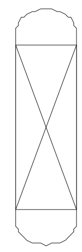
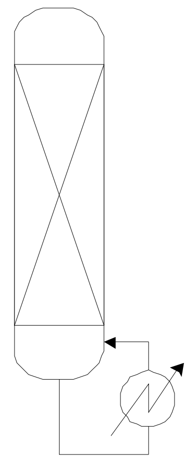
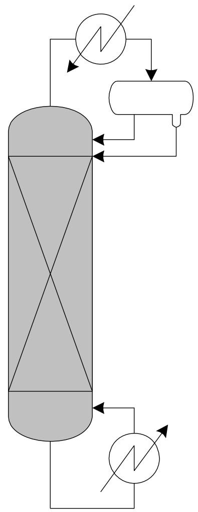
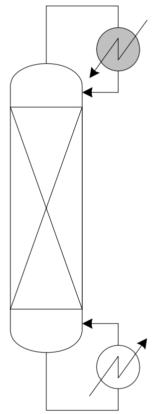
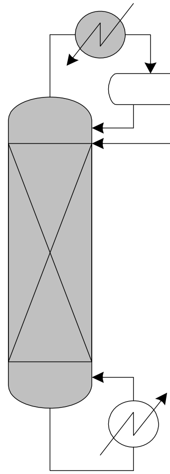
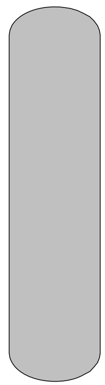
ProSimPlus Library (Standard version + rate base option)

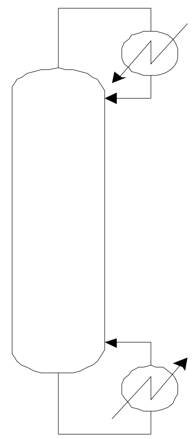
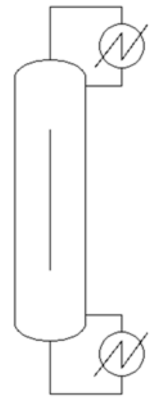
Contents

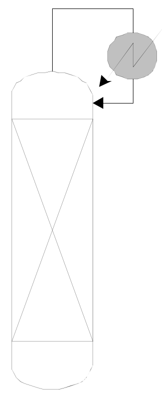
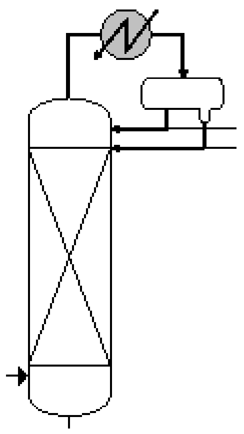
UNIT OPERATIONS

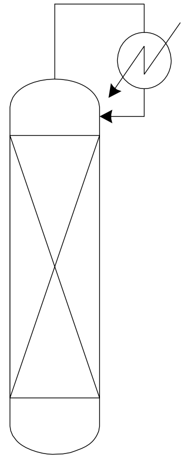
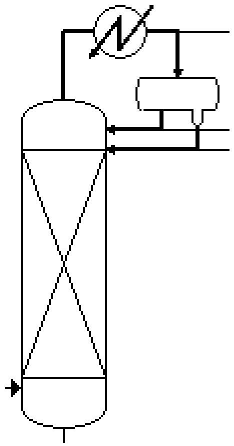
Unit operation	Short description	Module on the flowsheet
Absorber	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column without boiler nor condenser. A liquid feed, a vapor sidestream at the column overhead, a vapor feed and a liquid sidestream in bottom of column are necessary. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Absorber
Absorber with reboiler	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column with a boiler but without condenser. A liquid feed, a vapor sidestream at the column overhead and a liquid sidestream in bottom of column are necessary. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Absorber with a reboiler

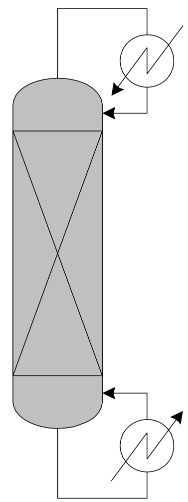
Rigorous two-phase distillation (L-V) with partial condenser and decanter	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column with a boiler, a partial condenser, and a top decanter. A feed and at least a vapor distillate and a liquid bottom product are required. Side streams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage; nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Two-phase distillation with partial condenser and decanter
Rigorous two-phase distillation (L-V) with total condenser	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column with a boiler and a total condenser. A feed and at least a liquid distillate and a liquid bottom product are required. Side streams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Two-phase distillation with total condenser

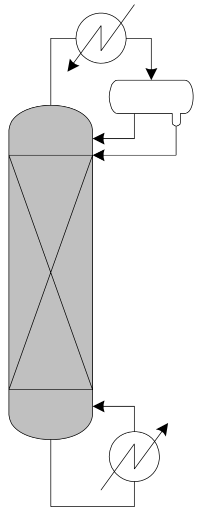
Rigorous two-phase distillation (L-V) with total condenser and decanter	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column with a boiler, a total condenser and a top decanter. A feed and at least a liquid distillate and a liquid bottom product are required. Side streams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Two-phase distillation with total condenser and decanter
Column sizing	The COLUMN SIZING unit block is used to carry out or to check the sizing of a column, without having carried out preliminary rigorous calculation. No fluid phase equilibrium or enthalpy calculation is carried out inside this unit operation, input streams being considered equal to outlet streams. Nevertheless, transport properties (density, viscosity and area tension...) can either be calculated from the input streams characteristics or provided by the user. These properties being known, the column sizing unit operation enables to check existing columns hydraulic operation or to size a column according to various criteria.	 Column sizing

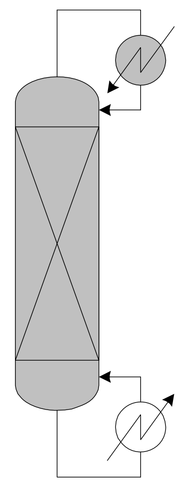
Distillation "short-cut"	Makes it possible to design a simple distillation column with one feed and two products, the distillate and the bottom product. When the separation fractions of two key components at the distillate and at the bottom product are specified, the unit operation provides: the reflux ratio, the number of theoretical stages, the position of the feed stage, the distillate and bottom product compositions, the reboiler heat duty, the heat to be removed at the condenser. This unit operation can be used for the approximate design of a distillation column. The standard methods used in this unit operation are: Fenske, Underwood, Gilliland and Kirkbride.	 Distillation « short-cut »
Divided wall column “shortcut”	Makes it possible to a size a distillation column with a separation wall, with a feed and three products: the distillate, the waste, and the intermediate sidestream. Specifying the recovery rate of the three key-compounds for each outlet stream and some operating constraints allows the unit operation to calculate a sizing by theoretical stages, and initializations for the intermediate streams required for a rigorous calculation. The pre-sizing method adapted is based on the combination of several shortcuts for these classical pre-sizing methods: Fenske, Underwood, Gilliland and Kirkbride.	 **Divided wall column “short-cut”**

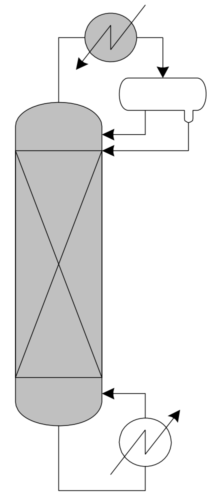
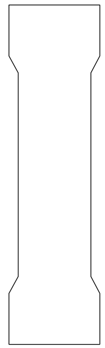
Stripper with total condenser	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column having a total condenser but without boiler. A column bottom vapor feed and at least a liquid distillate and a column bottom liquid sidestream are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Stripper with total condenser
Stripper with total condenser and decanter	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column having a total condenser and a decanter but without boiler. A column bottom vapor feed and at least a liquid distillate and a column bottom liquid sidestream are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Stripper with total condenser and decanter

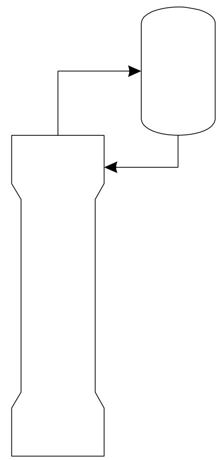
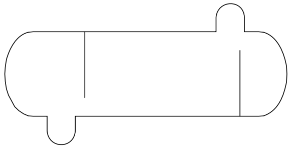
Stripper with partial condenser	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column having a partial condenser but without boiler. A column bottom vapor feed and at least a vapor distillate and a column bottom liquid sidestream are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage; nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Stripper with partial condenser
Stripper with partial condenser and decanter	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column having a partial condenser and a decanter but without boiler. A column bottom vapor feed and at least a vapor distillate and a column bottom liquid sidestream are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Stripper with partial condenser and decanter

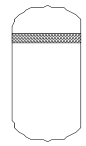
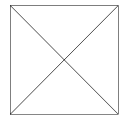
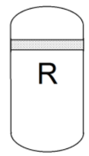
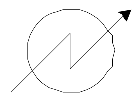
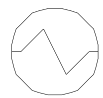
Rigorous three-phase distillation (L-L-V) with partial condenser, without decanter	Makes it possible to represent a multi-stage liquid-liquid-vapor separation process where takes place a counter-current mass transfer between one or two liquid phases and a vapor phase within a column with a boiler and a partial condenser, but without top decanter. Each stage of the column can be three-phase and phase stability tests are carried out in order to determine the locations of the two liquid phases coexistence. The distinction between heavy phase and light phase is carried out automatically by the program, by comparing the densities. A feed, a vapor distillate and a liquid bottom product are required. Heavy or light sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Three-phase distillation L-L-V

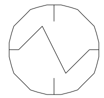
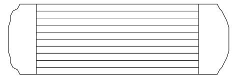
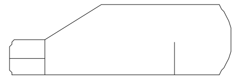
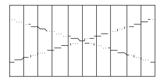
Rigorous three-phase distillation (L-L-V) with partial condenser and decanter	Makes it possible to represent a multi-stage liquid-liquid-vapor separation process where takes place a counter-current mass transfer between one or two liquid phases and a vapor phase within a column with a boiler, a partial condenser, and a top decanter. Each stage of the column can be three-phase and phase stability tests are carried out in order to determine the locations of the two liquid phases coexistence. The distinction between heavy phase and light phase is carried out automatically by the program, by comparing the densities. A feed, a vapor distillate and a liquid bottom product are required. Heavy or light sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Three-phase distillation L-L-V with

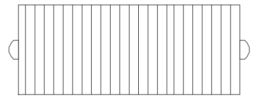
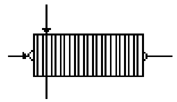
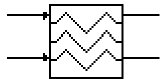
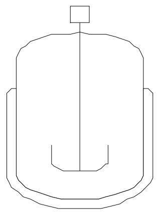
Rigorous three-phase distillation (L-L-V) with total condenser, without decanter	Makes it possible to represent a multi-stage liquid-liquid-vapor separation process where takes place a counter-current mass transfer between one or two liquid phases and a vapor phase within a column with a boiler and a total condenser, but without top decanter. Each stage of the column can be three-phase and phase stability tests are carried out in order to determine the locations of the two liquid phases coexistence. The distinction between heavy phase and light phase is carried out automatically by the program, by comparing the densities. A feed, a liquid distillate and a liquid bottom product are required. Heavy or light sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Three-phase distillation L-L-V with total condenser

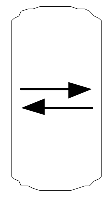
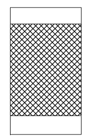
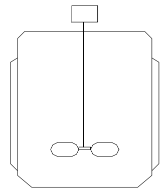
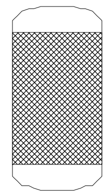
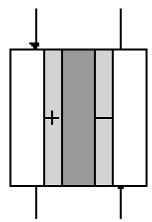
Rigorous three-phase distillation (L-L-V) with total condenser and decanter	Makes it possible to represent a multi-stage liquid-liquid-vapor separation process where takes place a counter-current mass transfer between one or two liquid phases and a vapor phase within a column with a boiler, a total condenser and a top decanter. Each stage of the column can be three-phase and phase stability tests are carried out in order to determine the locations of the two liquid phases coexistence. The distinction between heavy phase and light phase is carried out automatically by the program, by comparing the densities. A feed, a liquid distillate and a liquid bottom product are required. Heavy or light sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage. The mathematical model is based on the concept of theoretical stage, nevertheless it is possible to introduce Murphree efficiencies. The column sizing or rating can be carried out for all kind of column internals as well as many types of plates (see column sizing). It is also possible to specify that the whole column, or part of it, corresponds to a zone in which occur chemical reactions.	 Three-phase distillation with total condenser and decanter
Liquid-liquid extraction	Makes it possible to represent a multi-stage liquid-liquid extraction process where takes place a counter-current mass transfer between two liquid phases. Two feed streams including solvent, an extract sidestream and a raffinate sidestream are required. A feed, an extract sidestream and a raffinate sidestream can also be specified at each stage. The mathematical model is based on the concept of theoretical stage. For liquid-liquid equilibrium calculations, splitting ratios between the raffinate and extract phases can be calculated by the selected thermodynamic model or provided by the user.	 Liquid-liquid extraction column

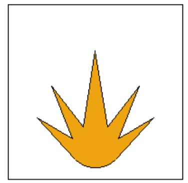
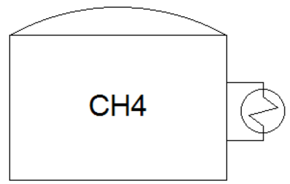
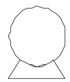
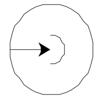
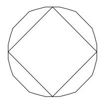
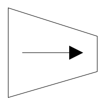
Liquid-liquid extraction with reflux	Makes it possible to represent a multi-stage liquid-liquid extraction process where takes place a counter-current mass transfer between two liquid phases. In this case the first stage is replaced by a stage known as “reflux stage”. Its role is to represent a separation process that enables to regenerate solvent, from the extract resulting from the extraction process itself. Two feed streams including solvent, an extract sidestream, a raffinate sidestream and a recovered solvent stream are required. A feed, an extract sidestream and a raffinate sidestream can also be specified at each stage. The mathematical model is based on the concept of theoretical stage. For liquid-liquid equilibrium calculations, splitting ratios between the raffinate and extract phases can be calculated by the selected thermodynamic model or provided by the user.	 Liquid-liquid extraction column with reflux
Decanter	Used to represent a liquid-liquid separation supposed to be at constant temperature and pressure thermodynamic equilibrium. If a demixing is detected, at the outlet a stream corresponds to the "light" liquid and another one to the "heavy" liquid. It is possible to specify liquid-liquid splitting ratios, independently from the selected thermodynamic model.	 Decanter
Generalized three-phase flash (liquid-liquid-vapor)	Used to model a flash separation for which two liquid phases and a vapor phase are at thermodynamic equilibrium. Several kind of flashes are available such as constant temperature and pressure flash (isothermal), constant heat duty and pressure flash (adiabatic) or constant pressure and vapor fraction flash. This unit operation has three outlet streams corresponding to the vapor stream, the "light" liquid stream and the "heavy" liquid stream.	 Generalized three-phase flash (liquid-liquid-vapor)

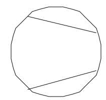
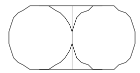
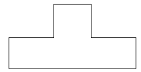
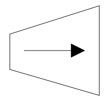
Generalized two-phase flash (liquid-vapor)	Used to represent a flash operation for which it is supposed that thermodynamic equilibrium is reached. This module simulates all kind of flashes such as constant temperature and pressure flash, constant pressure and heat duty flash, constant vapor fraction and temperature or pressure flash, constant pressure and entropy flash.	 Liquid-vapor separator  Two phases flash with one outlet stream
Reactive two-phase flash	A flash operation that includes chemical reactions. The liquid phase is homogeneous (no liquid phase splitting) and the physical state on output is 2-phases (i.e. vapor-liquid). Thermodynamic equilibrium is assumed.	 **Reactive two-phase flash**
Simple heat exchanger	Calculates the physical state (temperature and vapor fraction) of a stream when a heat duty is supplied. It allows to simply simulate a heat exchanger to heat or cool a stream.	 Simple heat exchanger
Cooler/Heater	Allows adjusting a stream temperature without worrying about the exchanger geometry. This module makes it possible to simulate a heat exchanger and to calculate the heat duty required to reach a specified temperature.	 Cooler / heater

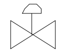
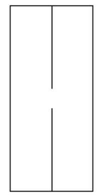
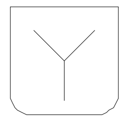
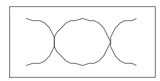
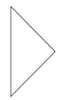
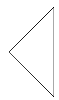
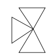
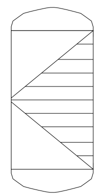
Heat exchanger	Calculates the heat exchange between two streams in a counter-current or co-current heat exchanger. For a given specification, the unit operation determines the output streams characteristics and calculates the exchanged heat duty (if it is not given). Moreover, from the knowledge of the global heat transfer coefficients, the unit operation enables to calculate a heat exchange area with or without taking into account possible phase changes. For heat exchangers with several tubes side and/or shell side passes, efficiency compared to pure counter-current is calculated.	 Generalized heat exchanger  Shell and tube heat exchanger  Kettle reboiler  Plate and frame heat exchanger
Double pipe heat exchanger	This unit operation is used to determine the heat duty exchanged and the outlet temperatures (tube side and annular space side) of a heat exchanger of double-tube type knowing its geometry and the inlet stream characteristics. The correlations used to determine the pressure drops and the heat transfer coefficients on the two sides (tube and annular space) can be chosen by the user in the list proposed in this module. The flow inside the double-pipe heat exchanger can be counter-current or co-current with the availability of condensation or evaporation on the two sides.	 Double-pipe heat exchanger

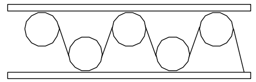
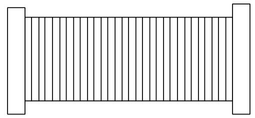
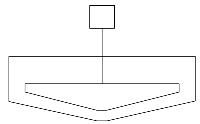
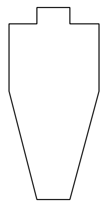
Multi-fluid heat exchanger	Calculates the heat exchange between a main stream and several secondary streams. As the streams remain unchanged on the mass level, only an energy balance is carried out. From the knowledge of the input and outlet temperatures of secondary streams, the thermal characteristics of the main outlet stream and the heat duties are calculated.	 Multi-fluid heat exchanger
Brazed plate fin heat exchanger	This module calculates the thermal performances and the pressure drops of a unit operation, or a battery of unit operations in parallel, of given geometry in which can circulate up to 10 fluids in co-current or counter current flow. For a given specification, the module determines the output streams characteristics, calculates the quantities of exchanged heat and the temperature and enthalpy internal profiles, assuming a wall temperature constant. The brazed plate-fin heat exchanger (BPFHE) technology is relatively complex and this module allows a detailed description of the geometry of the BPFHE as well as the flow topology.	 Brazed plate fin heat exchanger
MHX exchanger	Allows calculation of mass and enthalpy balances on a multi-streams heat exchanger or on a heat exchangers network. Heat energy integration could be evaluated from cold and hot composite curves.Two modes are available : 1. Checking of an existing heat exchanger 2. Heat exchanger calculation. Several options are available to meet different specifications on streams, pinch, duty, heat exchange coefficient…	 MHX exchanger
Continuous stirred tank reactor	Makes it possible to represent the operation of a perfectly stirred reactor with continuous feed and side stream. The mixture inside the reactor can be monophasic or two-phase. It is possible to take into account controlled and/or complex and/or equilibrium chemical reactions. For the calculation of the temperature within the reactor, various possibilities are proposed: adiabatic, isothermal... Phase changes are taken into account.	 Continuous stirred tank reactor

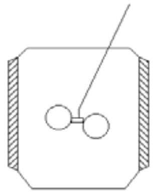
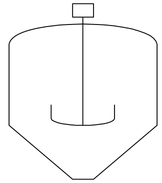
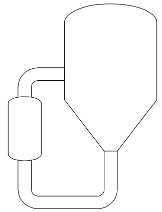
Equilibrium reactor	The EQUILIBRIUM REACTOR unit operation is used to represent a chemical equilibrium in gas phase, with a specified system pressure, and with the choice of the temperature (isothermal reactor) or of the heat duty (for example adiabatic reactor).The equilibrium is calculated either by using the method of the equilibrium constants or by minimizing Gibbs free energy of the system. With the equilibrium constants method, the user can define approach temperatures to the equilibrium by giving for each reaction temperature deviations compared to the system temperature. The equilibrium constants are then calculated at the corresponding approach temperatures and not at the system temperature.	 Equilibrium reactor
Simple chemical reactor	Used to represent a reactor that can be adiabatic, isothermal, at imposed outlet temperature or with heat duty supplied, in which several reactions are taken into account with a set of conversion rates or a set of selectivities.	 Simple reactor  Reaction tank
Plug flow reactor	Allows representing the operation in steady state of a tubular flow reactor in which the hydrodynamics corresponds to an "ideal plug" type flow. This unit operation makes it possible to take into account equilibrium chemical reactions or reactions with controlled or complex kinetics. Moreover, for the temperature profile inside the reactor calculation, various options are possible; in particular, it is possible to describe an external jacket in which circulates a co-current or counter-current service fluid.	 Plug flow reactor
Solid oxide fuel cell (SOFC)	Calculates mass and heat balance on a pile of electrochemical cells. This module is used to represent the behavior of the core of a Solid Oxide Fuel Cell without internal reforming of methane.	 Solid oxide fuel cell

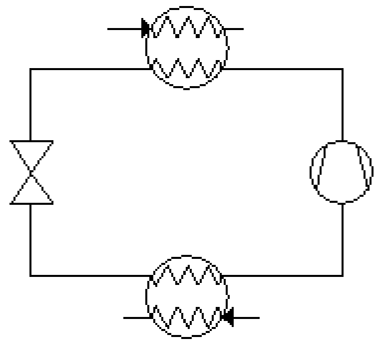
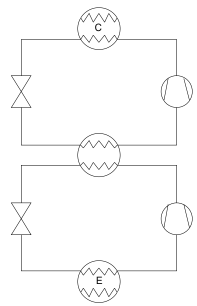
Combustion	Allows the simulation of chemical exothermal redox reactions, referred to as combustion reactions, which produce heat. The combustion requires two reagents: the combustive that brings the oxygen (O_2), essential for the reaction, and the fuel that brings the material being burnt. The combustion unit operation can deal with gaseous fuels, as well as with solid or liquid fuels.	 Combustion
Methanization reactor	Allows the simulation of the anaerobic digestion of biodegradable compounds. This microbial biological process occurs in wet conditions in the absence of oxygen. The aim is to transform a complex organic waste (treated mixture) into a biogas (mainly composed of methane and carbon dioxide) and into a digestate (composed of organic and inorganic substance non degradable under the conditions of the process). The volatile matter applies to the organic part of the treated mixture, i.e. the compounds likely to produce biogas. The treated mixture is made up of all the compounds entering the unit operation.	 Methanization reactor
Pump	Used to simulate a pump. The pump exhaust pressure can either be provided or calculated from the knowledge of the electric power it consumes. Two representation models of its operation are available: volumetric pump or isentropic pump. Isentropic or volumetric efficiency as well as mechanical efficiency can be provided.	 Centrifugal pump  Linear pump  Generalized pump
Compressor	Used to simulate a mono or multistage compressor with or without intermediate cooling. Isentropic or mechanical efficiency can be provided. At the level of possible intermediate exchangers, the user can specify the cooling temperatures.	 Compressor

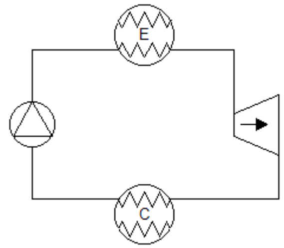
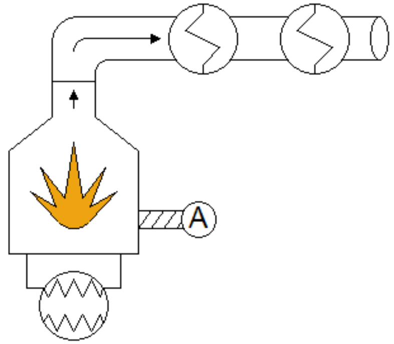
Generalized compressor	Used to simulate a mono or multistage isentropic or polytropic compressor, with or without intermediate cooling. It has all the functionalities of the simple compressor unit operation but this unit operation makes it possible to use the manufacturer's curves as data of simulation.	 Generalized compressor  Rotary compressor  Reciprocating compressor
Expander	Used to simulate a mono-stage expander with possibility of condensation. Calculation is performed from the outlet pressure or the temperature of dew point (or bubble point) pressure corresponding to the dew point (or bubble point) pressure expected on exit (this pressure will then be calculated by the module).	 Expander
Pressure drop calculations	Enables to calculate pressure drops sustained by a fluid during different transports (isothermal, adiabatic or including thermal exchanges) in a pipe with linear segments (tubular pipe) and/or fittings (valve, elbow ...) and/or swages (enlarger or reducer).. The unit operation also carries out the calculation of possible phase changes and gives their location.	 Pipe segment
Vapor ejector	A VAPOR EJECTOR is a device fed with two fluids, a primary fluid and a secondary fluid. It allows the compression of the secondary fluid with an enthalpy decrease of the primary fluid.	 Vapor ejector

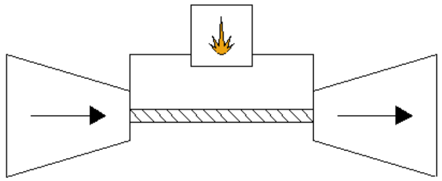
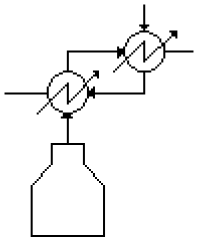
Expansion valve	Used to represent an adiabatic expansion of a mixture, making the assumption that the thermodynamic equilibrium is reached. Several feeds can be connected to the unit operation. In this case, these feeds are adiabatically mixed with the lowest pressure of the feeds pressures. In any case, the unit operation only has one outlet, allowing the liquid and vapor phases not to be split at the unit operation outlet (only one outlet stream).	 Expansion valve
Orifice plate	Used to represent an adiabatic expansion operation of a mixture making the assumption that the thermodynamic equilibrium is reached. The main function of an orifice plate is to measure a fluid flowrate. This type of unit operation is the simplest and the cheapest to reduce pressure. Like every de-pressurizing unit operation, this one is inserted into a pipe in order to limit a fluid flow and to create a pressure drop. The main application is to measure the flowrate of the fluid according to the Bernoulli theorem.	 Orifice plate
Mixer	Used to mix several streams to obtain a single outlet stream	 Mixer  Static mixer  Other mixer
Stream splitter	Divides the stream resulting from the feeds adiabatic mixing into several streams of the same composition, temperature and pressure.	 Stream splitter  Three way valve
Component splitter	Makes it possible to separate the components of one stream between several streams. The recovery ratio of each component in the first outlet stream is fixed and also in intermediate sidestream. The rest of the feed is put in the last stream (bottom product). This unit operation can be used to simulate the calculation of a separation process in a simple and not time consuming way.	 Component splitter

Belt filter	Makes it possible to simulate a belt filter to perform liquid-solid separation. Calculation is performed from knowledge of cake moisture, solid fraction in the filtrates and solid separation fractions of the components in the mixture. The filter is fed by a suspension and eventually by wash water for belt and/or for vacuum chambers. A solid phase and a filtrate are recovered as outlet streams.	 Belt filter
Filter press	Makes it possible to simulate a filter press to perform liquid-solid separation. Calculation is performed from knowledge of cake moisture and solid fraction in the mother liquors leaving the filter. The filter is fed by a suspension. A solid phase and a filtrate are recovered as outlet streams.	 Plate frame filter
Clarifying filter	Makes it possible to simulate a clarifying filter to perform liquid-solid separation. Calculation is performed from knowledge of solid fraction in the sludge and in the overflow settler. The filter is fed by a suspension. A clarified effluent and sludge are recovered as outlet streams.	 Clarifier
Hydrocyclone	Makes it possible to simulate an hydrocyclone to perform liquid-solid separation. Calculation is performed from knowledge of solid fraction in the solids discharge and in the liquid discharge. A calculation for each component is also possible from knowledge of splitting ratios for n-1 components. A top discharge clarified stream and a bottom rich solid discharge streams are recovered as outlet streams.	 Hydrocyclone

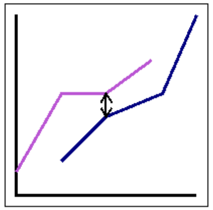
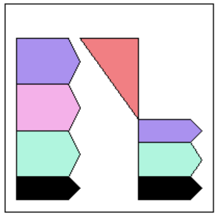
Tank (solid-liquid separation)	Calculates the liquid and/or vapor outlet streams from the mixture of the inlet streams, as well as the residence time in the tank from the supplied tank volume, using only the liquid phase. No reaction is taken into account. The tank is assumed adiabatic.	 Tank
Liquid-solid crystallizer	Allows to model any equipment for separation of a solid phase and a liquid phase making the assumption that the thermodynamic equilibrium is reached. Moreover, it is possible to define some parameters that can take into account the deviation from the thermodynamic equilibrium. This unit operation can be used to calculate only the saturation level of the studied solution.	 Liquid-solid crystallizer
Evaporator-crystallizer	Used to model any equipment for separation of a solid phase, a liquid phase and a vapor phase, making the assumption that the thermodynamic equilibrium is reached. Moreover, it is possible to define some parameters that can take into account the deviation from the thermodynamic equilibrium. This unit operation can be used to calculate only the saturation level of the studied solution.	 Evaporator-crystallizer

Heat pump	Objectives: Simulation of the transfer of heat from one medium considered as a “transmitter” (supplier medium) to a medium considered as a “receptor” of calories. Depending on the direction of the transfer, the heat pump can operate as a “radiator” (heat cycle) or as a “refrigerator” (refrigeration cycle). Main purpose: - Cool the hot utility ➔ Refrigerating unit operation (RU) - Heat the cold utility ➔ Heat pump unit operation (HP) Includes the following equipment: - A condenser - An expander or a turbine - An evaporator - A compressor	 Heat pump
Generalized heat pump	The GENERALIZED HEAT PUMP unit operation is a unit for the simulation of heat transfer from one medium considered as a "transmitter" (supplier medium) to a medium considered as a "receptor" of calories. Depending on the direction of the transfer, the heat pump can operate as a "radiator" (heat cycle) or as a "refrigerator" (refrigeration cycle). The Generalized heat pump unit operation benefits compared to the Single heat pump unit operation are the following ones: • reduction of the compressor discharge temperatures; • very low evaporation temperatures; • increased efficiency of the thermodynamic efficiency of the machine. The main purpose of the Generalized heat pump unit operation may be: • either to cool the hot utility-> Refrigerating unit operation (RU) • or to heat the cold utility -> Heat pump unit operation (HP) In ProSimPlus , the Generalized Heat Pump unit operation includes the following equipment: • A condenser (countercurrent heat exchanger); • Two expanders; • An evaporator (countercurrent heat exchanger); • Two compressors; • An intermediate exchanger.	 Generalized heat pump

Organic rankine cycle	The Organic Rankine Cycle unit operation allows the simulation of a thermodynamic cycle with a dual heat source in order to produce power with a turbine. Using an organic fluid allows to use the heat sources at low and mean temperature and to improve the expander efficiency. The mechanical work produced by the turbine is used to produce power with an alternator. This unit operation incorporates the following elements: • A condenser (countercurrent exchanger); • A pump; • An evaporator (countercurrent exchanger); • A turbine. It is possible to improve the efficiency by adding a heat recovery exchanger between the outlet fluid of the turbine and the outlet fluid of the pump. A part of the power of the turbine outlet stream is no longer sent to the condenser but recovered to pre-heat the pump outlet fluid and to decrease the heat consumption to the evaporator.	 Organic rankine cycle
Fuel engine	The Fuel Engine unit operation is a complete combustion unit of a fuel, generally gaseous, by a combustive stream. The first aim of this unit operation is to produce electricity using a shaft and an alternator. The unit operation includes the following equipment: • A combustion chamber with a mechanical shaft and an alternator: the power released by the fuel consumed is partially turned into mechanical power through a mechanical shaft. This mechanical power is converted into electricity in an alternator. • A cooling heat exchanger of the engine, called Low Temperature exchanger (LT). This exchanger is compulsory for the smooth running of the engine, as it allows to cool the mechanical parts of the engine. The cooling fluid circulates in closed loop between the engine and the exchanger. • Heat exchangers on fumes, called High Temperature exchangers (HT). The combustion power that is not completely transformed into electrical power and that is not released by the cooling fluid produces high temperature fumes. It then becomes possible to recover this power using HT exchangers. In the Fuel engine unit operation, you can define up to two HT exchangers.	 Fuel engine

Fuel turbine	The general purpose of the Fuel turbine unit operation is to simulate a thermodynamic rotating machine. It aims at producing mechanical energy by a shaft rotating directly from the kinetic energy of the gases produced by a combustion. The combustion gases expansion creates a mechanical work by means of a turbine. The mechanical work is used for the electricity production through an alternator. The specificity of the Fuel turbine is that the turbine and the compressor are on the same rotation axis; there is only one alternator efficiency. The Fuel turbine unit operation includes: • A compressor. • A combustion chamber. • A turbine.	 Fuel turbine
Boiler	The BOILER unit operation is a complete combustion unit of a gaseous or liquid fuel by a combustive. The aim of this module is to produce hot fumes to produce a utility fluid (generally vapor from liquid water).	 Boiler

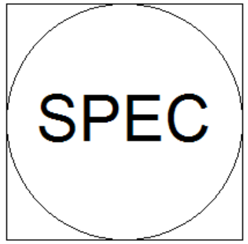
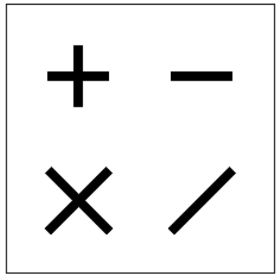
ENERGY EFFICIENCY

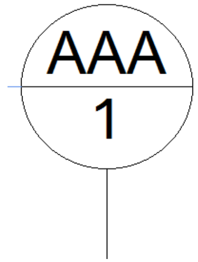
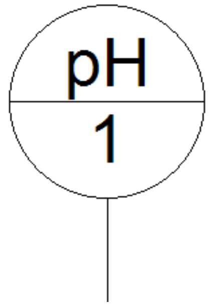
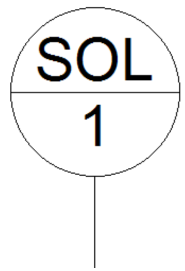
Unit operation	Short description	Module on the flowsheet
Pinch analysis	The pinch unit operation is used to carry out energy integration calculations with the pinch method in ProSimPlus. Such energy integration allows to determine the minimum process utilities consumption required. From the enthalpy curves of each stream, the hot and cold composite curves are graphed. According to the pinch acceptable for the whole process (minimum temperature difference between the hot streams and the cold streams), the minimum needs in utilities (hot and cold) are also calculated. The pinch unit operation is aware of all unit operations where a heating or a cooling occurs (boiler and column condenser, heat exchangers, flash, reactors...).	PINCH  Pinch analysis
Exergy balance	The exergy balances unit operation is used to carry out exergy calculations on all or part of the process. The outlet streams from the process may be considered "waste" if they are not recovered directly (for instance byproducts of reaction). The exergy balances may be carried out on all or part of the process, or a balance for each unit operation can be performed in addition to a global balance. In order to carry out balances on the process where the composition changes, it is possible to select the calculation of the chemical exergy in addition to the physical exergy. Depending on your process, the exergy balance module calculates physical exergy, thermal exergy, mechanical exergy, chemical exergy (if required), working exergy, heat exergy, exergy losses (physical, chemical, heat), maximum quantity of recoverable mechanical exergy, maximum quantity of recoverable thermal exergy, intrinsic efficiency, simple efficiency (or system yield), and irreversibilities (relative and intrinsic).	EXERGY  Exergy balance

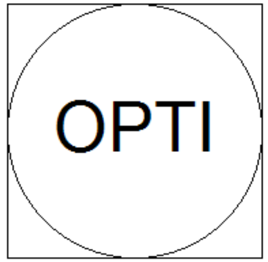
ECONOMIC EVALUATION

Unit operation	Short description	Module on the flowsheet
Economic evaluation (COST)	The Economic evaluation module is used to estimate the gains and the costs associated to a process and provides the initial and secondary investment costs, operating gains and costs, maintenance costs, economic indicators, schedule, and economic indicators profiles. This functionality takes the form of a unit operation placed on the flowsheet, that may also be connected to information streams. You can use two methods included in ProSimPlus that are based on the **Manual of Process Economic Evaluation***: the Functional Module Method or the Pré-Estime Method. Or enter your own correlations for each unit operation. * A. CHAUVEL, G. FOURNIER, C. RAIMBAULT « Manual of Process Economic Evaluation – New, revised and expanded edition » Editions TECHNIP (2003)	 Economic evaluation (COST)

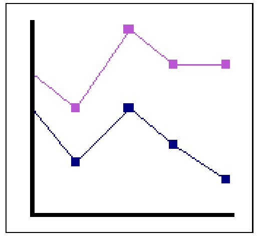
OPTIMIZATION AND DESIGN SPECIFICATIONS

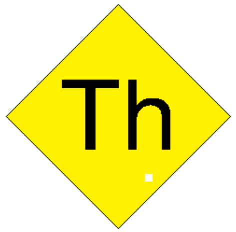
Unit operation	Short description	Module on the flowsheet
Constraints and recycles	The SPECIFICATION block unit applies an operating constraint or an objective to reach in terms of purity, flowrate, temperature... at a given place of the process by acting on an operating parameter of a unit operation located at another place of the same process. The SPECIFICATION block unit, INFORMATION STREAM HANDLER block unit, and the MEASUREMENT block unit can be used to handle constraints and recycles.	 Specification
Information stream handler	The INFORMATION STREAM HANDLER block unit makes it possible to modify the value of one (or of several) information stream using a by basic operations. The basic equation that makes this transformation possible is: Output Information Stream = A*(Input Information Stream)^P + B - C where A, B, C and P can be constants or information. The exponent P can be integer or real, positive or negative. The SPECIFICATION block unit, INFORMATION STREAM HANDLER block unit, and the MEASUREMENT block unit can be used to handle constraints and recycles.	 Information stream handler

Measurement	The MEASUREMENT block unit makes it possible to extract the value of a variable (temperature, pressure, total flowrate, and partial flowrate or composition) from a stream and to compare this value with a set point. This block unit is connected to a material input stream and a material outlet stream and must be associated to an outlet information stream. It is usually used in connection with a SPECIFICATION block unit but can also be used with a WINDOWS SCRIPT unit. The SPECIFICATION block unit, INFORMATION STREAM HANDLER block unit, and the MEASUREMENT block unit can be used to handle constraints and recycles.	 Measurement
pH meter	The pH meter is used to calculate : • The pH of an outlet stream (from the activity instead of the concentration) • All the characteristics of the solubility of the salts It is necessary to use an appropriate thermodynamic model (i.e. all the electrolytic models except the “Engels” model).	 pH meter
Solid solubility measurement	The solid solubility measurement is used to calculate the solid solubility of an outlet stream.	 Solid solubility measurement

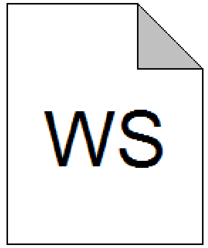
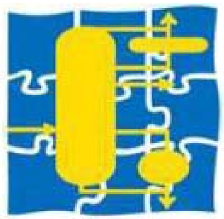
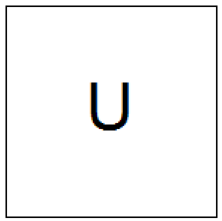
Optimization	The OPTIMIZATION block unit is used to solve problems of minimization in continuous variables with or without constraints. The objective of this block unit is to minimize a criterion function described, whatever its form may be, by action on the operating parameters selected, while respecting possible constraints. The expressions characterizing the criterion and the constraints can possibly take nonlinear forms.	 Optimization

Unit operation	Short description	Module on the flowsheet

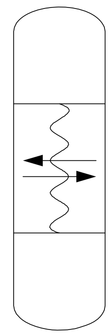
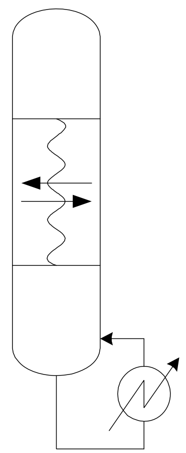
HCurves	The HCURVES tool makes it possible to calculate enthalpy curves. The HCURVES calculations are carried out after convergence of the simulation file. For modules in which HCURVES calculations are planned (heat exchangers, flashes and columns), the calculation range of the HCURVES is perfectly defined and corresponds to input and output conditions of the module. Two calculation modes are proposed:
	• Temperature and pressure increments fixed (succession of flash calculations at given pressure and temperature),
	• Heat duty and pressure increments fixed (succession of flash calculations at given enthalpy and pressure).
	
	Four calculation modes can be specified in the HCURVES modules positioned on the streams:
	• Temperature and pressure increments fixed (succession of flash calculations at given pressure and temperature)
	• Heat duty and pressure increments fixed (succession of flash calculations at given enthalpy and pressure)
	• Calculation of a bubble curve
	    • Bubble temperature or Bubble pressure
	• Calculation of a dew curve
	    • Dew temperature or Dew pressure
		
		HCurves

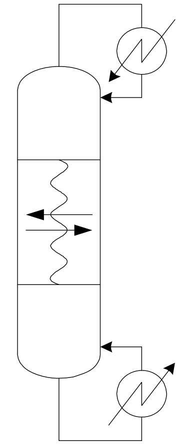
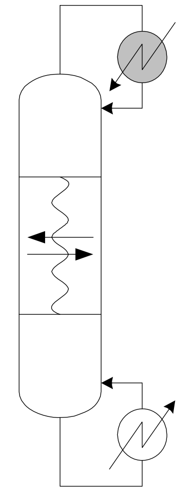
Calculator switch	The CALCULATOR SWITCH unit operation allows changing the thermodynamic calculator of a material stream when it enters another unit operation with a different thermodynamic model. This change is required, notably when the two calculators do not use the same enthalpy basis, the same enthalpy calculation path or the same thermodynamic approach. By default, the outlet conditions are taken equal to the inlet conditions, and the physical state as well as the enthalpy are recalculated. However, it is also possible to specify to keep the inlet physical state; in this particular case the temperature and the enthalpy are being recalculated. The enthalpy deviation due to this calculator change is printed in the simulation report (as absolute and relative deviations).	 Calculator switch

USER DEFINED UNIT OPERATIONS

Unit operation	Short description	Module on the flowsheet
Windows scripts	The WINDOWS SCRIPT module makes it possible to create quickly and simply new calculations modules (unit operation or other type of modules) in the ProSimPlus simulation environment. These modules, once created, can be used exactly in the same way as those which are provided with ProSimPlus. Their use is completely transparent and does not need any additional handling. Each Windows Script module is described (programmed) directly in the ProSimPlus graphical environment using a simple but powerful language. This language, Microsoft VBScript, is a simplified version of Microsoft Visual Basic. It allows writing the source code of a module in a few minutes. A specific help is available directly from the unit operation's main window	 Script module
CAPE-OPEN unit operation	Use CAPE-OPEN compliant unit operations from third party process simulators. CAPE-OPEN defines a set of standardized interfaces for the use of a unit operation in a steady state process simulator adopting a sequential resolution. The CAPE-OPEN unit operation allows the use of this type of unit operation in ProSimPlus. More information about CAPE-OPEN is available at http://www.colan.org/	 CAPE-OPEN
User defined unit operation (UTI)	Every ProSimPlus user can create their own modules in addition to those available in the standard ProSimPlus library. Several integrated development environments can be used, including Visual Fortran (preferred and recommended), C or C++, Visual Basic or other languages. These modules, once programmed by the user, can be used exactly in the same way as those which are provided with ProSimPlus.	 User defined unit operation UTI

RATE BASE OPTION

Absorber by rate-based model (optional)	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column without boiler nor condenser. The rate-based model takes into account thermodynamic equilibrium at the interface, mass and energy transfer between the two phases as well as hydrodynamics (fluid flows). Contrary to a model based on the concept of theoretical stage, it is here possible to describe the type of flow (plug flow, perfectly stirred...), as well as the type of column internals used (plate, packing...). The concept of theoretical stage is replaced by the concept of non-equilibrium stage. A liquid feed, an overhead vapor, a vapor feed and a liquid sidestream at the bottom of the column are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage.	 Mass transfer absorber
Absorber with reboiler by rate-based model (optional)	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column without condenser. The rate-based model takes into account thermodynamic equilibrium at the interface, mass and energy transfer between the two phases as well as hydrodynamics (fluid flows). Contrary to a model based on the concept of theoretical stage, it is here possible to describe the type of flow (plug flow, perfectly stirred...), as well as the type of column internals used (plate, packing...). The concept of theoretical stage is replaced by the concept of non-equilibrium stage. A liquid feed, an overhead vapor, a vapor feed and a liquid sidestream at the bottom of column are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage.	 Mass transfer absorber with a reboiler

Distillation with partial condenser by rate-based model (optional)	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column with reboiler and partial condenser. The rate-based model takes into account thermodynamic equilibrium at the interface, mass and energy transfer between the two phases as well as hydrodynamics (fluid flows). Contrary to a model based on the concept of theoretical stage, it is here possible to describe the type of flow (plug flow, perfectly stirred...), as well as the type of column internals used (plate, packing...). The concept of theoretical stage is replaced by the concept of non-equilibrium stage. A liquid feed, an overhead vapor and a liquid sidestream at the bottom of column are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage.	 Mass transfer distillation column (partial condenser)
Distillation with total condenser by rate-based model (optional)	Makes it possible to represent a multi-stage liquid-vapor separation process where takes place a counter-current mass transfer between a liquid phase and a vapor phase within a column with a reboiler and a total condenser. The rate-based model takes into account thermodynamic equilibrium at the interface, mass and energy transfer between the two phases as well as hydrodynamics (fluid flows). Contrary to a model based on the concept of theoretical stage, it is here possible to describe the type of flow (plug flow, perfectly stirred...), as well as the type of column internals used (plate, packing...). The concept of theoretical stage is replaced by the concept of non-equilibrium stage. A liquid feed, an overhead liquid distillate, and a liquid sidestream at the bottom of column are required. Sidestreams and/or intermediate liquid or vapor feeds as well as exchanged heat duties can be specified at each stage.	 Mass transfer distillation column (total condenser)