EURUS MINERAL CONSULTANTS

THE KINCALC® FLOTATION KINETICS CALCULATOR AND ORGANISER

BRIEF DESCRIPTION AND CAPABILITY

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1. SUMMARY OF KINCALC®

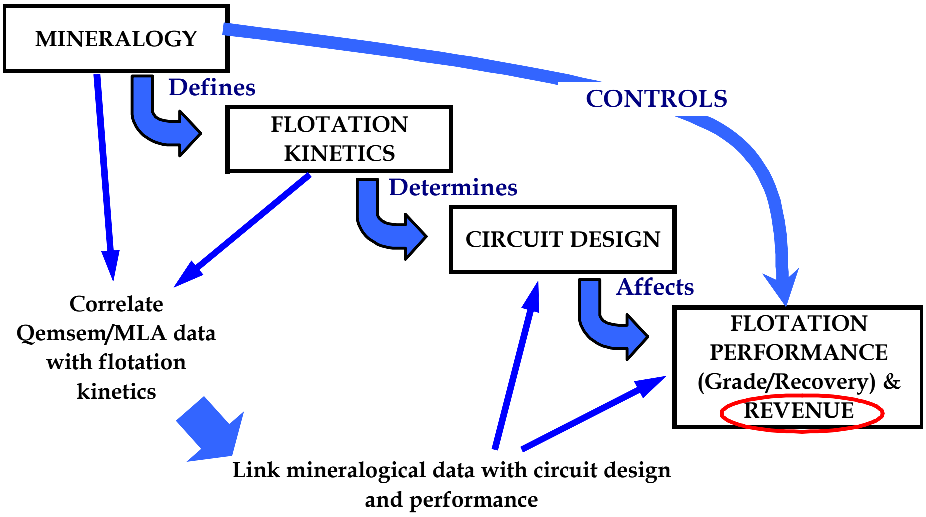
KinCalc® calculates flotation kinetics from laboratory float test data in excel format. The program employs an Import Wizard to automatically import data (test data and conditions etc) by identifying the cells or range of cells where the data occurs. This is done by setting-up a format which can be customised for any arrangement of data in an excel worksheet/spreadsheet including multiple data sheets per worksheet and multiple worksheets per file. The import wizard therefore obviates the need to type in or copy/paste testwork data. **KinCalc®** can be set-up to handle the importation and processing of multiple files in a folder. There is no limit to the number of files and/or data sheets that can be imported and processed in one batch; however in practice it is best to restrict importation to about 200 data sheets at one go.

Once data is imported, **KinCalc®**,

1. Calculates flotation kinetics with and without boundary algorithms,
2. Generates five standard graphs for each test,
3. Produces a summary sheet containing test descriptions; kinetics; laboratory test results; cumulative recovery, grade and mass pull; headgrade, various kinetic ratios and a measure of SSE (sum of squared errors). These tables are formatted so that they can be copied into a report,
4. Allows for kinetics to be calculated manually via scroll bars set-up for each kinetic parameter. This is done in that part of the program called **ScrollCalc®**,
5. Allows any set of data to be averaged and its kinetics calculated,
6. Allows one button generation of correlation coefficient tables and histograms which are time consuming to generate each time by manual application of the relevant excel function,
7. Stores all data in Access or SQL where searches can be set up to collate all data according to requirements such as ore type, reagent type, test date…. etc. The data can be dumped into excel for data mining or statistical processing.

Overall, the value of **KinCalc®** to the client/user is that **KinCalc®** is an integrated system capable of handling and organising large amounts of data which can be stored in one Access or SQL file. With mineralogical data from Qemsem or MLA it also provides the facility to dump both kinetic and mineralogical data into Access in order to generate correlations as per the diagram below.

Flotation Performance Influence Diagram (*Flotation "PID"*)



The value of **KinCalc®** lies in clients/users being able to,

1. Calculate kinetics from float tests they have performed and as a result be able to benchmark one test, ore type or set of test conditions against another,
2. Automatically import, process and store large quantities of data,
3. Have a customised graphing facility and one touch generation of r^2 correlation tables and histogram/ cumulative frequency graphs,
4. Use **KinCalc®** to graph test data and determine r^2 correlations without having to use the kinetics calculation section of the program,
5. Conduct an array of statistical analysis on the data having previously been conveniently arranged in the **KinCalc®** summary sheet or in the Access database,
6. Load Qemsem mineralogical data into the Access database and link with the associated kinetic data for a particular test. This provides the possibility of being able to correlate Qemsem data with flotation kinetics which are correlated with plant design and performance,
7. Collate all tests into one database and vehicle for easy access and processing,
8. Generate tables and graphs which are report quality and can be copied and pasted to a word document.

Figure 1 summaries **KinCalc®** main functions in flowsheet format,

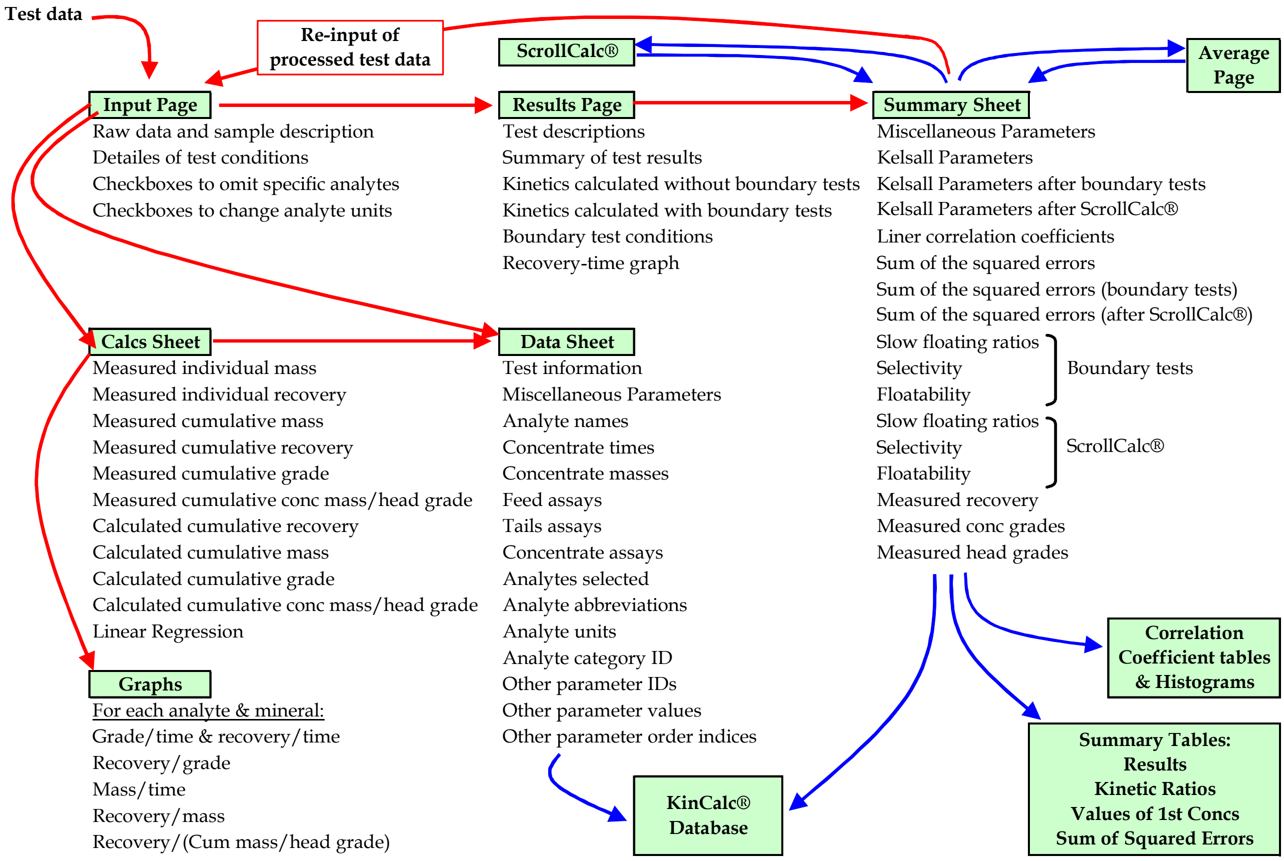


Figure 1 Organisation of KinCalc® Functions

2. THE VALUE OF FLOTATION KINETICS

How an ore responds to milling and flotation is determined by laboratory-scale batch milling and flotation tests. Under chosen conditions a flotation rate test is performed which generates a recovery, grade and concentrate mass profile over time. A graph showing typical recovery-time profiles of two "good" ores and one "bad" ore is shown in Figure 2 below. The shape of these profiles and the relationship between recovery, grade and mass with time is described mathematically by Kelsall's equation where R equals recovery and t equals time. The equation describes fast and slow floating components which relate to material that is easily and quickly recovered at the beginning of the process and material that is not (ie the slow and difficult to recover component).

The equation has four unknowns (kinetics), a fast fraction, a fast rate, a slow fraction and a slow rate. These are estimated from the testwork data in Excel by using the Solver facility. Accuracy is improved by use of additional algorithms derived from experience.

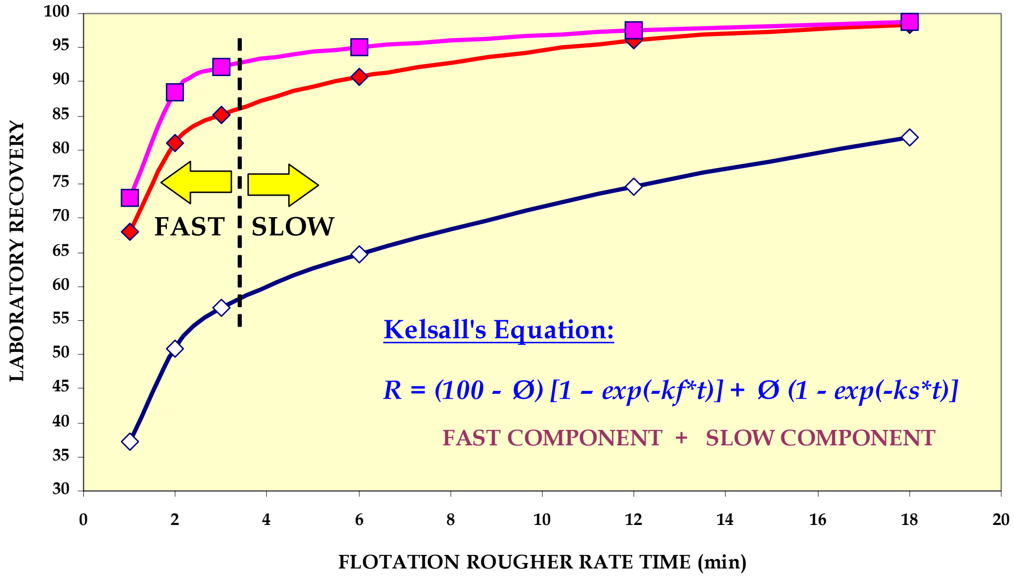


Figure 2 Results from a Flotation Rate Test and Kelsall's Equation

The outcome of using Kelsall's equation is that the behaviour and response of the ore as in Figure 2 is now described by a set of numbers or kinetics. The various components of the ore that have been measured by assay (floatable gangue, economic metals and minerals and other gangue or metal contaminants if desired) each have their own set of kinetics. An example is shown below in Table 1. If each set of kinetics was put back into Kelsall's equation then it would recreate the recovery-time curves in Figure 2 as well as grade-time, mass-time and floatable gangue-time curves (not shown).

Line	IPF	kPF	kPS	IGF	kGF	kGS
Pink	0.9011	1.6263	0.1158	0.0496	0.3586	0.0063
Red	0.7705	1.8396	0.1493	0.1062	0.2201	0.0021
Dark Blue	0.5135	1.1383	0.0554	0.2493	0.5582	0.0043

Table 1 Flotation Kinetics

Where,
I = fraction
k = rate
P = Platinum Group Metals (PGMs)
G = Gangue

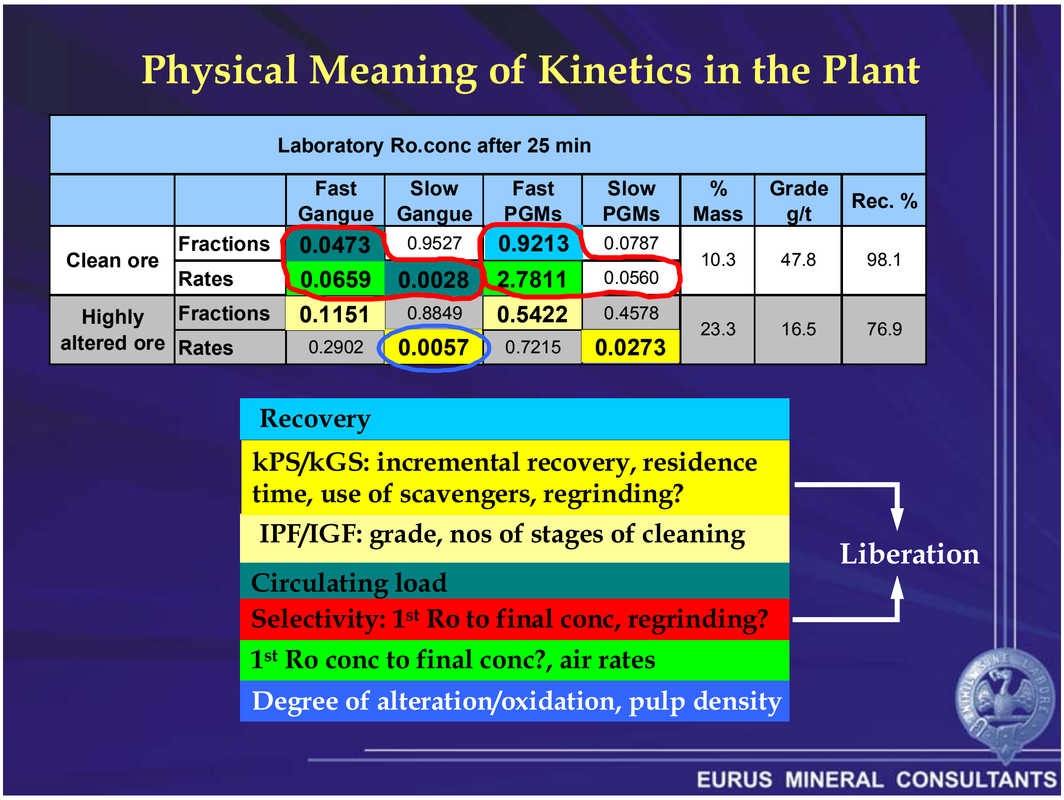
Thus, IPF = fast floating fraction of PGMs and kGS = slow floating rate of gangue.

The usefulness of flotation kinetics is that the flotation response of both minerals/metals and gangue can be reduced to a set a numbers. Different ores will have a different set of flotation kinetics as will the same ore under different test and/or operating conditions. This makes benchmarking of one ore or one condition against another possible and it then becomes easy to determine which the better is by simply comparing one set of numbers against the other.

Taking this further, each parameter of rate and fraction has a specific physical meaning in terms of recovery, grade and mass in the laboratory test. Since the laboratory-scale test cell is merely a scaled-down version of much larger cells in operation in the industry, the kinetics are also an accurate description of the ore under *full-scale, continuous plant conditions* when allowance has been made for the difference in efficiencies between laboratory-batch and plant-continuous modes. The difference between batch and continuous systems is described by a set of scale-up factors (or froth factors). An illustration of the link between each kinetic parameter and operating plant design and performance is shown in Figure 3).

The importance of flotation kinetics is that understanding of the flotation process, whether in the laboratory, pilot plant or operating plant, is increased and the process can then be optimised[1]. Laboratory flotation kinetics are used by Eurus Mineral Consultants to simulation plant performance (see Figure 4 and Figure 5).

[1] Using the SUPASIM™ flotation model to diagnose and understand flotation behaviour from laboratory through to plant. Proceedings 37th Annual Meeting of the Canadian Mineral Processors Conference, Ottawa 2005.



Physical Meaning of Kinetics in the Plant

Laboratory Ro.conc after 25 min								
		Fast Gangue	Slow Gangue	Fast PGMs	Slow PGMs	% Mass	Grade g/t	Rec. %
Clean ore	Fractions	0.0473	0.9527	0.9213	0.0787	10.3	47.8	98.1
	Rates	0.0659	0.0028	2.7811	0.0560			
Highly altered ore	Fractions	0.1151	0.8849	0.5422	0.4578	23.3	16.5	76.9
	Rates	0.2902	0.0057	0.7215	0.0273			

Figure 3 Physical Meaning of Kinetics in the Plant

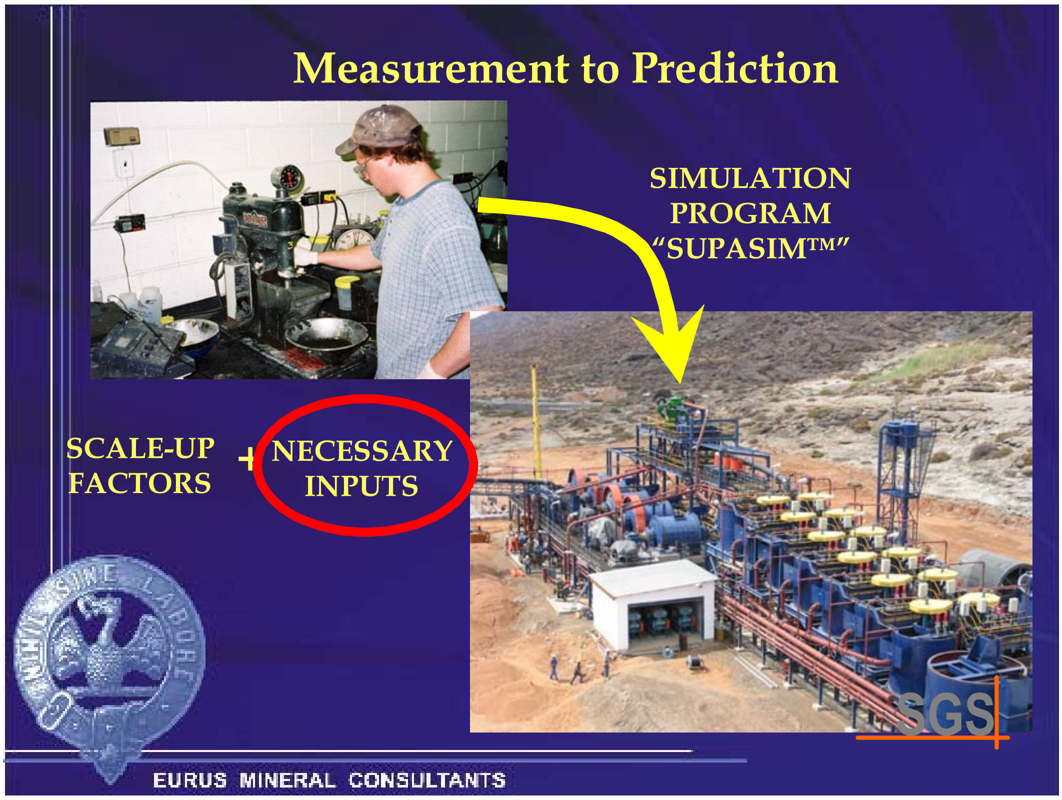


Figure 4 Simulation of Plant from Laboratory Data

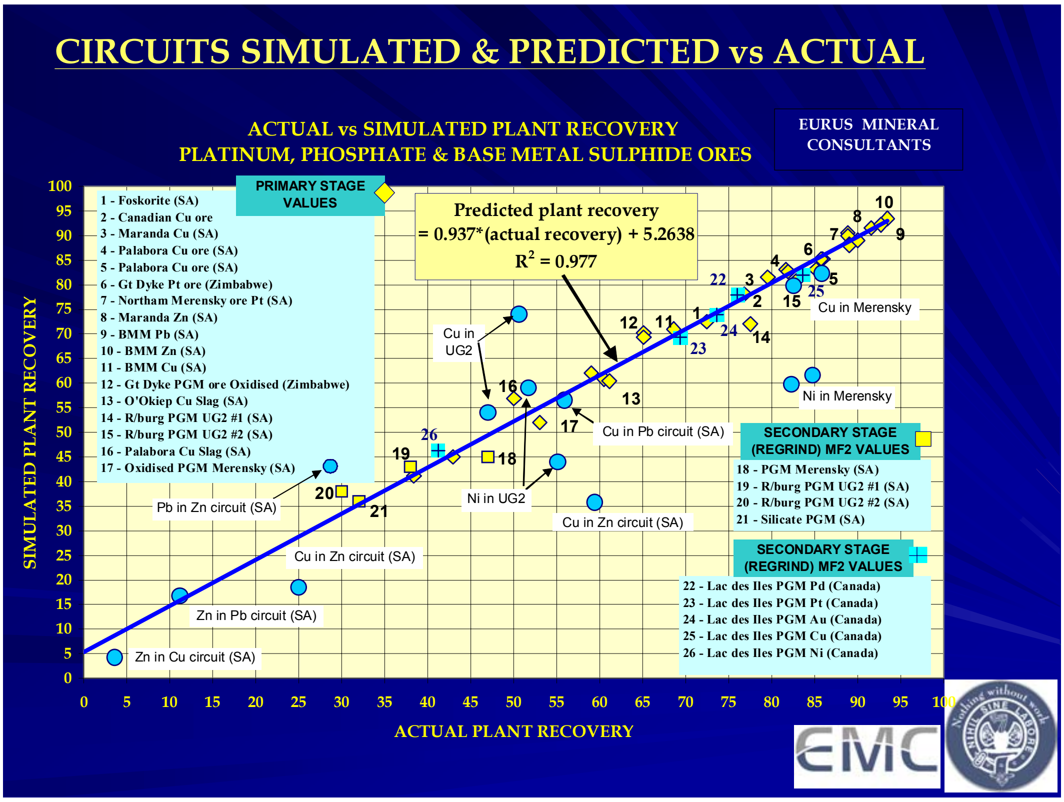


Figure 5 Accuracy of Simulation

3. AVAILABLE VERSIONS, PROTECTION, LICENSE AND PURCHASE

KinCalc® is available in 2003 and 2007 excel versions as a single-user, standalone version or as a network installation for multiple-users.

Protection is afforded using the Aladdin HASP Software Protection System. On purchase and receipt of the installation package, software is included for the HASP drivers. Included with this is a HASP key – otherwise known as a "dongle". The program will not operate unless the dongle is inserted into the USB port of the user's computer.

There is no license or license agreement required for **KinCalc®.**

KinCalc® may be purchased from Martyn Hay at Eurus Mineral Consultants at martynhay@worldonline.co.za. Cost will depend upon number of users, version and whether the KinCalc® database resides in Access or SQL.

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