Boiler Unit Operation in the Symmetry* Process Software Platform

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Boiler Unit Operation

Steam utility systems account for a significant portion of the energy consumption in many facilities and are also a source for greenhouse gas emissions. The Symmetry process platform offers a wide variety of tools to model and optimize utility systems. This article describes the main features of the Boiler unit operation which was officially released in Symmetry 2020 and offers great flexibility to specify the flue and steam sides.

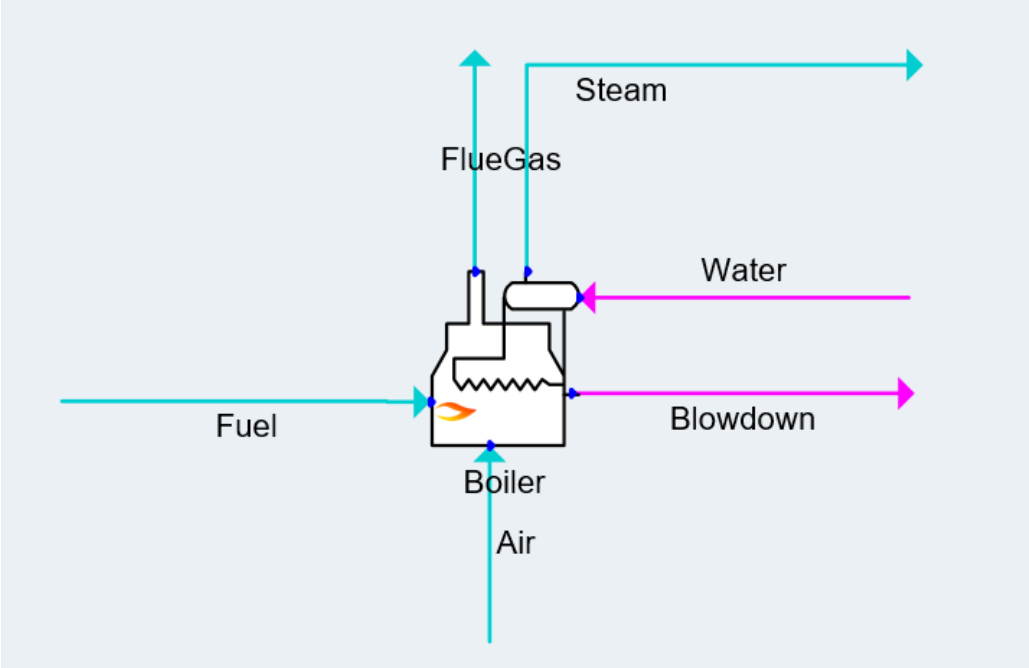

Figure 1. Boiler unit operation schematic with streams

1. Property package assignment

The boiler unit operation is in the “Fired Equipment” section of the Visio stencil. The unit operation is divided into two main sections, the flue side and the steam side. Each side can have a different property package such that the steam side can use the Steam 97 package and the other side can use a more suitable equation of state for the combustion calculations. For this example, we will assume that the default property package is using Advanced Peng Robinson (for the flue side) and that there is a second

property package set to “Steam 97” as the property model with WATER as the only component.

To assign the steam package, right-click on the unit operation and click on “Assign Property Package”. Make sure you assign the Steam package to the Steam side.

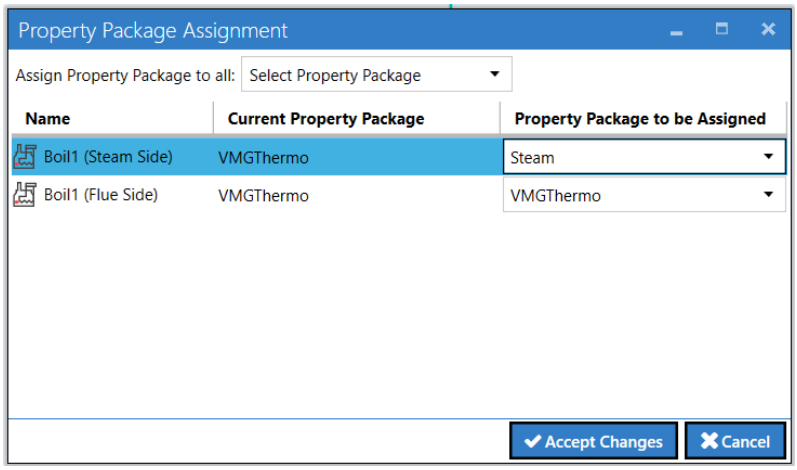

Figure 2. Property package assignment

This will display a different component list for each side as shown below.

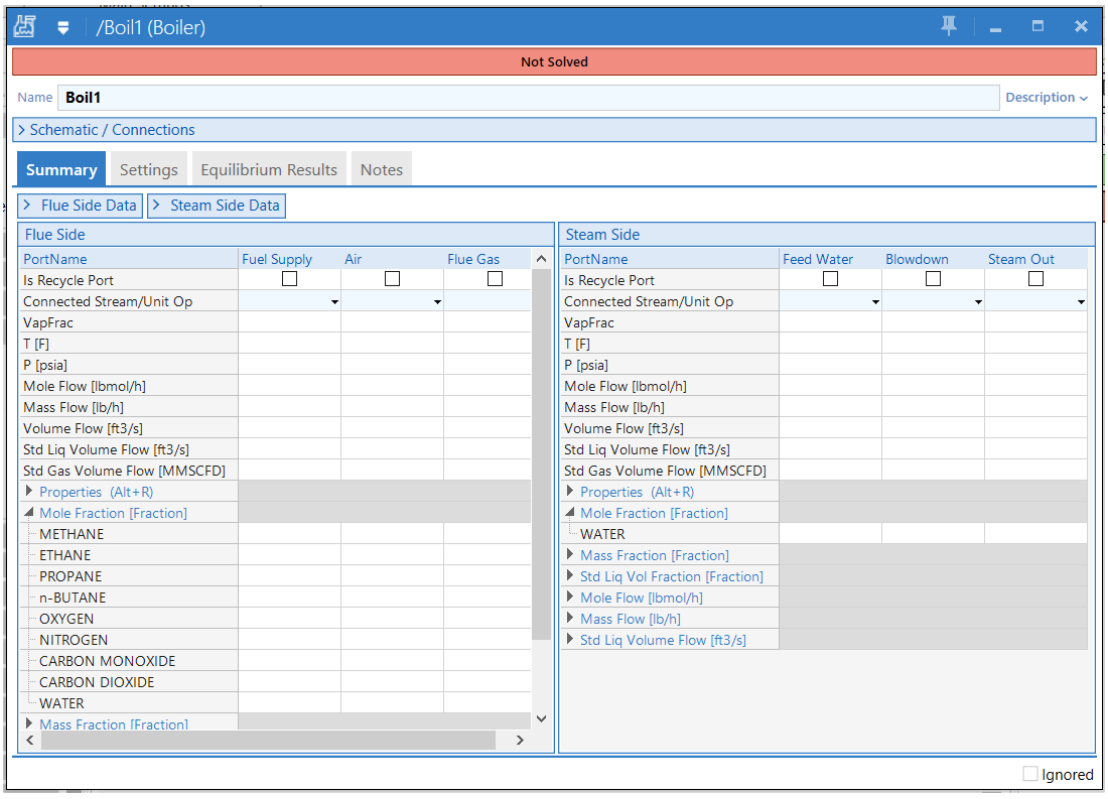

Figure 3. Boiler with steam side assigned

2. Specifications

The boiler unit operation is configured to monitor degrees of freedom and it will automatically solve as soon as enough specifications are provided to solve the heat and material balance. This flexibility enables a wide combination of specifications. The flue side includes an inlet air port, an inlet fuel port and an optional second inlet fuel port. The outlet from the combustion is assigned to the Flue Gas port. The flue side must include oxygen, nitrogen, water, carbon dioxide and at least one fuel component.

The air composition can be specified directly by the user or it can be set as a reference to the global default air definition from the root flowsheet. This option enables also an option to specify relative humidity.

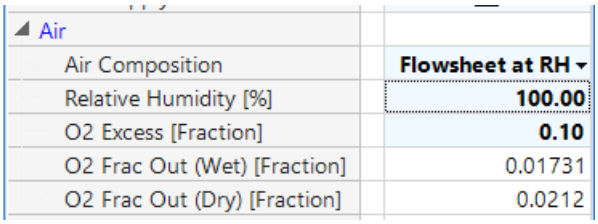

Figure 4. Specifying relative humidity for the air in the feed.

In the boiler unit operation, the fuel and air feeds are reacted in an exothermic reaction. The energy from this combustion is balanced as follows:

- Raise the energy content of the water to generate steam
- Losses (configured in the Energy Loss % variable)
- Outlet temperature of the Flue gas

The steam outlet can be defined with a quality such as saturated vapor, superheated steam or left to be calculated from the balance. Some common specifications include a specification of fuel flow to calculate the steam being raised or specifying the steam flow and back calculating the fuel instead. If both water and fuel flows are defined, then the heat content of the outlet steam would be calculated from the balance.

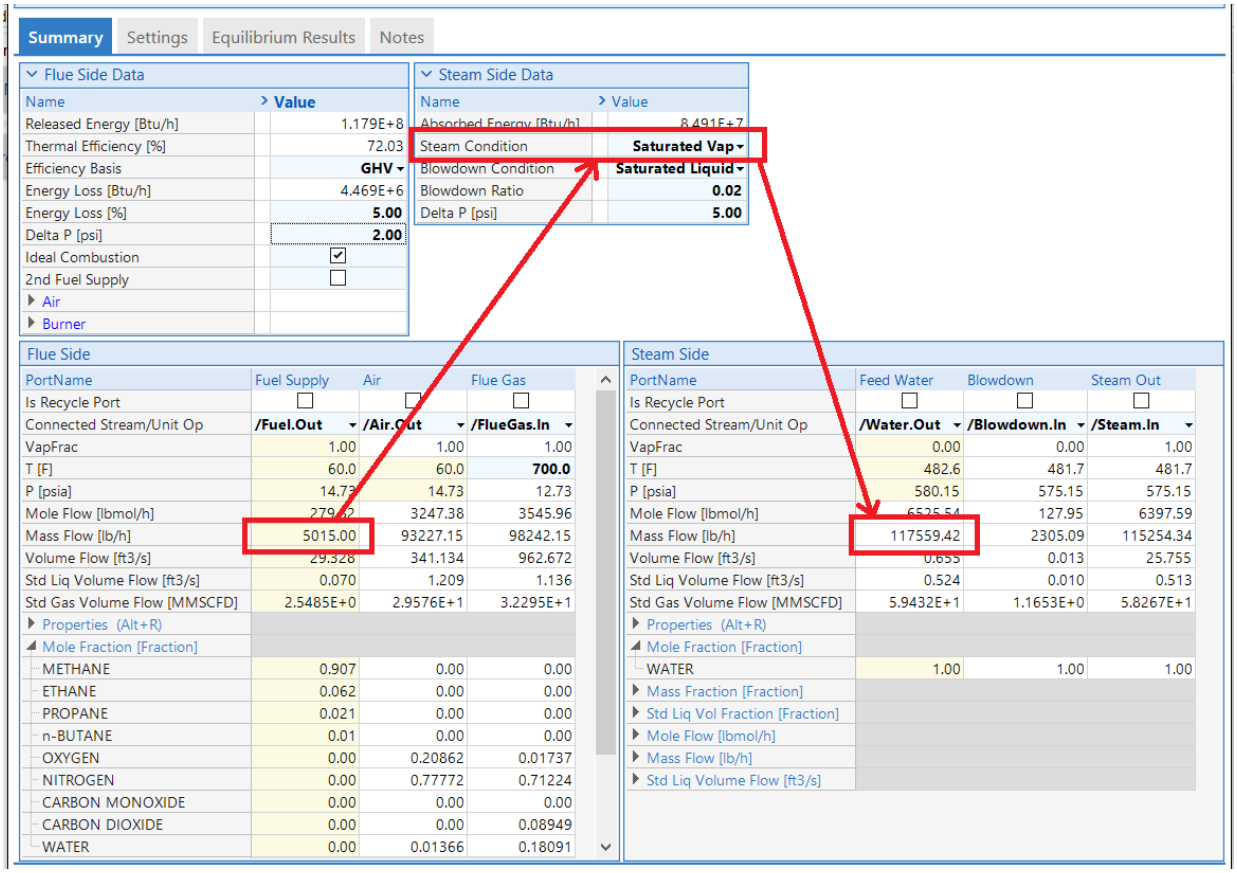

Figure 5. Calculating steam flow from fuel flow

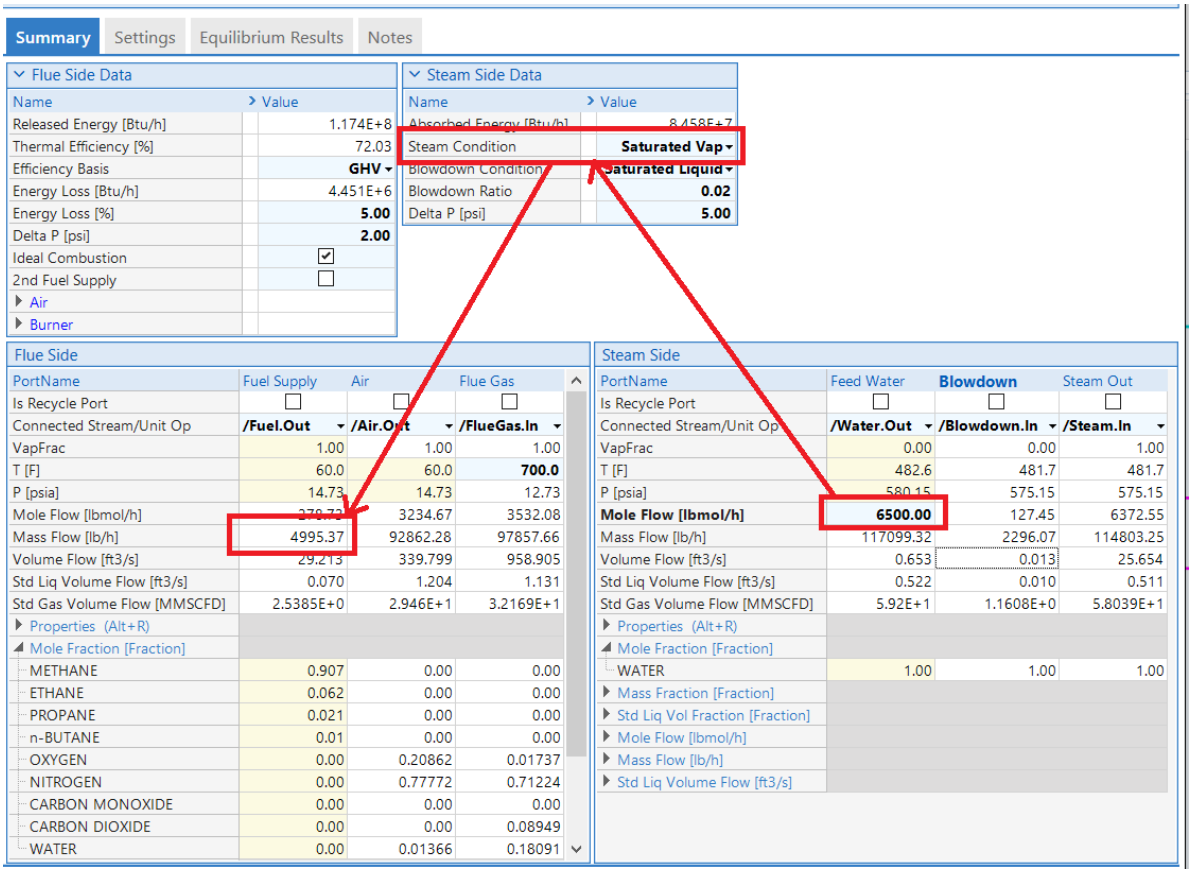

Figure 6. Calculating fuel from steam demand

There are two efficiencies in the boiler unit operation. The “Energy Loss %” is the percent of energy lost to the surroundings. The “Thermal Efficiency %” is the percent of energy transferred to the utility fluid (steam) in reference to the heating value available in the feed. The thermal efficiency can be defined in reference to the gross heating value or the net heating value. The outlet flue gas temperature can be specified or calculated from the thermal efficiency.

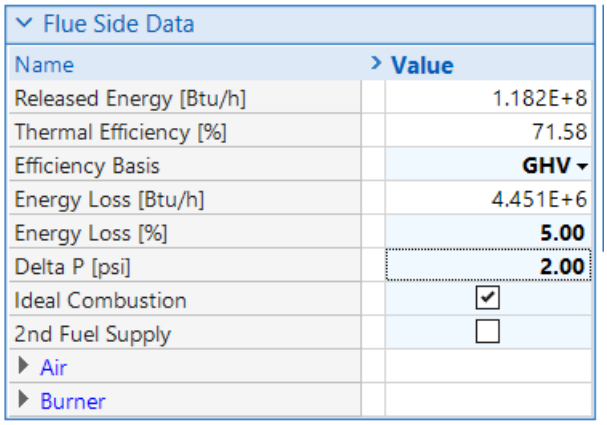

Figure 7. Thermal efficiency calculated from energy balance

Conclusion

A boiler unit operation was introduced in Symmetry 2020 to aid in the modeling of steam utility systems for processing facilities. The unit operation has two sides, one for the flue side and another for the steam. The boiler can be specified in multiple ways which facilitates the configuration of complex simulation models.

To learn more about the Symmetry Process Software Platform please contact your local Schlumberger office.