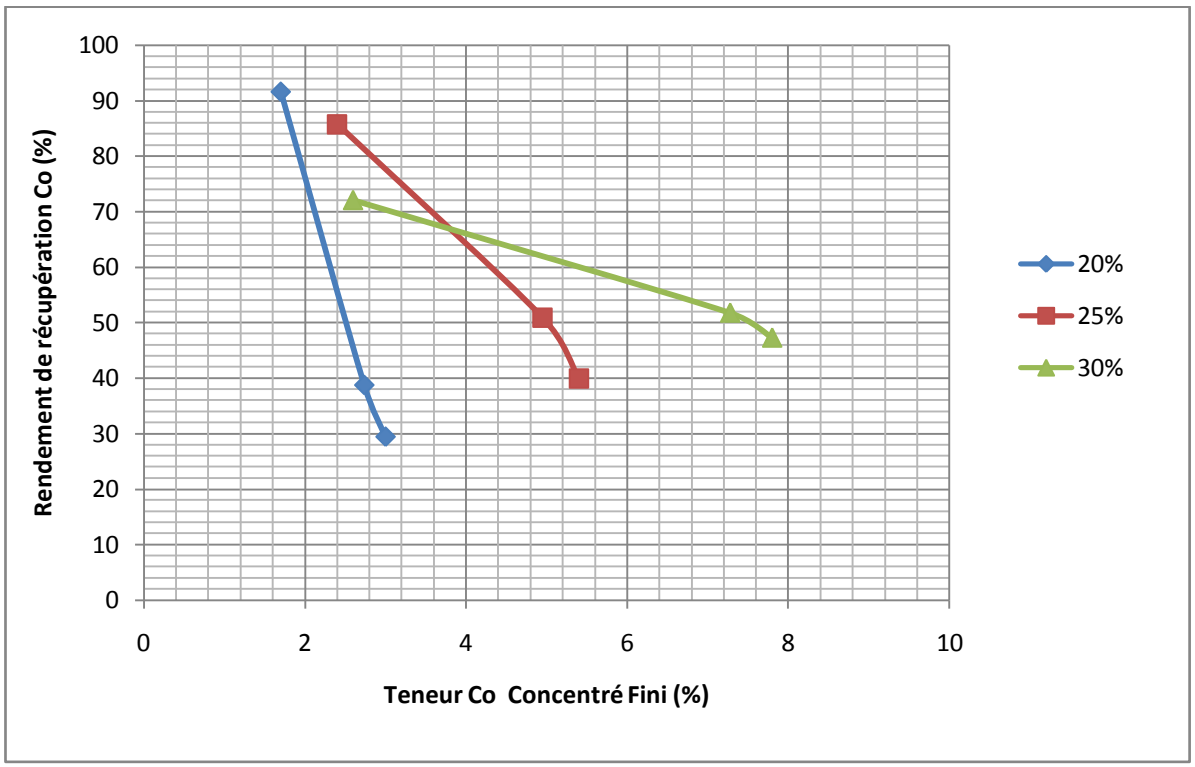

figure2: Grindability curve granulometry 3 slices + 75 µm Yield and content.

From the analysis of the table above, we notice that it is the grinding to theparticle size of 30% rejection on the 200 µm sieve that improved performance metallurgical is notable. indeed, at this particle size, we have 7.8% Co and a yield recovery of 47.3% Co. Moreover, a grinding to particle size less than 30% refusal + 75 µm reveals that there was an over-grinding which caused the presence of slimes that floattogether with the cobalt and dilute its content in the concentrate.Without referring to mineralogy, we share the same as well as theGécamines by confirming that for the oxide ores of the deposits of Katanga the granulometry favorable is to flotation is that of 30% rejection on the sieve of 75 µm

For copper, the metallurgical results are shown in the table 12 below:

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Table12: Metallurgical results of finishing tests with variation in particle size for Copper.

Fractions	Cu at 20 % + 75 µm		Cu at 25 % + 75 µm		Cu at 30 % + 75 µm	
	Content grade (%)	η (%)	Content grade (%)	η (%)	Content grade (%)	η (%)
CF_{1X}	7,3	47,6	9,7	47,5	11,8	54,8
CF_{2X}	2,9	9,2	5,1	11,3	3,6	7,1
CT_3	1,7	4,7	2,6	7,6	1,2	4,3
CT_2	0,7	7,2	0,7	4,3	0,8	5,3
CT_1	1,9	23	2	15,6	2,6	12,7
CE	2,6	91,7	3,7	86,4	3,9	84,2
R	0,8	8,3	0,6	13,6	0,7	27,9

Recovery efficiency Co (%) Concentrated Co content Finished.

From this table, we see that even copper floats well under the conditions particle size 30% of refusal + 75 µm.from the table above follows the grinding curve representing the% refusal + 75 µm depending grinding time. (Figure 3Concentrated Cu content Finished (%)- 1400 g / t of mixture (composed of 42% NaHS, 41% of Rinkalore, 840 and 17% of Rinkabre R10);

- 1200 g / t NaHS;
- 5000 g / t KAX;
- 250 g / t of Rinkalore Booster.

From the Kakanda Concentrator, the reagent consumption ratios are:

De ce tableau, nous voyons que même le cuivre flotte bien dans les conditions granulométrie 30 % de refus + 75 µm.

Du tableau ci-dessus découle la courbe de broyabilité représentant le % refus + 75 µm en fonction du temps de broyage. (Figure 3)

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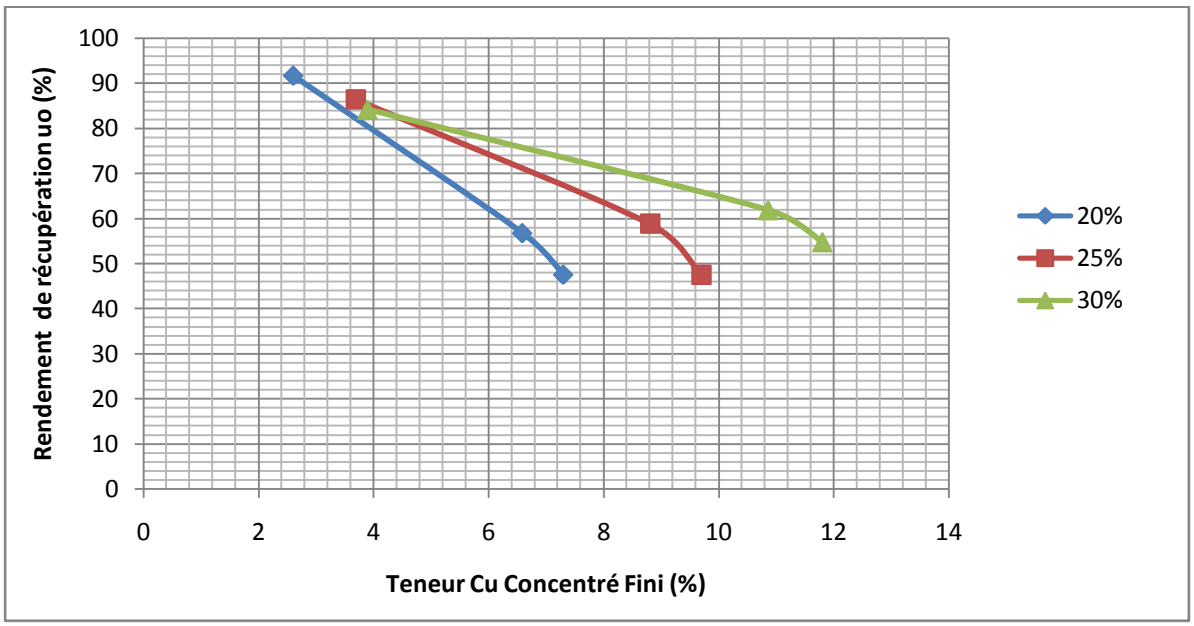

Figure 3 :Concentrated Cu content Finished (% Grindability Curve Granulometry 3 Slices + 75µm Yield and content.

IV. DETERMINATION OF THE CLASSICAL OPERATIVE COST

IV.1. Cost of the reagents used in the finishing test with the Rinkalore 840 mixture.

Calculations of the operating cost of the reagents to the final flotation testwith the Rinkalore 840 mixture are shown in the tablesReagent Composition Price ($ Kg) Consumption (g / t) Cost ($ / t) below:

Table 13: Operating cost of the R840 mixture according to its components of the finishing test.

Reagent	Composition	Price ($ Kg)	Consumption (g/t)	Cost ($ /t)
Mixture	17% R10	2,983305	204	0,60859422
	41% R840	14,450006	492	7,10940295
	42% NaHS	0,733906	504	0,36988862
Total	100% mixture		1200	8,0878858

Table 14: Operational cost of the final flotation test of finishing with the mixture at R840.

Reagent	Consumption (g/t)	Price ($ Kg)	Cost ($ /t)
Rinkalore booster	250	3,451942	0,8629855
NaHS	1200	0,733906	0,8806872
Na_2SiO_3	600	0,460143	0,2760858
KAX	5000	2,422011	12,110055
Mixture	1200	6,73990483	8,0878858
Total	100% mixture		22,2176993

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The calculation of the cost of the mixture taking into account the proportion of the element thatthe compound and their corresponding price per kilogram is given in the table below.

To realize if the cost of the reagents used for our tests has decreased or increased we compare it with that obtained by referring to the consumption ratio of the reagents of the plant for which the cost is established on the basis of reagent prices per kilogram.

The results of the related calculations are shown in the tables below Reagent Composition Price ($ Kg) Consumption.

Table15:Cost of the reagents usedfinishing with the mixture at R840.

Reagent	Composition	Prixce($ Kg)	Consuption (g/t)	Cost ($ /t)
Mixture	R10	2,983305	221	0,65931041
	R840	14,450006	533	7,7018532
	NaHS	0,733906	546	0,40071268
Total	-	-	1300	8,76187628

Table 16: Calculation of Cost of Kakanda Concentrator Reagents from their consumption ratios.

Réactif	Consommation (g/t)	Prix ($ Kg)	Cout ($ /t)
Rinkalore booster	250	3,451942	0,8629855
NaHS	600	0,733906	0,4403436
Na_2SiO_3	900	0,460143	0,4141287
KAX	2500	2,422011	6,0550275
Mixture	1300	6,73990483	8,76187628
Total	-	-	16,5343616

IV.2. overall operating cost.

The evaluation of the overall operating cost is given in the table below:

Table 17: Evaluation of the overall operating cost.

NUMBERS	QUANTITY		UNITS
1. Ore weight	45000	45000	$
2. Performance Co	72,11	75	$
3. Concentrated weight	5816,81	4923,53	$
4. % Co Food	1,4	1,24	$
5. Concentrated Co content	7,81	8,5	$
6. Weight Co Food	630,00	558	$
7. Weight Co in the concentrate	454,293	418,5	$
8. Cost per tonne of concentrate	1122,47	1274,18	$
9. Rinkalore Booster $ / 45000 T of ore	38834,3475	38834,3475	$
10. NaHS $ / 45000 T of ore	39630,924	19815,462	$
11. Sodium silicate $ / 4500 T of ore	12423,861	18635,7915	$
12. KAX $ / 45000 T of ore	544952,475	272476,238	$

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13. Mixtured $ / of oreTotal $ / 45,000 T of ore	363954,861 999796,468	394284,433 744046,271	$ $
14. Ore used AT KDC	4978533	4978533	$
15. Lime	35626	35626	$
16. Sodash	36675	36675	$
17. Balls	25464	25464	$
18. Flocculent	200	200	$
19. Gas oil	40308	40308	$
20. Bars	29841	29841	$
21. Laboratory analysis	8880	8880	$
22. Water	0	0	$
23. Electricity	65842	65842	$
24. Labor	175220	175220	$
25. Sunday consumables	129393	129393	$
26. Depreciation of Plant Plant	0	0	$
27. Subtotal - KDC Cost	6525778,47	6270028,27	$
28. WIP adjustment	3422	3422	$
29. Total cost	6529200,47	6273450,27	$
30. unit of production	1122,470634	1274,17747	$
USD/T Cobalt	14372,2234	14990,3232	$

USD / T Cobalt 14,372.2234 $ 14,990.3232finishing to reach the grade of 8.5% Co and a recovery yield of 75% Co.

Of the 45,000 dry tonnes fed into a concentrator, the table reveals that to produce cobalt at the level of 7.8%, the operating cost is 14372.22 USD / t cobalt for NCSE flank ore while at the mill, the cost is 14990.32 USD / t cobalt.

V. CONCLUSION

Such an attack on a daily basis causes the effects of ore Cellular Mukondo flank NCSE fleet with difficulty giving finished concentrates of 5.8% Co and a recovery efficiency of less than 60% at the plant.

This bad behavior was verified by doing two flotation tests of comparison that gave:

- For NCSE flank ore: 4.4% Co and a 57% recovery yield Co in simple roughing,
- For Kakanda's feed: 6.1% Co and a yield of 84.5% Co.

This work consisted in the improvement of the metallurgical performances of the ore of Mukondo flank NCSE reaching a grade of 8.5% Co and a recovery yield of 75% Co. to achieve this, two sets of orientation tests were conducted but the relatively good metallurgical results were obtained in the series of tests using a Rinkabre 840 mixture,

namely: a content of 6.9% Co and a recovery yield Co of 75.31% in simple roughing with a dose of 1200 g of mixture per ton of cellular ore.

It was the same with the finishing where the mixture with Rinkalore 840 gave good results including a content of 7.8% Co and a recovery yield in the concentrated concentrate of 72.10% Co with a finishing step of the first fraction and a study the high release of mineral particles (ie the particle size of 30% rejection +75 μm)

Admittedly, we have not reached the qualitative and quantitative performances by the Mining Operator, but nevertheless a noticeable improvement in performance is noted: we went from 5.78% Co in concentrates finished to 7.8% Co which was not realized.

We recommend Boss Mining to work with this ore in the following conditions, taking only the first bench for finishing to avoid dilution cobalt content in concentrates:

- Do not recover on the finished concentrate of the first bench of the finishing flotation, avoid recover the poorer concentrate from the next bans;
- Adjust the grinding to achieve the granulometry of 30% of refusal + 75 microns;
  -600 g / t of sodium silicate;
  -1200 g / tc NaHS;
- 1200 g / t of Rinkalore 840 mixture;
- 5000 g / t of KAX.

A real approach to the annual budget of the Company, the calculation of the classic cost overall procedure reveals that a concentrate can be produced for 7.8% Co in the concentrate, with a current operating cost of 14372.22 USD / t cobalt for the NCSE flank Cellular ore, while at the factory, the cost is 14990.32 USD / t of cobalt.

So savings in earnings are possible by working in the conditions we recommendthe management of the Boss Mining B.M Mining company in acronym in dynamics, at the beginning, in joint venture, joint with the Gécamines a Agent Gécamines a setting apart the Director Production Department is a contact of Gécamines and reports then came the Director Deputy General of B.M before a short time ago and now in 2018 is an Agent Gecamines; the partner a multinational company Eurasian Natural Resources Corporation ERR (ENRC) currently undergoing ERGAFRICA transformation.

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VI.ANNEXES

T.D Mukondo Mining Management Course for PhD Students at the University of Lubumbashi given by P.O KALUNGA MAWAZO of Mr CHISUNKA KAMPOLOBWE Philippe the Assistant at the e Polytechnic Faculty in secondment of B.M Mining mixed Gécamines one foot assisting Production Management at Production Control uses and customs in DR

Congo Absences Authorized in the service of the Nation the meaning of the Republic, a very soon, the Minutes of the Provincial Inspectorate of Labor ex-Katanga no 445/2011 says the claim is well-founded and receivable, Contract suspension without prejudice of the Art.60 litera b of the Labor Code, the Government a word on this dispute a friendly negotiation, non-compliance with Art.100 of the Labor Code to Art.321. RTA 1710 Court of Appeal to Lubumbashi the plaintiff to Court of Cassation in Kinshasa. Respect for the Constitution Art.97 and Art.62, no one is supposed to ignore the law. BM Mining Collective Agreement 2006 Art.29 implementationneavailability → on request, payment of accommodation costs by BM Mining mixed Gecamines quid

setting off! ASLIC Syndicate notice to the Ministry of Mines in local, said vicesAdministrative B.M Mining not reply to the letters to his Agent and worse to the Chief, the Governor from Province of Former Katanga Management: Shakespeare to say 'To be or not to be'. Leader of the State RAĭS J. KABILA private mail, answer: SEA on 04/06/2016 → To fight alone for his Right, strength of the argument. LD KABILA the National Hero to say: 'Never betray the Congo'.

The theorem of PYTHAGORE says: 'The two shortest and oldest words' YES and NO'

are those who demand a lot of reflections' ... What to work for the services of the nation, of the people;

Work for the collective, the others, the Republic my country !!! On appeal and, or reminder.many offices and the social infrastructure that is to say the workers' houses the city,

The schools, the Hospital and others are from Gécamines mother environment RD Congo.

Sitting in offices buildings built by Gécamines an Agent in Congolese Employer of the upper class, a job description is assumed. The so-called 'Know Yourself' of Socrates.'SCIENTIA VISCIENRE TENEBRAS', amazing jokes ever seen yet, an Employer

is a technocrat has reflexes of height problematic knowledge of a very notion elementary of the 'posting' not a desertion, a free choice granted, a Grace through providence at the service of the community, respect for the prescribed of the ten commandments of the holy book the Bible of our sociological, steal the rights, not the vices of a illusory jealousy in defiance of an Agent and his family. Cicero says, 'Money is the nerve of wars' and it is also said 'give back to Caesar what is Caesar, to God what is to God', Gecamines RD Congo.

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