52. Mass Balance Examples

52.1. Unsized example

First open the flowsheet under the installation folder from C:\HSC8\MassBalance\Examples\Unsized example\unsized.Sim8. Next, go to Tools-Mass Balancing-Mass Balancing, which opens the following Mass Balance window:

52.1.1. Units

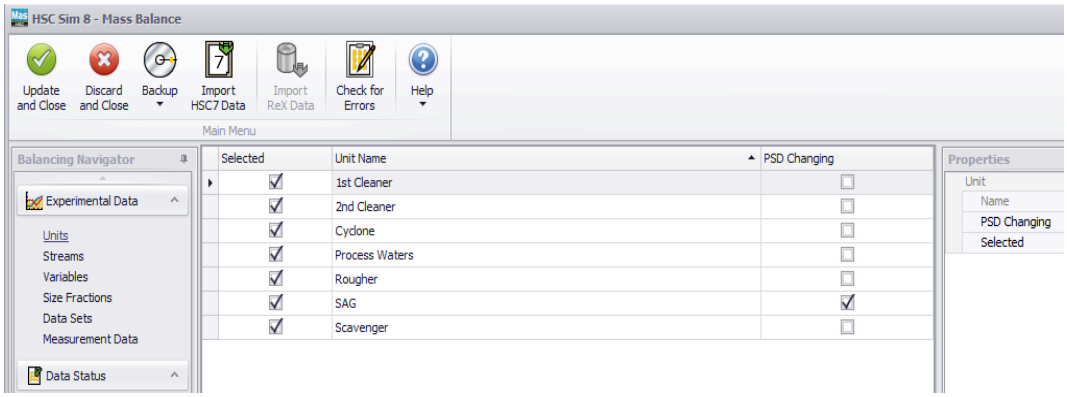


Fig. 1. Units.

You can see the units taken from the flowsheet. You can set PSD changing for the units if necessary (Particle Size Distribution changing. Used in Sized and Sized by Assay examples). You can also unselect some units when they are invisible in the solution.

52.1.2. Streams

In the next view we can see the streams read from the flowsheet. We can also select/unselect streams. Unselected streams will be invisible in the solution. At the moment all the types of the streams are Unknown because we do not yet have any measurement data. We can set each stream type manually by selecting Solids/Slurry, Liquid/Water, or Unknown from the dropdown menu. We can also do this automatically based on the measurement data after we have pasted the data in the Measurement Data view by pressing Detect Stream Type.

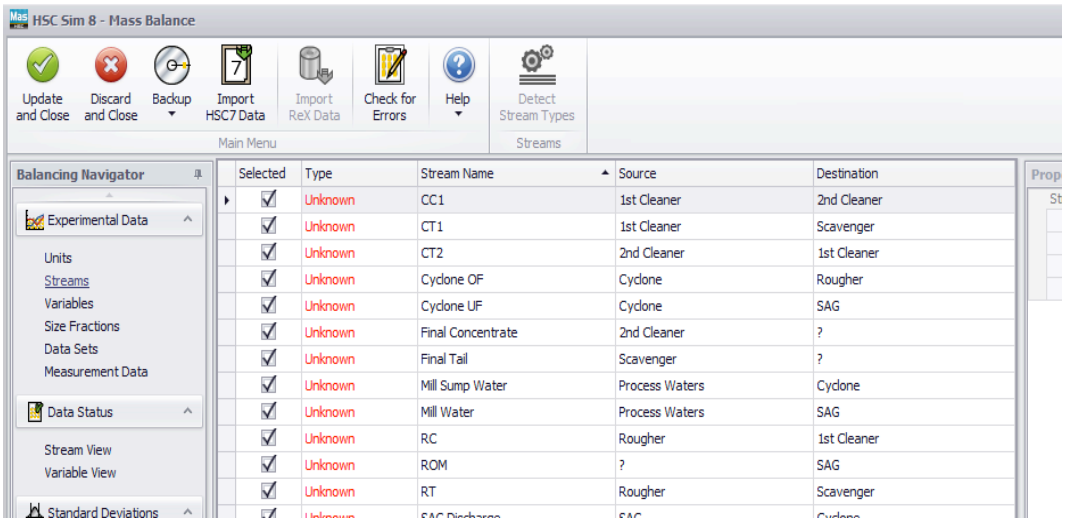


Fig. 2. Streams.

52.1.3. Variable view

In the next view we add the variables. We already have one variable, Total Solids. In this view you can select/unselect variables, change the type of the variable from the dropdown, and add new variables. Next we add the variables Cu %, Fe %, and S %. This can be done by clicking the Add Variable button, typing the variable name and selecting variable type Solids Component Assay. However, the easier way to do this is to click Add Elements and select the elements, which automatically generates the names and types.

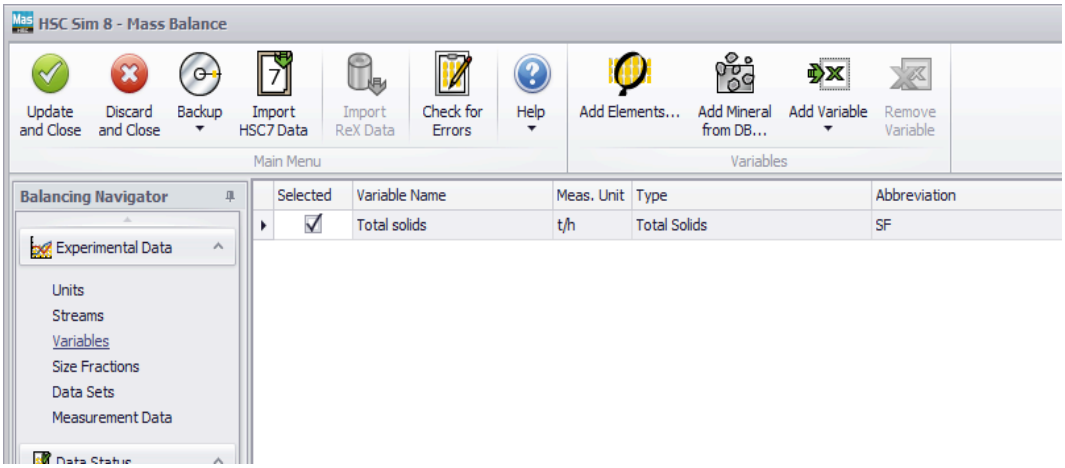


Fig. 3. Variable Total solids.

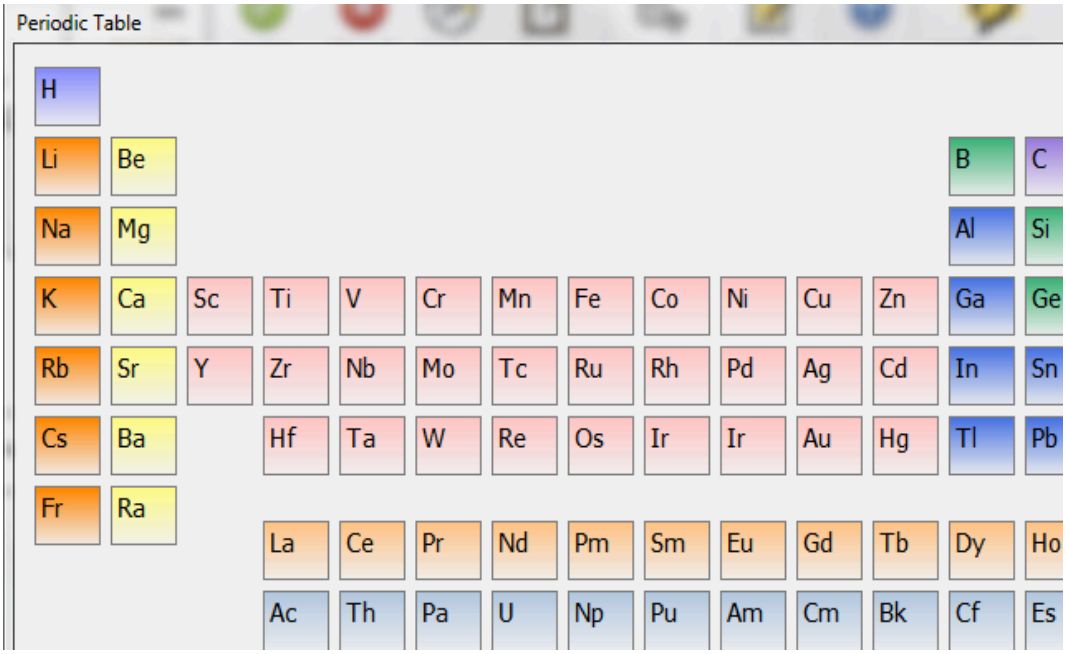


Fig. 4. Add Elements dialog.

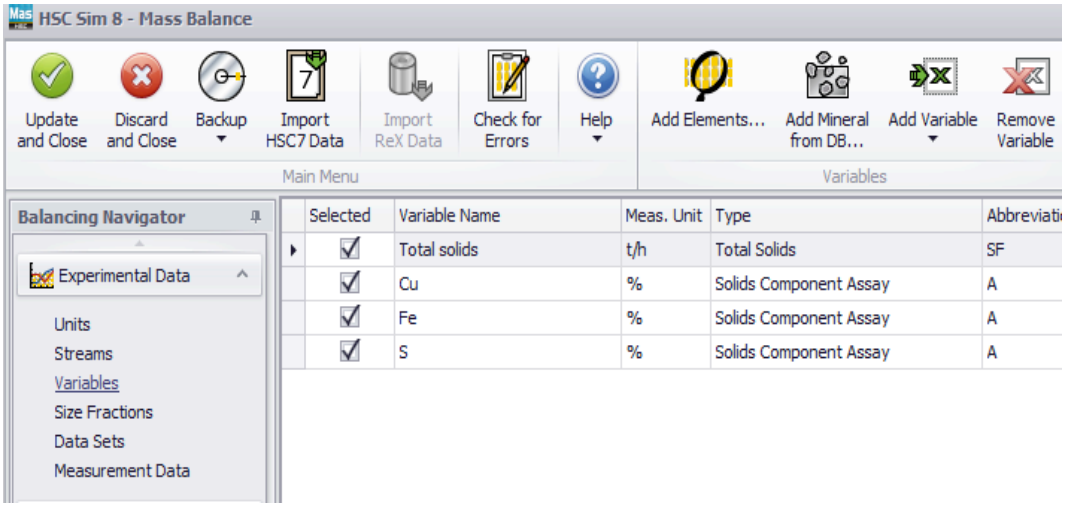


Fig. 5. Elements added.

52.1.4. Size Fractions

This is where we can add size fractions. In this case we only have bulk and do not need to add it because it is already there.

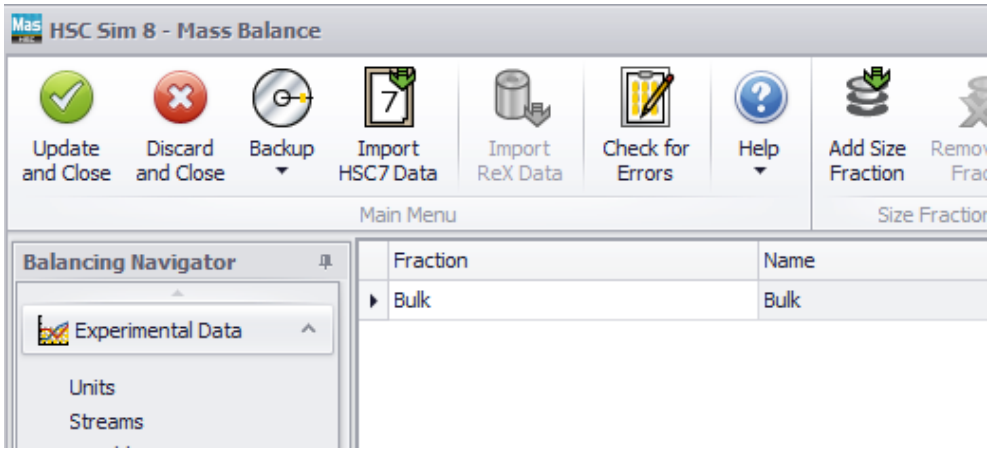


Fig. 6. Fractions.

52.1.5. Datasets

In this view we can select the active dataset. In this case, there is only one dataset.

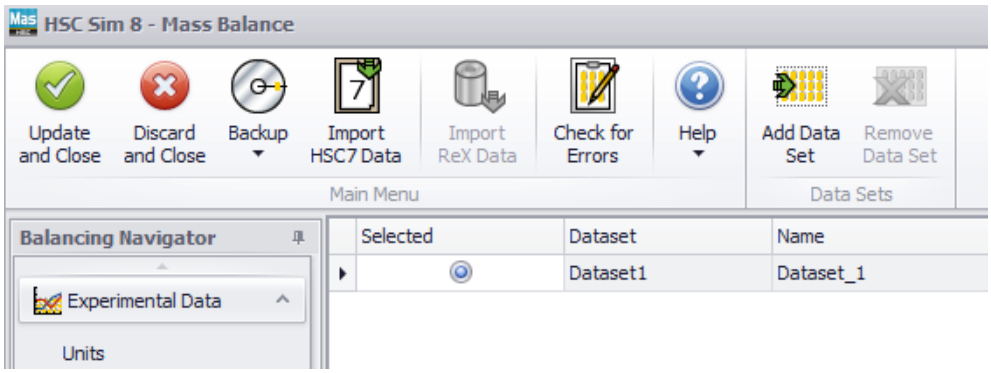


Fig. 7. Datasets.

52.1.6. Measurement data view

In this view, we can paste and change the measurement data. Pasting measurement data from the clipboard is done by clicking Paste Experimental Data.

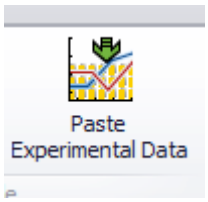


Fig. 8. Paste Experimental Data button.

The order of streams and variables on the clipboard and the measurement data table may be different. Also, some streams may be missing from the clipboard data. The clipboard data may contain variables that do not exist in the measurement data table. Notifications will be given of all these issues.

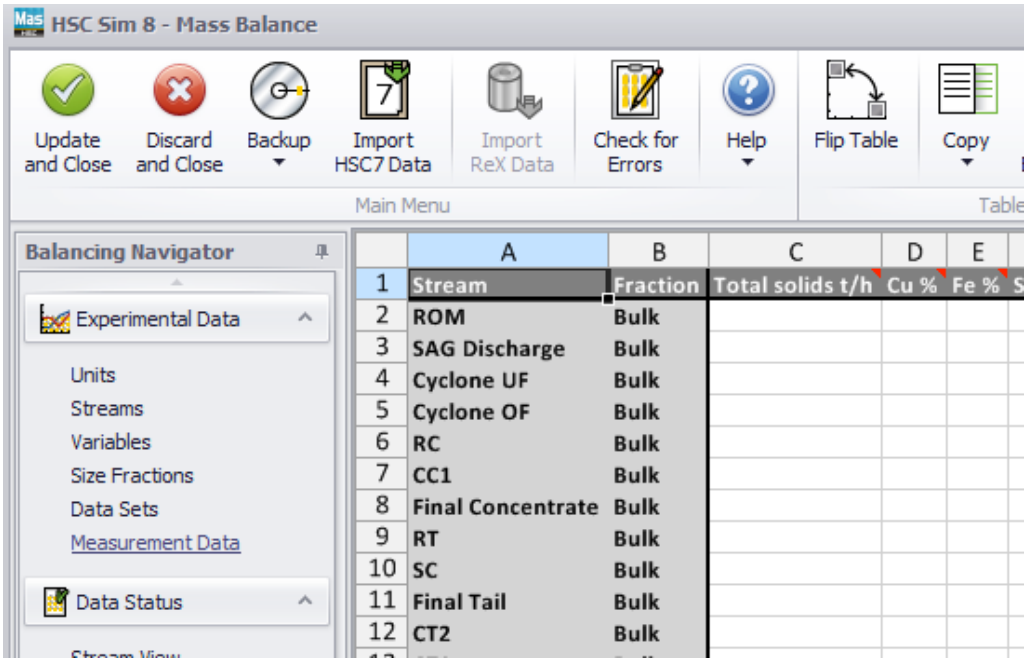


Fig. 9. Empty measurement data table

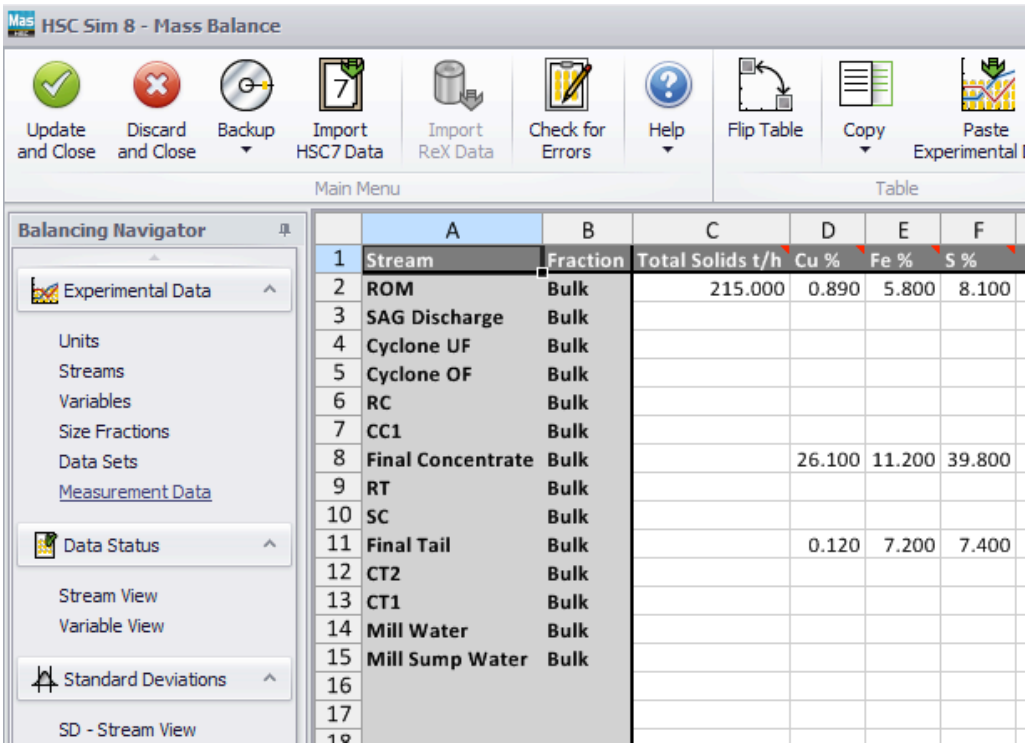
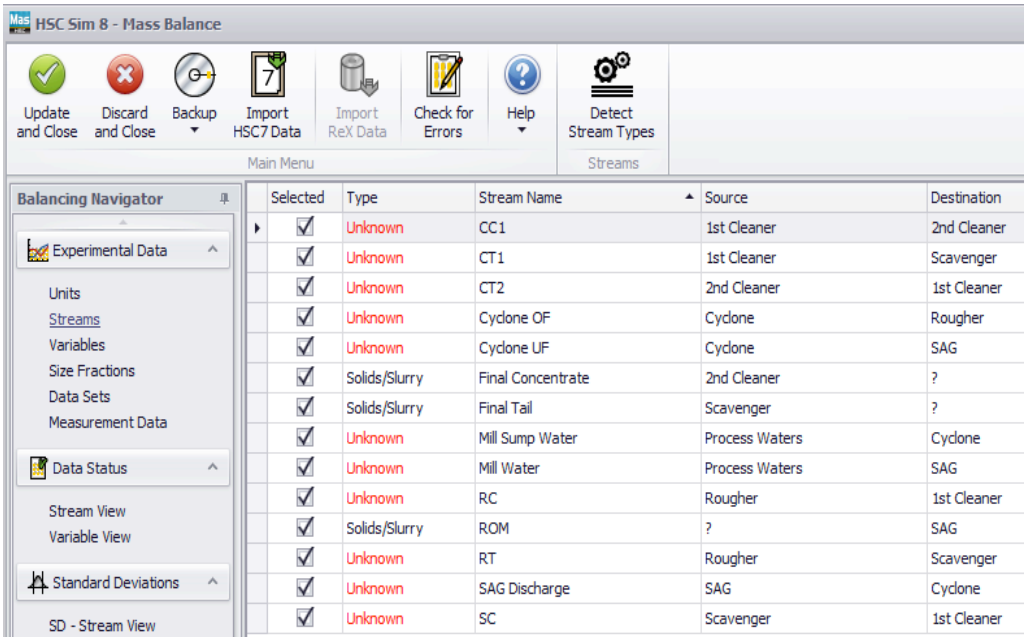


Fig. 10. Measurement data after the data has been pasted

After we have pasted the data, we have to return to Streams to set the stream types unless it has already been done. Since we now have the measurement data we can use the Detect Stream Types button. Pressing this button will not give the stream types of all streams in this case because some streams do not have measurement data. Before proceeding we must set the stream types manually.



Selected	Type	Stream Name	Source	Destination
☑	Unknown	CC1	1st Cleaner	2nd Cleaner
☑	Unknown	CT1	1st Cleaner	Scavenger
☑	Unknown	CT2	2nd Cleaner	1st Cleaner
☑	Unknown	Cyclone OF	Cyclone	Rougher
☑	Unknown	Cyclone UF	Cyclone	SAG
☑	Solids/Slurry	Final Concentrate	2nd Cleaner	?
☑	Solids/Slurry	Final Tail	Scavenger	?
☑	Unknown	Mill Sump Water	Process Waters	Cyclone
☑	Unknown	Mill Water	Process Waters	SAG
☑	Unknown	RC	Rougher	1st Cleaner
☑	Solids/Slurry	ROM	?	SAG
☑	Unknown	RT	Rougher	Scavenger
☑	Unknown	SAG Discharge	SAG	Cyclone
☑	Unknown	SC	Scavenger	1st Cleaner

Fig. 11. Streams after clicking Detect Stream Types

52.1.7. Stream view

In the next view we can have a look at the stream data. We can see the Value Status and Balanced Value Status of the data. The Value Status may be Measured, Missing, Fixed, Guesstimated, or Excluded. The user can change the Value Status.

However, the user cannot change the Balanced Value status which indicates the status of the data after balancing. Please note the balanced value status is calculated using the assumption that only solids (not water) are balanced. The Balanced Value status may be Balanced, Calculated, or Non-available.

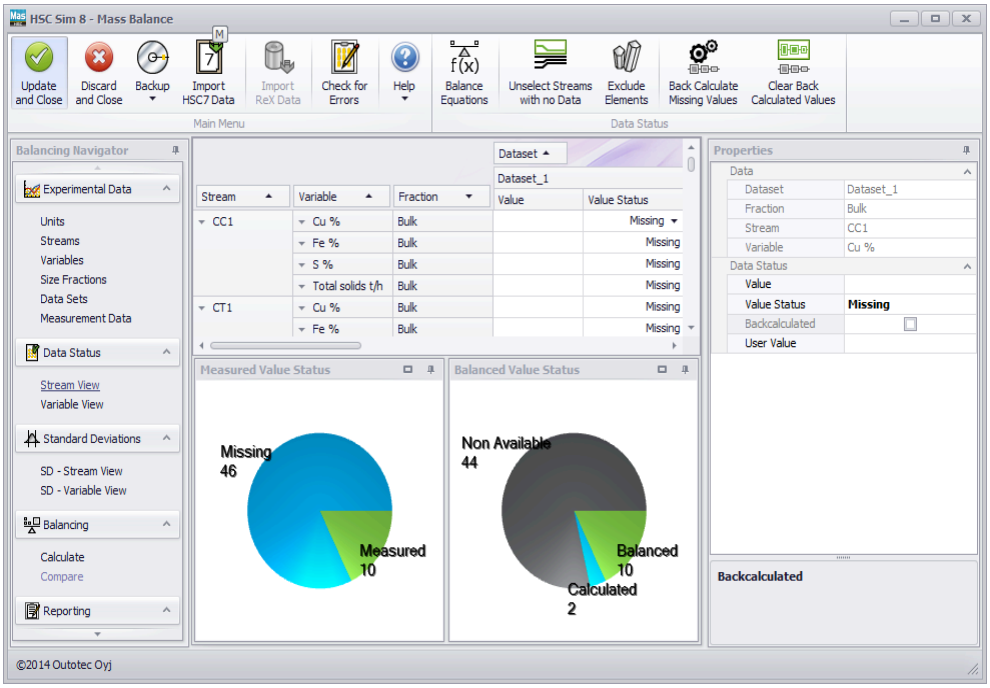


Fig. 12. Stream view

By clicking Balance Equations you can see the balance equations and the member units of the combined units. In this case the whole flowsheet forms one combined unit with the input ROM and outputs Final Tail and Final Concentrate.

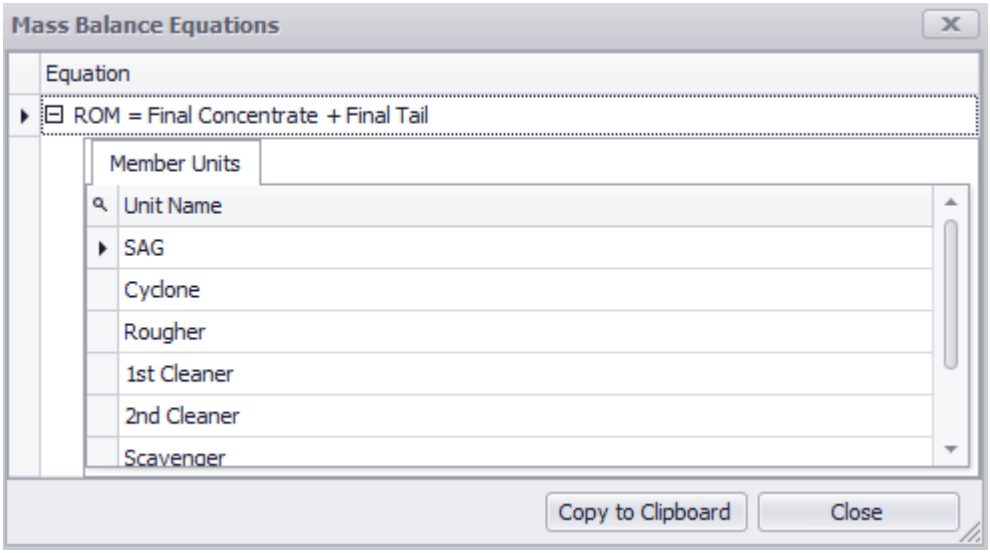


Fig. 13. Balance equations

52.1.8. Variable view

The Variable view is similar to the Stream view; only the order of fields is different.

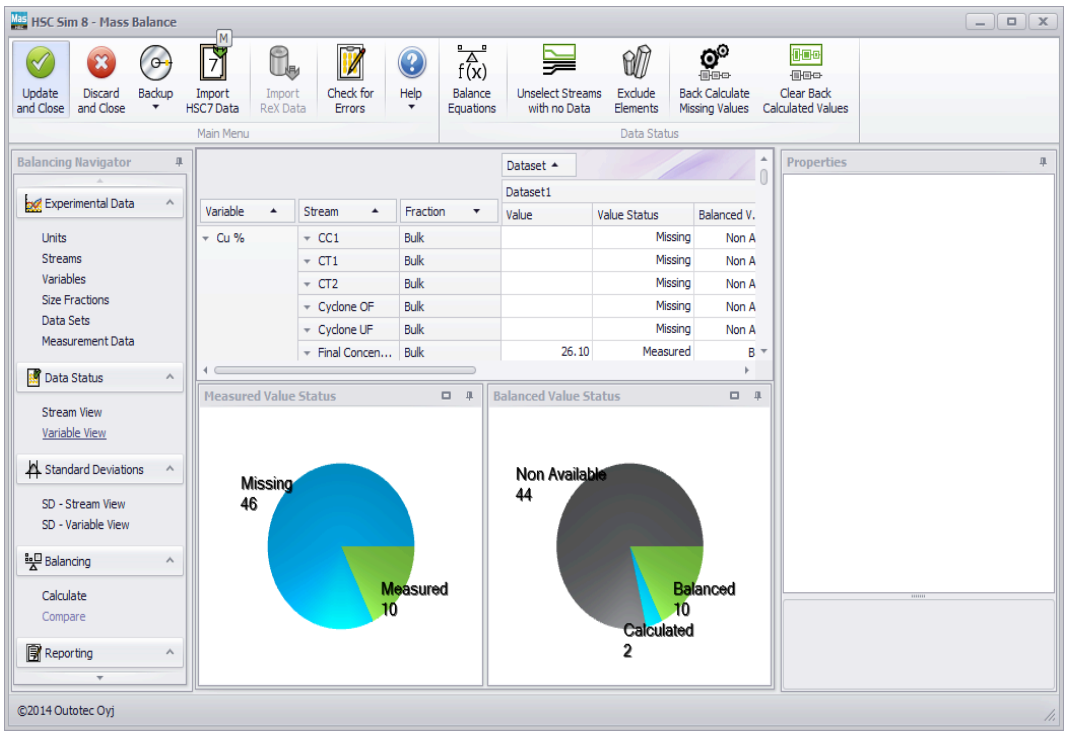


Fig. 14. Variable view

52.1.9. SD – Stream view

In this view, you can set standard deviations, error models and error model parameters for individual data or all data belonging to a stream. If you wish to change these values for an individual data object, please click this field and make the changes in the properties window on the right. If you want to make these changes to all data belonging to one stream, please click the stream and make the changes in the properties window. Please note that when you click a stream, you may find that some error model parameters are missing in the properties window. This is because in that case not all the data of that stream will have the same error model parameters, so no single value for the stream can be shown.

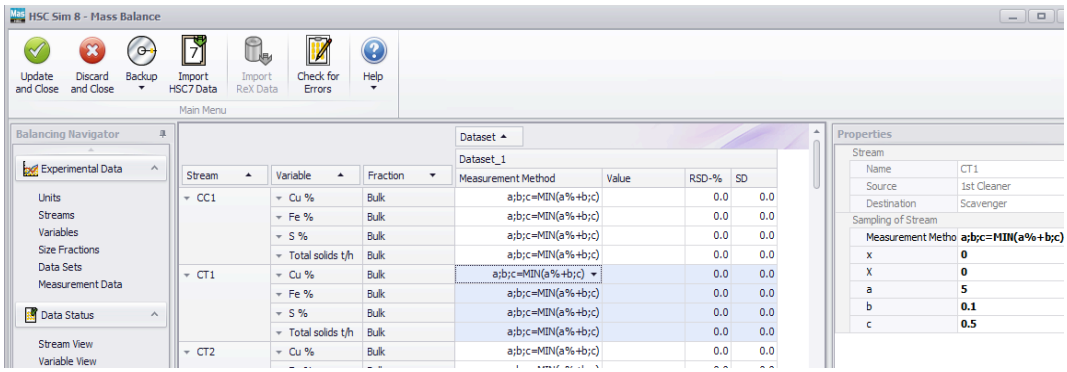


Fig. 15. SD – stream view

52.1.10. SD – Variable view

In this view, you can set standard deviations, error models and error model parameters for individual data or all data belonging to a variable. If you wish to change these values for an individual data object, please click this field and make the changes in the properties window on the right. If you want to make these changes to all data belonging to one variable you should click that variable and make the changes in the properties window. Please note that when you click a variable, you may find that some error model parameters are missing in the properties window. This is because in that case, not all the data of that variable will have the same error model parameters so no single value can be shown for the variable.

52.1.11. Calculate

In this view, you can select the solution method, for example. If the CLS solution method is chosen, you should give Min and Max values (the balanced value will be between these limits) for some data. Otherwise a notification will be given. This view also contains a parity chart to show the goodness of the solution. If you click a stream or a variable, you can see a property grid with values related to that stream/variable. If you click dataset, you can see a property grid where it is possible to change some solution parameters like Balance tolerance, Max iteration, and Estimate for null SD.

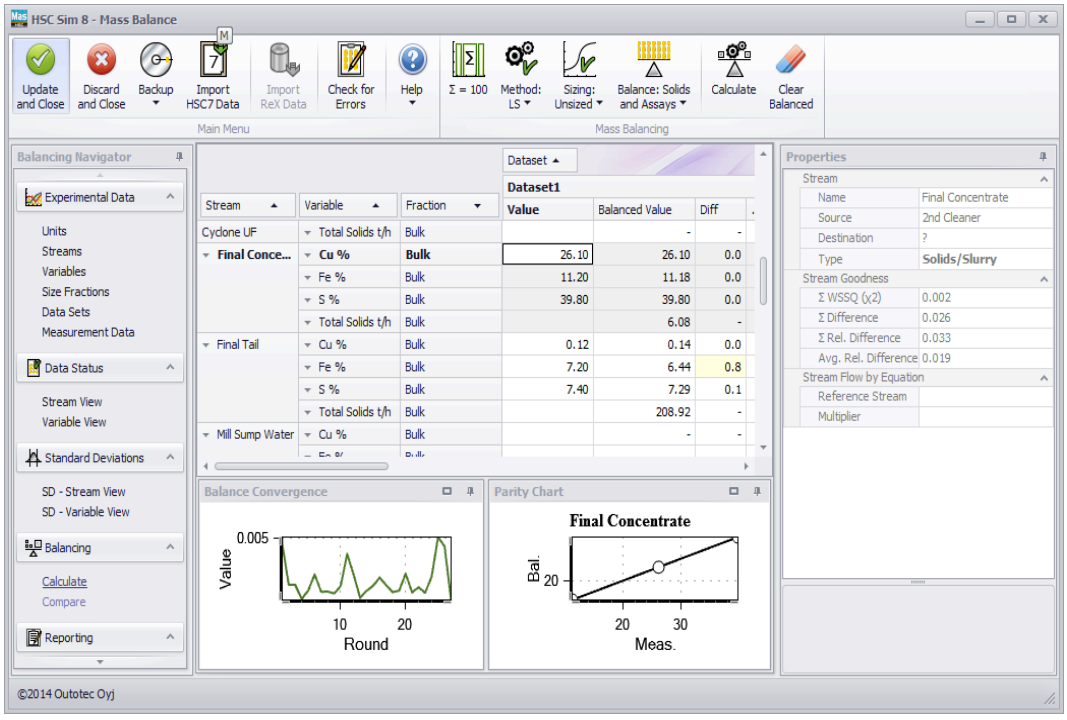


Fig. 16. Calculate view.

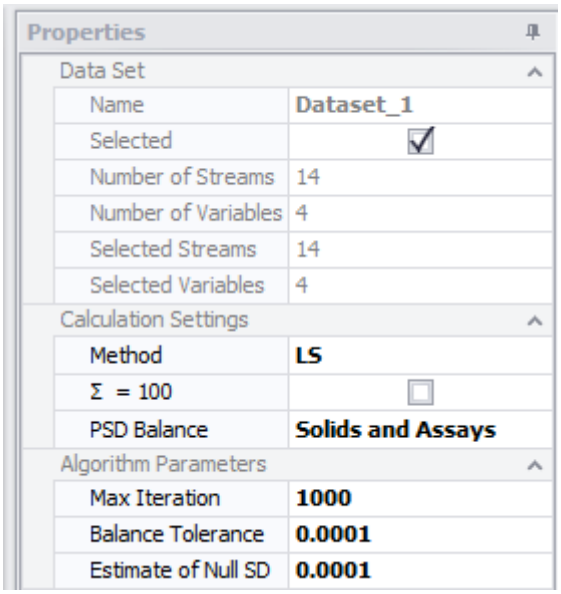
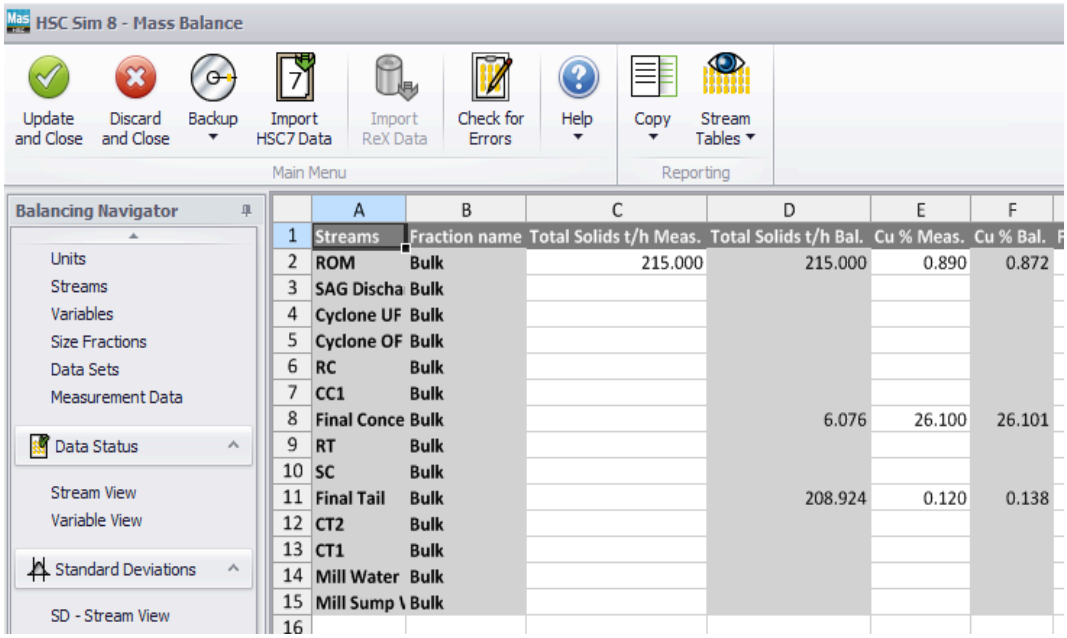


Fig. 17. Solution parameters.

52.1.12. Results

In the Results view, we can see the Stream Summary, Goodness, and Unit balance tables.



	A	B	C	D	E	F
1	Streams	Fraction name	Total Solids t/h Meas.	Total Solids t/h Bal.	Cu % Meas.	Cu % Bal.
2	ROM	Bulk	215.000	215.000	0.890	0.872
3	SAG Discha	Bulk				
4	Cyclone UF	Bulk				
5	Cyclone OF	Bulk				
6	RC	Bulk				
7	CC1	Bulk				
8	Final Conce	Bulk		6.076	26.100	26.101
9	RT	Bulk				
10	SC	Bulk				
11	Final Tail	Bulk		208.924	0.120	0.138
12	CT2	Bulk				
13	CT1	Bulk				
14	Mill Water	Bulk				
15	Mill Sump \	Bulk				
16						

Fig. 18. Stream summary.

	A	B	C	D	E	F
1	Variable	WSSQ	DiffTot	RelDif	AVG_SD	AVG_RSD
2	Total Solids t/h	0.000	0.000	0.000	0.500	0.002
3	Cu %	0.045	0.037	0.136	0.250	0.028
4	Fe %	6.681	1.556	6.429	0.450	0.056
5	S %	0.102	0.222	0.401	0.490	0.027
6						
7	Stream	Sum WSSQ	DiffSum	RelDiffSum	RelDiffAvg	
8	ROM	4.044	0.907	0.393	0.007	
9	SAG Discharge	0.000	0.000			
10	Cyclone UF	0.000	0.000			
11	Cyclone OF	0.000	0.000			
12	RC	0.000	0.000			
13	CC1	0.000	0.000			
14	Final Concentrate	0.002	0.026	0.033	0.019	
15	RT	0.000	0.000			
16	SC	0.000	0.000			
17	Final Tail	2.781	0.882	6.354	0.070	
18	CT2	0.000	0.000			
19	CT1	0.000	0.000			
20	Mill Water	0.000	0.000			
21	Mill Sump Water	0.000	0.000			

Fig. 19. Goodness.

	A	B	C	D	E	F	G
1	Units	Equations	Stream	Total Solids	Cu %	Fe %	S %
2	SAG + Cyclo	ROM = Final Concentrate + Final Tail					
3		Inputs	ROM	215.000	1.874	14.142	17.653
4		Outputs	Final Conce	6.076	1.586	0.679	2.418
5			Final Tail	208.924	0.288	13.463	15.235
6		Balance		0.00E+00	8.73E-13	-3.62E-11	-5.13E-12
7							

Fig. 20. Unit Balance.

52.1.13. Visualization

In the Results view, you can import data to the flowsheet by using the following dropdown.

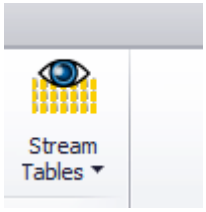


Fig. 21. Stream tables dropdown.

After that, close Mass Balancing and return to the flowsheet. Then press the blue icon with the green arrow underneath on the left.

Fig. 22. Select visualization.

The following combo box will appear:

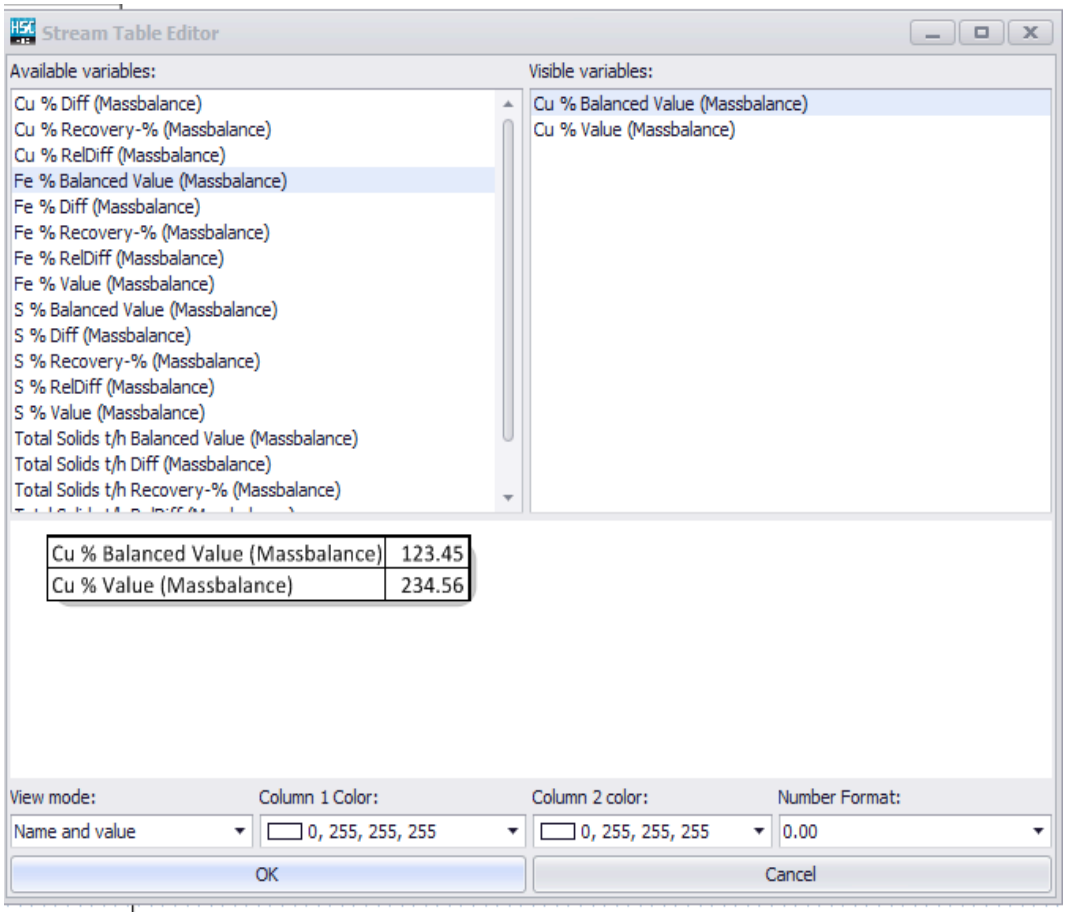


Fig. 23. Combo box.

Select the items you want to visualize by double-clicking. Press OK.

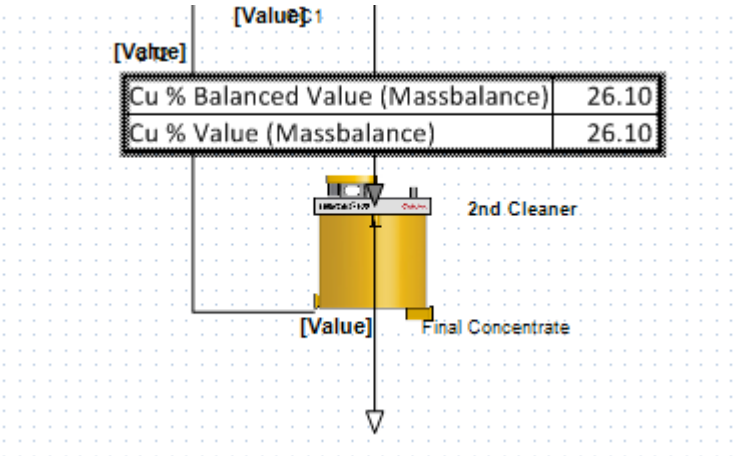


Fig. 24. Stream tables.

52.2. Sized Example

First open the flowsheet under the installation folder from C:\HSC8\MassBalance\Examples\sized example\sized.Sim8. Then go to Tools-Mass Balancing-Mass Balancing.

52.2.1. Units and Streams

Units and streams are similar to the case of the unsized example.

52.2.2. Variables

This time a variable of the type Size Fraction Assay wt % is added.

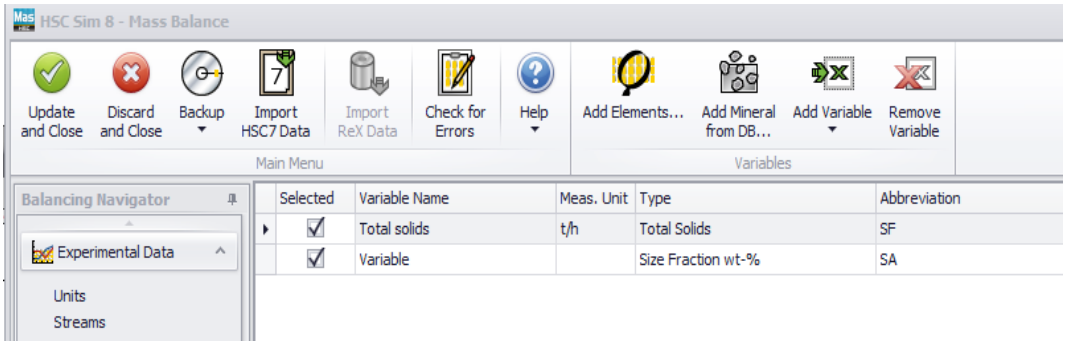


Fig. 25. Variables.

52.2.3. Fractions

Next add the size fractions. Be careful when writing the names of the fractions because they should be exactly the same as in the data to be pasted.

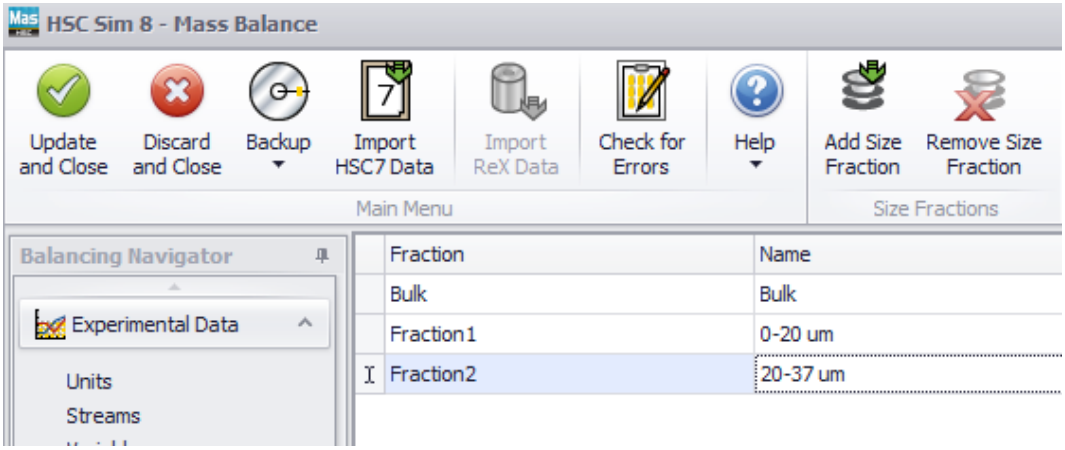


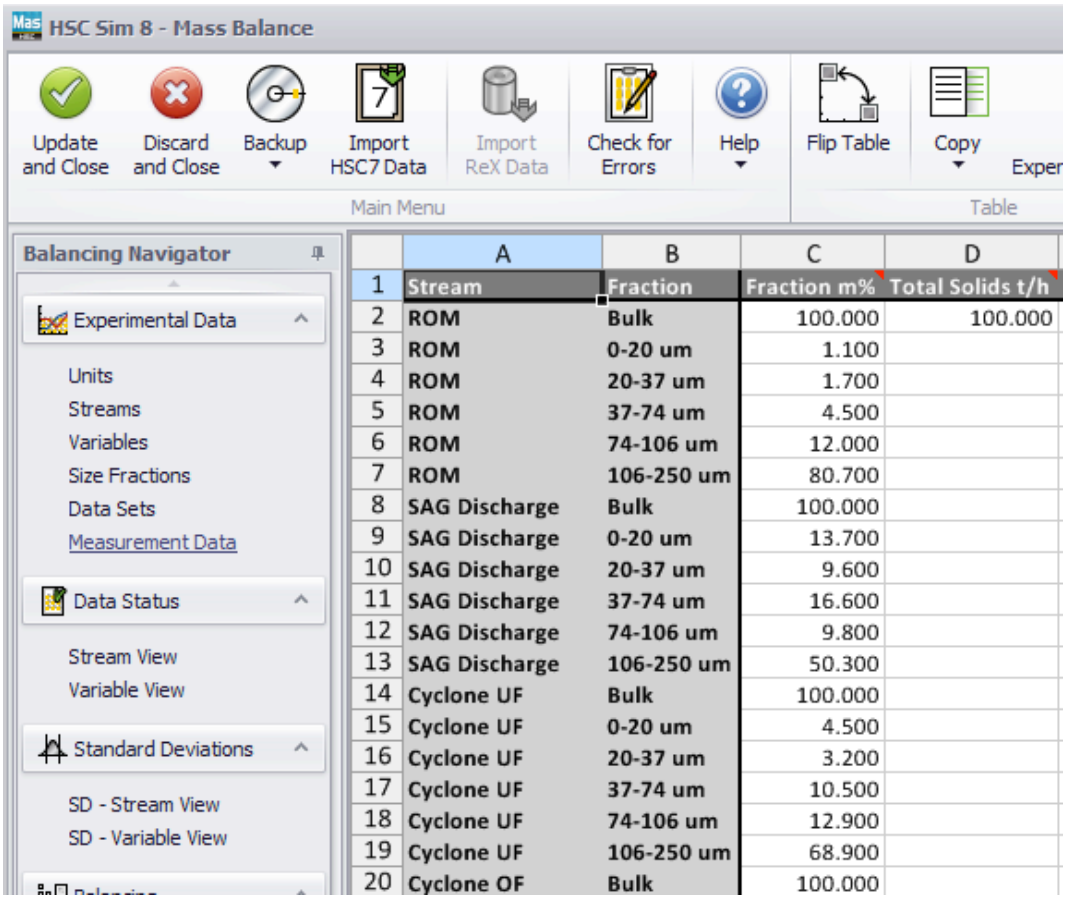
Fig. 26. Fractions.

52.2.4. Datasets

In this case there is only one dataset.

52.2.5. Measurement data

After the data have been pasted it should look like this:



	A	B	C	D
1	Stream	Fraction	Fraction m%	Total Solids t/h
2	ROM	Bulk	100.000	100.000
3	ROM	0-20 um	1.100	
4	ROM	20-37 um	1.700	
5	ROM	37-74 um	4.500	
6	ROM	74-106 um	12.000	
7	ROM	106-250 um	80.700	
8	SAG Discharge	Bulk	100.000	
9	SAG Discharge	0-20 um	13.700	
10	SAG Discharge	20-37 um	9.600	
11	SAG Discharge	37-74 um	16.600	
12	SAG Discharge	74-106 um	9.800	
13	SAG Discharge	106-250 um	50.300	
14	Cyclone UF	Bulk	100.000	
15	Cyclone UF	0-20 um	4.500	
16	Cyclone UF	20-37 um	3.200	
17	Cyclone UF	37-74 um	10.500	
18	Cyclone UF	74-106 um	12.900	
19	Cyclone UF	106-250 um	68.900	
20	Cyclone OF	Bulk	100.000	

Fig. 27. Pasted data.

After you have pasted the measurement data, return to Streams and press Detect Stream Types. If this does not set all the stream types, then set them manually.

52.2.6. SD Stream view and SD Variable view

These views are similar to the case of the unsized example.

52.2.7. Calculate

When calculating the balance for the first time, we can see that the balance is not good. There is one point in the parity chart that differs greatly from the others. By clicking this point we can place the focus on that item of data in the table. In this view we can change the SD values of the data. Let's set a high SD value of 10. After this modification, press Calculate again.

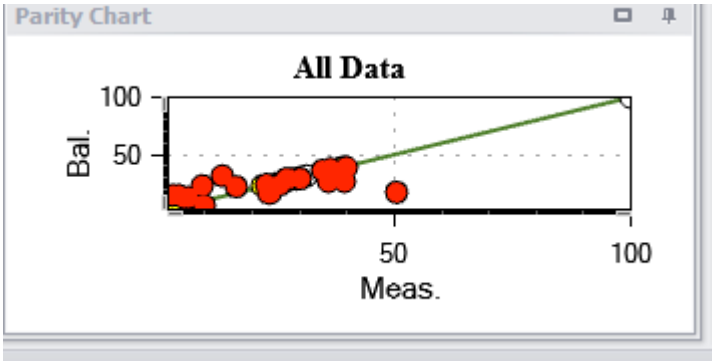


Fig. 28. Parity chart before SD modification.

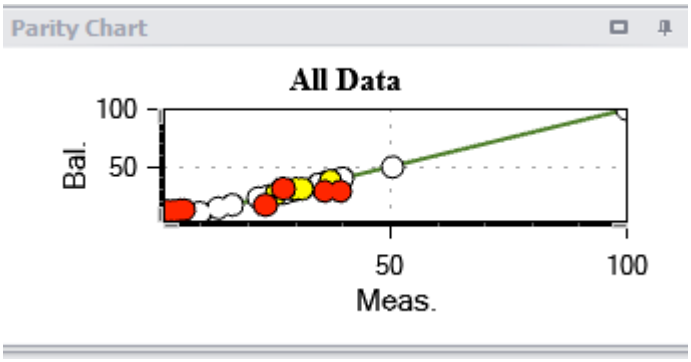


Fig. 29. Parity chart after SD modification

52.3. Sized by assay example

First open the flowsheet under the installation folder from C:\HSC8\MassBalance\Examples\sized by assay example\sized by assay.Sim8. Then go to Tools-Mass Balancing-Mass Balancing.

52.3.1. Units and Streams

Units and streams are similar to the case of the unsized example.

52.3.2. Variables

Now add the variables.

Selected	Variable Name	Meas. Unit	Type	Abbreviation
☑	Fraction m%		Size Fraction wt-%	SA
☑	Total Solids t/h		Total Solids	SF
☑	Cu %		Solids Component Assay	A
☑	Fe %		Solids Component Assay	A
☑	S %		Solids Component Assay	A

Fig. 30. Variables.

52.3.3. Size fractions

Add the size fractions.

Fraction	Name
Bulk	Bulk
Fraction1	0-20 um
Fraction2	20-37 um
Fraction3	37-74 um
Fraction4	74-106 um
Fraction5	106-250 um

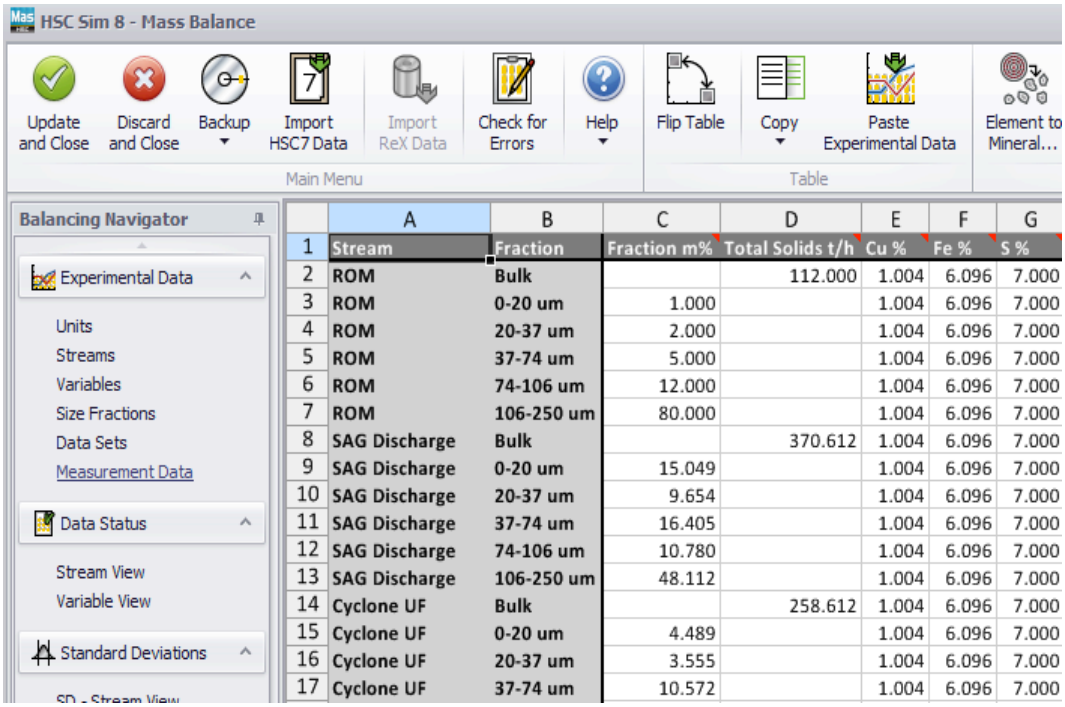
Fig. 31. Fractions.

52.3.4. Datasets

There is only one dataset.

52.3.5. Measurement data

After pasting the measurement data the view should look like this:



	A	B	C	D	E	F	G
1	Stream	Fraction	Fraction m%	Total Solids t/h	Cu %	Fe %	S %
2	ROM	Bulk		112.000	1.004	6.096	7.000
3	ROM	0-20 um	1.000		1.004	6.096	7.000
4	ROM	20-37 um	2.000		1.004	6.096	7.000
5	ROM	37-74 um	5.000		1.004	6.096	7.000
6	ROM	74-106 um	12.000		1.004	6.096	7.000
7	ROM	106-250 um	80.000		1.004	6.096	7.000
8	SAG Discharge	Bulk		370.612	1.004	6.096	7.000
9	SAG Discharge	0-20 um	15.049		1.004	6.096	7.000
10	SAG Discharge	20-37 um	9.654		1.004	6.096	7.000
11	SAG Discharge	37-74 um	16.405		1.004	6.096	7.000
12	SAG Discharge	74-106 um	10.780		1.004	6.096	7.000
13	SAG Discharge	106-250 um	48.112		1.004	6.096	7.000
14	Cyclone UF	Bulk		258.612	1.004	6.096	7.000
15	Cyclone UF	0-20 um	4.489		1.004	6.096	7.000
16	Cyclone UF	20-37 um	3.555		1.004	6.096	7.000
17	Cyclone UF	37-74 um	10.572		1.004	6.096	7.000

Fig. 32. Measurement data

52.3.6. SD Stream view and SD Variable view

These views are similar to those in the unsized and sized examples.

52.3.7. Calculate

If we click Calculate in this view, it will automatically calculate the sized by assay balance. In this case it is also possible to calculate the unsized or sized balance. This can be done by selecting unsized or sized from the Sizing dropdown.

Fig. 33. Sizing.

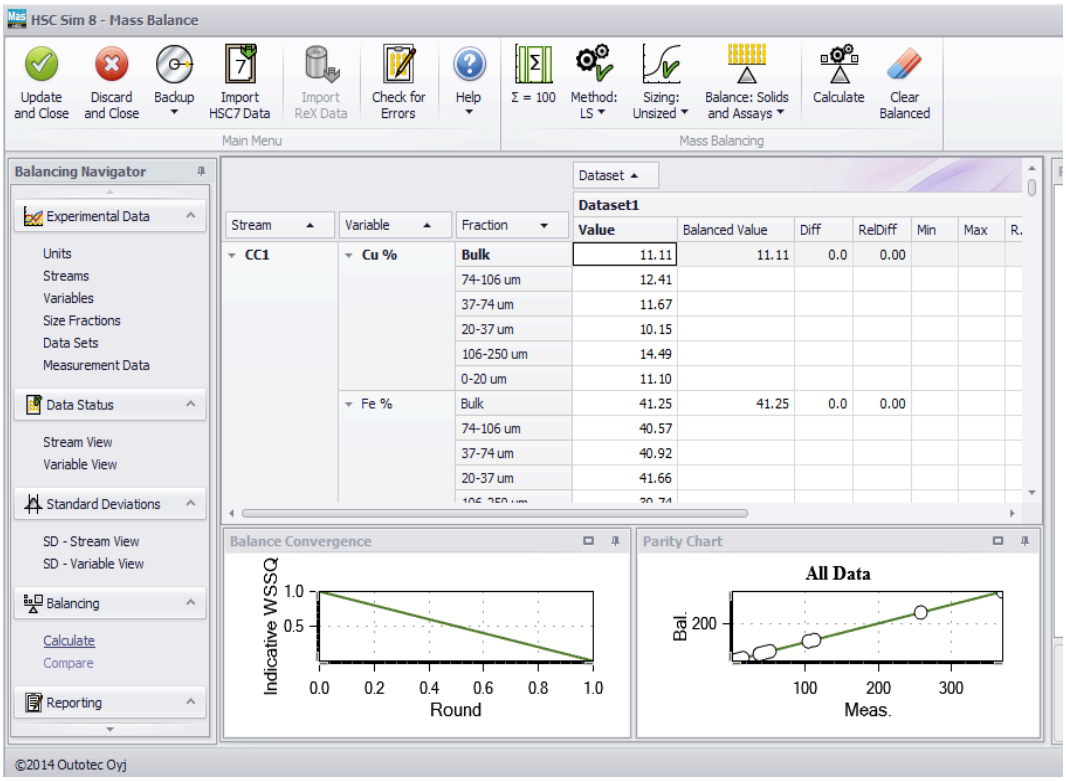


Fig. 34. Solved as unsized.

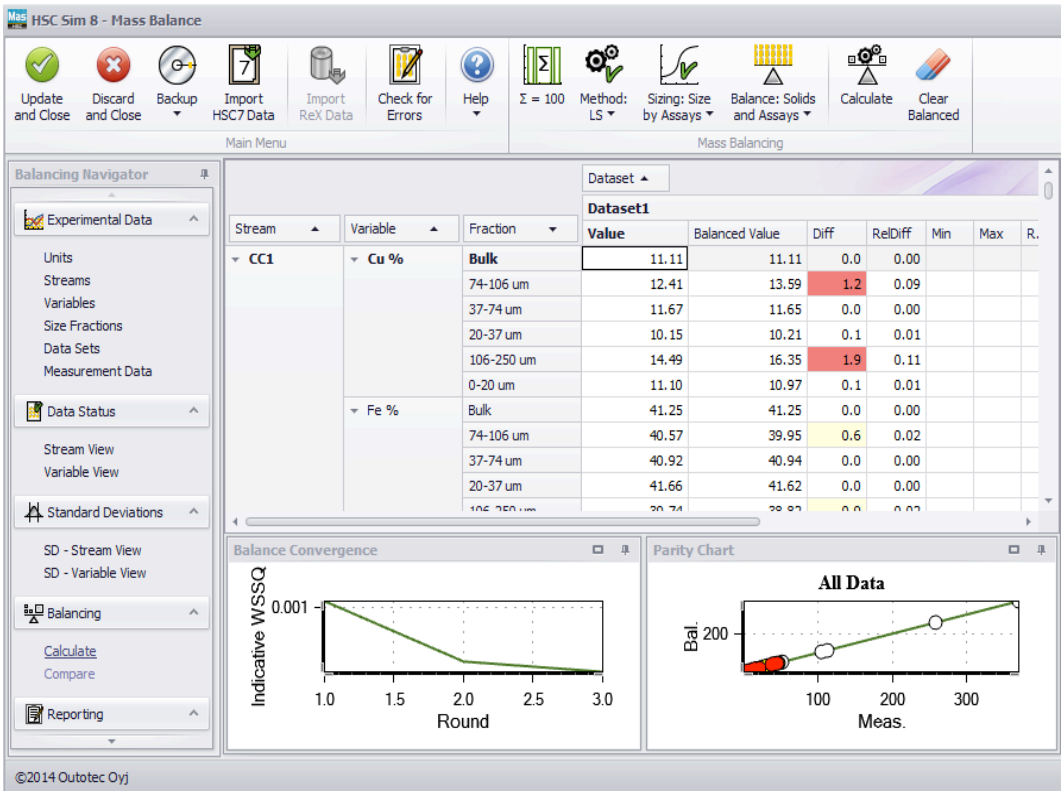


Fig. 35. Solved as sized by assay.