PROCESS SIMULATION LAB

Day 3
Group 2

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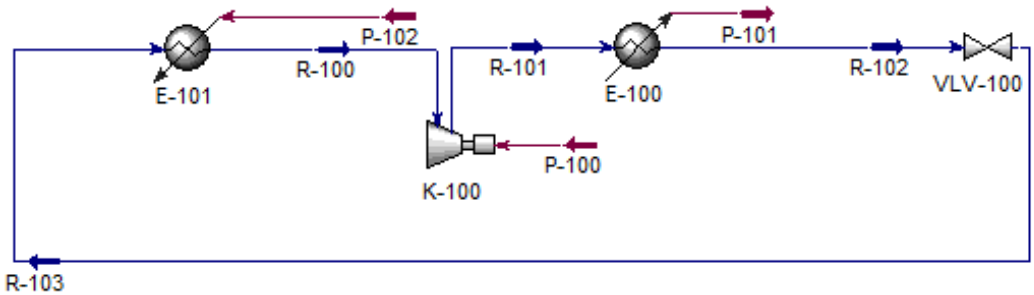
Question

In an industrial refrigeration unit, 300 $kgmole/h$ of $R\ 134a$ is used as a refrigerant. A compressor with 70% adiabatic efficiency is used to compress the refrigerant vapour coming out of the evaporator (cooling unit) at 1 bar and 25 ℃ to a pressure of 10 bar. The superheated refrigerant vapour coming out of the compressor is air cooled in an outdoor heat exchanger to 30 ℃. The liquid refrigerant is then throttled through an adiabatic expansion valve to 1 bar exit pressure whereby the refrigerant flashes and its temperature drops. The low temperature refrigerant is now allowed to pass through the evaporator (use a heater for simulation), where a fan forces fresh air to blow over tubes containing the liquid refrigerant while the refrigerant evaporates to vapour. Calculate the (a) cooling capacity, which is the heat load of the evaporator = 1518 kw, 1 ton refrigeration = 3.51 kw and (b) Compressor power requirement = 722.7 kw, and 1 $kw = 1.359\ hp$.

Answer

Fluid Package Used: NRTL



E-101		
Duty	1530	kW
Feed Temperature	-26.37	C
Product Temperature	25.00	C

E-100		
DUTY	2288	kW
Feed Temperature	121.3	C
Product Temperature	30.00	C

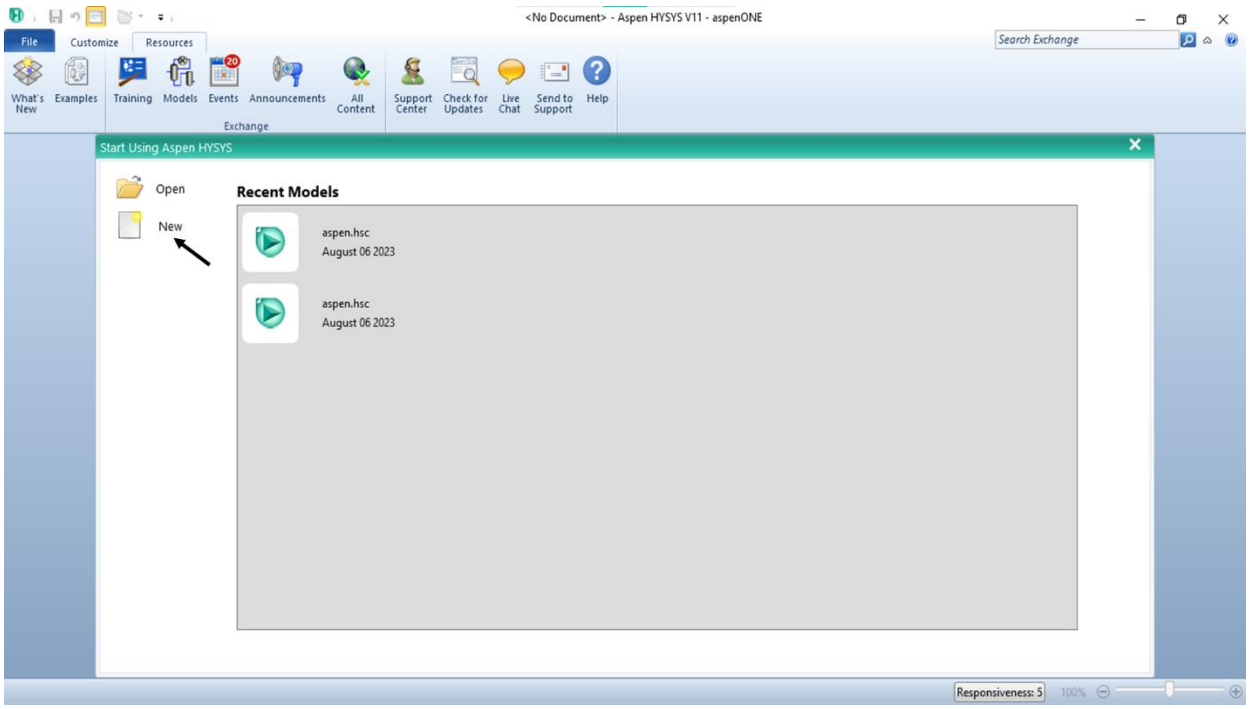
K-100		
Feed Pressure	100.0	kPa
Product Pressure	1000	kPa
Feed Temperature	25.00	C
Product Temperature	121.3	C
Energy	757.2	kW

VLV-100		
Feed Pressure	1000	kPa
Product Pressure	100.0	kPa
Feed Temperature	30.00	C
Product Temperature	-26.37	C

a) Rate of heat removal from the refrigerated space, $Q_{in} = 1530\ kW$
b) Power input of the compressor, $W_{in} = 757.2\ kW$
c) Heat release, $Q_{out} = 2288\ kW$
d) COP of the refrigerator, $\frac{Q_{in}}{W_{in}} = \frac{1530}{757.2} = 2.02$

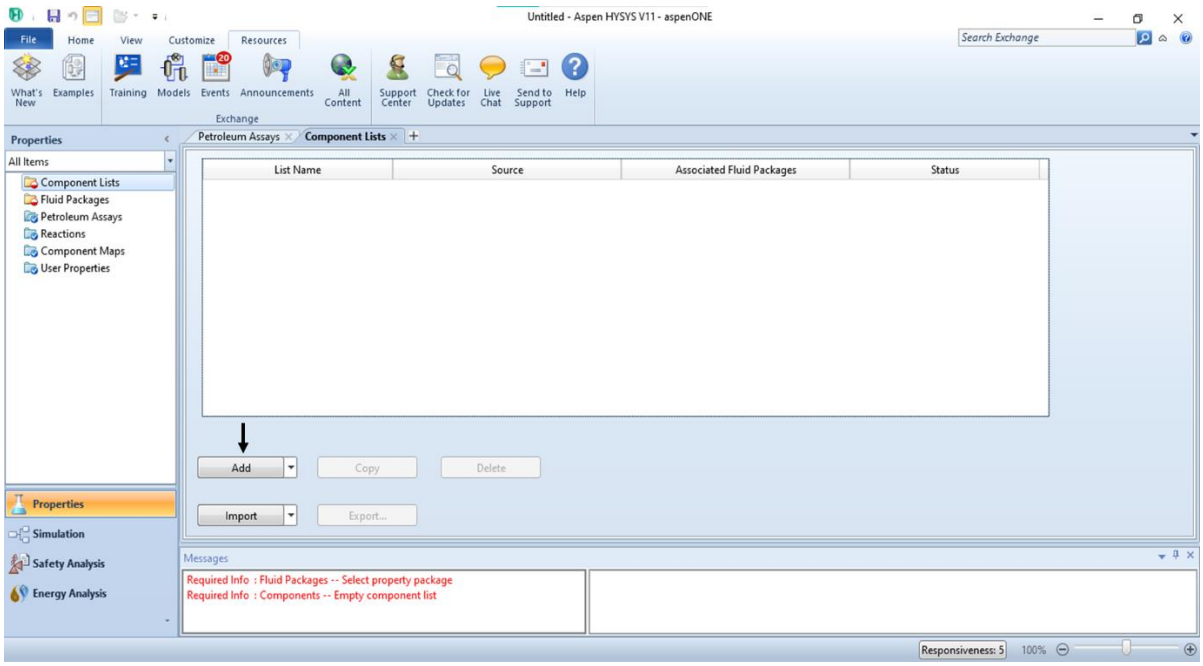
Steps to solve the questions are as follows:

Step 1:
At first, we ASPEN HYSYS software by clicking on the shortcut icon from the desktop. The Initial Layout looks like the following. From the New menu we clicked on button to create a blank Simulation Workbook page.



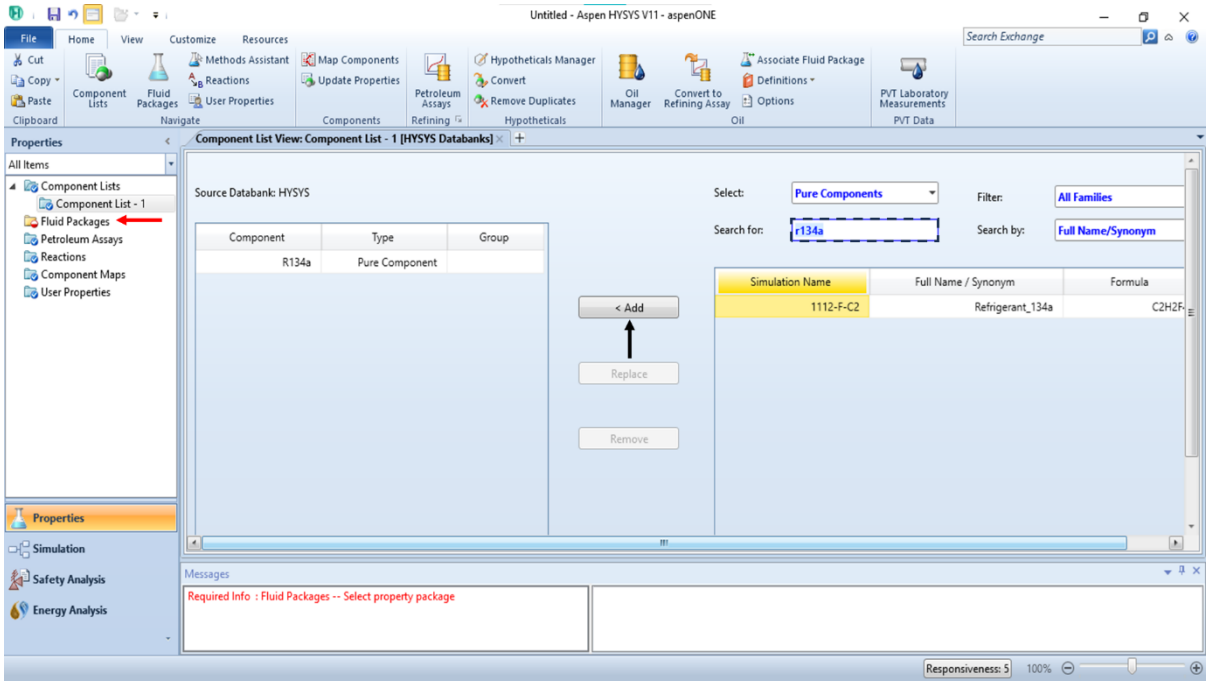
Step 2:

Now in the next page we will click on Add icon to select the components required for our simulation. Here we are dealing only with $R134a$ we will add only $R134a$.

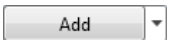


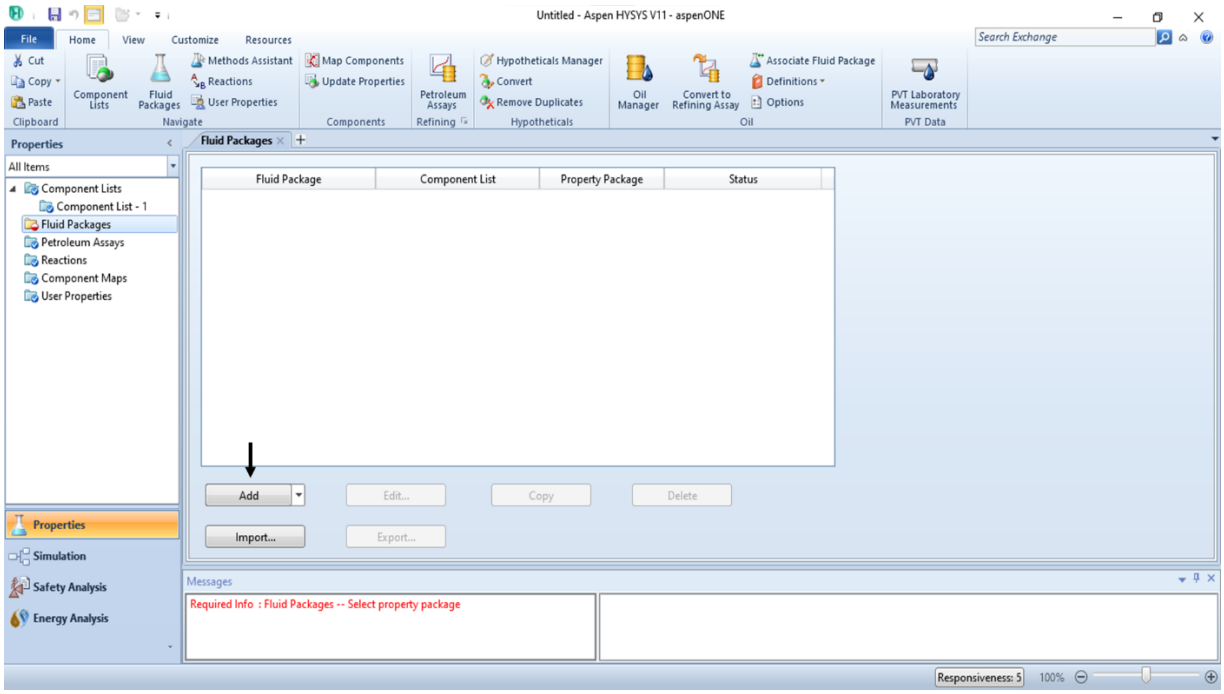
Step 4:

Now in the Component list page we will search $R134a$ in Search for: box. Then we will select the $R134a$ and < Add click. This will add $R134a$ in the component list. Now we will choose the desired fluid packages by clicking on Fluid Packages icon.



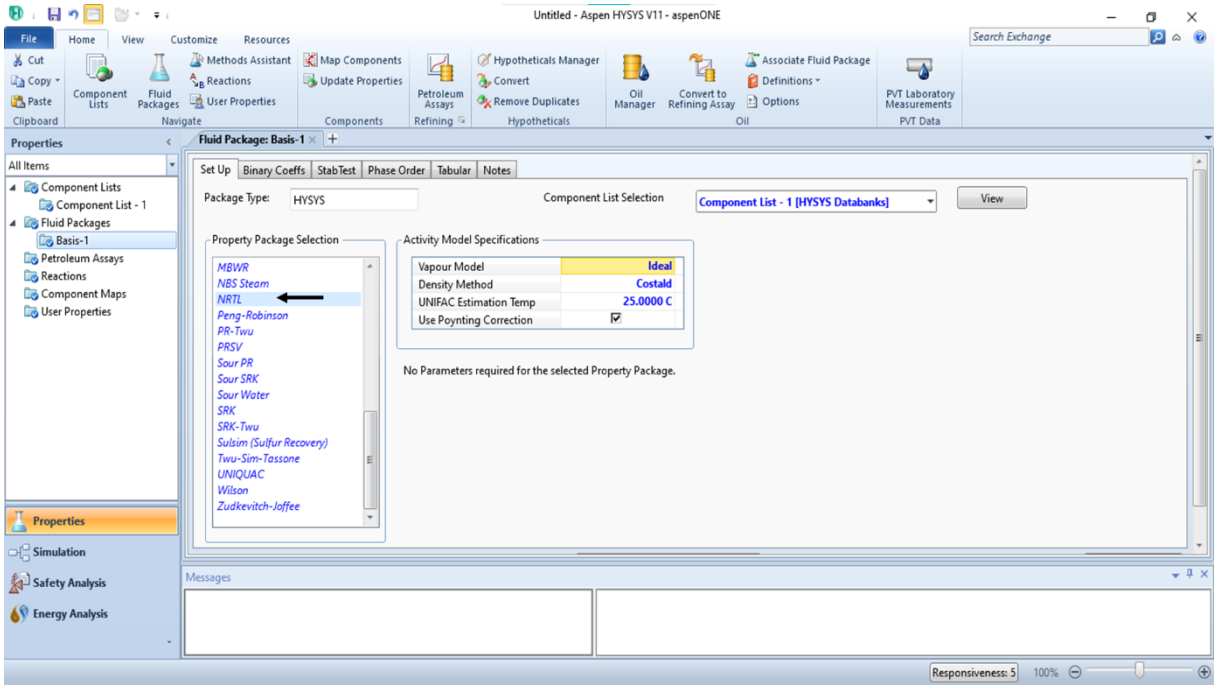
Step 5:

In the Fluid Packages tab, we will click  to add new fluid packages.



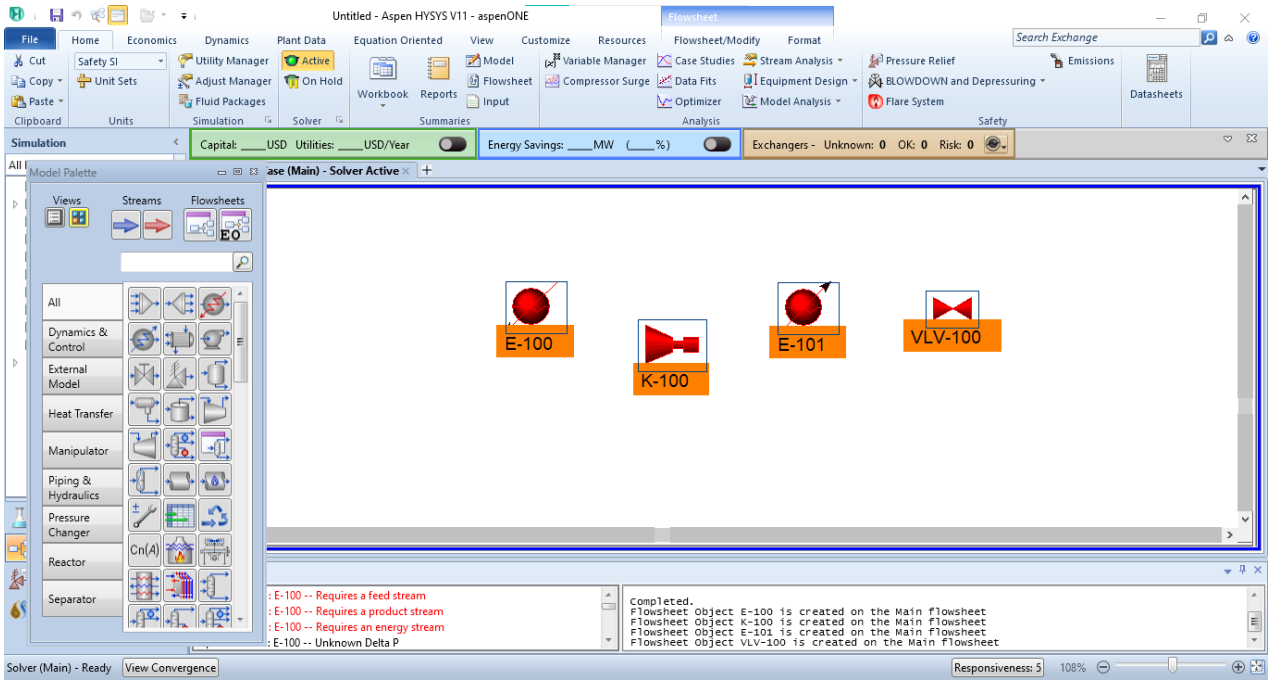
Step 6:

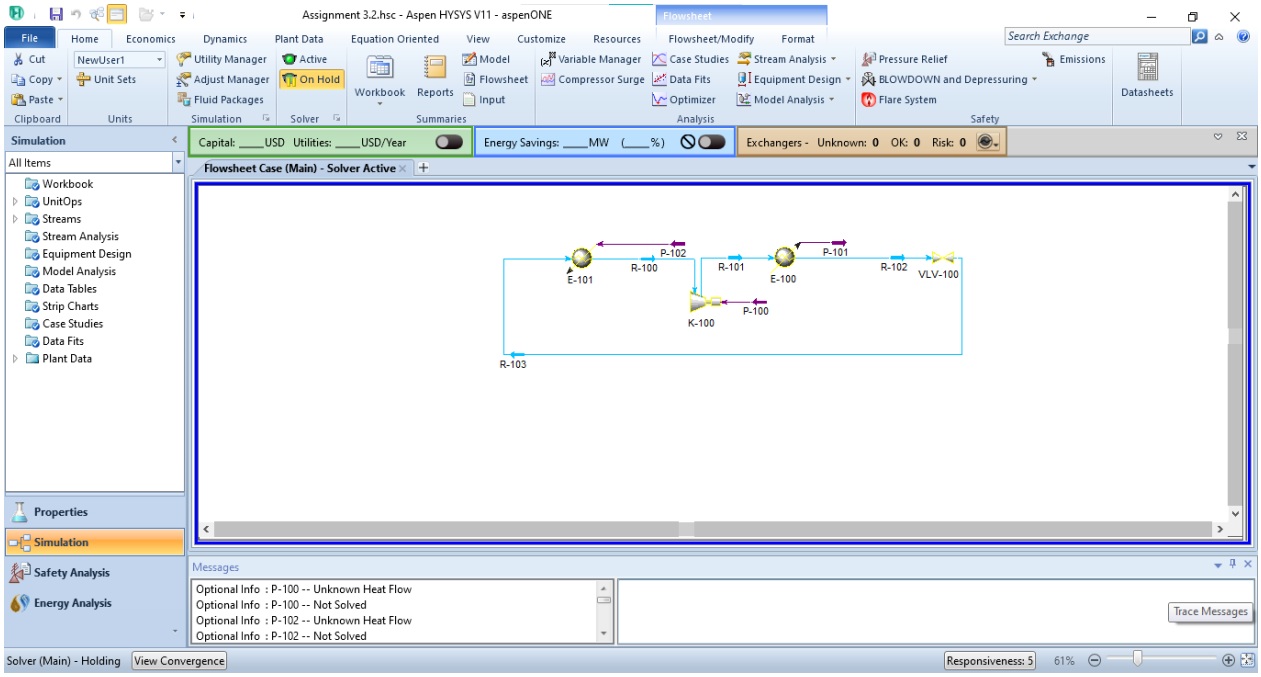
According to our given problem, we are supposed to use NRTL package for our problem. So, from the dropdown menu, we will select the NRTL steam option. Now our components and property databases are ready. We are ready to move to Simulation Tab by clicking  the button.



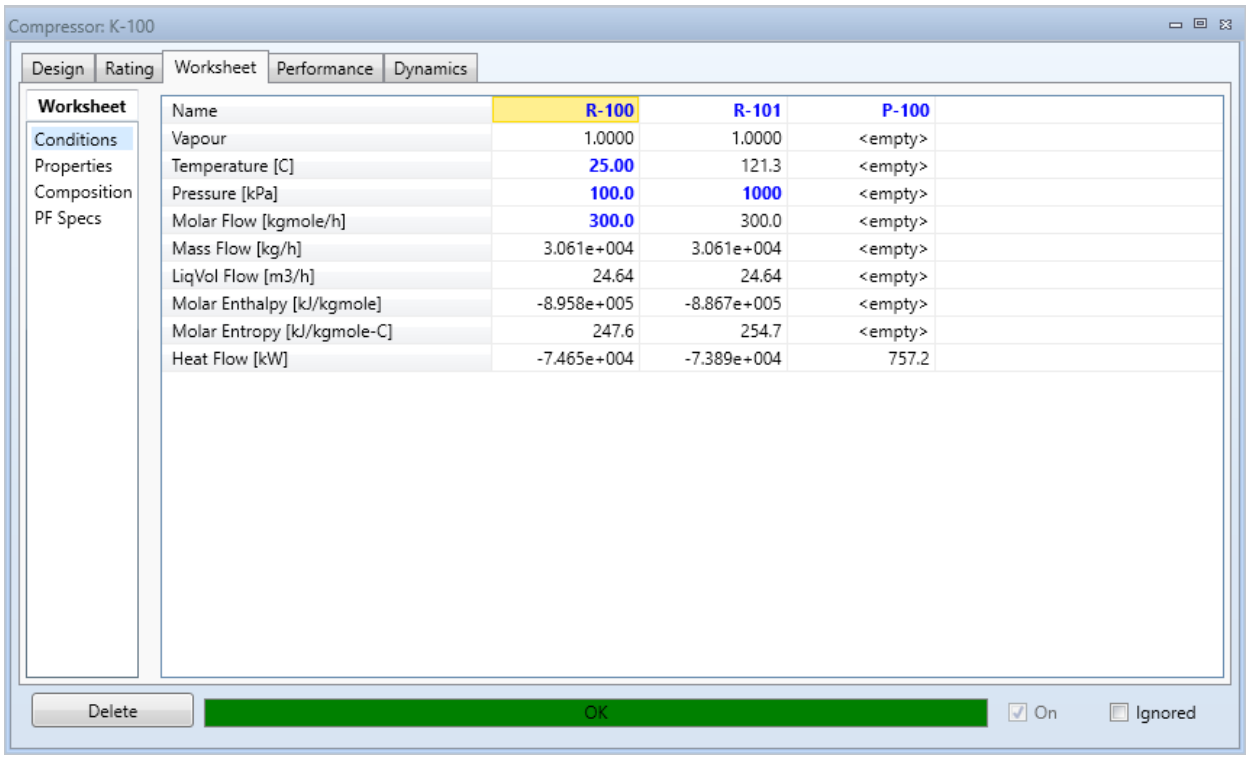
Step 7:

This is the most important step. First, we will drag a compressor, a cooler, a control valve, a heater and drop them to the blank space. Now we will name all the connected streams required for this problem. Now, we need to input all the given data for the problem.

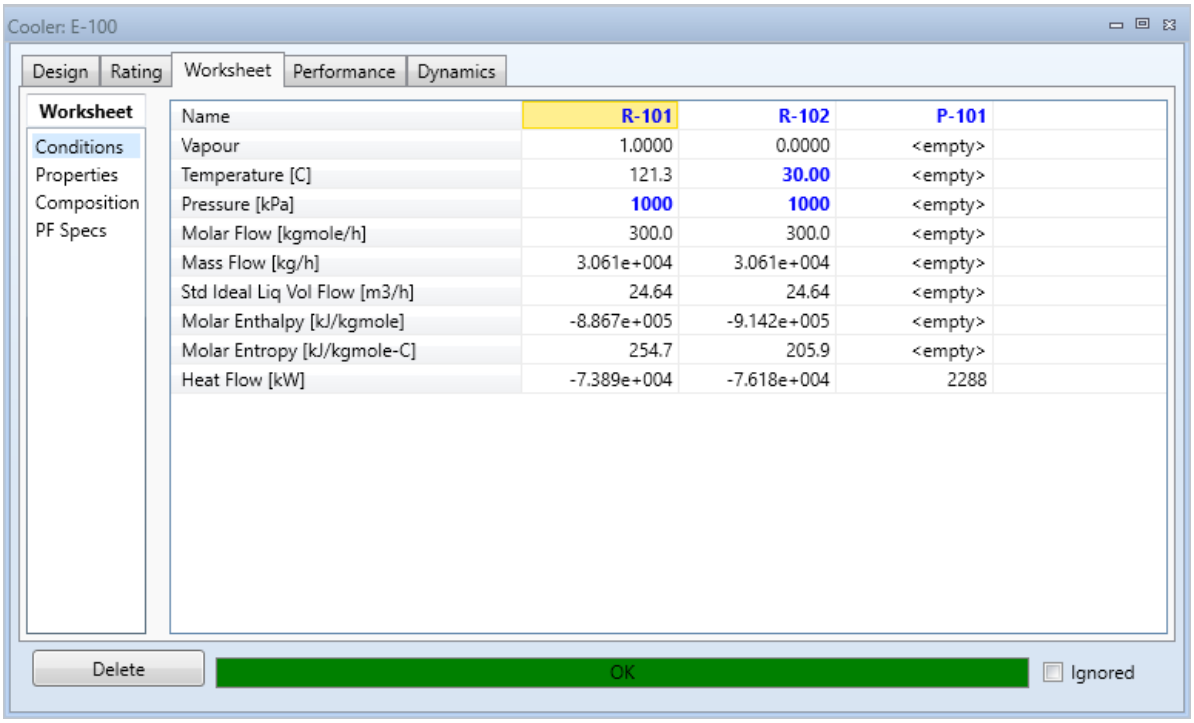




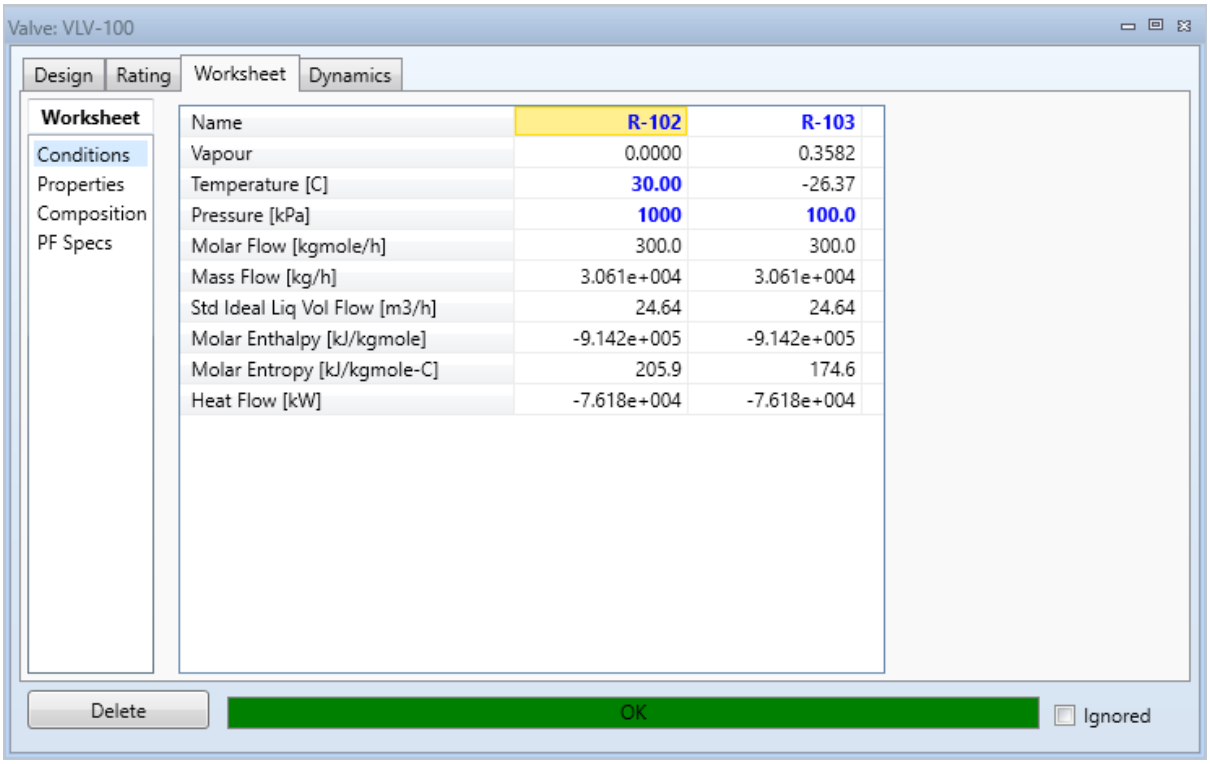
After clicking on the compressor, we will click on tab which will open another dialogue where we can enter the inlet and outlet stream Worksheet properties according to the given problem statements. We will do the same for all the components added in the worksheet.



Now we will click on the cooler then on Worksheet to set the outlet data as given in the problem. Also the the inlet and out pressure will be same as pressure inside the cooler van be neglected.



Similarly, we will enter the outlet data for the valve too.



After than we can close the window and go back to our simulation page. Now we will right click on the components and click on the show table option to show necessary outputs. Our output is shown at the very beginning of the report.