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Sugars™ for Windows - A Revolutionary Update



**SUGARS
INTERNATIONAL**

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ABSTRACT

The new Windows® version of Sugars™ has a full graphical interface for building models of sugar factories and refineries. It is fast, flexible and very user-friendly. Models are built using drag-and-drop techniques to draw the flow diagram. Stencils containing shapes of stations are provided with the program and these shapes are used to draw the flow diagram of the process. Connections are made between shapes using a connector tool with automatic line routing and crossovers. Data for each station and flow stream in the model is entered on dialog screens that are displayed by double clicking on the station shape, or flow stream. Changing a model, after it is built, is done by simply revising the flow diagram and/or modifying the performance data for any station. All of the data for a model is stored in a Microsoft® Access database that can be addressed by other programs. Heat, material and color balances are quickly obtained from simulations of the model to predict the performance results for the process. A revenue screen shows the net process revenues generated by the process to assist with financial decisions. The new Sugars for Windows computer program is a major upgrade to assist cane and beet sugar factory and refinery process engineers and management with decisions for making improvements to their operations.

INTRODUCTION

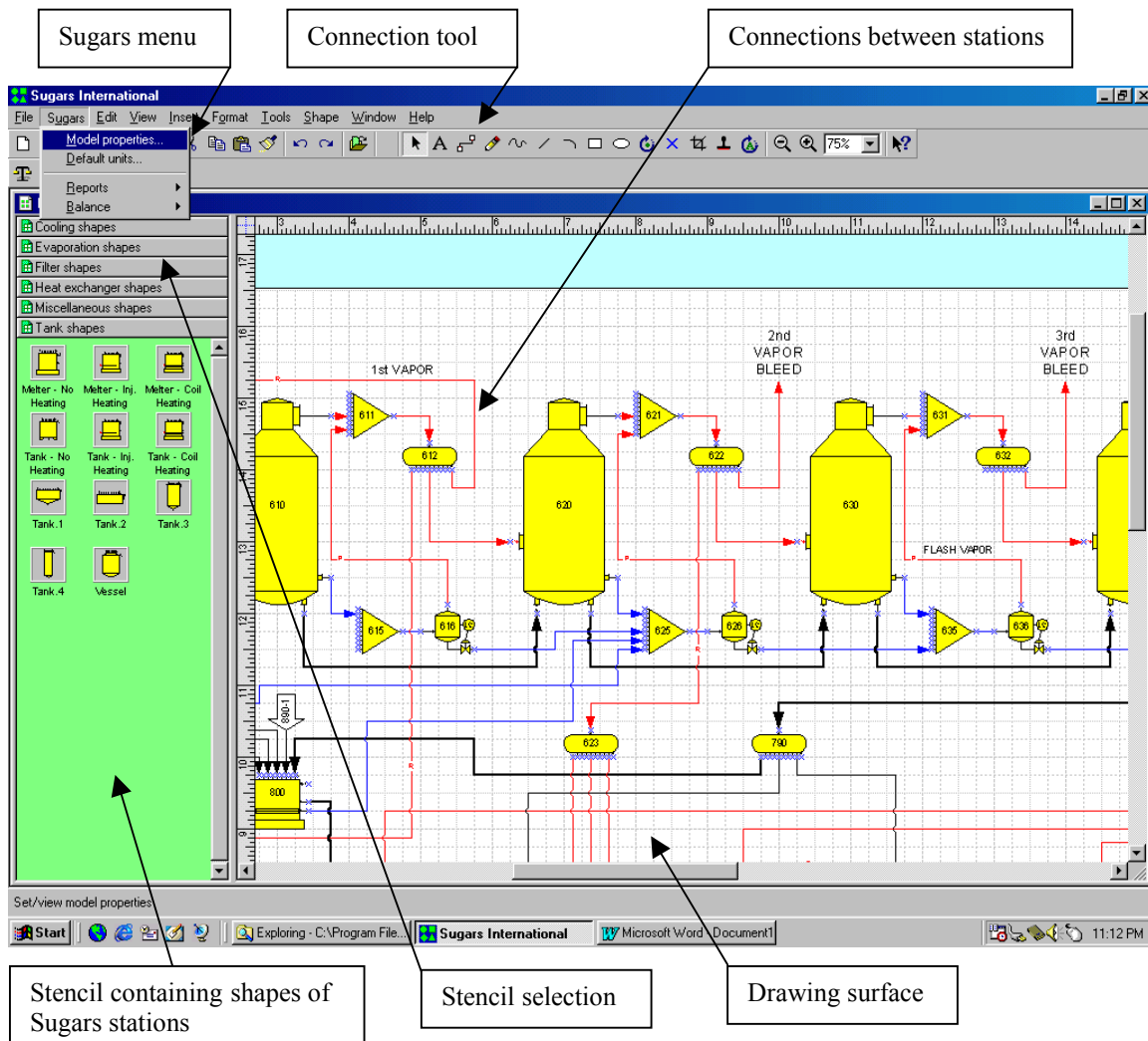
The Sugars™ Computer Program is used to model sugar factories and refineries. The program has successfully modeled thousands of sugar processes since it was first introduced in 1986. It is a reliable program that is used by sugar companies and engineering firms to design new beet and cane sugar factories and refineries, or to redesign existing factories and refineries. Sugars is the most widely used program in the world for modeling and simulating beet and cane sugar processes.

The original program used a text-based interface that was designed for use on IBM compatible personal computers using the DOS operating system. A drawing was made of the process model for simulation by using a separate diagramming program. The drawing was then used as a reference to build text files with a text editor to describe the model for simulation by Sugars. This method worked well for users that were familiar with personal computers, and simulations from Sugars were found to be an accurate representation of the process. However, modern Windows® based software has allowed dramatic improvements in the user interface for computer programs and tools began to appear that would allow integration of the drawing and model building steps.

In August of 1997, Visio Corporation released version 5.0 of their diagramming software. The Visio® program was known to be an excellent program for making process flow diagrams; however, it lacked some of the necessary features for integration with Sugars until the release of version 5. Once it was determined that this new release had the necessary functionality, development work was directed to a new Windows version of Sugars that would use Visio to give Sugars a robust graphical interface. Early versions of the integrated programs were shown last year at the SIT meeting in Marseille, France and at the ICUMSA meeting in Berlin, Germany. A beta test version of the new program was released in December 1998 to some sugar companies in the USA and the first showing of the complete program was made at the ASSBT meeting on February 11, 1999 in Orlando, Florida. The new Sugars for Windows program is an exciting change. Now, using Sugars, it is a simple procedure to build a model and obtain material, energy and color balances that can be used to evaluate a process.

NEW USER INTERFACE

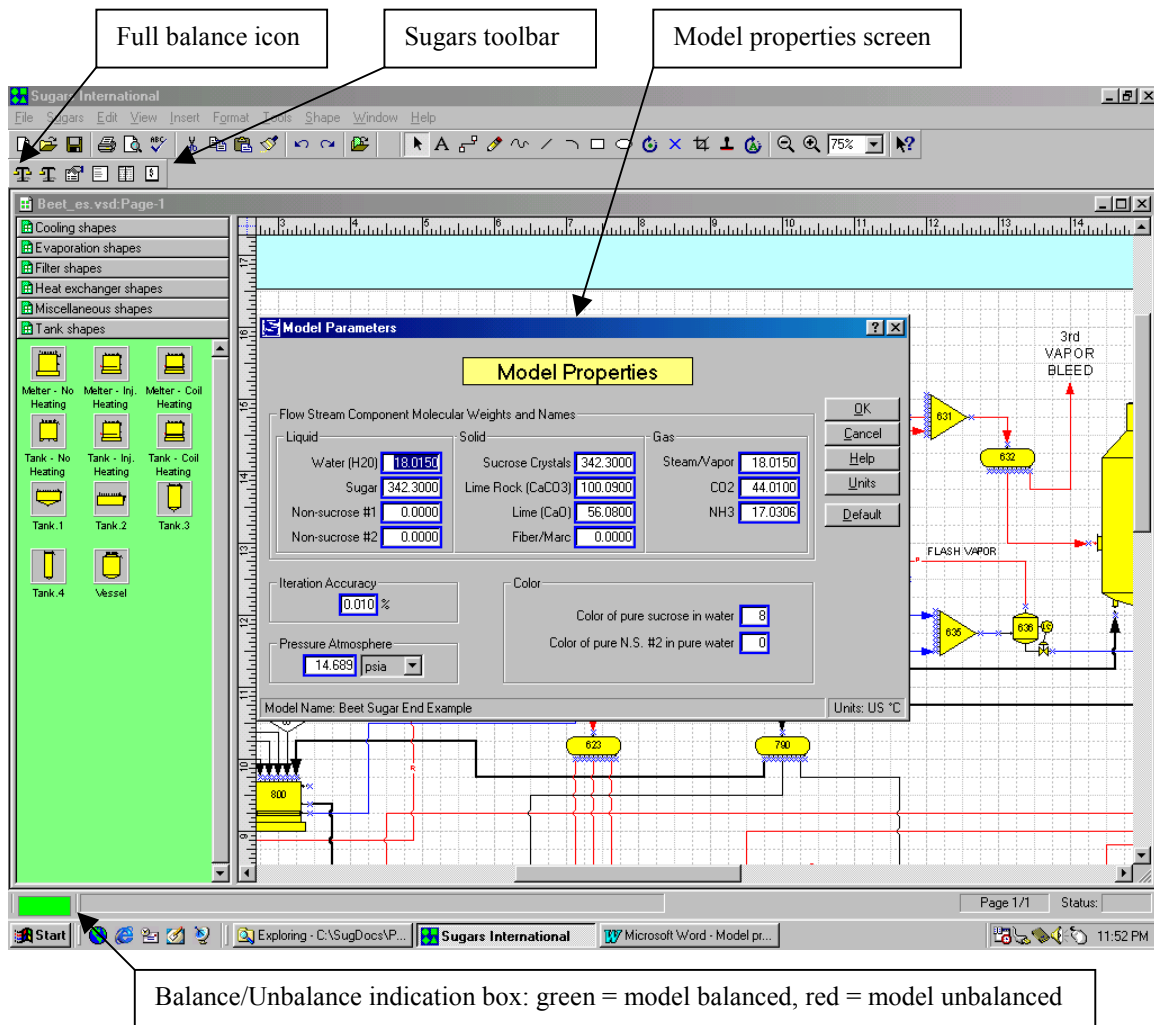
The new graphical interface for Sugars makes model building a simple matter of dragging pre-drawn shapes from a Shapes Stencil to the drawing surface. The shapes are designed to represent stations for modeling the process by Sugars. Connections between the shapes are drawn using a connection tool that automatically routes connections between associated stations. Data entry dialogs for controlling the performance of each station are displayed by double clicking on the station shape. Flow stream properties are entered and displayed on a dialog screen by double clicking on the flow stream. Sugars for Windows is now a fully functioning Windows 95/98/NT program that gives all of the benefits to a user that are available in the Windows environment; such as, drop-down menus, online help, print preview, scrolling, object design and database storage. It is a dramatic change for users of Sugars and it makes the program much easier to learn and use while still providing all of the flexibility needed for modeling sugar processes.



The new interface is shown in the figure above. Stencils on the left contain shapes of stations that are used to build a model. Different stencils are selected by clicking on the gray bar with the name of the stencil. Shapes on a stencil are dragged from the stencil to the drawing surface and dropped in place. Drawing tools are available to design shapes of factory equipment and add them to the stencils as needed. Connections between stations are drawn using a connection tool that features auto routing around shapes and crossovers (line jumps) for crossing connection lines. Drawings can be composed of different layers and pages. Full zoom-in, zoom-out and panning features are provided in the interface.

The menu selections at the top of the window include a Sugars menu entry that gives a drop-down menu containing selections for:

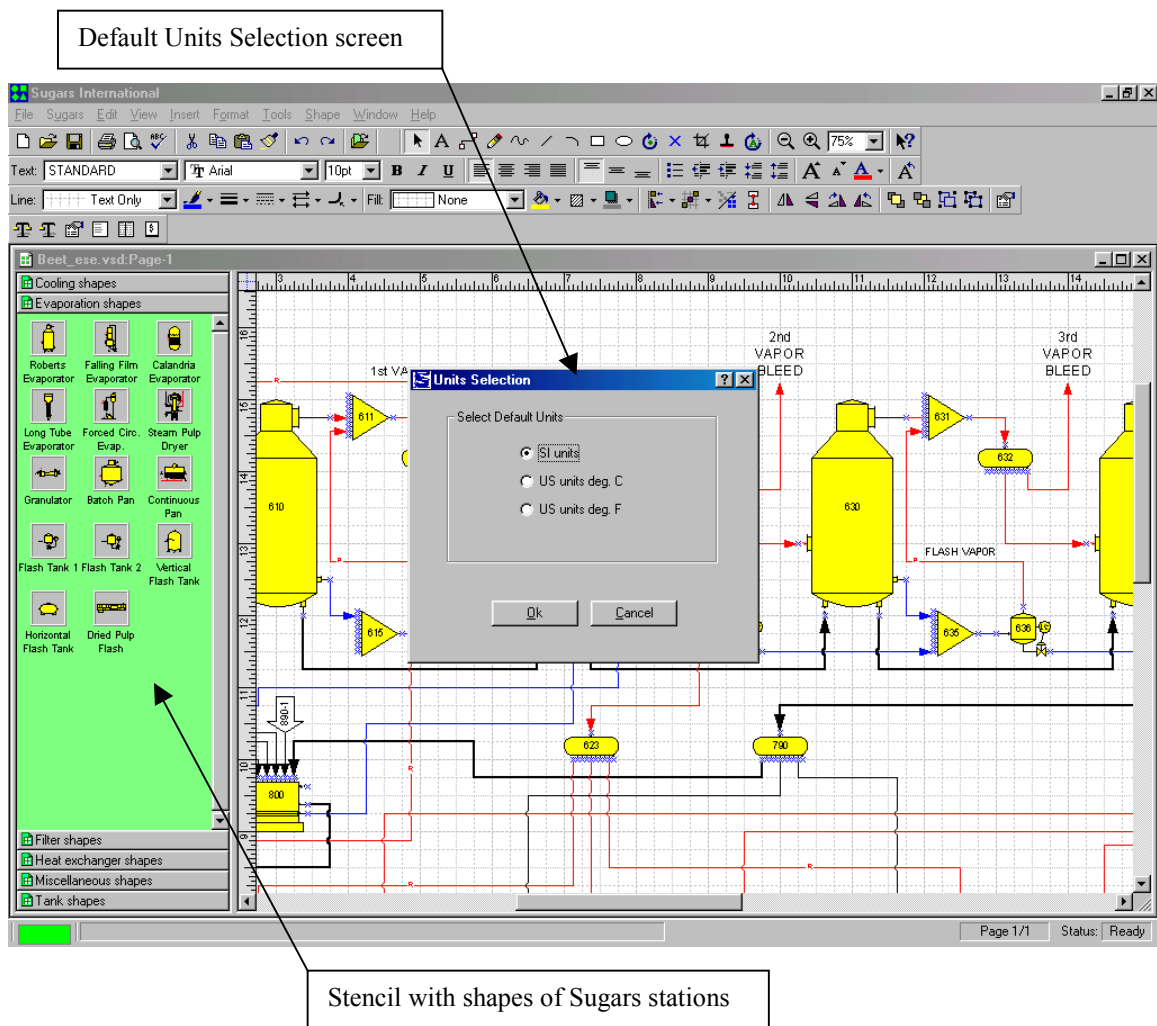
- Model properties - overall properties of the model such as molecular weights for flow stream components, colors, iteration accuracy and atmospheric pressure are set on this screen,
- Default units - units used for all entries and when a model is saved,
- Reports - selection of reports for print preview and printout,
- Balance - model iteration balance calculations (single, or full).



The figure above shows the Model Properties screen when it is selected from the Sugars drop-down menu.

Also, shown on the figure above is the Sugars toolbar. The Sugars toolbar provides icons for (numbered from left-to-right): (1) Balance - full, (2) Balance - single step, (3) Display last error or warning messages, (4) Summary report, (5) Detail report and (6) Revenues report. The tool bar icons provide a quick method for selecting items that appear on the Sugars menu without having to go to the menu to make the selections. Item (1) Balance - full, gives a full iteration balance of the model. If any errors occur during the balance calculations, they will be displayed on an error, or warning, message screen. Sometimes revisions to the design of the model, or data controlling the performance of stations in the model, may be needed to bring the model into balance. The last error, or warning, message screen can be referenced as corrections are made to the model. Item (2) Balance - single step, can be used to see how the model changes between iterations.

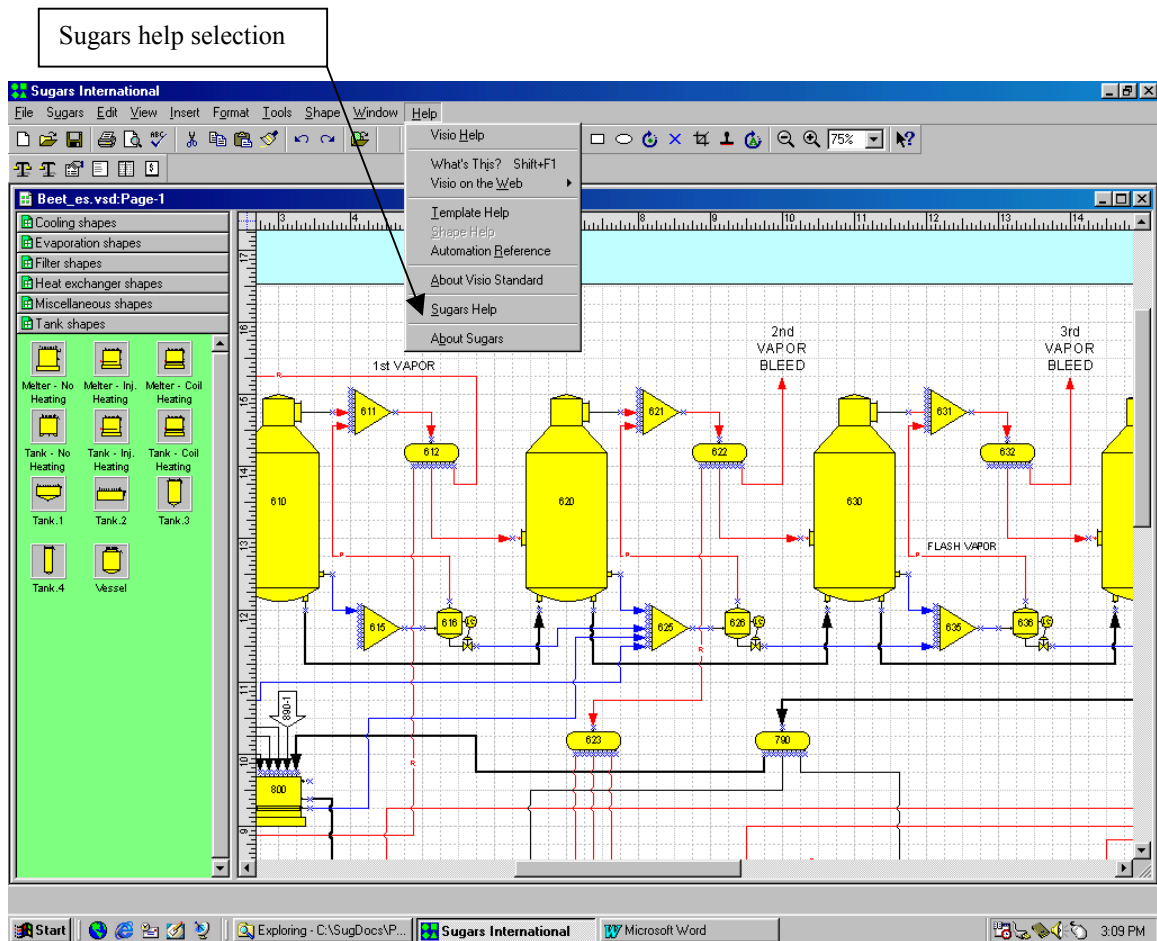
At the bottom of the screen, in the lower left-hand corner, a small box indicates whether the model is in, or out of, balance. When the box is green (as shown in the figure above), the model is in balance. When the box is red, the model is unbalanced. Any changes to a model will cause the balance indicator box to change to red for a model that was in balance (box was green).



The above figure shows the Units Selection screen for selecting the system of units to be used with Sugars for entering data and displaying the results from the balance calculations. The default system of units is used when a model is saved, even if the displayed units are different. Units are available for SI, US with temperature in °C and US with temperature in °F systems.

As shown on the figure above, the stencils on the left contain shapes of stations that can be used to build a model of a sugar factory, or refinery. Each of the station types in Sugars is represented on the stencils and many of the stations have more than one shape that can be used for the process flow diagram of a model. Also, other unique shapes can be drawn and added to the stencils, if needed. There is no limit to the number of different shapes that can be used to represent the Sugars station types.

Complete online help systems are available from the main menu for both Visio and Sugars (see figure below). Help for Visio describes all of the drawing features available in Visio, and help for Sugars describes each of the stations, input properties, examples and features of each station. Also, the Sugars help system describes how to design shapes so that they will work with Sugars and other features of the program. The help system includes features such as a table of contents, index and full search for key words.



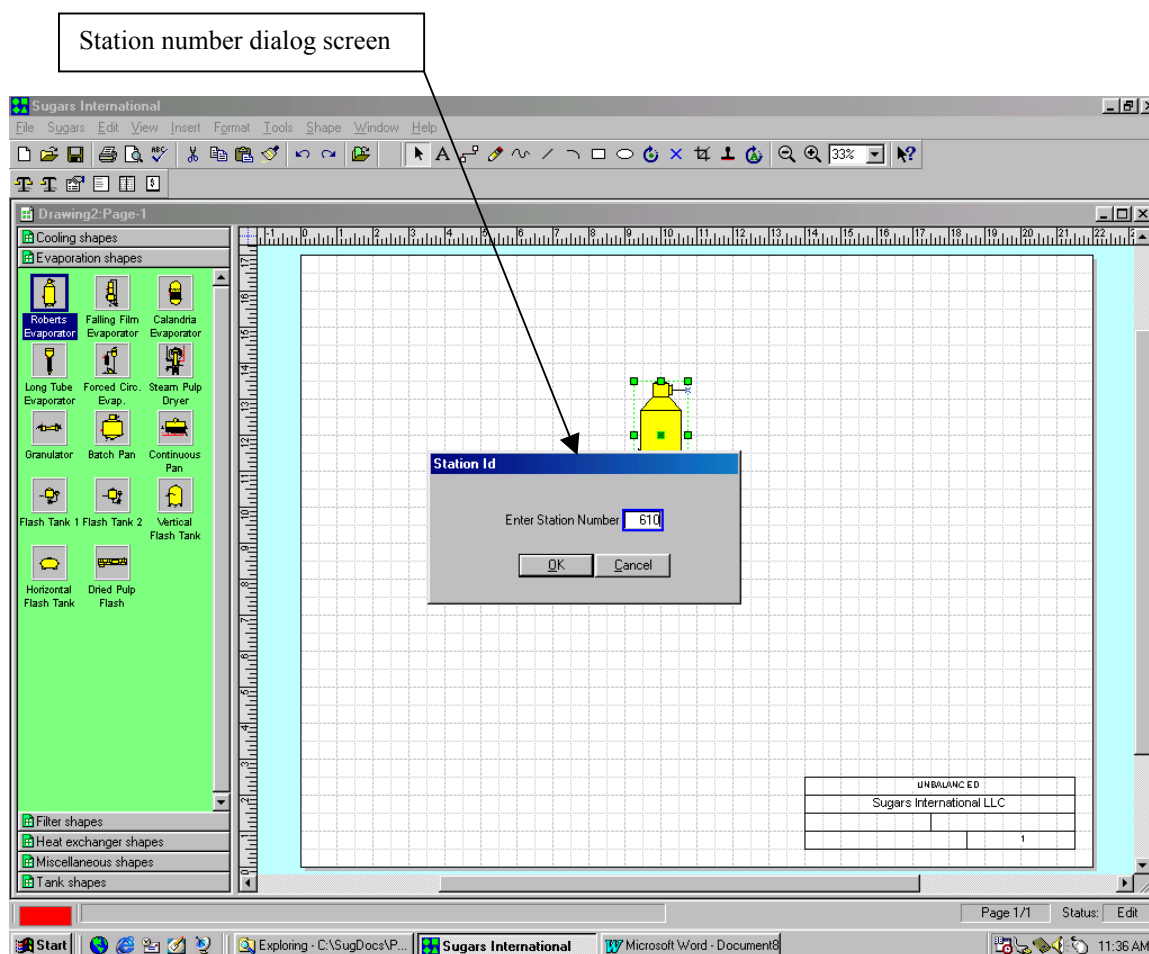
The input and output connections for the shapes stay glued to the shapes even when the shapes are moved, or the flow streams are rerouted. Stations can be copied from one part of the flow diagram and pasted into another part with the data for the station repeated in the copied station. Also, groups of stations may be combined and placed on the drawing as a group instead of having to add each station individually (station numbers for each station are entered when the group is dropped on the drawing).

MODEL BUILDING

Every model of a factory, refinery, or portion of a process is built by selecting stations from the available station modules in Sugars and connecting the stations together using flow streams. Flow streams between stations, and flow streams that leave a model, are called *internal flows*. Flow streams that go into the model from outside sources (e.g., beets, steam, water, CaO, etc.) are called *external flows*. All external flows must be fully specified before a balance can be done. Internal flows are calculated by Sugars during the balance calculations.

Sugars has sixteen different station modules that can be used to simulate a process. The sixteen station modules in Sugars are: centrifugal (batch and continuous), heater (or heat exchanger), melter, pan, distributor, dryer, crystallizer, evaporator body, tank, receiver, flash tank, cooler, separator/filter, blender (also used to model a contact condenser), reactor, and

compressor/pump. When a shape is dragged from a stencil to the drawing surface, a dialog screen appears to assign a number to the station (see figure below).

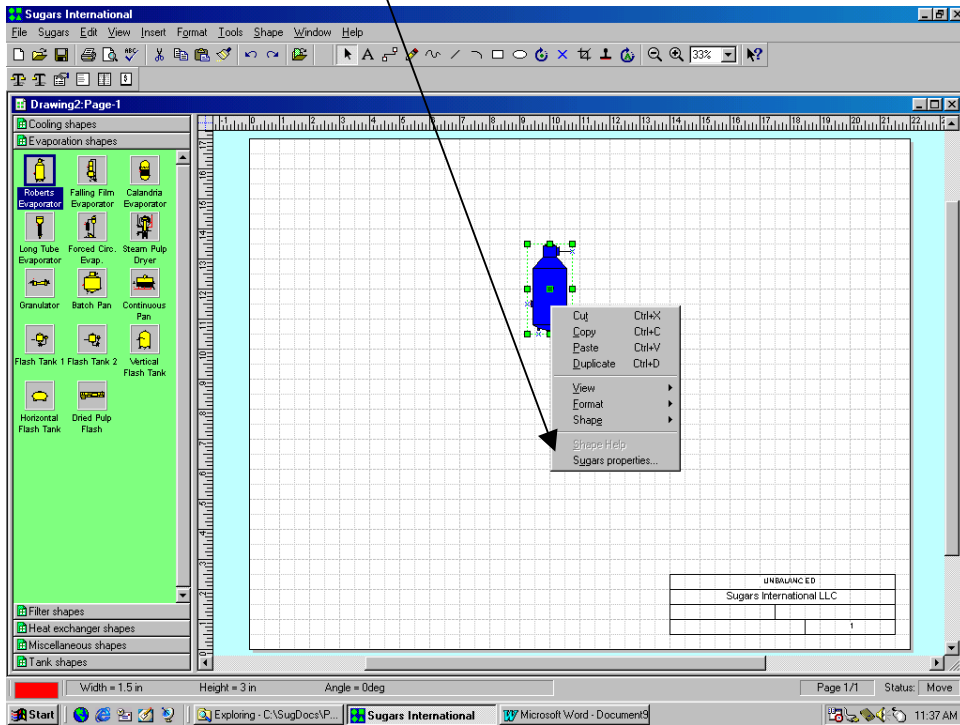


The station number for each station in a model must be unique. Sugars will automatically index the station numbers by 10 as each new one is added to the flow diagram; however, the number may be changed on the dialog screen to any unused number in the model.

Each Sugars station type has a data input screen (dialog) that is associated with the shapes for that type of station. The data input screen defines the properties of each station (object) in a model. Drawing the process flow diagram defines the model. The output flows emitted from a station are a result of the properties of the station. Changing the properties of a station will control how the station processes flows coming into the station. For example, an evaporator station, with juice and steam input flows, will process the juice flow to evaporate water while using steam, or vapor, to boil the juice. Thus, the properties of the stations in a model and the characteristics of the external flows into the model control all of the internal flows between stations, and the flows leaving the model. Each station type has a properties dialog screen for entering the appropriate data, and a dialog screen is provided for entering the data to define external flows into the model.

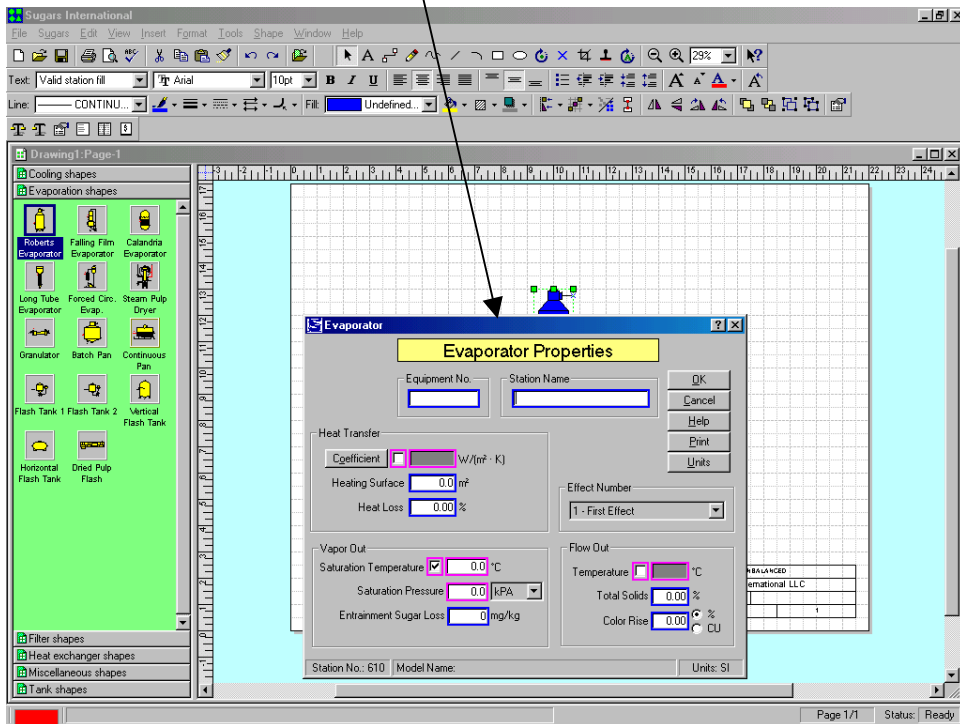
Shapes on the stencils are associated with their respective Sugars station modules by naming the shape in Visio with a Sugars station name and identifying the input and output ports for the station. The Sugars help system provides full details on how to make a shape that will be identified by Sugars.

Sugars properties selection



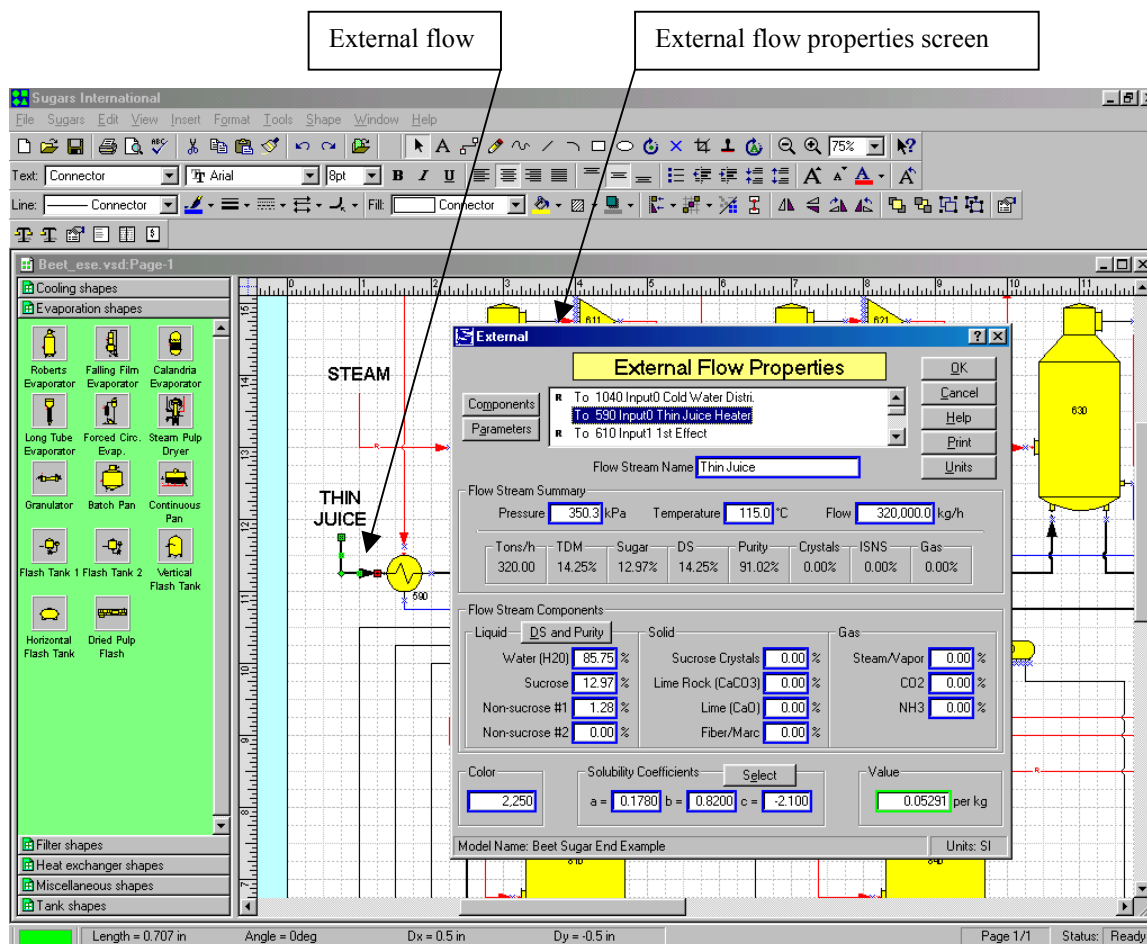
The shape color turns to blue after the station number is entered. Double click the shape (or right click and select "Sugars properties" from the drop-down menu - see figure above) to get the data entry screen (Evaporator Properties screen in the figure below).

Data entry (properties) screen



All of the necessary data to describe the performance of the station is entered on the Properties screen. The station turns yellow to indicate that data for the station was entered after the Properties screen is closed by clicking on the OK button. Shapes are added to the drawing until all of the stations for the model are on the drawing and data is entered for each station until all of the stations in the model have turned to yellow.

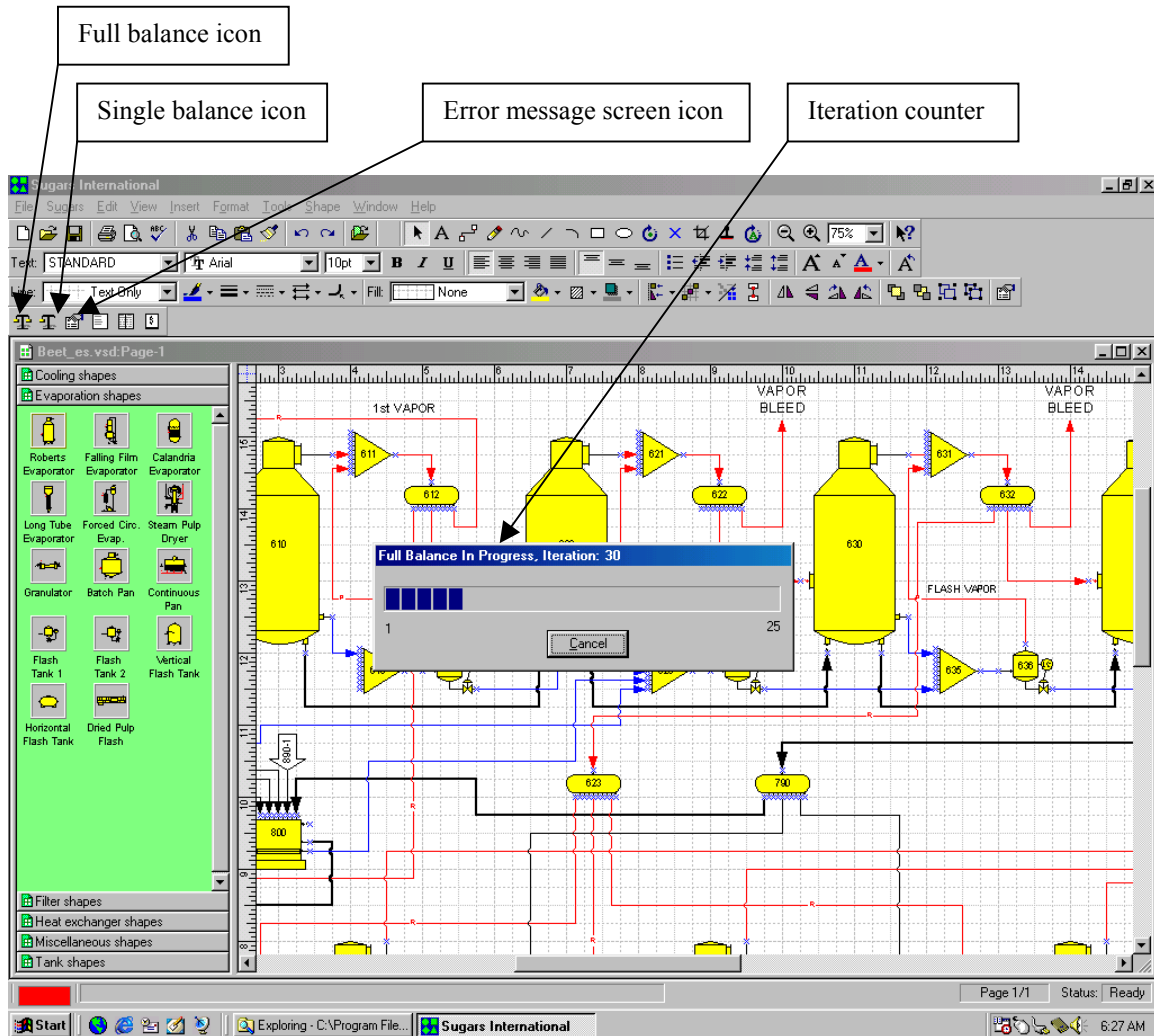
Connections are made between input and output ports on each station using the connection tool until all of the ports on the stations have connecting flows. Some stations, such as distributors, melters, tanks and receivers, do not need to have all of their ports connected (extra ports are provided), but these stations must have at least one input and output flow.



Data for external flows into the model is entered on the External Flow Properties screen. The External Flows Properties screen (see figure above) is accessed by double clicking on the external flow, or right clicking and selecting "Sugars properties" from the drop-down menu. Every external flow stream going into the model must be specified with pressure, temperature and flow stream components. If the flow stream contains dissolved non-sucrose components, the solubility coefficients must be defined. And, if the flow is not a required flow, the quantity of the flow stream must be specified. Required flows are flows that have their quantity determined by the properties of a station. For example, the vapor flow into a pan is a required flow because the quantity of the vapor needed by the pan is determined by the properties of the pan. A flow stream color entry must be made for the external flow if the color balance is being done. And, a currency value for the flow stream can be entered if the net process revenues are being calculated for the model.

SIMULATION

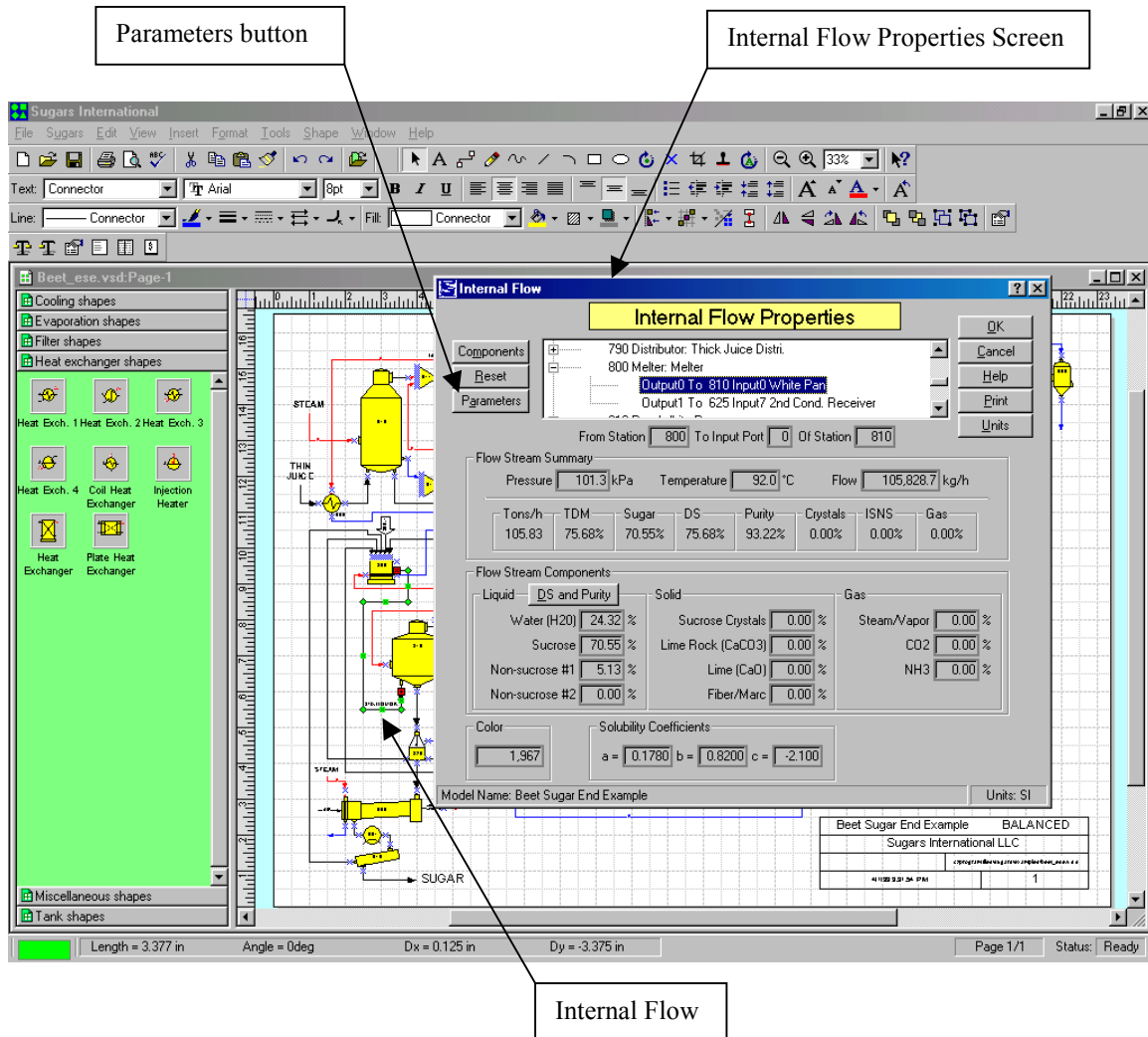
The model is ready for balancing once the data for every station in the model and every external flow stream into the model is entered. The balance calculations give a simulation of the process and provide all of the details of the internal flow streams in the model.



Clicking on the full balance icon will initiate the balance calculations and give a small window showing the progress of the iterations (see figure above). Single balance iterations can be done (to observe the progress of the balance) by clicking on the single balance icon. An error message screen will appear if any errors are detected during the iterations. Fatal errors have to be corrected before the calculations can be completed. Sometimes warning, or informative, messages appear giving information about the calculations, or observations about the model. Many of these messages do not require any action by the user, but are merely displayed as information that might be important, or helpful to the user. The error/warning message screen may be recalled at any time after the balance calculations are done so that it can be referred to as corrections are made to remove any errors that occurred during the balance calculations. Clicking on the error message screen icon will recall the display of the last error messages that occurred during a balance.

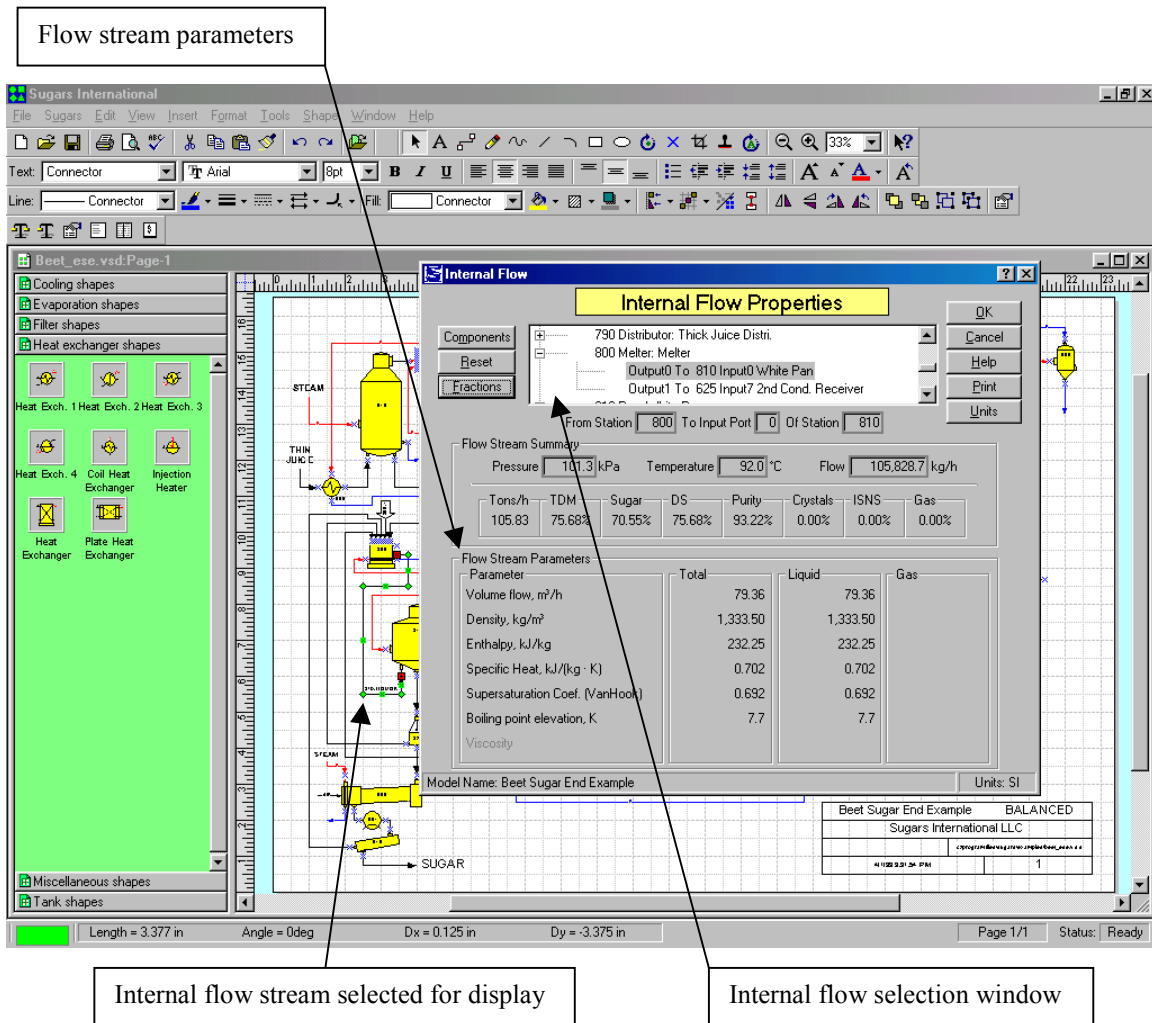
RESULTS

The results of the calculations can be displayed after the balance calculations are completed. Sugars provides several different presentations of the results.



The figure above shows the display of the Internal Flow Properties screen after a balance. This screen shows all of the details of the internal flow, such as pressure, temperature, flow quantity, components, color and solubility coefficients. In addition, the % total dry matter (TDM), % sugar, % dry substance (DS), % purity, % crystals, % insoluble solid non-sugars (ISNS) and % gas are given in the middle of the screen with the quantity of flow in tons per hour. Clicking the DS and Purity button, under the Flow Stream Components, in the Liquid phase section, will give the % dry substance and purity for the liquid portion of the flow. For a massecuite, this would be the mother liquor %DS and % Purity.

Clicking the Parameters button on the Internal Flow Properties screen gives additional characteristics of the flow, such as: volume flow, specific weight, enthalpy, specific heat capacity, supersaturation and boiling point elevation (see figure below). The Flow Stream Parameters feature is also available for external flows.

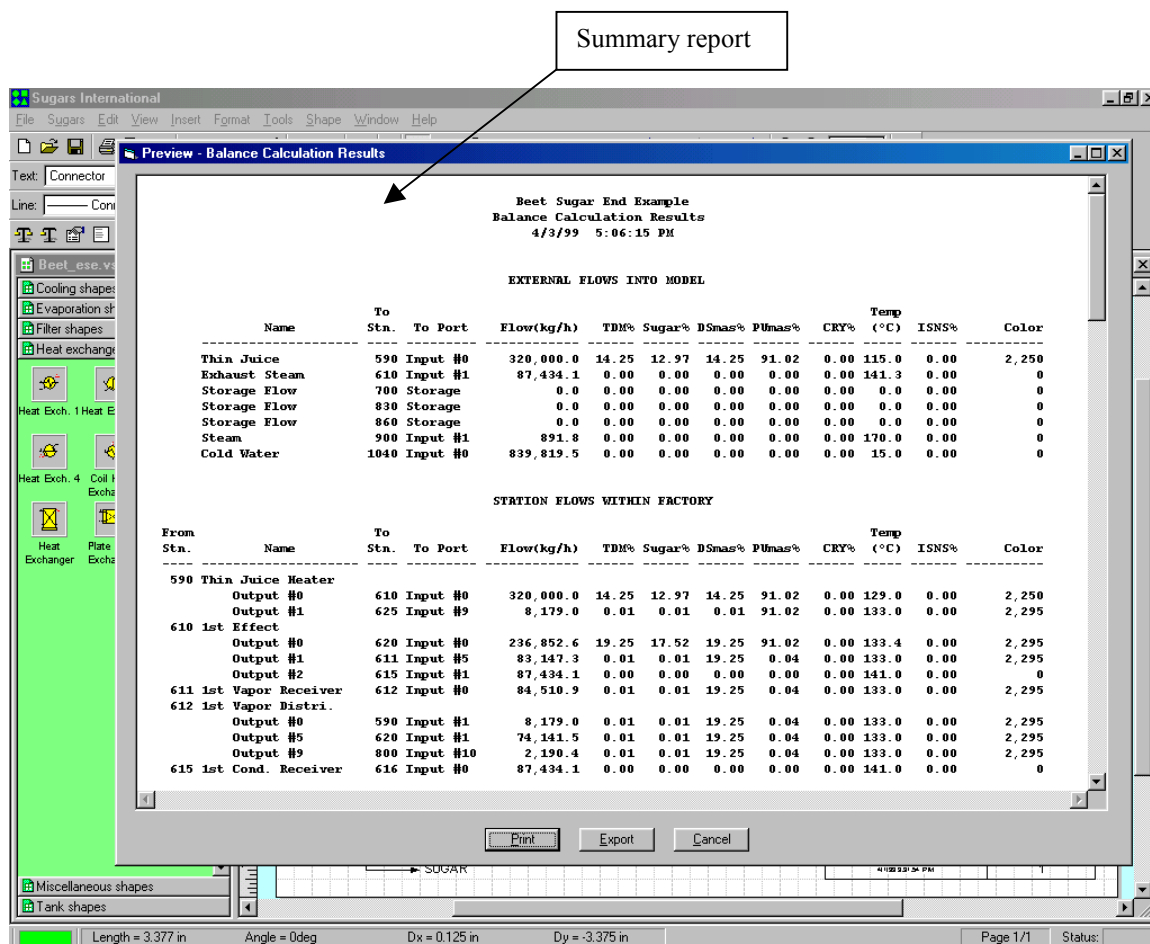


Every internal flow in the model can be displayed using the Properties screen. Also, flow streams that are required and/or pressure feedback (flow streams that need a pressure value from another station) are identified on the flow diagram by a small 'R' for required and a small 'P' for pressure feedback. Sugars will place these indicators on the flow streams after the balance calculations are completed.

The Internal Flow Properties screen has a small internal flow selection window (scrollable) that shows every internal flow stream in the model. Using this window, individual flow streams can be displayed quickly without having to close the Internal Flow Properties screen and double click on another flow stream to display its properties. The External Flow Properties screen also has a similar external flow selection window for viewing external flows. The internal and external flow properties screens provide valuable information about the process that can be used for engineering design and/or data reconciliation.

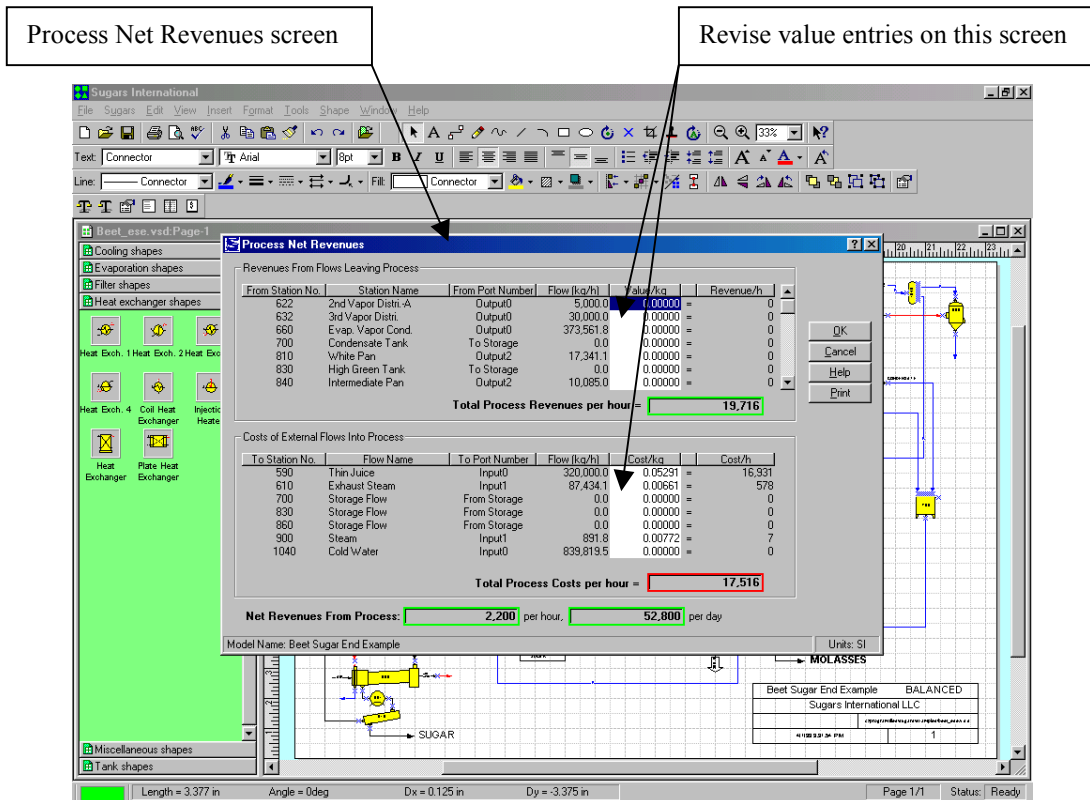
Printouts are available for the Revenues report, Summary report and Details report. These reports provide an overview of the balance calculations. The Details report shows every flow stream in the model with the fraction of each component listed along with the station the flow originates from and the station to which it goes. Also, the pressure, temperature, flow quantity, color, solubility coefficients and currency value is printed for each flow stream.

The Details report is a listing of most of the information that is on the Internal Flow Properties and External Flow Properties screens with component fractions displayed instead of percentage values for purity, dry substance, etc. The summary information on the Internal Flow Properties and External Flow Properties screens is basically the same as shown on the Summary report for each flow (see figure below).



Some of the most useful information from Sugars is given on the Process Net Revenues report (see print preview screen in the figure below). As changes are made to the model, the process net revenues will either increase, or decrease. New process equipment with new station properties, or changes in the process routing, can be evaluated quickly to see how the revenues will change. The Process Net Revenues are calculated from the values for all flows leaving the model (internal flows) minus the cost of all flows into the model (external flows). This information is very useful for making investment decisions. Also, it is the most convenient way to show how changes to the model will affect the operating performance of the process.

The value entries for all external flows into the model and internal flows that leave the model are entered on the External Flow Properties and Internal Flow Properties screens. These values are used to calculate the process net revenues. The entered values can also be changed on the Process Net Revenues screen as shown in the figure below.



SUMMARY

The Sugars™ program is widely used by sugar companies to make process and investment decisions. It is used to increase the yield and reduce the energy consumption of existing beet and cane sugar factories and refineries and to design new ones. Also, it is used to evaluate the feasibility of R&D projects, train process engineers, reconcile factory data and give process information that cannot be measured. The new Windows® interface for Sugars greatly enhances its use for these applications and makes it much easier to build models for process simulation. Building a model is simply a matter of dragging shapes from one of the shape stencils in the program to the drawing surface. The shapes represent actual stations in the factory, or refinery. External flows into a station and flows leaving a station are connected to other stations by using a connector tool with automatic line routing and crossovers. A dialog screen for entering data to describe the characteristics of each station and external flow is displayed when the station, or external flow, is double clicked. After the flow diagram of the model is drawn and the data is entered, the model is balanced by simply clicking on the balance icon. The results of the balance calculations provide material, energy and color values for all flows in the model and they can be printed out, or displayed on print preview screens. The results give a summary of the flows into the model and leaving each station, or the overall net revenues generated by the process being modeled. Calculated flow stream values give detailed information about the process and engineering data (density, enthalpy, boiling point rise, sucrose supersaturation, etc) that is useful for process design. Process net revenue results are used to make investment decisions for new equipment, or process revisions. All of the data and calculated results for a model are saved in a Microsoft® Access database. The new Sugars for Windows program is a dramatic improvement to the Sugars program that makes it much easier to build models and show the calculated results to assist with decisions for improving the efficiency of a sugar factory, or refinery.

ZUSAMMENFASSUNG

Das „Sugars™-Programm“ wird in vielen Zuckerfirmen zur Entscheidungsfällung bezüglich Verfahren und Investitionen herangezogen. Es dient zur Ertragssteigerung und Verringerung des Energieverbrauchs in bestehenden Zuckerrüben- und Zuckerrohrfabriken und –raffinerien bzw. zum Design neuer Anlagen. Es wird ferner zur Beurteilung der Rentabilität von F&E-Projekten, zur Schulung von Verfahreningenieuren, zur Abstimmung von Fabrikdaten verwendet und liefert Prozeßdaten, die sonst nicht meßbar sind. Die neue Windows®-Schnittstelle des „Sugars“-Programms erleichtert seine Anwendung und vereinfacht die Modellerstellung für die Verfahrenssimulation. Zum Modellbau werden verschiedene Formen einfach von einer der Vorlagen im Programm auf die Zeichenfläche gezogen, um die verschiedenen Stationen in der Fabrik oder Raffinerie darzustellen. Der externe Fluß in eine Station hinein und aus dieser heraus wird mit einem Verbindungstool mit automatischer Leitungsvorlegung und Querverbindungen angezeigt. Durch Doppelklicken auf eine Station oder einen externen Fluß wird ein Dialogbildschirm aufgerufen, über den beschreibende Daten für die einzelnen Stationen und den externen Fluß eingegeben werden können. Nach Zeichnung des Flußdiagramms des Modells und Eingabe der beschreibenden Daten wird das Modell durch Klicken auf das Symbol „Balance“ ausgeglichen. Die Ergebnisse der Ausgleichskalkulationen liefern Material-, Energie- und Farbwerte für alle Flüsse im Modell. Sie können ausgedruckt oder auf Druckvorbereitungsbildschirmen angezeigt werden. Diese Ergebnisse stellen eine Zusammenfassung der Flüsse in das Modell und aus den Stationen bzw. die gesamten Nettoeinnahmen, die von dem Verfahrensmodell zu erwarten sind, dar. Die berechneten Strömungswerte liefern detaillierte Informationen über das Verfahren sowie technische Daten (Dichte, Enthalpie, Erhöhung des Siedepunktes, Saccharoseübersättigung usw.), die für das Design des Verfahrens nützlich sind. Die Nettoertragsergebnisse des Verfahrens helfen bei Investitionsentscheidungen, was neue Anlagen oder Verfahrensänderungen betrifft. Sämtliche Daten und Kalkulationen für ein Modell werden in einer Microsoft® Access-Datenbank gespeichert. Das neue „Sugars“-Programm für Windows stellt eine enorme Verbesserung des vorherigen Programms dar, indem es die Modellerstellung und Anzeige der Kalkulationen erleichtert und dazu beiträgt, die Entscheidungsfällung in einer Zuckerfabrik oder –raffinerie effizienter zu gestalten.

RESUME

Le programme Sugars™ est largement utilisé dans l'industrie sucrière pour faciliter la prise de décision en matière de processus de production et de choix d'investissement. Il aide à accroître le rendement et à réduire la consommation d'énergie dans les usines de betterave et de canne à sucre, ainsi qu'à concevoir de nouvelles raffineries. En outre, ce programme sert à évaluer la faisabilité des projets de recherche et de développement, former des ingénieurs de production, harmoniser les données dans l'entreprise et procurer des informations qualitatives sur la chaîne de production. La nouvelle interface Windows® pour Sugars améliore grandement son utilisation pour ces applications et rend beaucoup plus facile la construction de modèles pour réaliser des simulations de production. Pour construire un modèle, il suffit de sortir des formes de l'un des stencils du programme et de les amener sur l'écran de travail. Les formes représentent les postes de travail de la raffinerie. Les flux qui transitent par les postes de travail sont reliés aux autres postes par un outil de connexion comportant un routage automatique et des échangeurs. Un écran de dialogue, qui permet d'entrer les données comportant les caractéristiques de chaque poste et les flux externes, s'affiche quand on clique

deux fois sur le poste ou ce flux. Lorsque le diagramme de flux du modèle est établi et que les données ont été entrées, il suffit, pour calculer le modèle, de cliquer sur l'icône balance. Les résultats du calcul fournissent des informations numériques, d'énergie et de couleur pour chacun des flux du modèle et elles peuvent être imprimées à part ou affichées sur des écrans d'aperçu avant impression. Les résultats donnent un résumé des flux entrant dans le modèle et sortant de chaque poste de travail aussi bien que les revenus nets globaux générés par le processus à l'étude. Les valeurs calculées pour les flux fournissent des informations détaillées sur le processus de fabrication ainsi que des données techniques (densité, enthalpie, élévation du point d'ébullition, saturation en saccharose, etc.) utiles pour la conception de la chaîne de production. Les résultats concernant les revenus générés aux différentes étapes de la fabrication facilitent les choix d'investissement dans de nouveaux équipements ou les décisions de modification du processus de fabrication. Tous les calculs et informations concernant un modèle sont mémorisés dans une banque de données Microsoft® Access. Le nouveau programme Sugars sous Windows constitue un progrès considérable par rapport au programme Sugars pour ce qui est de la construction de modèles et la présentation de résultats. Il aide à prendre des décisions visant à améliorer l'efficacité d'une raffinerie de sucre.

ACKNOWLEDGEMENTS

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