EMC FLOTATION TEST PROCEDURE 2

LABORATORY FLOTATION TEST PROCEDURE FOR MF1 AND MF2 TESTS AND REGRINDING OF CLEANER TAILINGS

SYNOPSIS

Performing a flotation rate test characterises the ore. The results of the test are used to calculate the flotation kinetics of metal or mineral and gangue under chosen test conditions. The kinetics describes the behaviour of the ore and is a numerical representation of the ore's mineralogical qualities and its metal – mineral – gangue associations. Change the test conditions and the kinetics change. Change the state of the ore and the kinetics also change. This is why rougher and cleaner rate tests should be performed for MF1 and MF2 conditions.

Flotation kinetics are derived from Kelsall's unmodified equation and comprise fast and slow floating fractions and rates of metal and/or mineral and gangue. Together, these variables define a flotation system, whether in the laboratory, pilot plant or production plant. The numerical values of these variables change in order to define the particular system and take into account the differences between systems under consideration – e.g. laboratory to pilot or laboratory to plant.

An explanation is given regarding how the data from each test is used and a brief description of any effect on a plant scale is included.

This test procedure is applicable to any ore to determine its flotation characteristics under chosen conditions.

FLOTATION MF1/MF2 TEST PROCEDURE FOR ORES

OBJECTIVE

The purpose of this procedure is to generate information to achieve the following;

- Characterise the ore
- Ascertain what metallurgical changes result in an improvement of recovery/grade (this is usually confined to testing changes in grind and reagent type and/or addition)
- Generate data to simulate plant performance
- Determine metallurgical variability of samples from the deposit

OVERVIEW

In summary suggested tests are;

(note that more tests can be done at the metallurgist's discretion)

<u>MF1</u>

1. Rougher rate tests at 35%, 60% and 80% -75µm
2. Test changes of reagent and/or dosage depending upon knowledge of the material
3. Cleaner rate tests at 35%, 60% and 80% -75µm

<u>MF2</u>

Regrind of primary rougher tails ***<u>at same assay as expected in the plant</u>*** (see "Method for a MF2 Test" below to determine how to do this)

4. Rougher rate tests at 60% and 80% -75µm
5. Test other grinds and changes of reagent and/or dosage depending upon knowledge of the material
6. Cleaner rate tests at 60% and 80% -75µm and at other grinds if tested

<u>Regrinding of Cleaner Tails</u>

Applies to both MF1 and MF2 tests.

7. Rate tests of cleaner tails with and without addition of extra reagents
8. At the grind(s) selected conduct rate tests of cleaner tails with and without addition of extra reagents

METHOD FOR A MF2 TEST

1. **First, conduct a MF1, ie primary stage, rate test**

   - Grind fresh ore to the chosen primary stage grind %- 75μm,

   - Conduct a rate test under the chosen test conditions.

2. **Second, conduct the MF2 test by first preparing feed to the secondary stage**

   - Again grind fresh ore to the chosen primary stage grind %- 75μm

   - Float at the same conditions as 1 above, but this time float only for a time sufficient to recovery the fast floating fraction of values (this is normally 3-4 minutes). See the flow diagram in Figure 2. Note here that conducting this particular MF2 rate, the MF1 primary rougher batch test was done for 7 minutes. This is because this particular ore was very slow floating. For 90% of ores a primary rougher batch flotation time of 3 minutes is standard and will generate a secondary float feed head grade which will be close to the grade that will be seen on the plant,

   - The recovery of this primary stage rougher concentrate is equivalent to the recovery in primary stage final concentrate in an operating plant. Thus, the primary rougher tailings generated, ie secondary mill feed, will be at a grade equivalent to that seen in an operating plant treating this ore,

   - Grind these primary rougher tails to the desired grind %- 75μm,

   - Conduct a rate test under the chosen test conditions,

   - Figure 1 provides an indication and guideline for time of laboratory flotation to recover the fast floating mineral fraction and the rate of flotation. The fast floating fraction of mineral is what the primary mill/float circuit recovers in the plant, thus floating to this time in the laboratory will generate a secondary float feed head grade which will be close to the grade that will be seen on the plant.
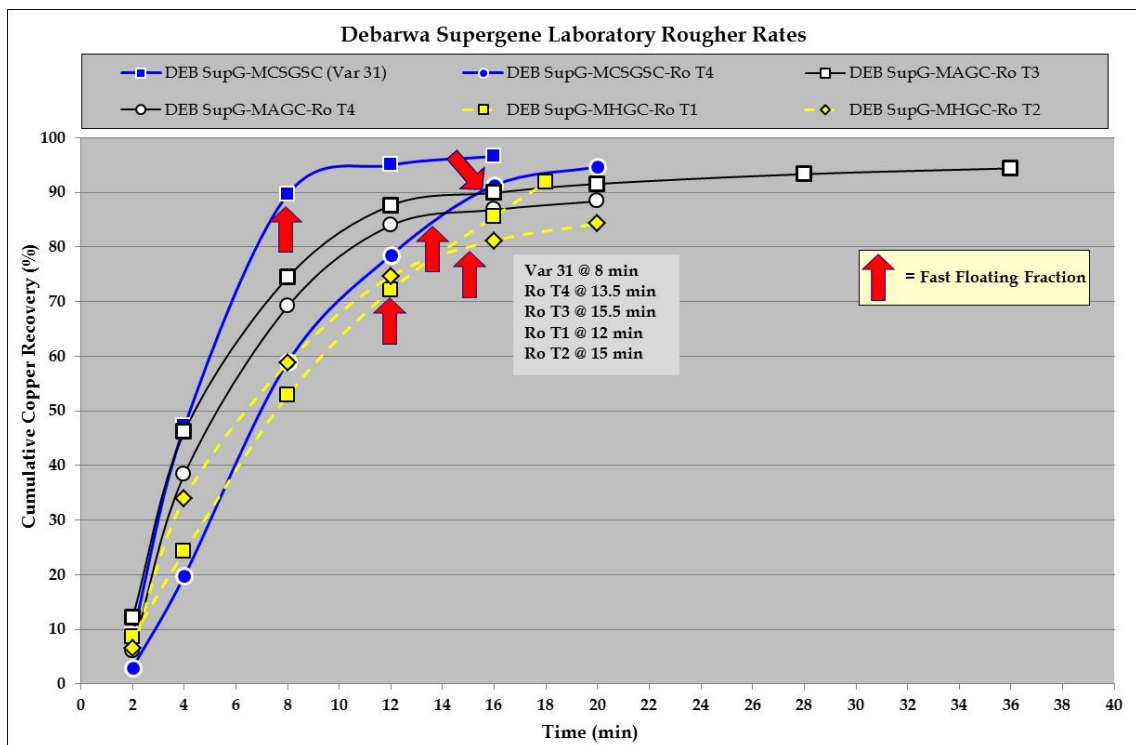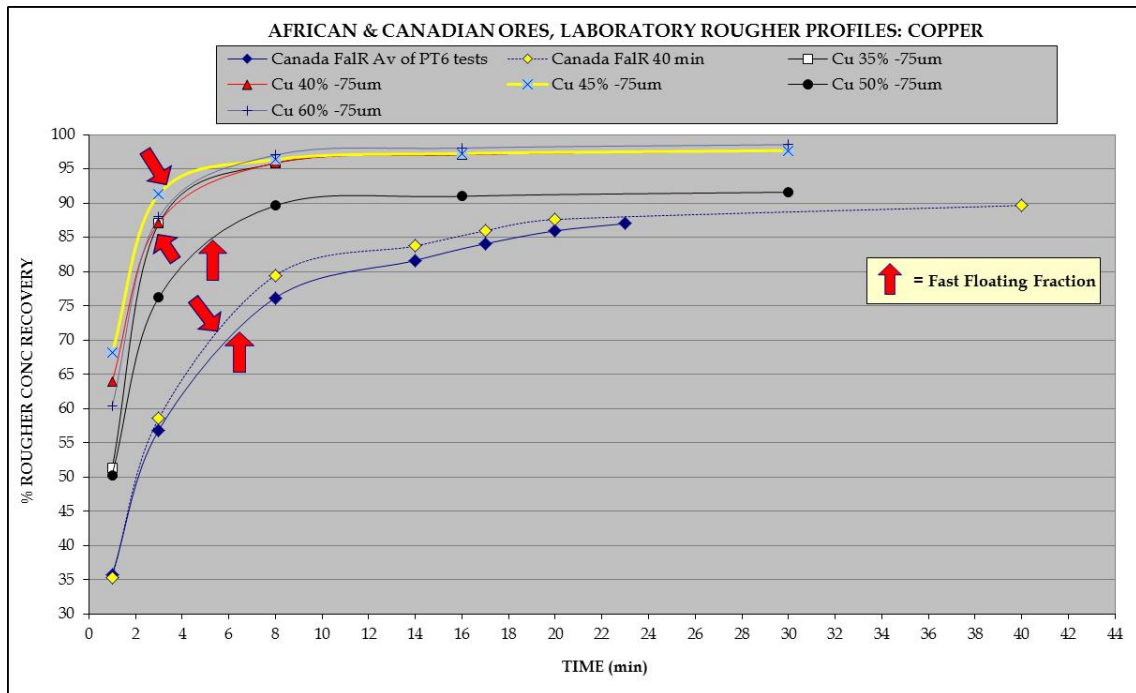
Figure 1   Laboratory Recovery-Time Profiles

HOW THE INFORMATION GENERATED FROM THE TESTS IS USED

Point	Use of Information
1	<u>The standard rate test</u>. Used to characterise an ore and simulate a MF1 circuit. The effect of grind on metallurgy is determined & simulated on a plant scale. The simulation of an MF1 circuit at coarse grind generates the plant assay of the rougher tails (feed to MF2 circuit).
2	Effect of changes of reagent &/or dosage on metallurgy determined & simulated on a plant scale. Sometimes magnitude of effect seen in the lab is lost on a plant scale.
3	Used to characterise the cleaning characteristics of an ore. Sometimes there is significant drop-out from rougher to first cleaner concentrate. This usually indicates a liberation problem. The lab cleaner rate test is simulated using the kinetics in point 1 to confirm the kinetic values. Also the cleaning section of a plant is simulated and the recovery/grade relationship of the final concentrate is checked against that generated in the MF1 simulation in point 1.
4	Lab test and simulation data from point 1 is used to conduct a rougher test for a time necessary to generate a plant rougher tails assay. This primary rougher tailing is then reground to characterise the ore and simulate the 2nd stage of an MF2 circuit. The effect of grind on metallurgy is determined & simulated on a plant scale. MF1 and MF2 circuits are compared to determine the benefit of MF1 vs MF2 wrt recovery and grade.
5	Effect of changes of reagent &/or dosage on metallurgy determined & simulated on a plant scale. Sometimes magnitude of effect seen in the lab is lost on a plant scale.
6	Same as point 3 above.
7 and 8	A cleaner scavenger bank of various stages of roughing/cleaning and various configurations is simulated using the data and kinetics form freshly generated cleaner tails (i.e. "As Is") and reground cleaner tails. This simulation is compared with the simulations of this same circuit generated in points 1, 3, 4 and 6 above as a validation procedure and to ascertain the difference between circuit conditions. For example in point 1 the MF1 roughing kinetics is used to simulate the rougher and cleaning banks, plus the roughing and cleaning section of the cleaner scavenger portion of the plant.

DETAILS OF PROCEDURE TO CONDUCT A ROUGHER AND CLEANER RATE TEST

(Written for Platinum ore tests – equally applicable to other ores which will utilise different reagents)

The procedure below is a guide; however the number of concentrates collected should not be less than that specified because the accuracy of the flotation kinetic values calculated becomes suspect. The first concentrate should always be collected after 1 minute because this has a marked influence on the value of the fast floating fraction and rate. The time of the last concentrate can be extended or an additional collection made if the material is particularly slow floating.

Flotation Test

- Roughing: The test is performed on 1.0kg of milled ore in a 2.5l Denver cell. Pulp density will be about 35% solids

- Roughing: Conditioning is done at 1500 rpm. For Merensky ore condition for 1 min with 50g/t $CuSO_4$ then 3 min with 150g/t SIBX then 3 min with 150g/t CMC and finally 1 min with 15g/t frother. For UG2 ore condition for 1 min with 50g/t $CuSO_4$ then 3 min with 150g/t SIBX then 1 min with 15g/t frother.

- The rougher rate test is normally conducted at 1200 rpm. 5 concentrates are collected; *0-1min; 1-3min; 3-9min; 9-20min; 20-30min. It is ideal to collect the first concentrate at 1min. If this is not possible (e.g. for UG2 ores where there is not enough material for assay) then collection from 0-2min is acceptable but no longer. The test must be run long enough to ensure that the cumulative recovery-time curve flattens out and is at or is approaching a plateau.* Note, extra concentrates at extended times may be collected if desired. Froth should be collected every 15 seconds. The first concentrate has 4 collections, at 15, 30, 45 and 60 seconds. The second concentrate also has 4 collections at 75, 90, 105 and finally 120 seconds and so on. During the test pulp level should be maintained at 1.5 to 2.0 cms below the cell lip.

- Cleaning: Conditioning is done at 1200 rpm (if it is chosen to add reagents).

- The cleaner rate test is normally conducted at 1000 rpm. 4 concentrates are collected; 0-1min; 1-3min; 3-9min; 9-15 or 20min.

- Tests are performed at ambient temperature and natural pH. Tap water is used.

Concentrate and Tailings treatment and assay

The concentrates and tailings are prepared in the normal way and assayed for elements of interest.

VARIABILITY TESTS

The objective is to analyse each sample or borecore to determine its milling and flotation characteristics so that it can be compared to the bulk sample and to other samples taken from different areas of the deposit. It is important to;

- Measure the sample's hardness either by a direct method (Bond and/or Mintek Grindmill tests) or by comparison (slope of the % -75µm – time relationship in the laboratory mill obtained during milling for float tests compared against slopes of ores of known hardness),
- Measure the sample's response to flotation.

Assuming the bulk sample has been subjected to all or any combination of Bond, JK and Mintek Grindmill laboratory scale tests and a bulk sample has been campaigned through a pilot plant to obtain its milling and flotation performance, then each variability sample should be tested as follows;

Milling and Flotation

If sufficient sample is available then Bond and/or Mintek Grindmill tests can be done at the discretion of the metallurgist. If sufficient sample is not available (i.e. at least 20kg) to conduct Bond and/or Mintek Grindmill tests then the following may be done (this assumes that only borehole sample of normal reef width is available of approximately 6 kg);

1. Based on the bulk sample, or any other appropriate sample, which has a % -75µm – time relationship previously measured in the laboratory mill an appropriate milling time is chosen to grind to the required % -75µm. This time is applied to all the variability samples

2. Conduct a rougher rate test at 35% -75µm (5 or 6 concentrates for 30 minutes as per page 3 above). From the results estimate IMF (the fast floating fraction of mineral, in this case PGMs). As a percentage, this is approximately the recovery in the first stage mill/float of a production plant MF2 circuit.

3. Repeat 2 above, but float only for a time necessary to achieve a recovery equal to IMF. This is to generate a primary rougher tailings assay equal to what would be produced in a production plant. These tailings are then reground to 80% -75µm and a rougher rate test conducted (5 or 6 concentrates for 30 minutes as per page 3 above). This test <u>may</u> need the use of 2kg of sample to obtain enough to for the subsequent regrind flotation test.

4. Screen the tailings from points 2 and 3 above to obtain the actual % -75µm. Select the hardest and softest samples and perform a milling test on them.

If more sample is available, cleaning rate tests can be done and/or the testing of conditions found to be appropriate to treat the bulk sample or other cores i.e. such as depressant addition etc.

The use of reagents and their addition rates for these tests will be based on previous work and what has been found to be appropriate.

Summary re MF2 lab test

The MF2 test is to determine the kinetics and flotation response of a secondary mill-float section of an MF2 circuit. The kinetic rate data is used to simulate the performance of a production plant. To do this feed to the secondary mill-float must be at the same grade expected in the plant.
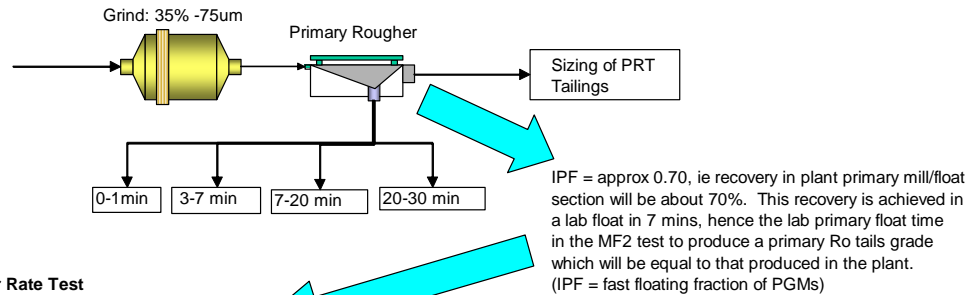
The lab primary float is run to generate a plant primary rougher tail – so lab rougher flotation may be only 3 to (say) 7 minutes. Lab primary rougher tails are reground to the desired grind and a full rougher rate test is done as per "Flotation test" above.

Suggested Standard test

1. A milling curve will be constructed on Core BBW 56.
This core seems not to have many faults and could be classified as a good core.
2. All subsequent cores will be grind, based on this milling curve.
A primary grind of 35%-75um will be aimed for and a Secondary grind of 80% -75um.
3. An MF 1 as well as MF 2 circuit will be tested, as shown in Figure 1 and 2.
4. The PRT and SRT will be sized repectively.
Based on the size distribution obtained for the cores, two or three cores,
based on it's relative hardness will be chosen for Grindmill testwork.

Reagents	Primary Rougher	Secondary Rougher
SIBX [g/t]	150	75
M82 [g/t]	40	40
Dow 200 [g/t]	40	40

MF 1 Primary Rougher Rate Test

IPF = approx 0.70, ie recovery in plant primary mill/float section will be about 70%. This recovery is achieved in a lab float in 7 mins, hence the lab primary float time in the MF2 test to produce a primary Ro tails grade which will be equal to that produced in the plant. (IPF = fast floating fraction of PGMs)
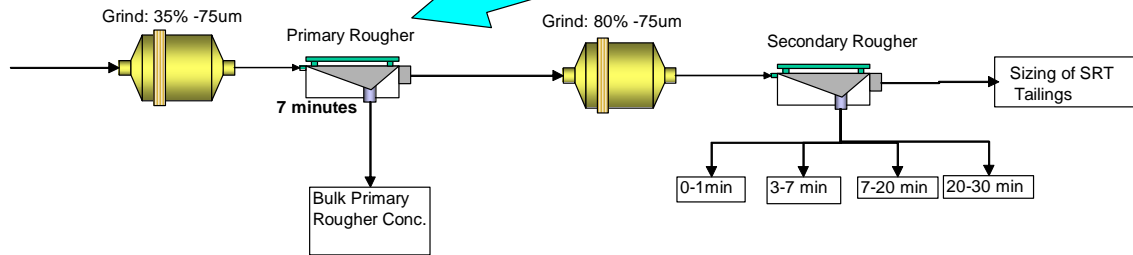
MF 2 Secondary Rougher Rate Test

Figure 2   Diagram describing MF2 Test