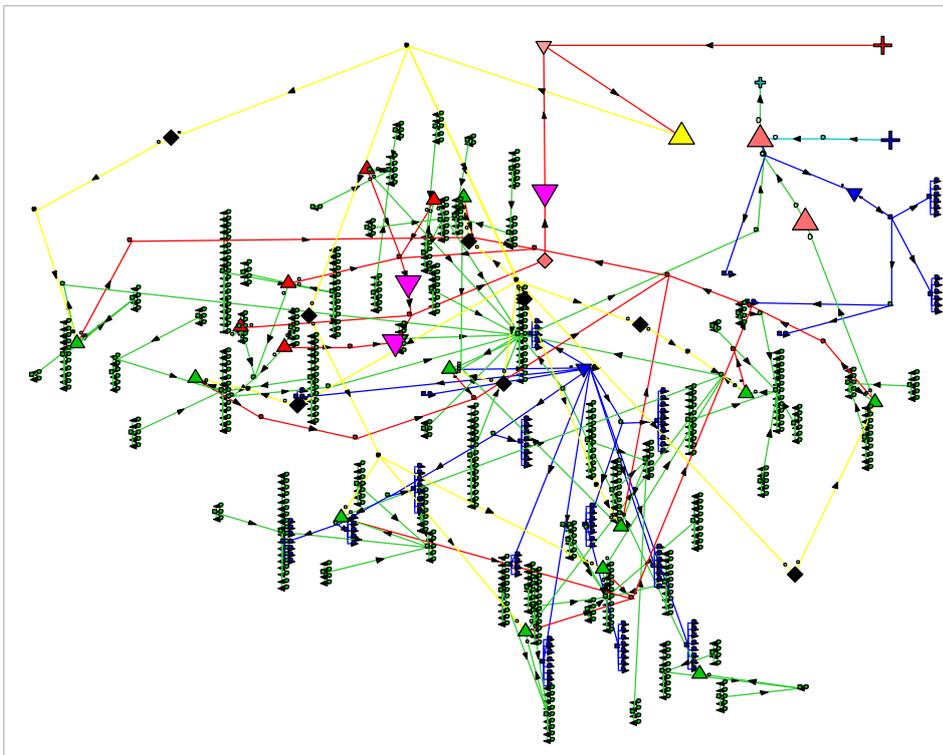


FACILITIES

By visualizing the surface facility network, two fundamental tasks in the work of the process engineer can be carried out: the monitoring of the network flow rates and the detection of possible problems associated with the properties of the existing facilities or future extensions.

Sahara's Facilities module allows the visualization, editing and calculation associated with surface facilities and electrical networks and their interconnections. The user can perform a fluid balance analysis through time, both for the field production history and for the different forecast scenarios. The evolution of the network can be seen to evaluate the ongoing projects and future developments.

A large set of charts, reports, diagrams and bubble maps can easily identify those nodes and pipes whose design values have been exceeded, as well as identify potential bottlenecks and deficit or surplus water demands in the network.



This module allows designing and verifying the current and future network of surface facilities, as well as planning development management and identifying potential problems.

Through the Facilities module, a network of surface facilities can be associated with existing and future wells in a project. The wells will be directly recognized from the Sahara project, and the completion of the network will include the creation of new nodes, such as manifolds, injection satellites, batteries, treatment plants, cut plants, water injection plants or gas compression plants, among many others. Each of these nodes may have associated properties in order to perform monitoring tasks. In addition, the pipes interconnecting the different nodes may have properties that will be taken into account when performing the calculations.

The module time bar in the main window can display the historical evolution of the facilities and help to define future modifications or extensions. In a complementary window, for the main nodes, it is possible to draw a schematic block diagram representing the equipment that comprises the facilities and their interconnections (PFD - Process Flow Diagram).

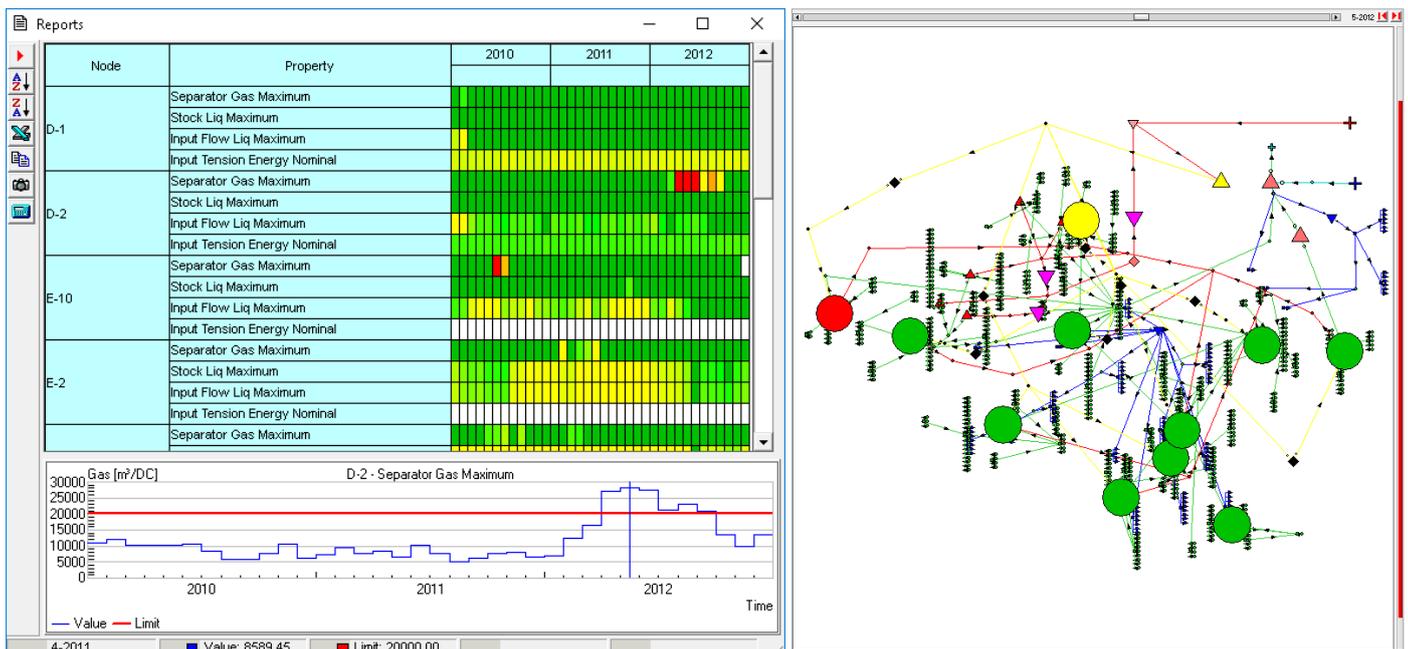
Once the network is defined, calculations can be performed, whether only for fluid balance, or incorporating pressure and power network calculations. Pressure calculations will take into account any differences in terrain level that may exist along the network, associating an elevation to each of the nodes. If the complete calculation is performed for each month, fluid flow rates and the corresponding pressure will be obtained in each node of the network. The corresponding pressure drop is calculated analyzing the velocities in the pipes and using the single-phase and multi-phase flow correlations, most commonly used in the industry, such as, Beggs & Brill and Poettman & Carpenter, among others.

As an additional calculation parameter, it is possible to define an API density for the different wells to obtain the oil density at the delivery point and corroborate it is within the required specifications.

Once the calculation results have been obtained, the user will be able to choose among multiple visualization options, being each of them oriented to perform an analysis with a defined purpose. The different networks (production, injection, water, gas and electricity transference) have an independent treatment and a hierarchical structure. This allows partial visualizations at different levels, and displaying some or all the networks at the same time. The representation of the different networks can be done geographically or by a conceptual scheme. In either case, any of the following options can be selected to highlight the different sections:

- Identify with different colors each of the particular networks.
- Identify in red those sections of the network that could not be calculated.
- Identify by color the network sections that converge to a node or, conversely, those that are affected by the selected node.
- Display the calculation results with ranges of colors for the detection of problem sectors. Among other variables, it is possible to associate the water cut, the pressure or the API oil density.

If the geographic display option is used, viewing a satellite image as a background may help to identify roads and detect interferences of pipes, among other possibilities.



Capacities Report. The Properties report shows a range of colors for the properties defined in each of the nodes. Also, bubbles on each node show the selected property and a time chart for the chosen node.

Within the module there is a series of reports displaying all the information associated with the network, including some specific reports that will be very useful to perform different analyses related to the project.

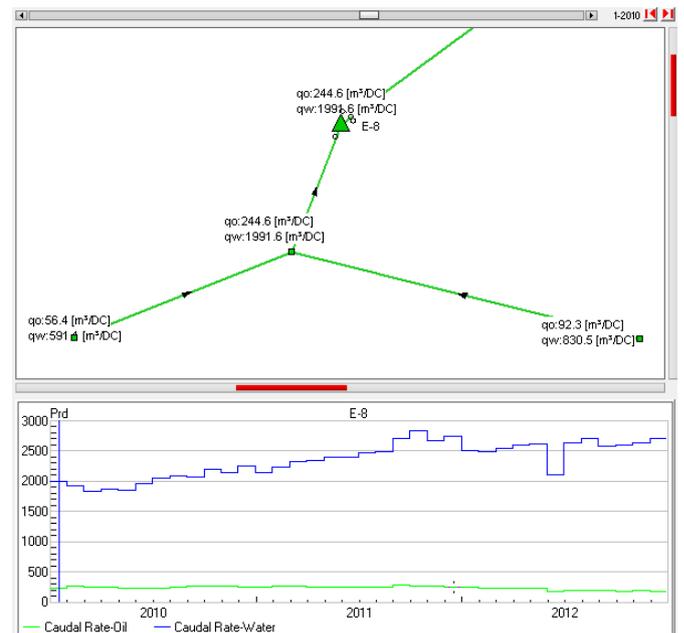
In particular, the Properties report is an attractive and convenient tool that compares the nodal values with established limits for each of the properties defined in the nodes. A range of colors, which can be configured by the user, allows quick identification of conflicting situations, such as a facility or pipe acting as a bottleneck, the need to incorporate new equipment or, otherwise, the detection of idle equipment in the facilities. The same reporting format can also be used to analyze gas and electricity consumption, calculated by applying factors or curves to production flow rates.

When working with reservoirs that handle water reinjection, there is a special report that analyzes the fluid movements. In these cases, the network can receive water from the wells or external sources, such as an aqueduct, to be later separated and treated in the treatment plants, and finally to be sent to different destinations like injector wells, drain holes, or just remaining with the oil production. For this type of projects, Facilities offers a water balance report that identifies those nodes where water excess or deficit may be a problem, and also informs the overall net water balance result. Using this report, together with production and injection forecasts, it will be possible to identify possible issues with the water balance that may require specific actions to solve the situation. For example, if the problem is excess water, the possibility of turning any well into a water drain hole could be considered.

Most reports have the peculiarity of being linked to the map, so when one of the map rows corresponding to a particular node is selected, the map in the main window is zoomed in.

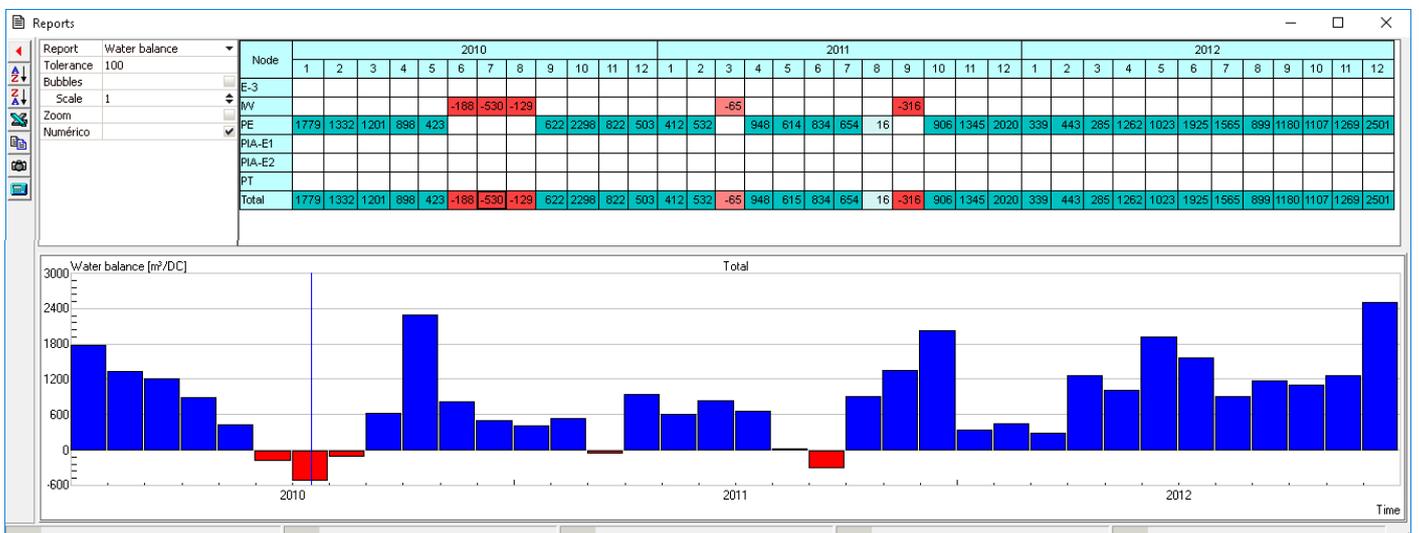
In addition, the Properties and Water Balance reports have the option of displaying the property selected with a bubble map on each node, on the corresponding date. Another feature of these reports is that the analysis can be carried out qualitatively using only the range of colors, or, just by adding numerical values a quantitative analysis can also be performed.

Apart from studying each of the networks in general, the analysis can focus on a particular node or pipe. User-configurable charts can be used to display variables over time, such as production or injection flow rates and pressures, and to compare them with the properties associated to each node. Values for the main variables of each of the different networks can also be displayed next to each pipe and node.

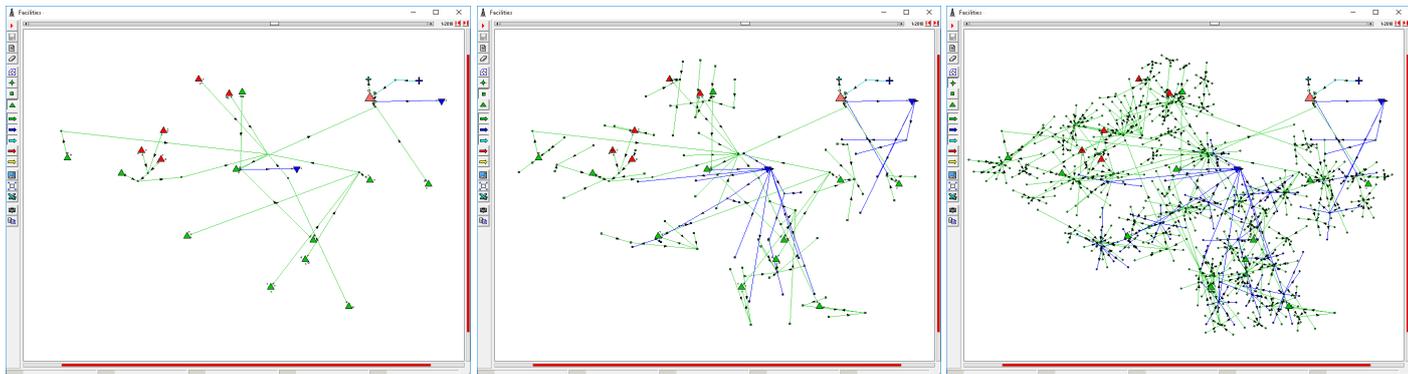


Display Focused on a Particular Node. For each node and pipe, specific data such as flow rates or pressures, and production charts

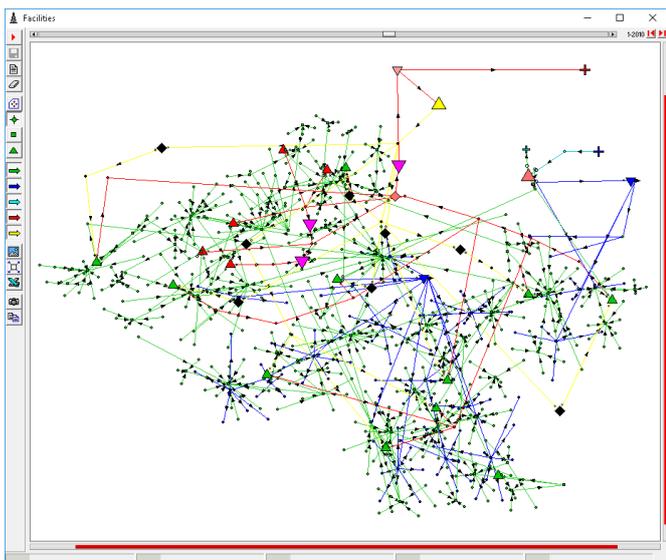
The Facilities module allows rapid analysis using specialized reports and locating problem zones or areas where improvements can be made.



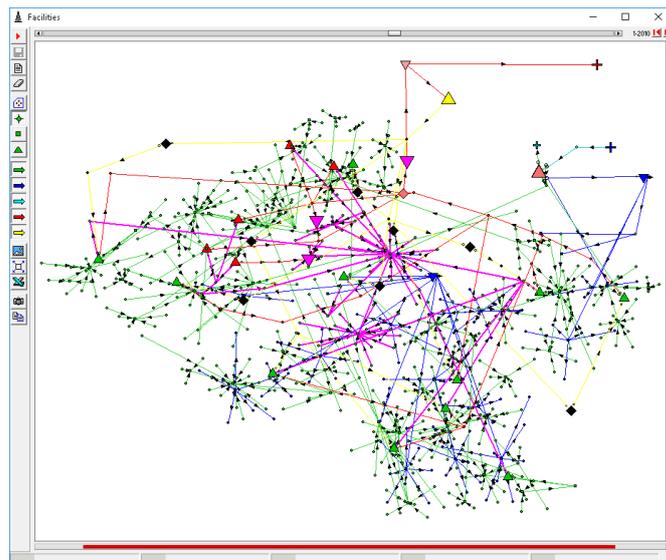
Water Balance Report. The movement of water can be observed in those nodes where there is entrance or discharge of water. Months in red show a water deficit. The report can be viewed qualitatively or quantitatively, showing the associated flow rates.



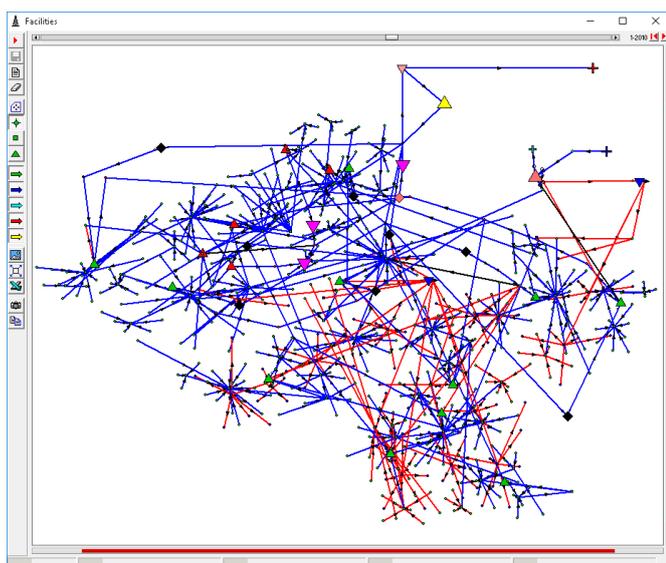
Visualization Options. Partial visualization is allowed at different levels of the hierarchy. We see from left to right, first the network at plant level, then at manifold and satellite level, and finally the complete network from wells to delivery point.



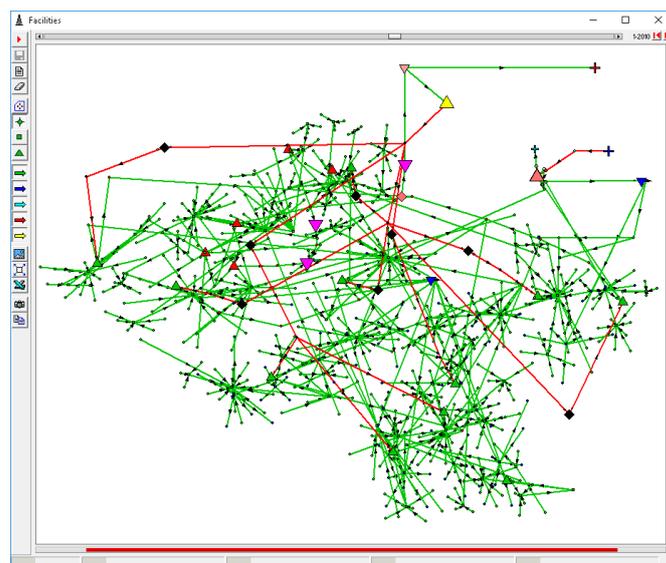
Identification of the Different Networks. The liquid production network is shown in green, the gas production network in red, the injection network in blue, and finally the water transference network in light blue if there is an external source.



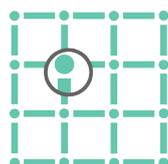
Associated Nodes. By selecting a node, all nodes that are upstream or downstream can be identified. The example highlights all the nodes converging to the E-3 Battery.



Identification of High and Low Pressure Zones. A range of colors can be used to show the pipes depending on the pressure they have. In this example, the range of colors from blue to red characterizes low to high pressures.



Identification of Calculation Problems. Pipes that have not been calculated can be identified. For example, that could be due to the disconnection of nodes from the network.



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