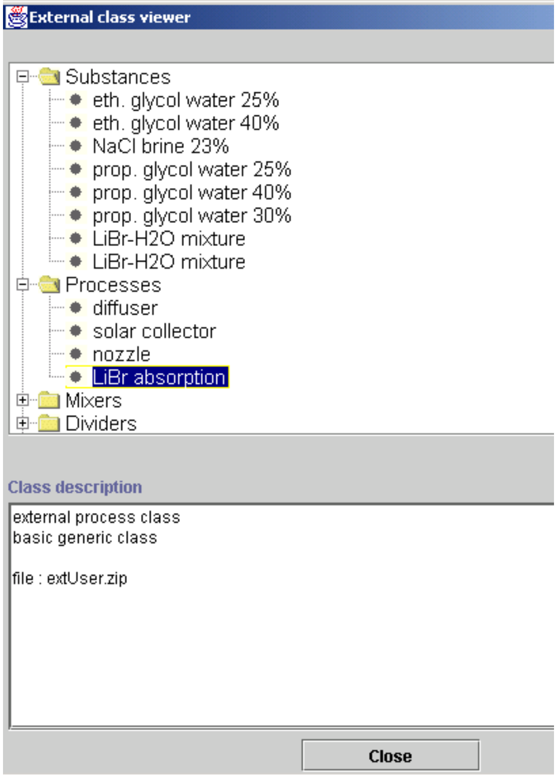
2.5 USING EXTERNAL COMPONENTS

2.5.1 VIEWING THE AVAILABLE EXTERNAL CLASSES

To help you use and manage the external classes, the line External Class Viewer from the Special menu displays all of the external classes available. They are sorted by type (substances, processes, mixers, dividers, drivers) with a short description of the class selected and where it comes from (extThopt.zip and extUser.zip archives as well as classes under development).

This screen can be consulted while you are developing your model.



External class viewer

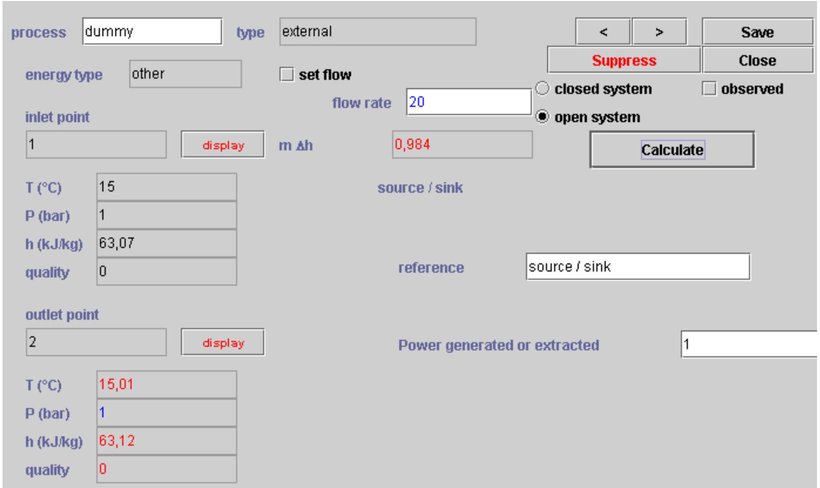
2.5.2 REPRESENTATION OF AN EXTERNAL COMPONENT IN THE DIAGRAM EDITOR

Specific icons were added to represent the external components ( for processes,  for mixers, and  for dividers). The external component is then selected when the simulator is updated from the diagram as indicated below.

2.5.3 LOADING AN EXTERNAL CLASS

To load an external process (for an external node, the process is the same), you can either:

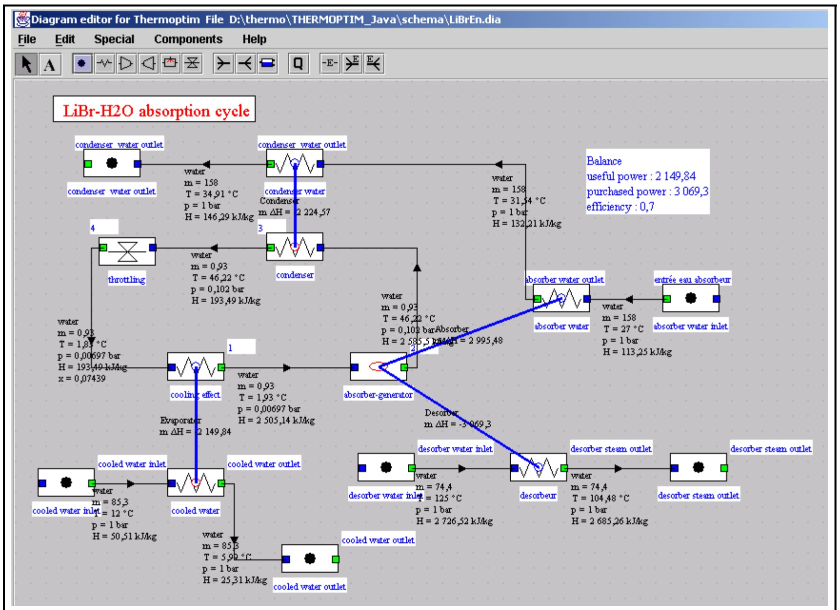
- from the simulator screen click on the column header of the process array, then choose External and finally select the type of external process you want from the list;
- or, from the diagram editor, build the external component graphically then update the simulator from the diagram. In the case of an external process, by default it is a "heat source / sink" type, as shown in the screen opposite.



Default screen of an external process

Once this default process is created, double click on the label "source / sink" to access the list of all external processes available. Choose the one you want and it will be loaded.

2.5.4 THERMOCOUPLERS

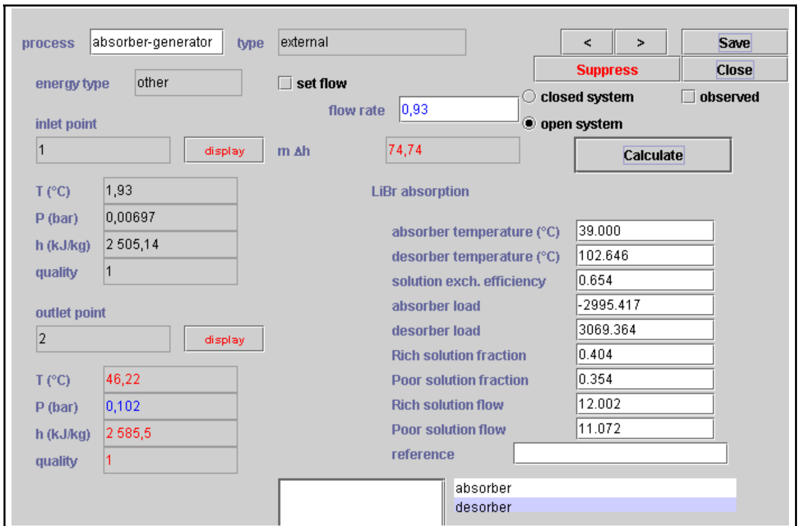


External component with two thermocouplers

The thermocoupler system completes the heat exchanger system by allowing components other than exchange processes to connect to one or more exchange processes to represent a thermal coupling. This system does not encompass the exchanger system: two exchange processes cannot be connected by a thermocoupler.

This system has a number of benefits, because it can be used to represent many thermocouplers that do not constitute a heat exchange in the traditional sense, like for example cooling the walls of the combustion chamber of a reciprocating engine, cooled compression, and above all supply or removal of heat from the multi-functional external components.

The figure above is an illustration of this: An absorption refrigeration cycle, whose absorption-desorption system is defined and integrated in an external process, is supplied with the steam that exits the evaporator then enters the condenser. This cycle involves the mixture LiBr-H_2O, whose properties are modeled either directly in the external process, or in an external substance, and requires high temperature heat supply to the desorber and medium temperature heat removal from the absorber. The representation of these thermocouplers is possible thanks to the thermocoupler system: the external process calculates the thermal energies that must be exchanged, and the thermocoupler recalculates the corresponding "exchange" process, which updates its downstream point.



External process

The types of thermocouplers used by an external component appear in the lower right hand corner of the screen. Double click on one of the types to open the screen of the corresponding thermocoupler.

Given that thermocouplers are a type of heat exchanger, it is valuable to define them by values such as effectiveness ε, UA, NTU or LMTD, that can be calculated using similar equations. The component sends to each of its thermocouplers the equivalent values for flow rates, inlet and outlet temperature and thermal energy transferred, which they must take into account in their calculations. Specific methods are provided in the external class code and are not user-modifiable.

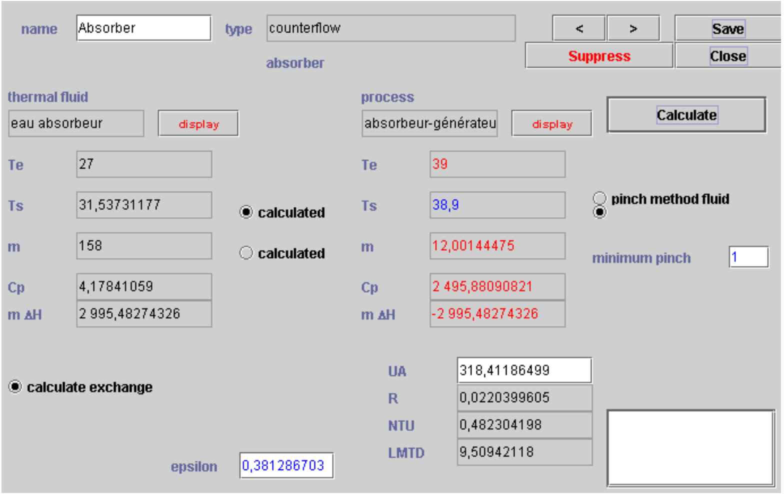
However, there are limits to the similarities with exchangers: for example, temperature crossovers unacceptable in an exchanger may occur in a thermocoupler, leading to absurd values.

So it is best to transmit values that are unlikely to lead to this type of situation. One possible solution is to assume that the thermocoupler is isothermal for calculations of characteristics that are similar to exchanger characteristics. For example, a combustion chamber may be assumed to be at mean temperature between its upstream and downstream points when calculating cooling. This assumption is not absurd and may prevent a temperature crossover between the cooling fluid and the gases that cross the component.

In the case of the absorption machine presented above, we assumed that the absorber and desorber were isothermal.

Both lead to the screens below. If we had not taken the temperature of the absorber as a reference for the exchange calculations, keeping the temperatures of the steam entering and exiting the external process, we would have ended up with a temperature crossover.

For external processes that accept several thermocouplers and for external nodes, the potential complexity of the calculations prevents the exchange process from driving the thermocoupler. Its load is always set by the external component. This is why there are fewer options for calculating a thermocoupler than for a heat exchanger: The user can only choose between calculating the outlet temperature of the exchange process (at a given flow rate) and the flow rate, when the temperature is known.

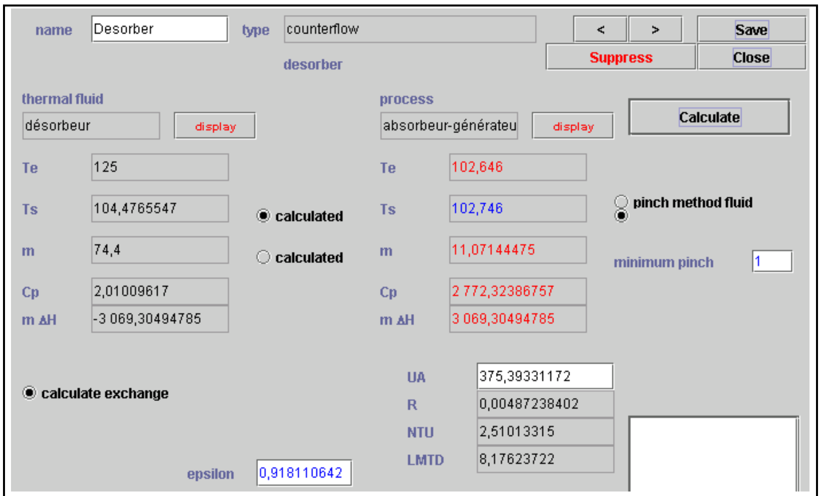


Absorber

Note that on the thermocoupler screen, the external component fluid can be selected as a pinch fluid and a minimum pinch value can be entered (see optimization method, volume 1).

2.5.5 External Nodes

The nodes of Thermoptim's basic set are extremely simple components used to complete the description of the fluid circuits. They are always adiabatic, and they ensure the conservation of the mass flow rate and enthalpy



Desorber

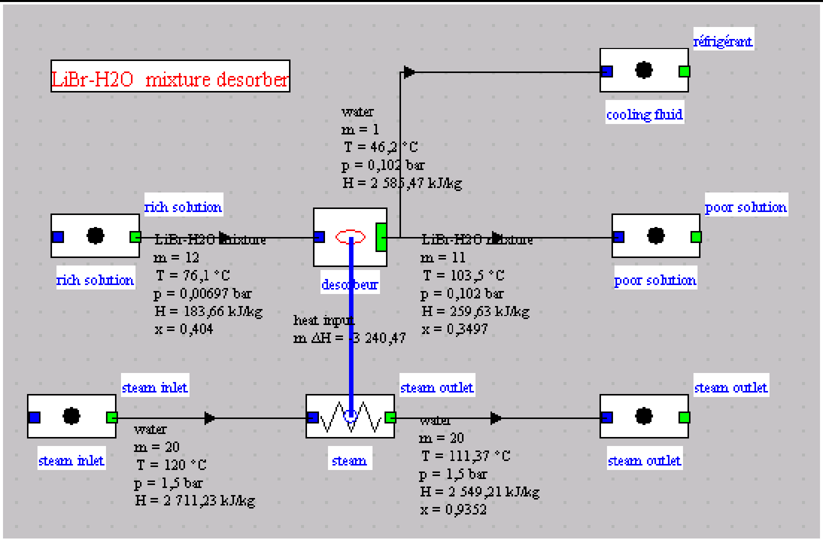
However, there is one somewhat special component, considered as a process, but which is in fact a node in most cases: combustion, which receives a oxidizer and a fuel, and from which burned gases exit.

In the LiBr-H2O absorption example, a number of energy systems are involved, as well as components of varying complexity, which can have a number of input and outlet fluids, after various internal calculations, with or without thermocoupling with external heat sources.

External nodes allow a user to define these components. Only external mixers and dividers are defined: no component simultaneously performs both functions (receiving and emitting several fluids), but you need only couple an external mixer with an external diffuser to do so.

In many respects, we encounter the same problems in implementing these external nodes as with thermocouplers: the potential complexity of the calculations to be made in the node makes it necessary for the node to take over and control both the main vein and the branches, since no default calculation is possible.

The verification and consistency problems are even more critical than for thermocouplers: only the node designer knows which processes it must be connected to in inlet and outlet. The user must refer to the documentation of the class to know how to use it.

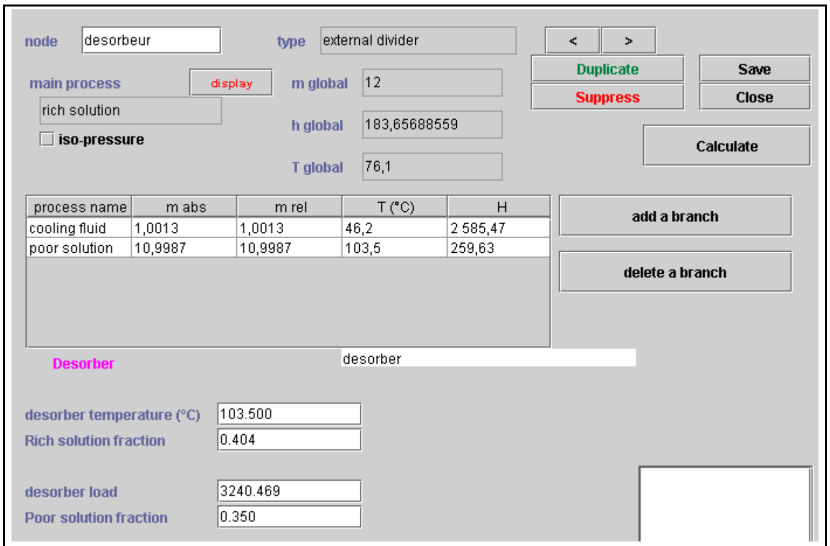


LiBr-H2O mixture desorber

The figure above shows the diagram of a desorber for an absorption machine using the LiBr-H_2O mixture whose properties must in this case be provided by an external substance.

The external node screen is shown opposite. As with external processes, it contains a general part defined in the Thermoptim basic set, completed by a part defined by the user (here the lower left zone). In the model shown here, the only parameter defined in the node is the temperature of the desorber. The properties of the rich solution (mass fraction and flow rate) and the state of the refrigerant are obtained from their respective processes.

The node calculates the flow rates of the refrigerant and the poor solution, its state, and heat supply required.



LiBr-H2O mixture desorber screen

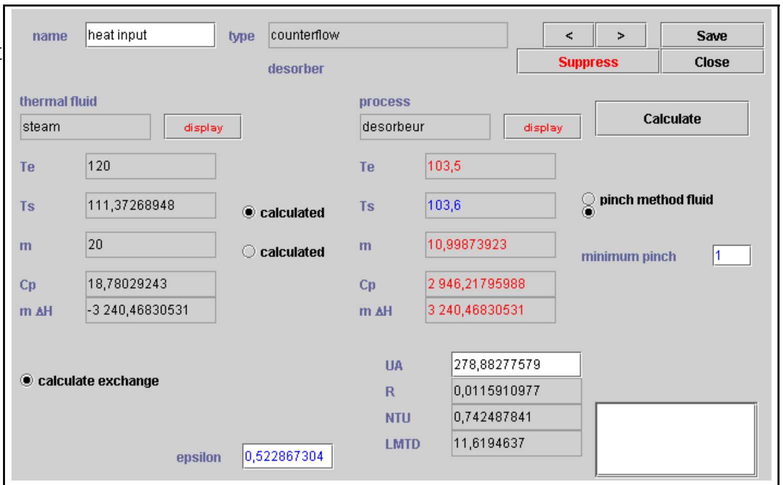
The thermocoupler then calculates the final state of the steam used.

Before each recalculation, the node checks that its structure is correct and loads the values that it needs to be calculated. Then it updates the thermocoupler that can in turn be recalculated. In this example, we assumed that the desorber was isothermal, and we took the flow rate of the poor solution as the reference flow rate.

2.5.6 Miscellaneous comments

You may have noticed that the screens of the external processes represented here are composed partly of Thermoptim internal code and partly of external code (lower right section in the processes, lower left in the nodes.). This is because the character strings used in the external components have not been "internationalized" the way the Thermoptim basic set has.

But this does not affect their use in any way. However, you can see that the number display has not been internationalized either, so the decimal separator is not the same: it is a period and not a comma. Of course, this can be modified, but it has not yet been done. This means that the figures must be entered with a point in the part defined in the external component, and with a comma in the rest of the screen. It is important to pay close attention to this issue, otherwise number formatting errors will be detected by Java.



Thermocoupler