

AUTOMATED FACTORY EXCEPTION REPORTING USING SUGARS™ 4.1 MASS AND ENERGY BALANCE SOFTWARE

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Introduction:

Sugar factory performance is often compared to a set of “standards” that are set at the beginning of each campaign based on anticipated average beet quality parameters. However, as beet quality and processing rates change, even the most optimized factory’s results will vary. It is more beneficial to compare the actual factory operating data to an accurate mass and energy balance that accounts for the actual throughput and beet supply conditions. This will give a much more realistic picture of the factory’s performance versus what would be expected under the actual conditions experienced.

Methods:

The first step to automated exception reporting is to build and validate an accurate mass and energy balance model of the factory. This involves a thorough audit of the entire process, including installed equipment, piping, manual valve settings, and typical process operating parameters. The model should be designed in such a way that process chemical inputs, steam loads, sugar and by-product production and other results are calculated based on inputs of beet slice rate, cossette sugar content, non-sugar load, beet temperatures, and other external variables.

Sugars™ is the mass and energy balance software used throughout the global sugar industry. The figures below show an example beet sugar factory simulation model in Sugars™.

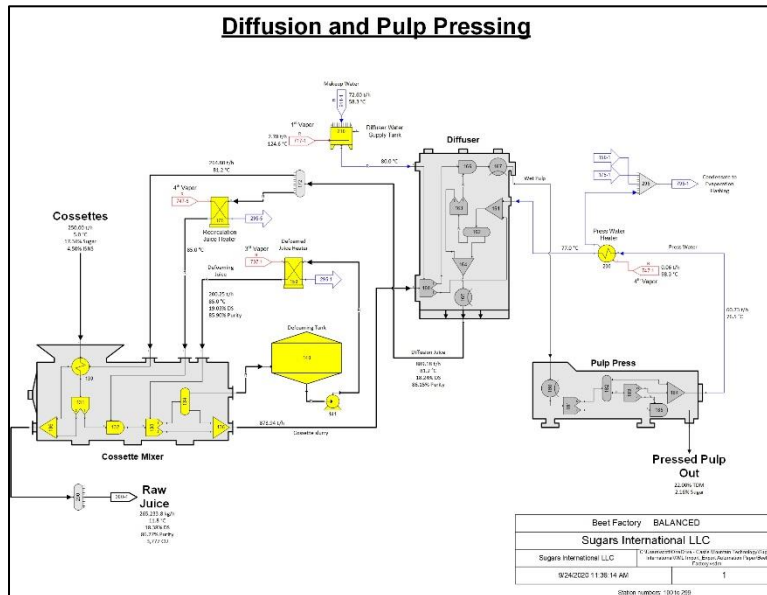


Figure 1: Beet Factory model, Diffusion Area

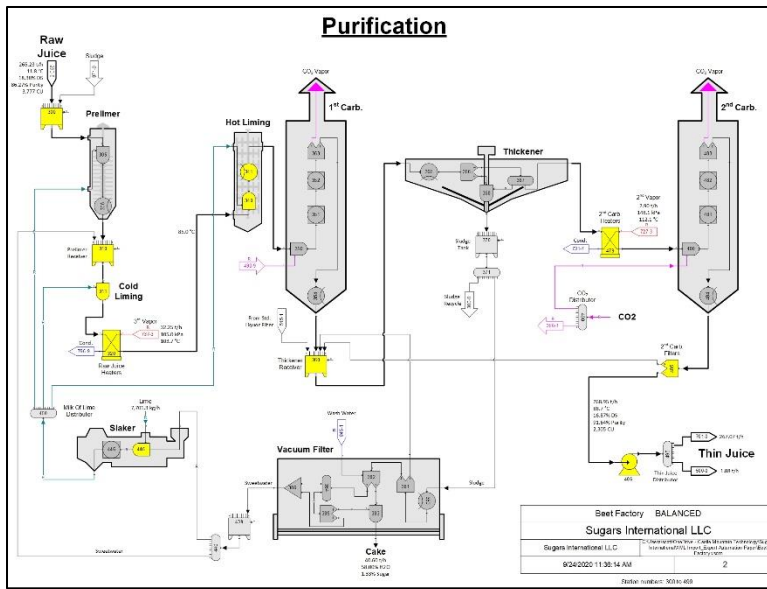


Figure 2: Beet Factory model, Purification Area

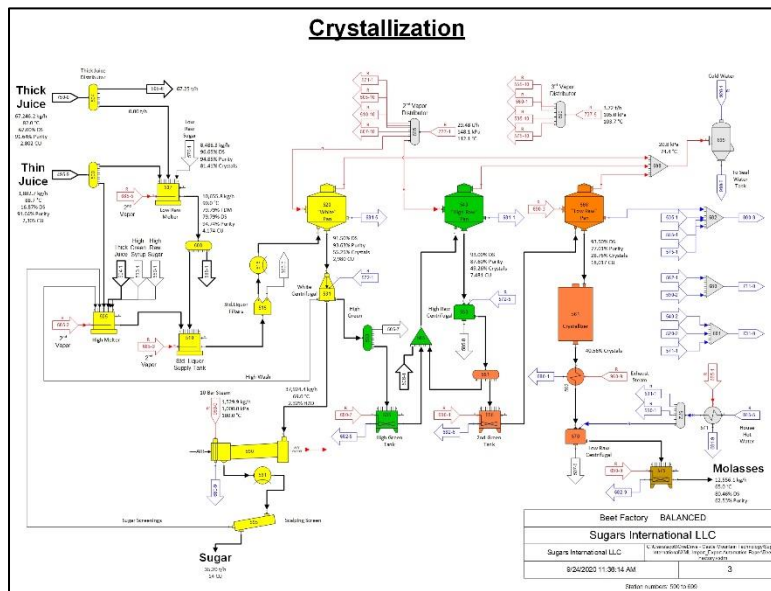


Figure 3: Beet Factory model, Crystallization Area

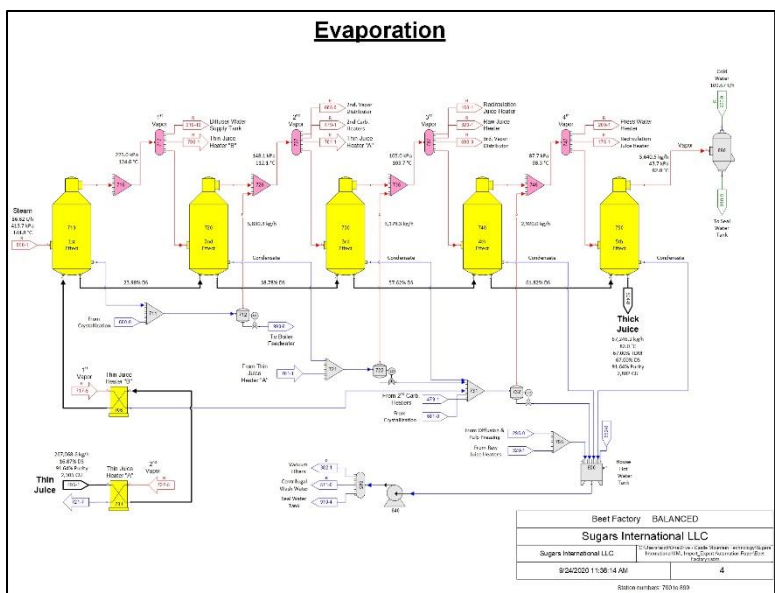


Figure 4: Beet Factory model, Evaporation Area

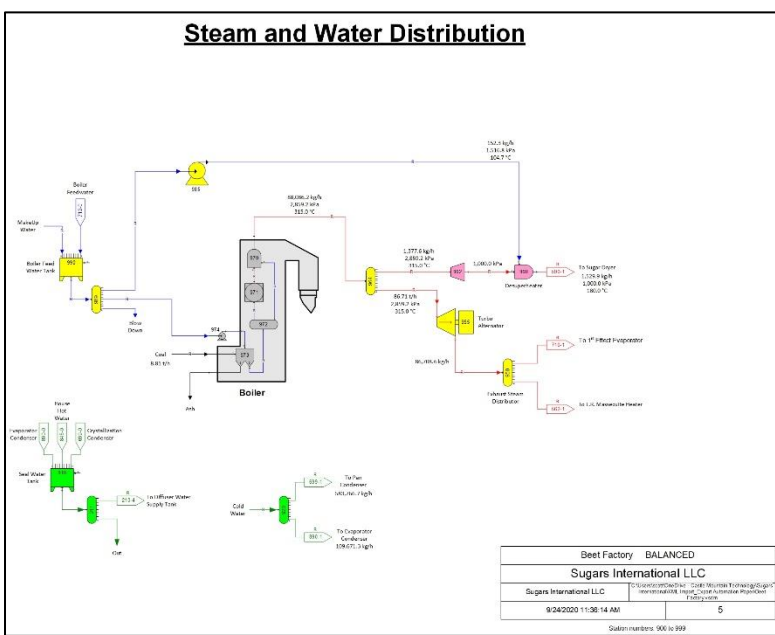


Figure 5: Beet Factory model, Steam and Water Area

Following model development, it is necessary to identify which process parameters will need to be included in the XML data import and export to and from Sugars™. For input to the Sugars™ model, the XML file should include, at a minimum, the external flow stream containing the cossettes entering the factory. This will allow parameters such as the beet slice rate, cossette sugar content, dissolved non-sucrose content, fiber (marc) content, and even cossette temperature to be input to the model. Depending on factory configuration, other input variables may include stored juice processing rates/quality, steam turbine generator loads, or other factory settings.

Additionally, flow streams containing sugar and co-product production rates and quality should be included in the XML file, as well as required energy and material inputs such as steam

and limestone. These results of the Sugars™ model will be compared to the actual factory operation.

Including Sugars™ flow stream and station parameters in the XML import or export files is easy. Simply add a “Station ID” to the desired stations; that triggers inclusion in the XML file of that station’s data, any external flows entering the station, and all internal flows leaving the station. Figure 6 below shows an example of a “Station ID” used to trigger inclusion of the first Cossette Mixer station, which will also include the external flow stream for cossettes entering the factory.

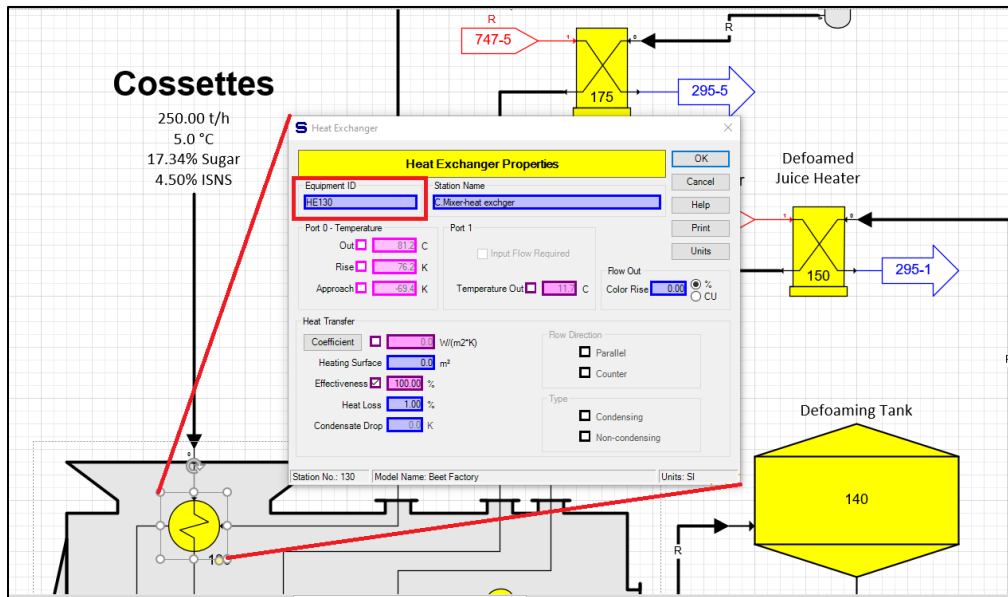


Figure 6: Adding “Equipment ID” to Sugars™ station

Once an “Equipment ID” is added to all the desired stations, an XML Data Export should be initiated to create an XML data file for the Sugars™ model. XML data files are a standardized text file format used in many program and web applications. Figures 7 and 8 below show the XML data export feature in Sugars™ and a portion of the XML data file for the Beet Factory example model given above. Note that to utilize this feature in Sugars™, the XML Data import/export feature must be activated in your software license.

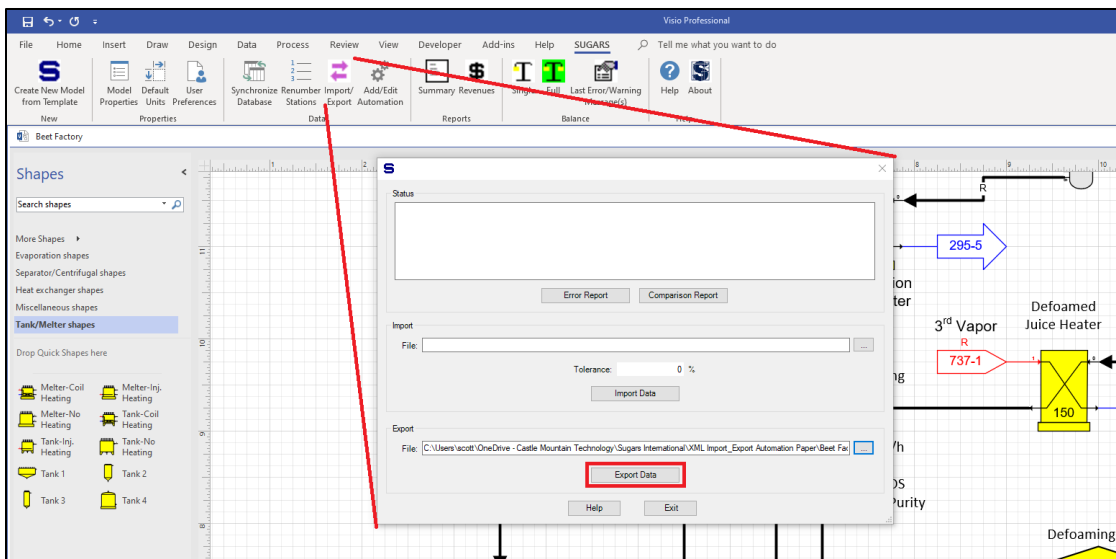


Figure 7: Manually exporting XML data file from Sugars™

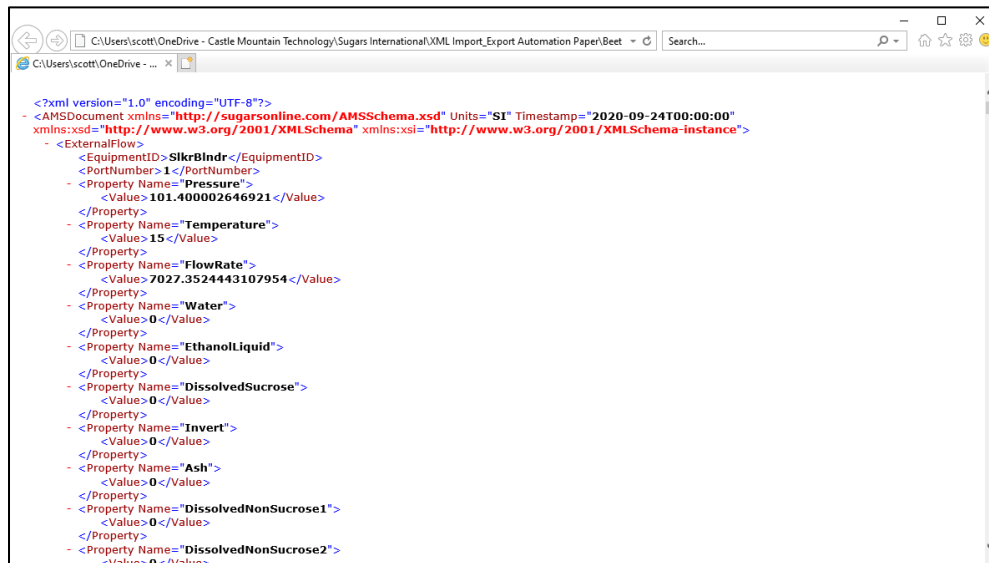


Figure 8: Example Sugars™ XML data file structure (only first few lines shown)

This exported XML data file will serve as the template for development of the interface from/to the factory's laboratory and/or process information system.

Programming this interface is the next required step, and the method will vary depending on the factory's data system(s). In all cases, a program should be written that opens the XML data file, over-writes the pertinent input parameters (slice rate, cossette quality, etc.) with their actual average values, and saves the file in a location accessible to Sugars™. This program should execute automatically on a specific frequency of the factory's choosing (daily, weekly, semi-weekly, etc.). Keep in mind that averages over at least a week's time will likely be more representative than more frequent aggregates due to fluctuations in factory tank levels and other transient conditions. A relatively simple example of factory operating data to be written from Microsoft Excel to the Sugars™ XML file is shown in Figure 9 below.

| | A | B | C | D | E |
|---|--|---|---|-------|--------|
| 1 | Beet Factory Daily Operating Report | | | | |
| 2 | | | | | |
| 3 | Input Values | | | | |
| 4 | Tons Beets Sliced: | | | 5,482 | tons |
| 5 | Cossette Sugar Content: | | | 16.85 | % |
| 6 | Cossette Purity: | | | 86.2 | % |
| 7 | Cossette Temperature: | | | 2 | deg. C |
| 8 | Cossette Marc: | | | 4.5 | % |

Figure 9: Example factory operating data to be written to Sugars™ XML data file

Following this step, Sugars™ 4.1 can be configured to automatically import this XML data file, balance based on the updated input values, and export an XML file with the results. Once activated, this sequence will occur any time the factory’s Sugars™ model file is opened. Figure 10 below shows the Automation Settings form that contains the entry fields for specifying whether the automation is enabled, the path/filename of the XML data file to be imported, the parameter change tolerance (to trigger internal exception logging within Sugars™), and the path/filename of the XML data file that Sugars™ will export with the balance results. Note that once Automation Settings are configured, a text document with filename [modelname].txt will be saved in the same directory as the Sugars™ drawing and model database files. This file must remain in that directory for the automation process to proceed.

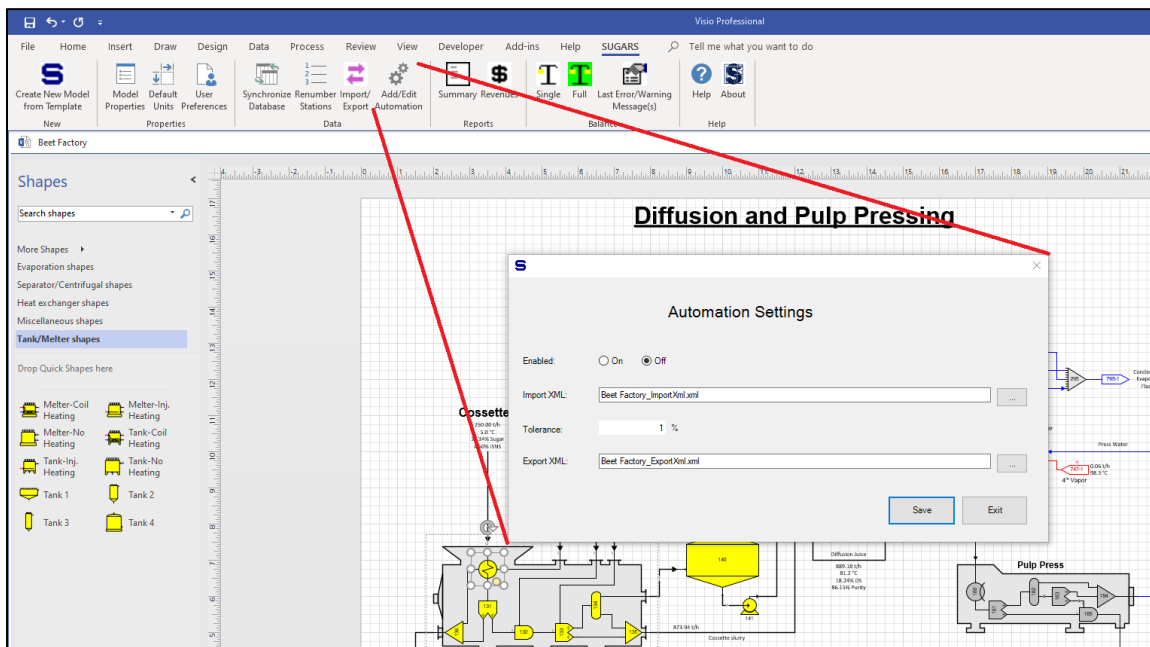


Figure 10: Sugars™ XML Import/Export Automation Settings

The factory’s Sugars™ model can be scheduled to automatically open on a specified frequency using Windows Task Scheduler. This will cause the model drawing to open, launch Sugars™, import the XML data file containing input data, balance the model, then export the XML data file with the results, and finally close Visio/Sugars™. The final screen of the “Create Basic Task Wizard” in Windows Task Scheduler is shown below in Figure 11, showing an example setup for automatically opening the Sugars™ model. Note that the “Argument” field is not shown, but must be set to the full path/filename of the Visio drawing file to be opened.

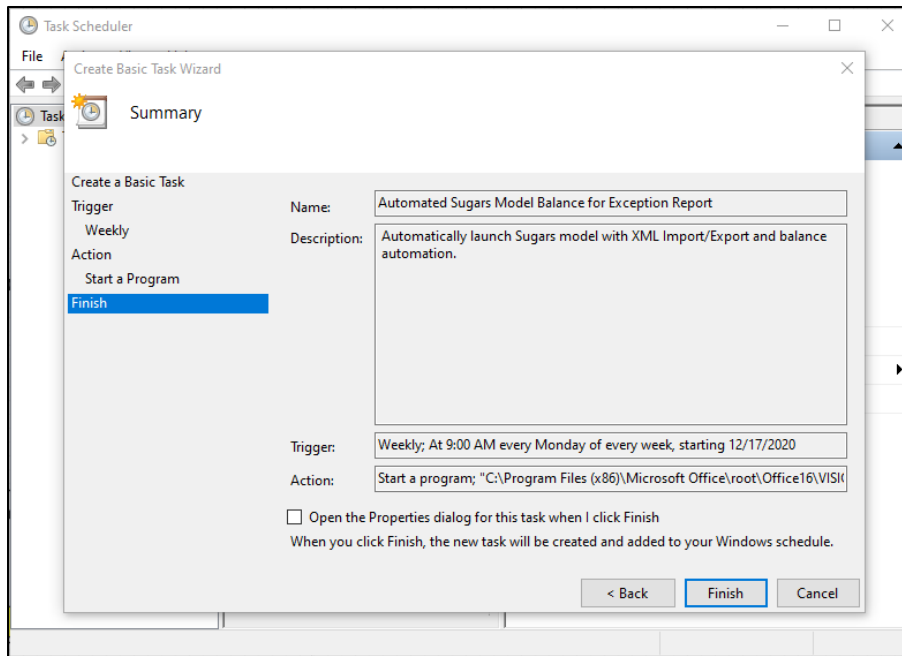


Figure 11: Example Windows Task Scheduler settings

With the SugarsTM model fully automated, the final step is to build an automated report that reads the SugarsTM balance results from the exported XML data file, and compares them to the actual factory operating results. This could be built as a Microsoft Excel spreadsheet using Visual Basic for Applications macros, or using SQL database programming, or any other platform based on local preference. A simple example is shown in Figure 12 below using Excel.

| Beet Factory Daily Operating Report Comparison | | | | |
|---|-------|---------------|---------------|-----------------|
| Input Values | | | | |
| Tons Beets Sliced: | 5,482 | tons | | |
| Cossette Sugar Content: | 16.85 | % | | |
| Cossette Purity: | 86.2 | % | | |
| Cossette Temperature: | 2 | deg. C | | |
| Cossette Marc: | 4.5 | % | | |
| Output Values | | | | |
| | | Report | Sugars | Variance |
| Lime Usage: | 175 | tons | 169 | tons 3.8% |
| Thick Juice Purity: | 91.8 | % | 91.6 | % 0.2% |
| Sugar Production: | 745 | tons | 770 | tons -3.2% |
| Molasses Production: | 271 | tons | 275 | tons -1.3% |
| Molasses Purity: | 63.4 | % | 62.5 | % 1.4% |
| Steam Usage: | 1,822 | tons | 1,939 | tons -6.0% |
| Steam/Beets: | 33.2 | % | 35.4 | % -6.0% |
| Pressed Pulp Production: | 661 | tons | 672 | tons -1.7% |
| Pressed Pulp Moisture: | 77.5 | % | 77.2 | % 0.3% |
| Pulp Loss: | 0.28 | %/bts | 0.26 | %/bts 6.6% |
| Total Extraction: | 80.7 | % | 83.3 | % -3.2% |

Figure 12: Example Exception Report

This exception report shows the actual factory operating results compared directly to the Sugars™ model balance results based on the same input values (shown again at the top for reference). In this example, the percent variance is calculated and color-coded so that any value over +/-5% is shaded pink.

In summary, the entire sequence of automation is as follows:

- 1) Creation of XML import file containing average input values from factory laboratory/process data system.
- 2) Opening of Sugars™ model drawing, with XML import/export and balance automation enabled. Model will automatically close when balance and export are complete.
- 3) Reading of XML export file (balance results) and creation of exception report.

Discussion and Conclusion:

Sugar factory operation exception reports are not a new concept; they have been utilized for many years across the industry. However, they typically compare actual results to a static set of “standards” which generally only apply to the average expected results over an entire campaign. Thus, on a more immediate basis (i.e. weekly), they are considered less applicable. For instance, an exception report that compares the operation of a factory in February conditions (potential for some frozen beets, some with moderate deterioration, reduced slice rate, etc.) to campaign average conditions is often ignored, as nearly every parameter shows major deviation.

However, when the basis for comparison is a Sugars™ mass and energy balance model that accounts for these changes in factory inputs, the exception report becomes much more valuable. Factory staff can use the results to identify potential opportunities with regard to operational efficiency, measurement accuracy, and other issues needing attention. In many cases, addressing these items results in many thousands of dollars of increased revenue or reduced cost.

The additional XML Import/Export and balance automation feature in Sugars™ 4.1, when combined with factory laboratory/process data systems, opens the door to automatic generation of useful exception reports on a regular basis. This is a valuable new tool for sugar companies across the globe to maximize revenues and minimize costs.