PIMSOFT

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Sigmafine for the Mining and Metals Industry

Sigmafine Industry Stories

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Topics

Presentation will discuss the following

- Introduction
- Reconciliation Challenges in Metals Accounting
- Sigmafine Features
- Demo – A couple of typical business case scenarios
  - Mass Balance of the overall circuit for Cu and Au
    - What are the overall Cu and Au recovery and production rates?
    - How much water has been added to the entire circuit?
    - What is the water addition ratio between grind and flotation?
    - Reporting
    - How is Sigmafine configured to do this?
  - Tracking of stockpile/bulk storage compositions
- Conclusions

Introduction

Increase in demand for better reporting standards and more stringent regulatory requirements require…..

- Increased accuracy of the Data used in Metals accounting
- Accessing the same data and working from one version of the truth
- Sigmafine can address key areas such as:
  - AMIRA standards compliance
  - Mass measurements
  - Data collection and analysis
  - Metal balancing
  - Reporting

- We will look at how Sigmafine can be applied to some of these key areas, specifically:
  - An example of a Mass Balance of the overall circuit for Cu and Au
  - Tracking of stockpile/bulk storage compositions

Reconciliation Challenges in Metals and Mining

There are many and these are just to name a few...

- Low redundancy
- Many analyzers
- Complex models (single model with multiple dimensions)
- Piles of materials that cannot be measured
- Material accounting per element

- Easy and flexible configuration of analyzers
- Simple control where component balance is computed
- Linear balance always converges and is very stable
  - Non-linear still available
- Transfers can handle component information

Sigmafine Features
For components

- Component balance in inventories that are not typically measured
- Component tracking in inventories
- Independent solvability of components
- Independent tolerance of measurements
- Independent component list per analyzer

Data Table Edit

Component N	Value	Tolerance	Maximum	Minimum	Default
Au	8.9E-07	4.45E-08	1	0	
Cu	0.0164	0.000328	1	0	
Fe	0.0203	0.000609	1	0	
S	0.0208	0.000416	1	0	
SiO2	0.638	0.01276	1	0	

Data Table Edit

Component N	Sensitivity	Solvability	Reconciled C	Reconciled T
Au	0	R	5.993694663	5.735692753
Cu	0	R	0.009554490	3.049590780
Fe	0	R	0.017295388	0.000147023
S	0	R	0.014346708	6.891813171
SiO2	0	R	0.642253487	0.004028530

Has a Unique Algorithm for Metals Accounting

- Overall Mass Balance

$$\min_{x}(y-x)^{T}\sum(y-x)$$

$$s.t.Ax=c$$

- For each component

$$\min_{x_i}(y*_i-x_i)^{T}\sum_i(y*_i-x_i)$$

$$y_i*\equiv xy_i$$

$$s.t.A_ix_i=c_i$$

Advantages

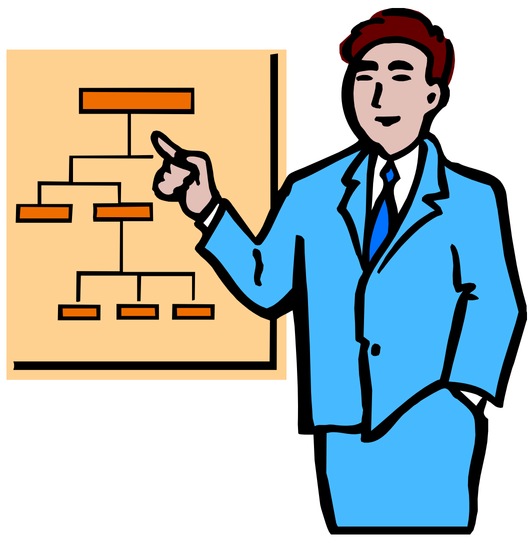
For the linear component balance…

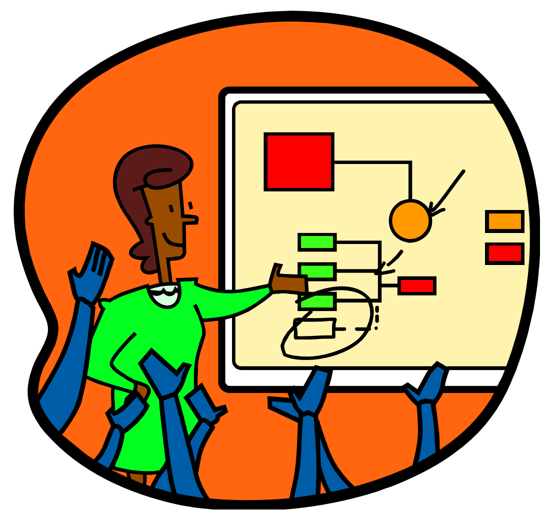
- No convergence problems
- Perfect balance for mass and components
- No cross-interaction of components measurements
- Results are simple to understand
- Good for balances with trace components (i.e., water balances include components under the ppm measurement range)

Typical Scenario

Let's look at a scenario and how Sigmafine is configured to address it

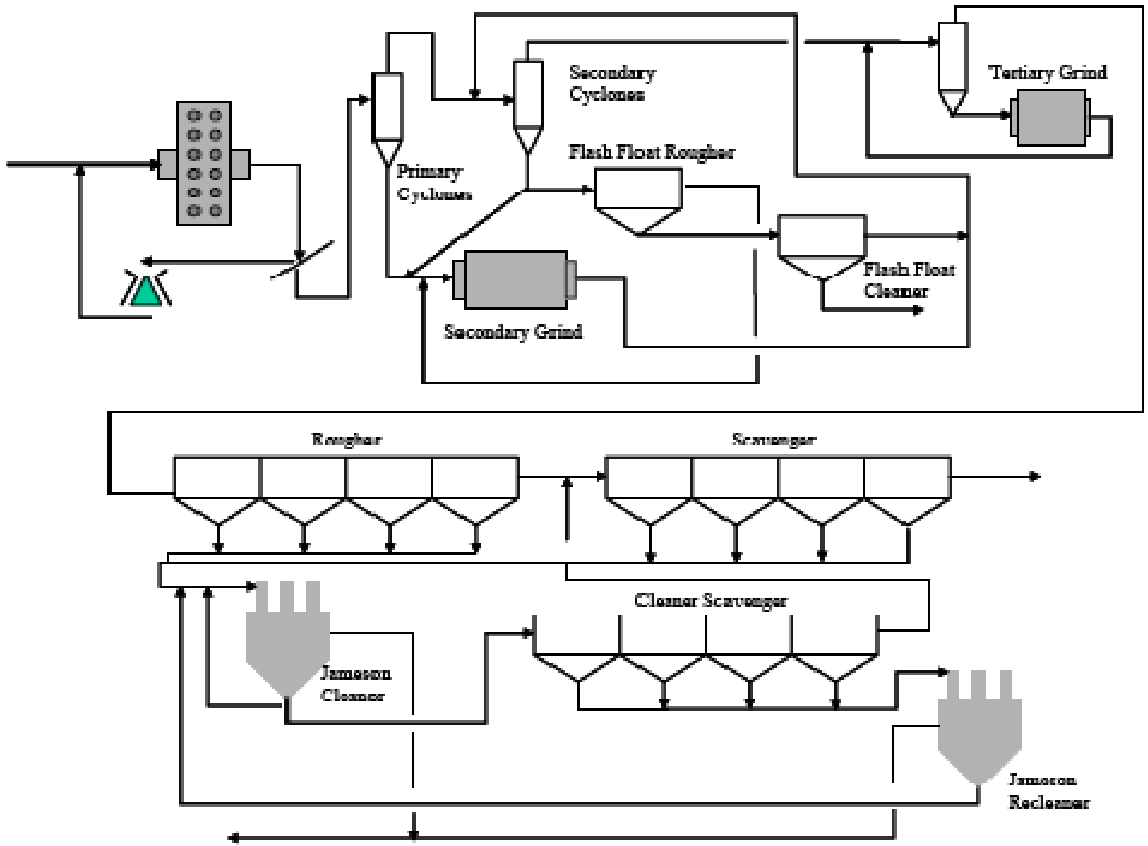
- Flowsheet
- Mass Measurements
- Assays – i.e. % Solids, Cu %, Au ppm





Flow Sheet

Flowsheet of Grinding and Flotation Plant



Mass Measurements

Info on mass measurements

Stream	Solids tph Exp
Primary Cyclone Feed	441.8
Flash Float Cleaner Concentrate	3.30
Secondary Cyclone Overflow	
Tertiary Cyclone Overflow	
Rougher Feed	
Rougher Cell 1 Concentrate	9.55
Rougher Cell 1 Tailing	
Rougher Cell 2 Concentrate	5.64
Rougher Cell 2 Tailing	
Rougher Cell 3 Concentrate	1.21
Rougher Cell 3 Tailing	
Rougher Cell 4 Concentrate	0.98
Rougher Cell 4 Tailing	
Combined Rougher Concentrate	
Scavenger Feed	
Scavenger Cell 1 Concentrate	0.73
Scavenger Cell 1 Tailng	
Scavenger Cell 2 Concentrate	1.56
Scavenger Cell 2 Tailng	
Scavenger Cell 3 Concentrate	1.01
Scavenger Cell 3 Tailng	
Scavenger Cell 4 Concentrate	0.36
Scavenger Cell 4 Tailng	
Combined Scavenger Concentrate	
Cleaner Feed	
Cleaner Concentrate	7.26
Cleaner Tailing	
Cleaner Scavenger Feed	
Cleaner Scavenger Cell 1 Concentrate	3.73

Assays

Info on assays

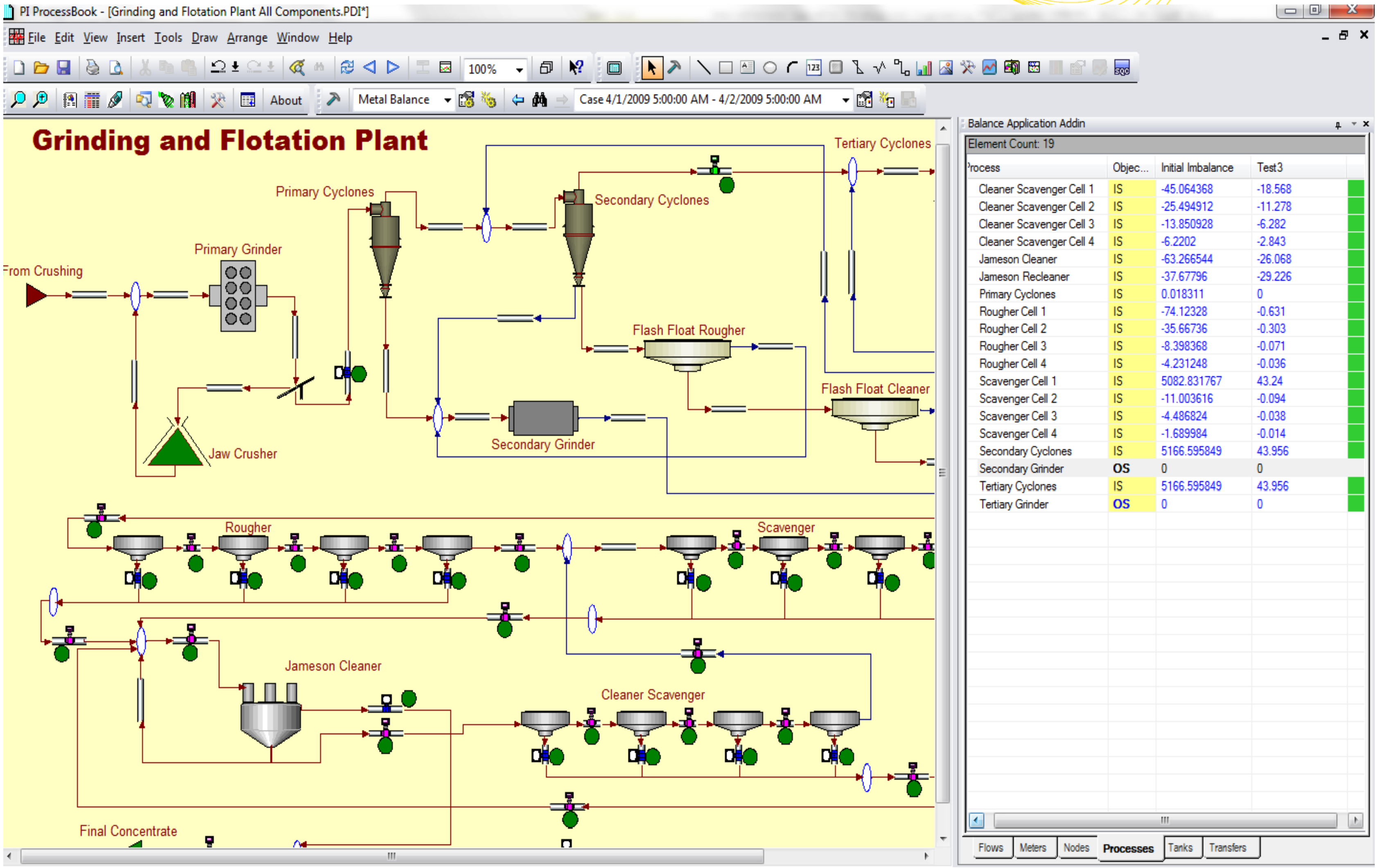
Sample Number & ID		NPM Job No.	% Solids	Cu %	Au ppm	SiO2 %	Fe %	S %
1	Primary Cyclone Feed	1313	48.90	1.64	0.89	63.80	2.03	2.08
2	Secondary Cyclone Overflow	1312	44.25	0.94	0.45	64.30	1.72	1.52
3	Amdel Flash Cleaner Con	1306	23.17	36.19	22.42	22.70	11.00	21.80
4	Tertiary Cyclone Overflow	1312	42.68	0.99	0.58	64.10	2.04	1.61
5	Rougher Feed	1312	42.73	0.98	0.48	62.70	1.69	1.44
6	Rougher Concentrate 1	1306	32.34	23.94	9.58	33.60	7.89	15.10
7	Rougher Concentrate 2	1306	26.35	16.79	7.13	43.60	6.30	11.25
8	Rougher Concentrate 3	1306	28.92	29.03	15.39	27.00	10.40	20.00
9	Rougher Concentrate 4	1306	17.99	15.58	6.50	42.40	6.09	10.95
10	Rougher Con Combined	1306	13.35	17.39	5.85	44.10	6.67	12.25
11	Rougher Tail 1	1311	41.48	0.340	0.31	65.70	1.60	1.25
12	Rougher Tail 2	1311	42.73	0.202	0.24	65.40	1.55	1.18
13	Rougher Tail 3	1311	40.15	0.164	0.22	65.80	1.58	1.09
14	Rougher Tail 4	1311	42.59	0.105	0.22	63.80	1.50	0.96
15	Scavenger Concentrate 1	1308	22.51	11.24	5.77	48.40	4.90	7.20
16	Scavenger Concentrate 2	1311	29.39	12.43	4.77	49.70	5.43	8.35
17	Scavenger Concentrate 3	1311	18.51	3.79	1.48	59.00	3.07	3.74
18	Scavenger Concentrate 4	1308	19.56	7.60	4.38	54.30	4.17	5.47
19	Scavenger Con Combined	1306	20.43	5.55	2.63	56.00	3.45	4.39
20	Scavenger Tail 1	1311	37.94	0.109	0.22	62.40	1.53	1.03
21	Scavenger Tail 2	1311	37.40	0.096	0.20	71.20	1.28	0.65

Sizing Data on Assays

Stream Name	Size Fraction	Weight %	Assays					
			Cu %	Au ppm	SiO_2 %	Si %	Fe %	S %
Primary Cyclone Feed	+9.50 mm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	+6.70 mm	0.16	1.34	0.79	65.74	30.73	1.85	1.55
	+4.75 mm	0.38	1.18	0.70	65.54	30.64	2.00	1.46
	+3.35 mm	0.63	1.17	0.75	66.14	30.92	1.90	1.47
	+2.36 mm	1.30	1.19	1.09	66.74	31.20	1.78	1.44
	+1.70 mm	2.18	1.10	0.65	65.14	30.45	2.07	1.53
	+1.18 mm	3.31	1.14	0.68	66.04	30.87	1.91	1.45
	+850 um	4.12	1.01	0.59	65.64	30.68	1.84	1.39
	+600 um	5.58	0.95	0.62	67.04	31.34	1.88	1.38
	+425 um	7.95	0.87	0.56	69.63	32.55	1.78	1.32
	+300 um	8.42	0.85	0.49	68.73	32.13	1.62	1.25
	+212 um	8.64	0.93	0.57	71.83	33.58	1.70	1.31
	+150 um	8.17	1.17	0.75	72.43	33.86	1.74	1.41
	+106 um	5.59	1.55	0.76	72.43	33.86	2.02	1.78
	+75 um	7.19	2.33	0.83	69.13	32.32	2.12	2.32
	+53 um	5.51	2.99	1.19	68.73	32.13	2.33	3.11
	+38 um	5.24	3.54	1.27	66.94	31.29	2.54	3.65
	+20 um	6.32	3.36	1.68	64.84	30.31	2.62	3.90
	+10 um	5.78	3.18	1.36	63.24	29.56	2.82	3.84
	-10 um	13.53	1.81		59.74	27.93	3.00	1.75
	Total - Calc	100.00	1.75	0.92	67.29	31.45	2.16	2.02
	Head		1.64	0.89	63.74	29.79	2.03	2.08
	-2.36 mm		1.76	0.97	63.84	29.84	2.12	2.36
	-20 um		2.46	1.36	59.64	27.88	2.84	2.89

Mass Balance of the Overall Circuit for Cu and Au - Demo

Now let's look at the Sigmafine model…



Mass Balance of the Overall Circuit for Cu and Au

Reporting using Sigmafine Excel add-in

GridingAndFloatationReport.xlsx - Microsoft Excel

PI System	WIN-DFUKHO9JR00
Database :	GrindingAndFloatation Circuit
Model :	Grinding and Flotation Plant
Analysis :	Metal Balance
Case :	4/1/2009 5:00:00 AM - 4/2/2009 5:00:00 AM

		Component	Value	Unit	Component Rates	Unit
Input	a-Primary Cyclone Feed					
	f-Primary Cyclone Feed	Conversion from typ	0.60	ppm	129.5	g/h
216.0	t/h	Conversion from typ	0.96	%	2.06	t/h
		Conversion from typ	1.73	%	3.74	t/h
		Conversion from typ	1.43	%	3.10	t/h
		Conversion from typ	64.23	%	138.75	t/h

		Component	Value	Unit	Component Rates	Unit
Output	a-Flash Cleaner Concentrate					
	f-Flash Float Cleaner Concentrate	Conversion from typ	23.07	ppm	17.6	g/h
0.76	t/h	Conversion from typ	37.37	%	0.29	t/h
		Conversion from typ	11.03	%	0.08	t/h
		Conversion from typ	22.05	%	0.17	t/h
		Conversion from typ	22.70	%	0.17	t/h

		Component	Value	Unit	Component Rates	Unit
Output	a-Scavenger Tail 4					
	f-Final Tail	Au	0.20	ppm	41.4	g/h
211.1	t/h	Cu	0.09	%	0.19	t/h
		Fe	1.50	%	3.17	t/h
		S	0.95	%	2.01	t/h
		SiO2	65.27	%	137.76	t/h

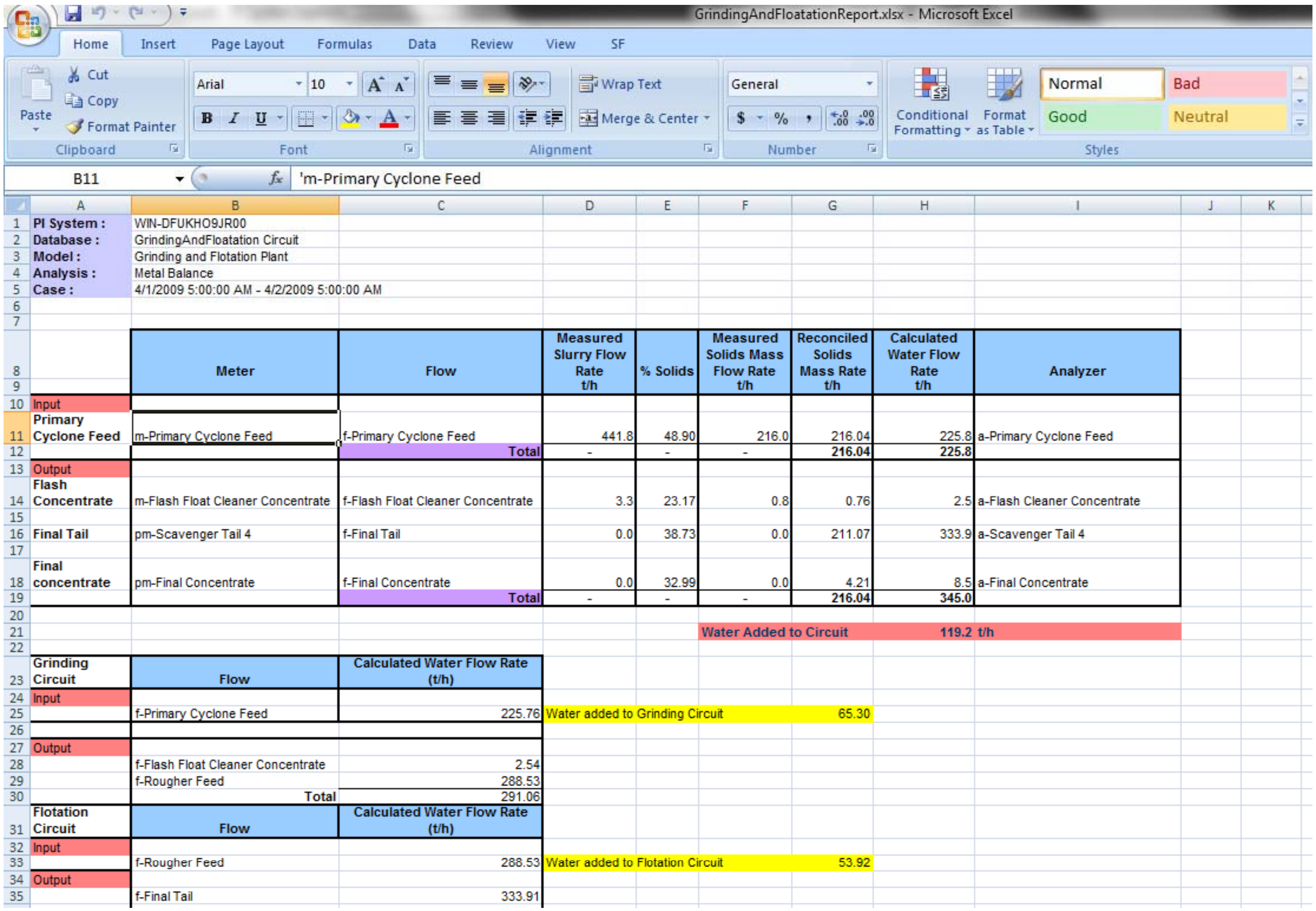
		Component	Value	Unit	Component Rates	Unit
Output	a-Final Concentrate					
	f-Final Concentrate	Au	16.75	ppm	70.5	g/h
4.21	t/h	Cu	37.70	%	1.59	t/h
		Fe	11.37	%	0.48	t/h
		S	21.85	%	0.92	t/h

Component	Feed	Tailing	Concentrates	Units
Conversion f	129.49	41.38	88.11	g/h
Conversion f	2.06	0.19	1.87	t/h
Conversion f	3.74	3.17	0.56	t/h
Conversion f	3.10	2.01	1.09	t/h
Conversion f	138.75	137.76	0.99	t/h

Au Recovery	**68.0%**
Cu Recovery	**90.7%**

Water Balance

How much water is added to the circuit?....



PI System :	WIN-DFUKHO9JR00
Database :	GrindingAndFloatation Circuit
Model :	Grinding and Flotation Plant
Analysis :	Metal Balance
Case :	4/1/2009 5:00:00 AM - 4/2/2009 5:00:00 AM

	Meter	Flow	Measured Slurry Flow Rate t/h	% Solids	Measured Solids Mass Flow Rate t/h	Reconciled Solids Mass Rate t/h	Calculated Water Flow Rate t/h	Analyzer
Input								
Primary Cyclone Feed	m-Primary Cyclone Feed	f-Primary Cyclone Feed	441.8	48.90	216.0	216.04	225.8	a-Primary Cyclone Feed
		Total	-	-	-	216.04	225.8	
Output								
Flash Concentrate	m-Flash Float Cleaner Concentrate	f-Flash Float Cleaner Concentrate	3.3	23.17	0.8	0.76	2.5	a-Flash Cleaner Concentrate
Final Tail	pm-Scavenger Tail 4	f-Final Tail	0.0	38.73	0.0	211.07	333.9	a-Scavenger Tail 4
Final concentrate	pm-Final Concentrate	f-Final Concentrate	0.0	32.99	0.0	4.21	8.5	a-Final Concentrate
		Total	-	-	-	216.04	345.0	

Water Added to Circuit 119.2 t/h

Grinding Circuit	Flow	Calculated Water Flow Rate (t/h)
Input		
	f-Primary Cyclone Feed	225.76
Output		
	f-Flash Float Cleaner Concentrate	2.54
	f-Rougher Feed	288.53
	Total	291.06

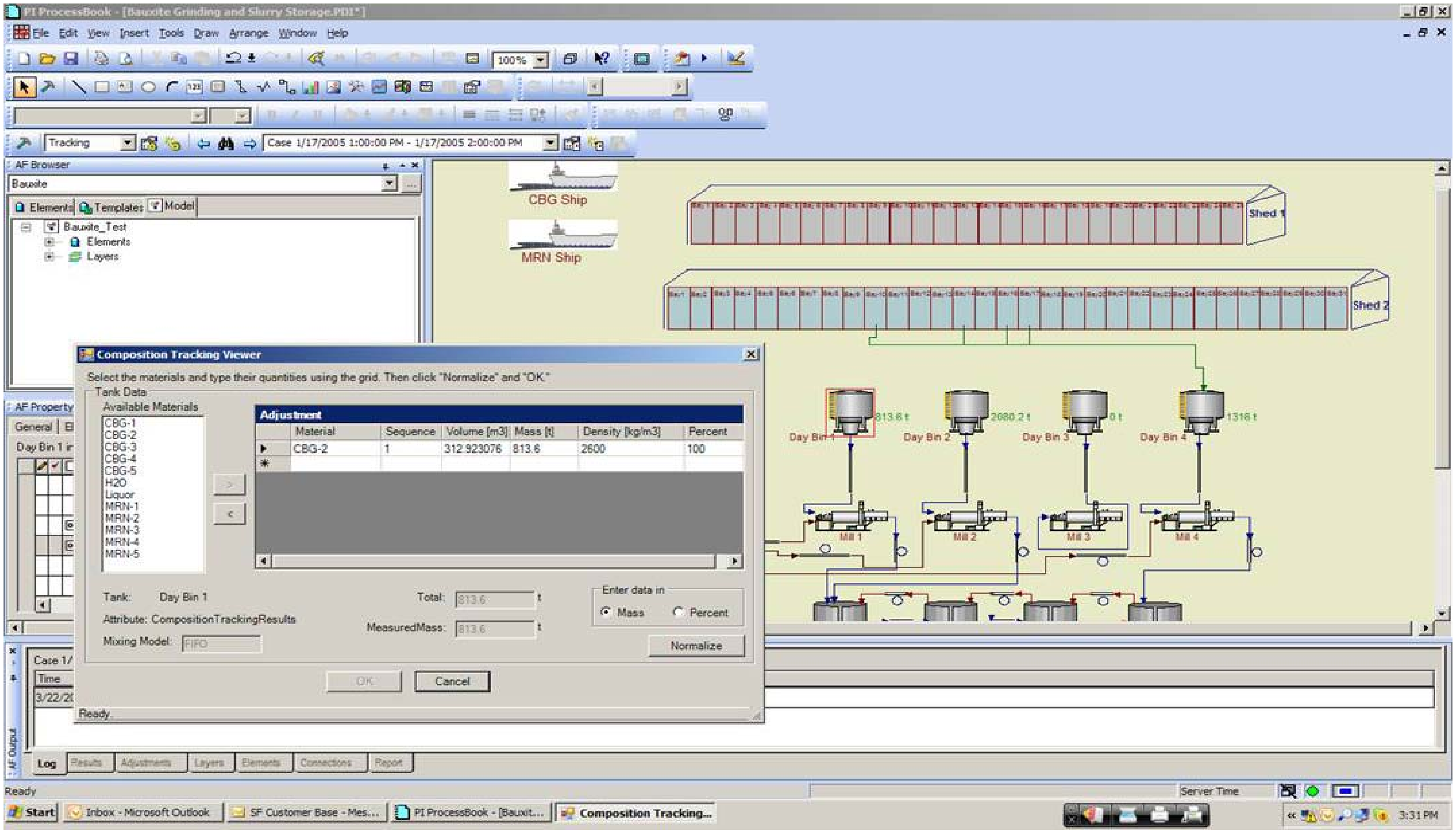
Water added to Grinding Circuit 65.30

Flotation Circuit	Flow	Calculated Water Flow Rate (t/h)
Input		
	f-Rougher Feed	288.53
Output		
	f-Final Tail	333.91

Water added to Flotation Circuit 53.92

Tracking of Stockpile/Bulk Storage Compositions

Composition Tracking Analysis Rule can be used



Conclusion
With Sigmafine.....

- *Accounting standards can be applied to Metals accounting.*
- *The accuracy of the information relating to the flow and transfer of materials and their metal content is increased.*
  - *By doing mass and component analysis*
  - *Correcting issues that are flagged*
- *The same data and working from one version of the truth can be accessed across the organization.*

Thank You

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