WOLLO UNIVERSITY

KOMBOLCHA INSTITUTE OF TECHNOLOGY

SCHOOL OF CHEMICAL AND MECHANICAL ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

ENVIRONMENTAL STREAM

COURSE NAME: - CAD PROCESS DESIGN AND SIMULATION (ChEg 5192)

TARGET GROUP: - 5TH YEARS, 1ST SEMISTER

SECTION: - A

TASK: - COMPUTER AIDED PROCESS DESIGN AND SIMULATION ASSIGNMENT USING ASPEN PLUS

NAME	ID No
1. GETASEW GUADIE	WOUR/1307/10
2. SIRAK WONDIFREW	WOUR/1310/10
3. GETASEW TEGEGNE	WOUR/1308/10
4. GENET WASIE	WOUR/1291/10
5. FIREHIWOT TSEGU	WOUR/1247/10

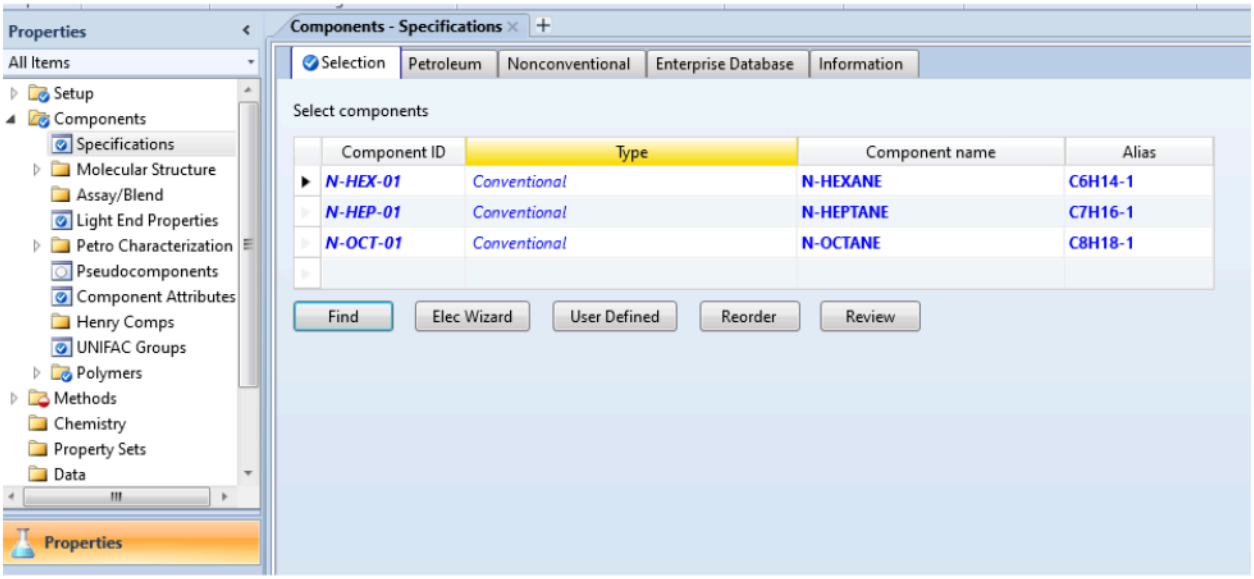
Submission Date: 02/10/2014

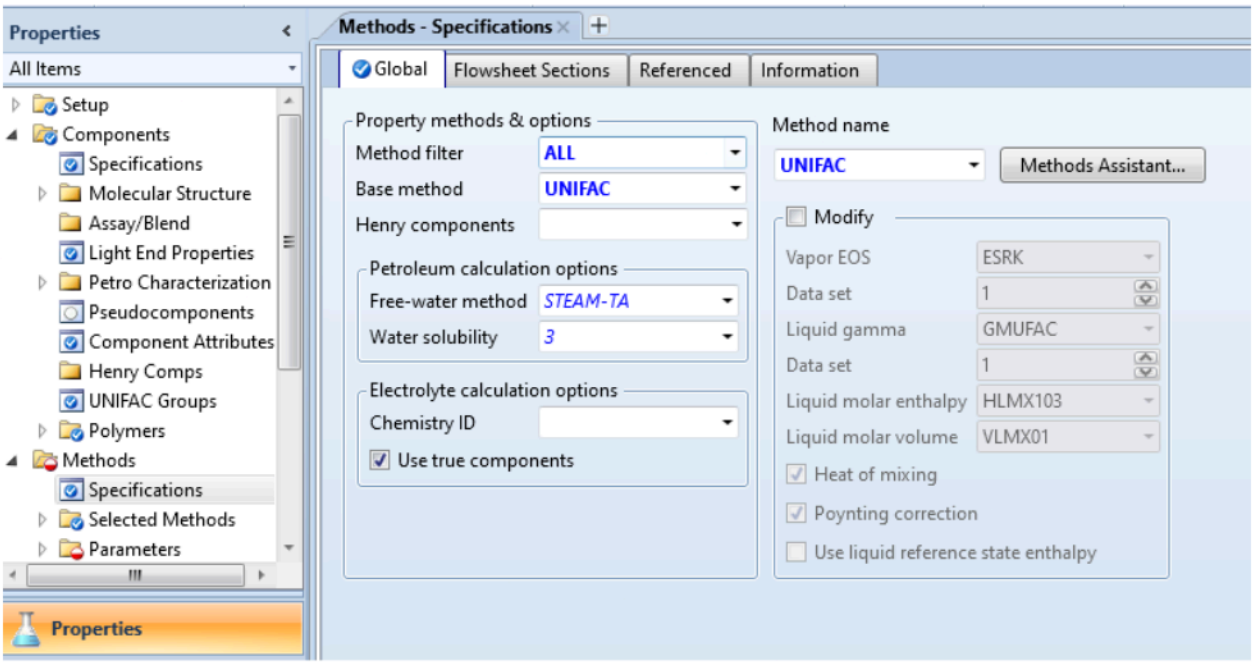
May, 2014

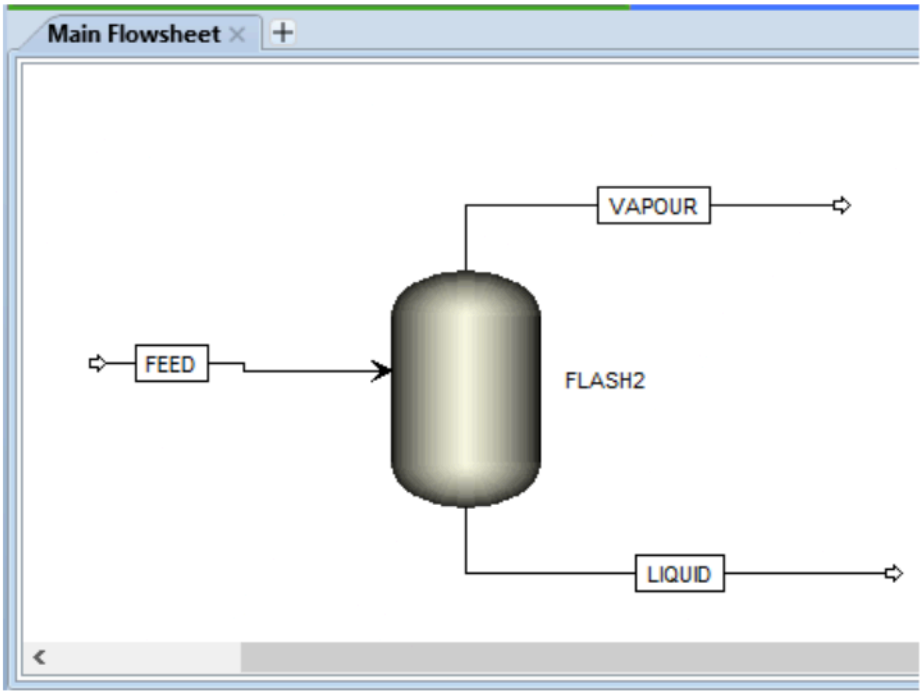
KOMBOLCHA, ETHIOPIA

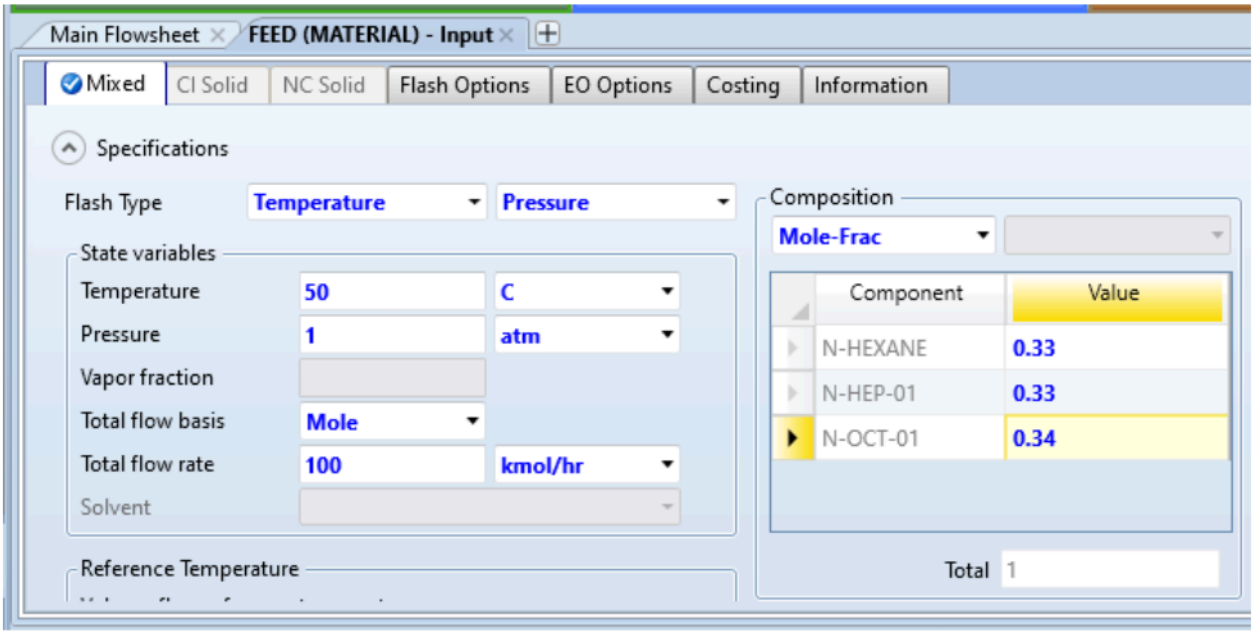
1. Find the bubble point and dew point temperatures and corresponding vapour and liquid compositions for a mixture of 33 mole% n-hexane, 33mole% n-heptane and 34mole% n-octane at 1atm pressure. The feed mixture with a flow rate of 100 kmol/hr enters at 50oC and 1atm. Consider ideality in both liquid and vapour phases.

SOLITIONS;

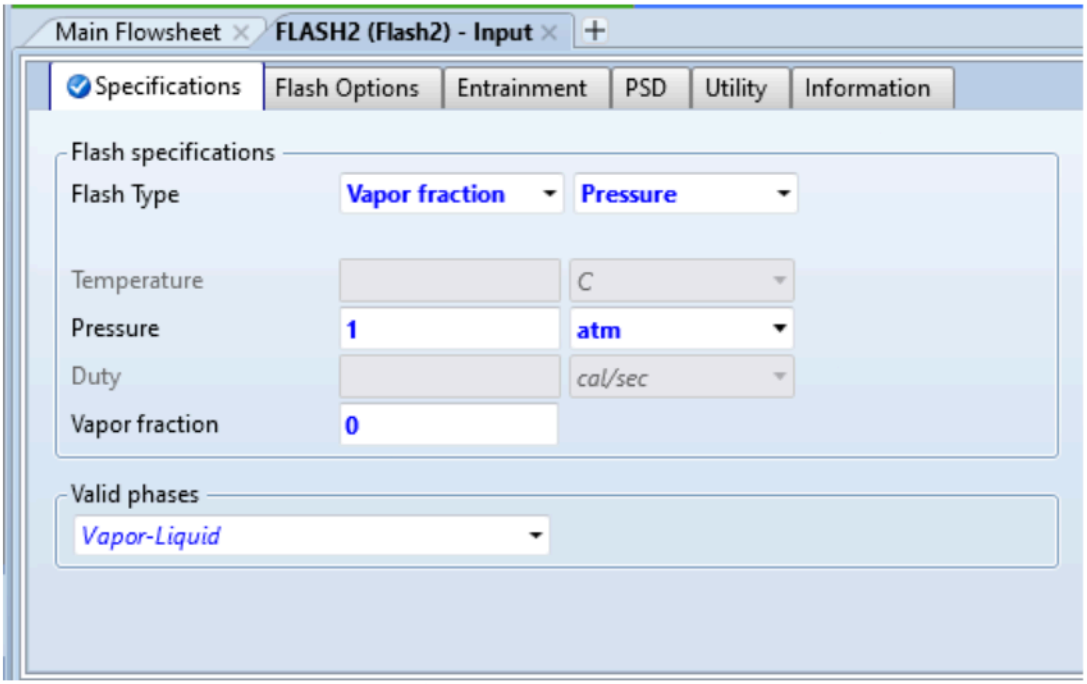




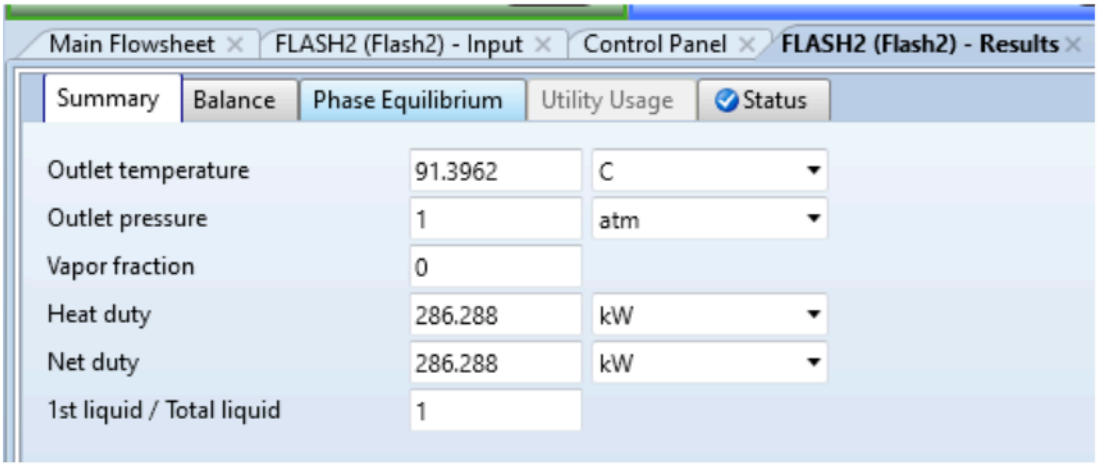

Main Flowsheet
VAPOUR
FEED
FLASH2
LIQUID


Main Flowsheet
FEED (MATERIAL) - Input
Mixed
CI Solid
NC Solid
Flash Options
EO Options
Costing
Information
Specifications
Flash Type
Temperature
Pressure
State variables
Temperature
50
C
Pressure
1
atm
Vapor fraction
Total flow basis
Mole
Total flow rate
100
kmol/hr
Solvent
Reference Temperature
Composition
Mole-Frac
Component
Value
N-HEXANE
0.33
N-HEP-01
0.33
N-OCT-01
0.34
Total
1

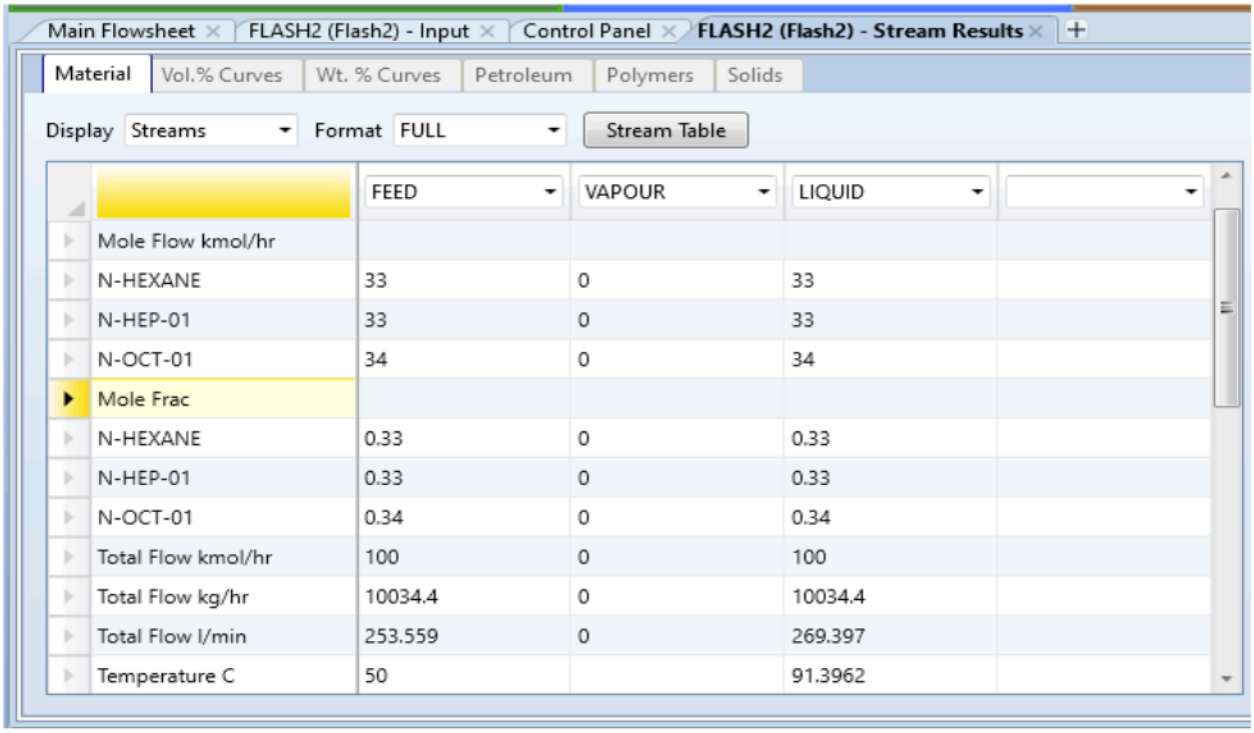
Bubble point input @ vapor fraction = 0



BUBBLE POINT TEMPERATURE

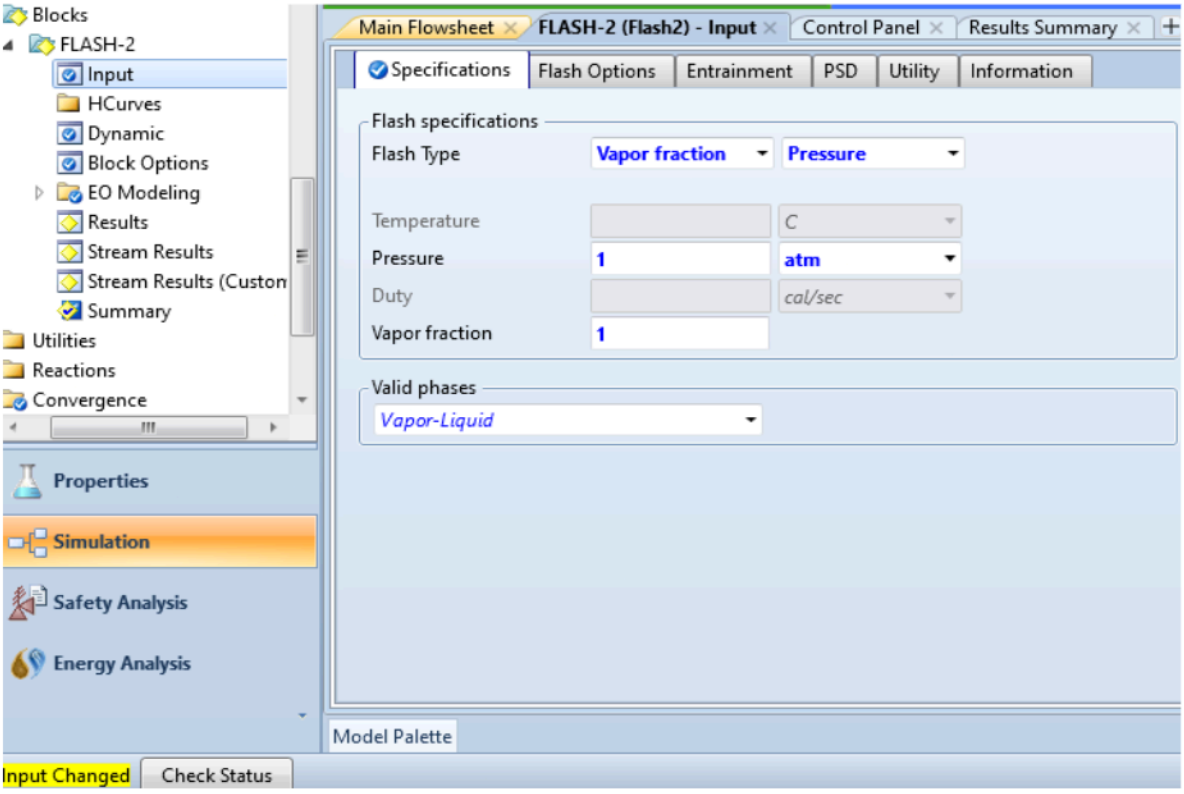


Bubble point compositions

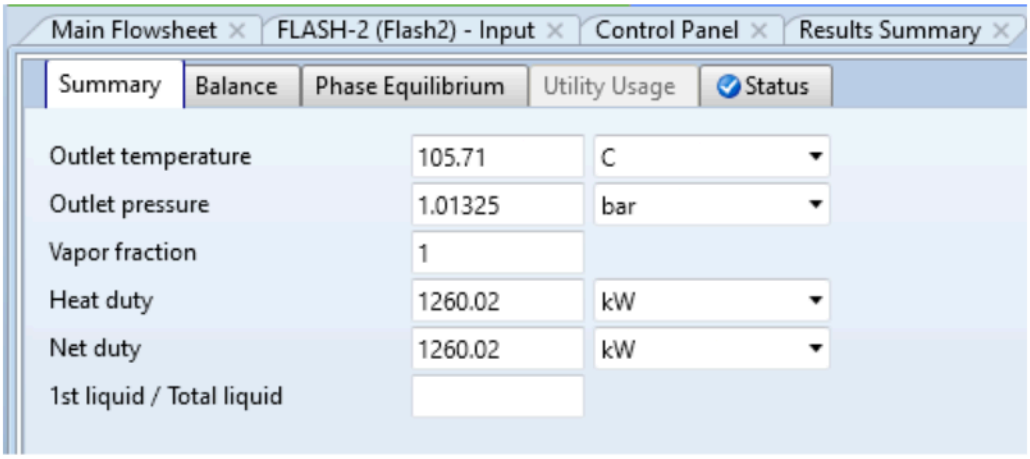


	FEED	VAPOUR	LIQUID	
Mole Flow kmol/hr				
N-HEXANE	33	0	33	
N-HEP-01	33	0	33	
N-OCT-01	34	0	34	
Mole Frac				
N-HEXANE	0.33	0	0.33	
N-HEP-01	0.33	0	0.33	
N-OCT-01	0.34	0	0.34	
Total Flow kmol/hr	100	0	100	
Total Flow kg/hr	10034.4	0	10034.4	
Total Flow l/min	253.559	0	269.397	
Temperature C	50		91.3962	

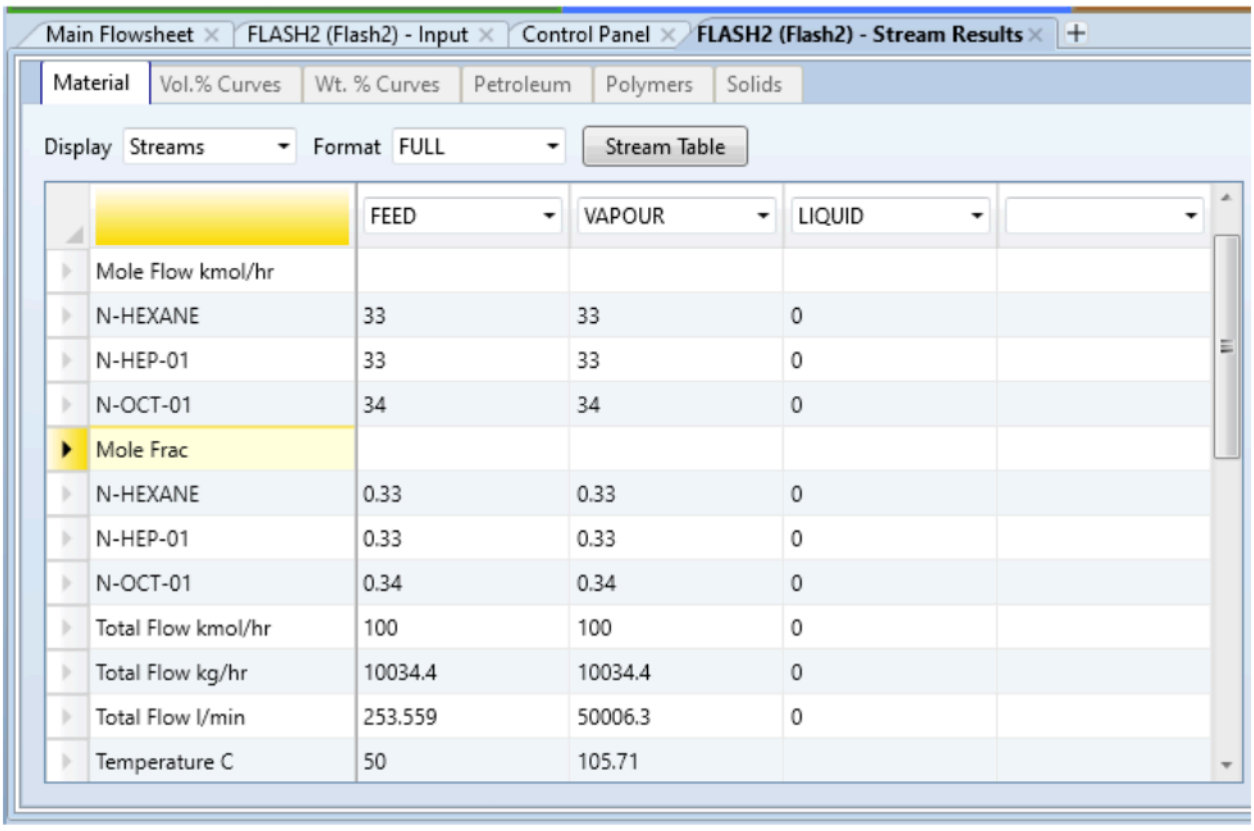
DEW POINT INPUTS @ VAPOR FRACTION =1



DEW POINT TEMPRATURE



DEW POINT COMPOSITIONS



	FEED	VAPOUR	LIQUID	
Mole Flow kmol/hr				
N-HEXANE	33	33	0	
N-HEP-01	33	33	0	
N-OCT-01	34	34	0	
Mole Frac				
N-HEXANE	0.33	0.33	0	
N-HEP-01	0.33	0.33	0	
N-OCT-01	0.34	0.34	0	
Total Flow kmol/hr	100	100	0	
Total Flow kg/hr	10034.4	10034.4	0	
Total Flow l/min	253.559	50006.3	0	
Temperature C	50	105.71		

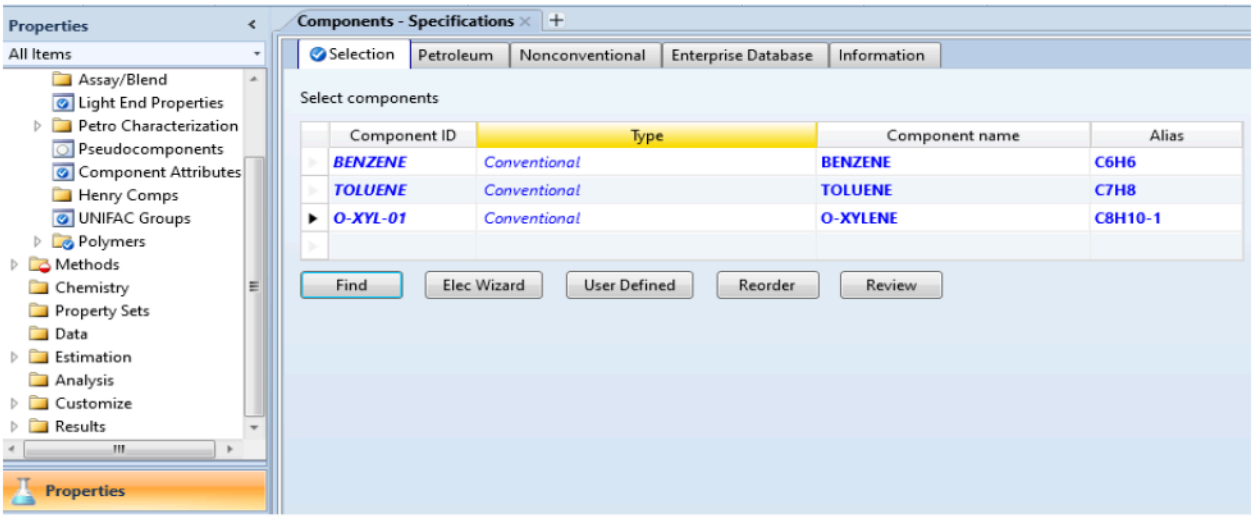
2. A liquid mixture, consisting of 60 mole% benzene, 30 mole% toluene and 10 mole% o-xylene, is flashed at 1 atm and110oC. The feed mixture with a flow rate of 100 kmol/hr enters the flash drum(Flash2) at 1atm and 80oC. Using the SYSOP0 property method,

A. Compute the amounts of liquid and vapour outlets and their compositions

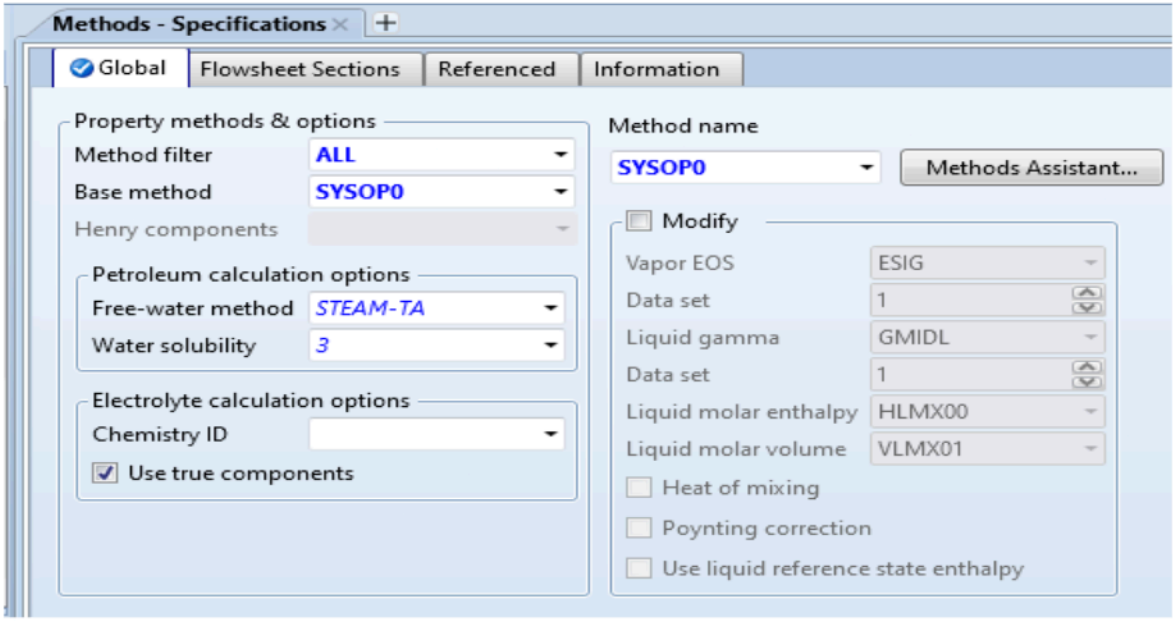
B. Repeat the calculation at 1.5 atm and120oC (operating conditions).

SOLUTIONS;

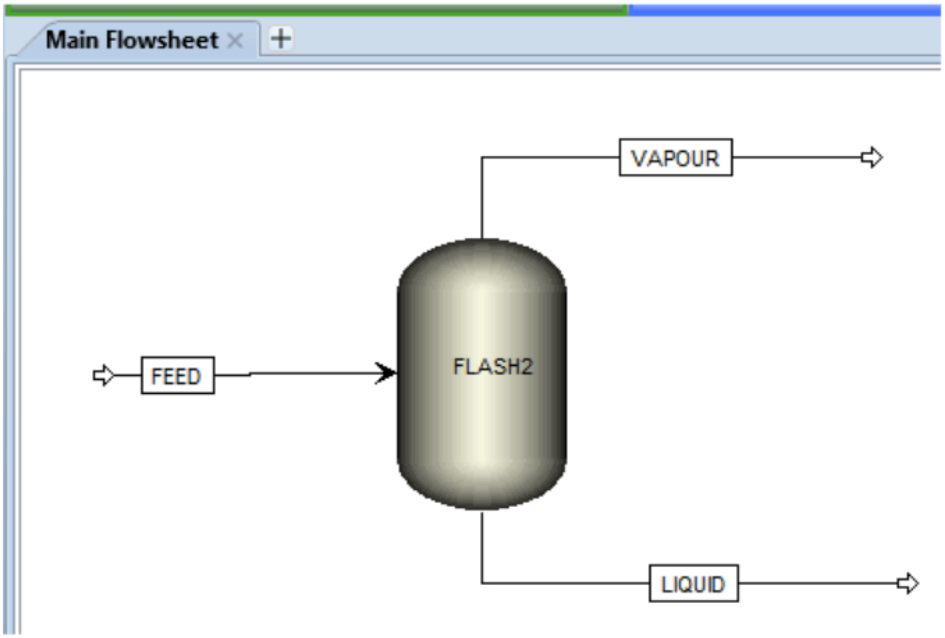
PROPERTIY (COMPONENT)SPESFICATION



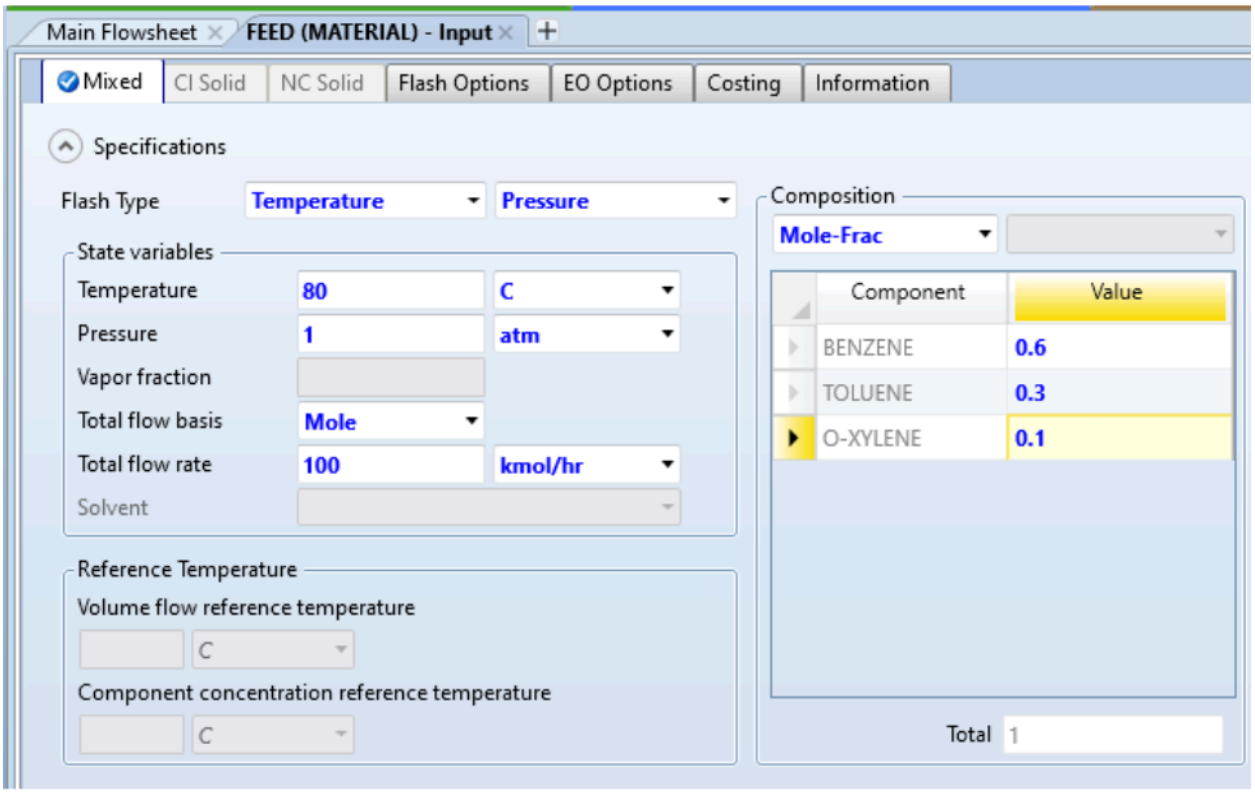
METHOD SPESFICATION



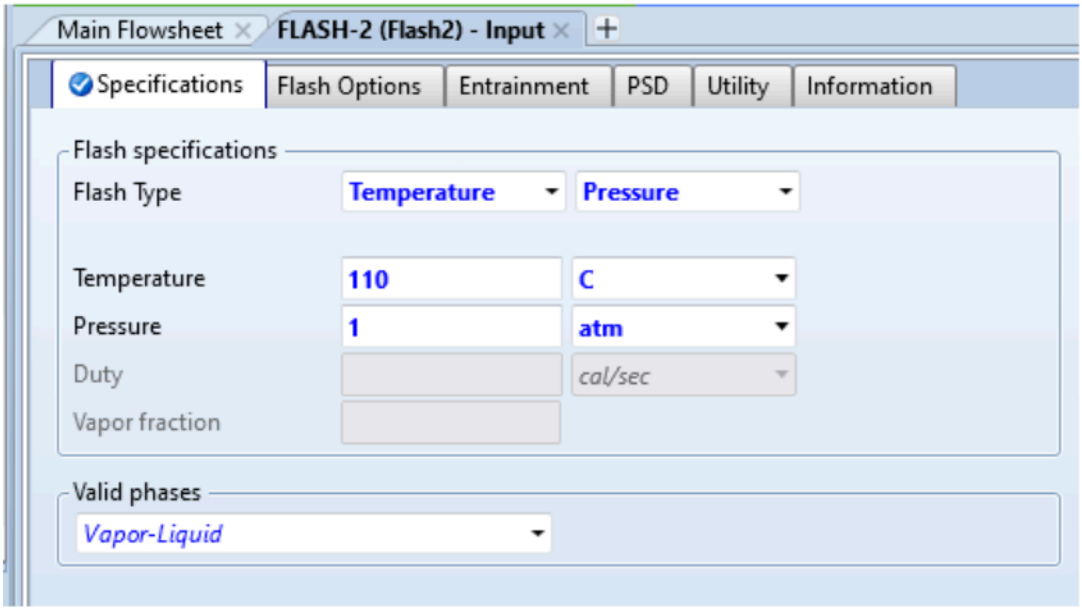
SIMULATION



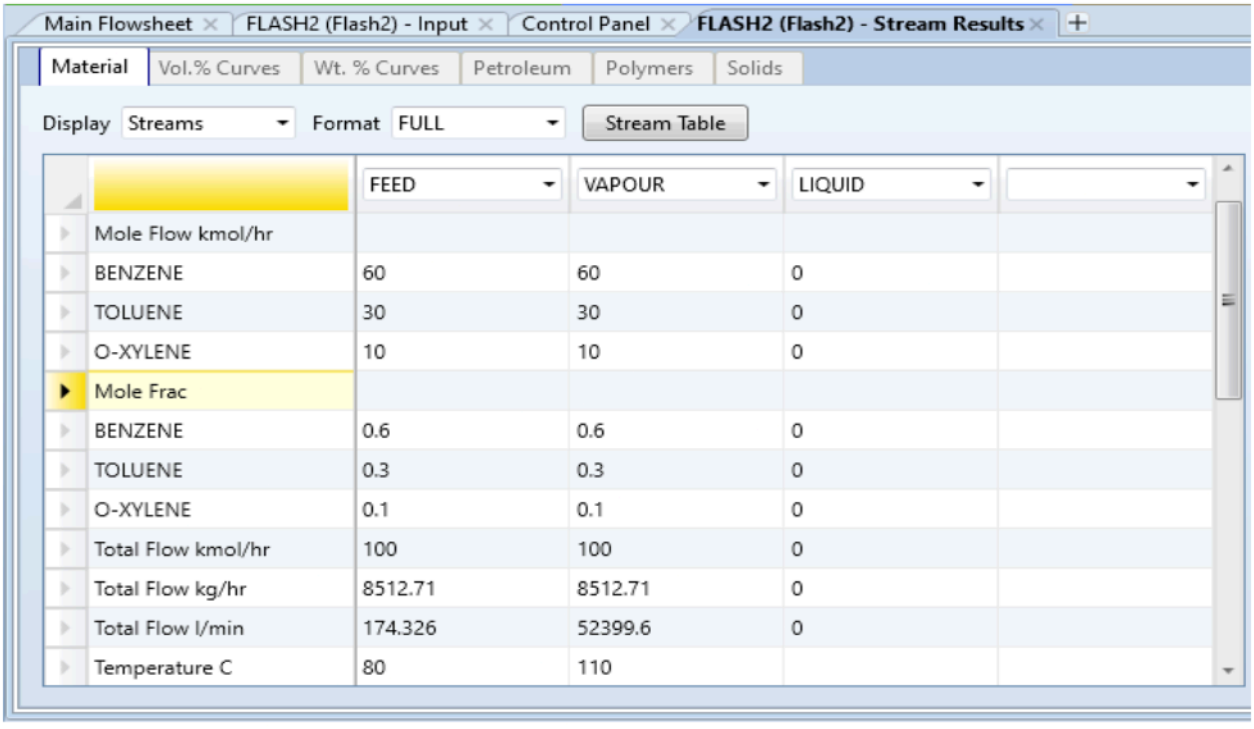
FEED INPUT



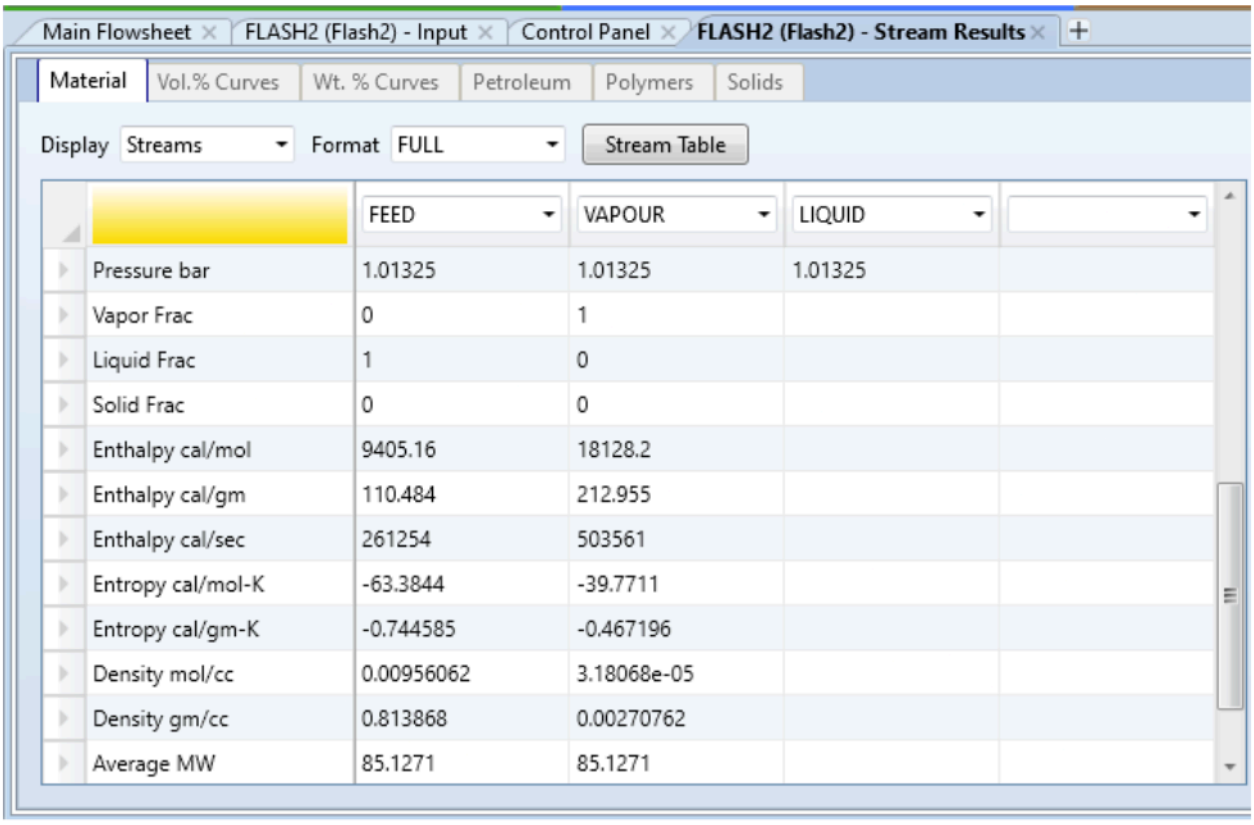
FLASH INPUT @ 1atm AND 110 ^{O}C



AMOUNTS OF LIQUID AND VAPOUR OUTLETS AND THEIR COMPOSITIONS @ 1atm AND 110 ^{O}C

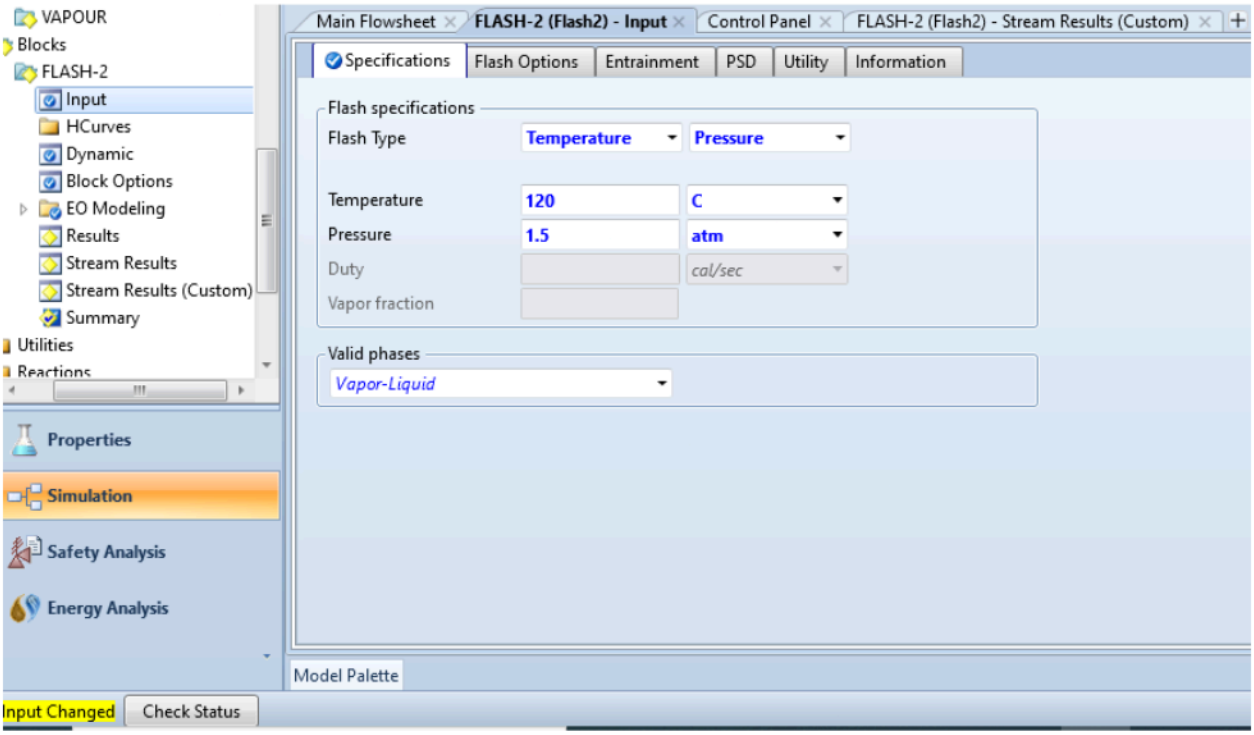


	FEED	VAPOUR	LIQUID	
Mole Flow kmol/hr				
BENZENE	60	60	0	
TOLUENE	30	30	0	
O-XYLENE	10	10	0	
Mole Frac				
BENZENE	0.6	0.6	0	
TOLUENE	0.3	0.3	0	
O-XYLENE	0.1	0.1	0	
Total Flow kmol/hr	100	100	0	
Total Flow kg/hr	8512.71	8512.71	0	
Total Flow l/min	174.326	52399.6	0	
Temperature C	80	110		



	FEED	VAPOUR	LIQUID	
Pressure bar	1.01325	1.01325	1.01325	
Vapor Frac	0	1		
Liquid Frac	1	0		
Solid Frac	0	0		
Enthalpy cal/mol	9405.16	18128.2		
Enthalpy cal/gm	110.484	212.955		
Enthalpy cal/sec	261254	503561		
Entropy cal/mol-K	-63.3844	-39.7711		
Entropy cal/gm-K	-0.744585	-0.467196		
Density mol/cc	0.00956062	3.18068e-05		
Density gm/cc	0.813868	0.00270762		
Average MW	85.1271	85.1271		

FLASH INPUT @ 1.5atm AND 120 ^{O}C



AMOUNTS OF LIQUID AND VAPOUR OUTLETS AND THEIR COMPOSITIONS @ 1atm AND 110 ^{o}C

Main Flowsheet | FLASH2 (Flash2) - Input | Control Panel | **FLASH2 (Flash2) - Stream Results** | Setup - Report Opt

Material | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

Display: Streams Format: FULL Stream Table

	FEED	VAPOUR	LIQUID	
Mole Flow kmol/hr				
BENZENE	60	60	0	
TOLUENE	30	30	0	
O-XYLENE	10	10	0	
Mole Frac				
BENZENE	0.6	0.6	0	
TOLUENE	0.3	0.3	0	
O-XYLENE	0.1	0.1	0	
Total Flow kmol/hr	100	100	0	
Total Flow kg/hr	8512.71	8512.71	0	
Total Flow l/min	174.326	35844.8	0	
Temperature C	80	120		

Main Flowsheet | FLASH2 (Flash2) - Input | Control Panel | **FLASH2 (Flash2) - Stream Results** | Setup - Report Opt

Material | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

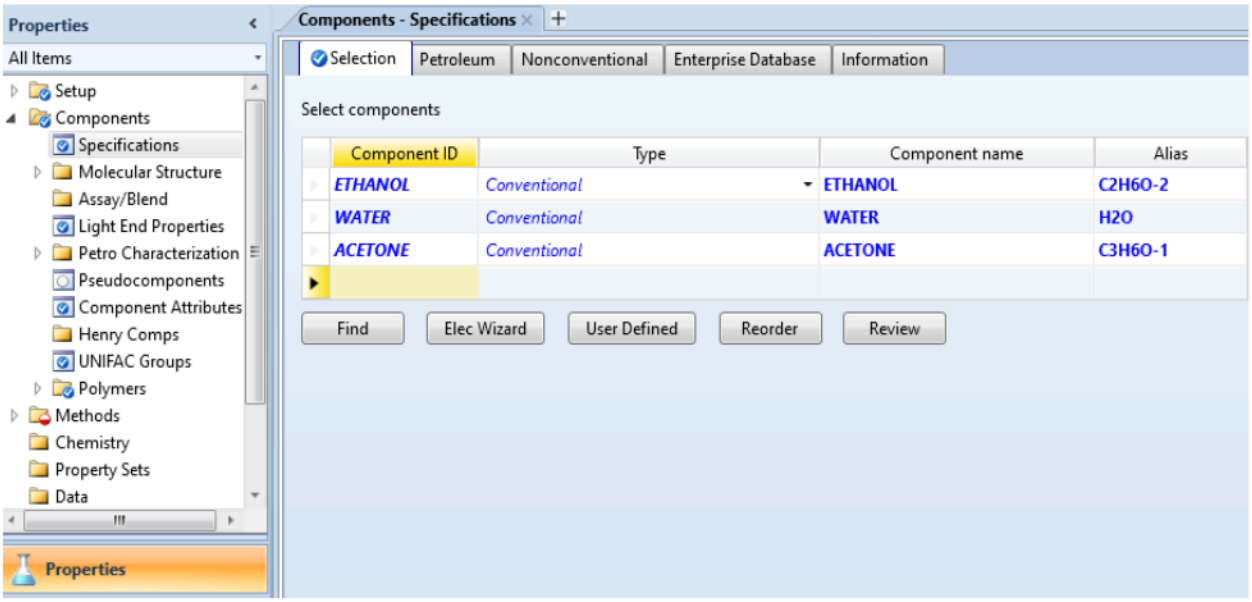
Display: Streams Format: FULL Stream Table

	FEED	VAPOUR	LIQUID	
Pressure bar	1.01325	1.51988	1.51988	
Vapor Frac	0	1		
Liquid Frac	1	0		
Solid Frac	0	0		
Enthalpy cal/mol	9405.16	18424.1		
Enthalpy cal/gm	110.484	216.43		
Enthalpy cal/sec	261254	511780		
Entropy cal/mol-K	-63.3844	-39.814		
Entropy cal/gm-K	-0.744585	-0.4677		
Density mol/cc	0.00956062	4.64967e-05		
Density gm/cc	0.813868	0.00395813		
Average MW	85.1271	85.1271		

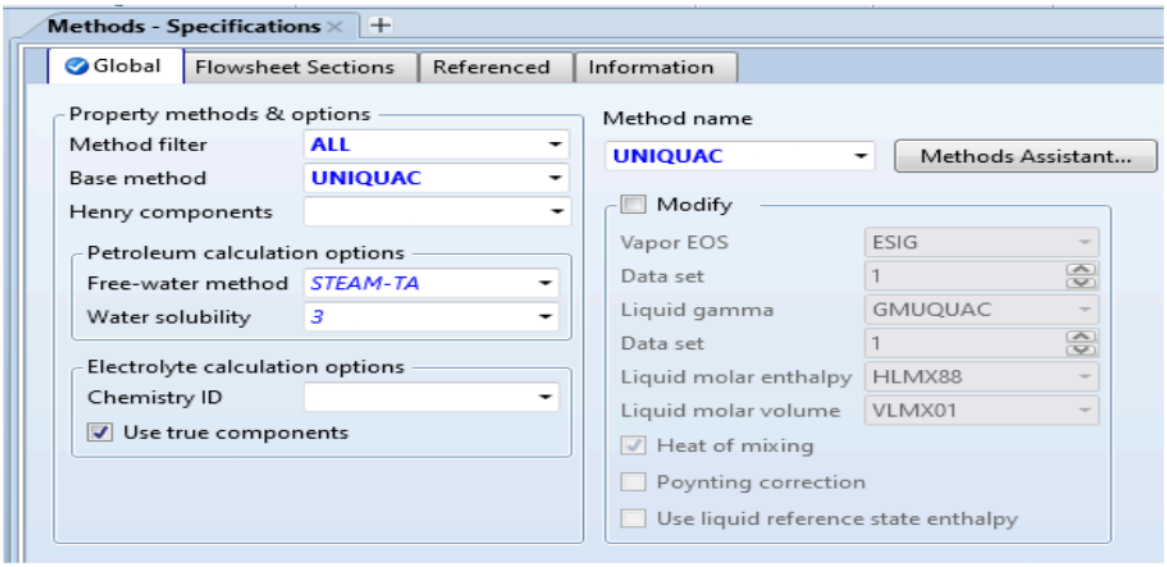
3. Use the Flash2 block to flash the feed below adiabatically at constant pressure for reducing the acetone composition in the bottom product. The feed temperature is 70 °C and pressure is 760 mmHg Table Feeds for Workshop 7.1 Component Feed1 (lb mol/h) Feed2 (lb mol/h) Ethanol 40 Water 50 Acetone 10. Be sure to set up appropriate units. Use Aspen Plus's stored UNIQUAC, NRTL, and Wilson parameters as the basis for the calculations. What do you observe?

SOLUTIONS;

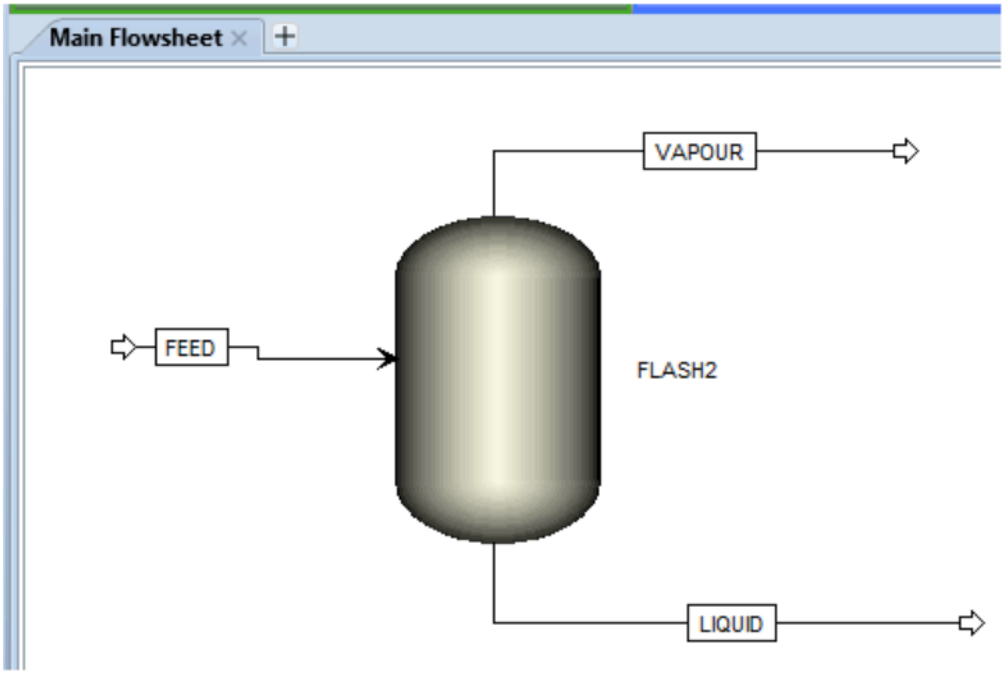
PROPERTY SPESFICATION



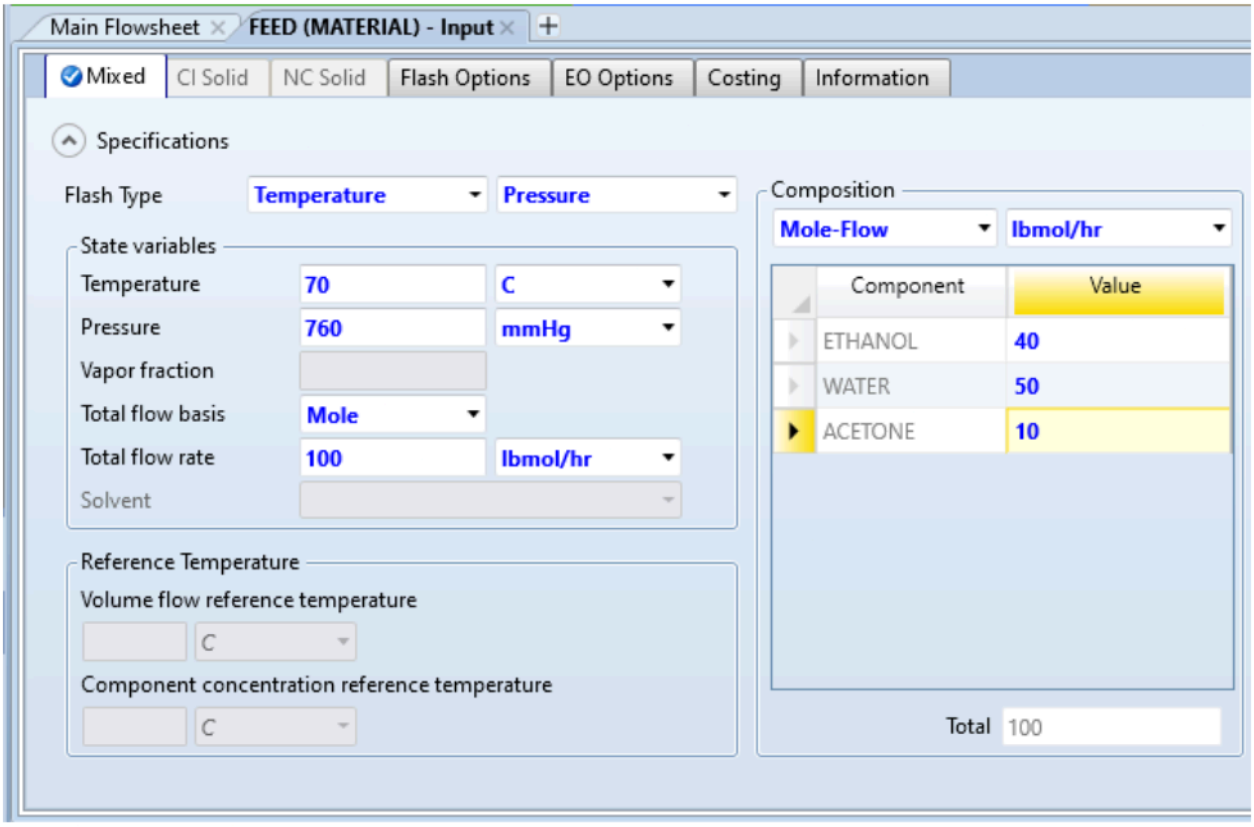
METHOD SPESFICATION



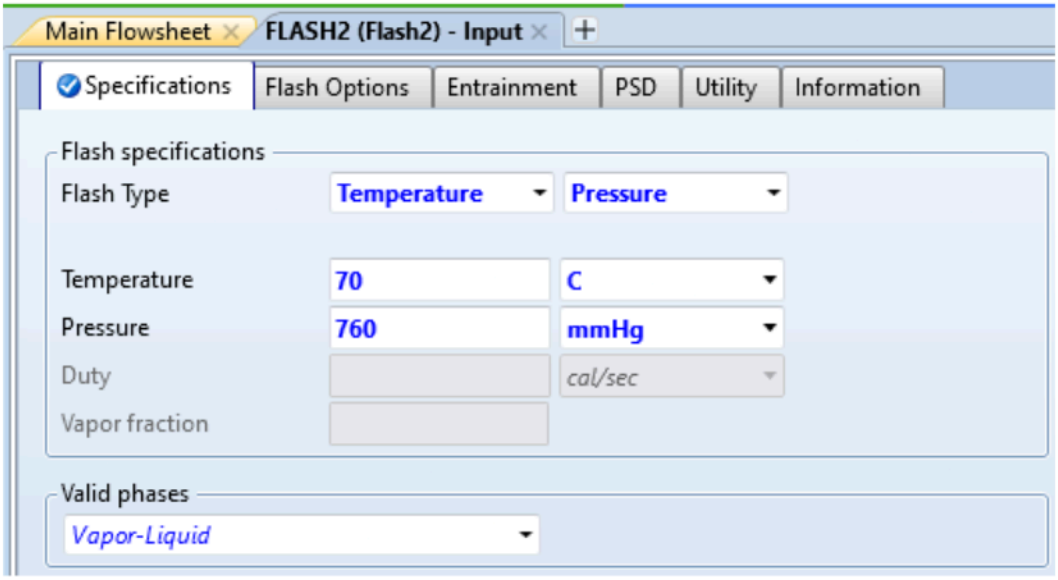
SIMULATION



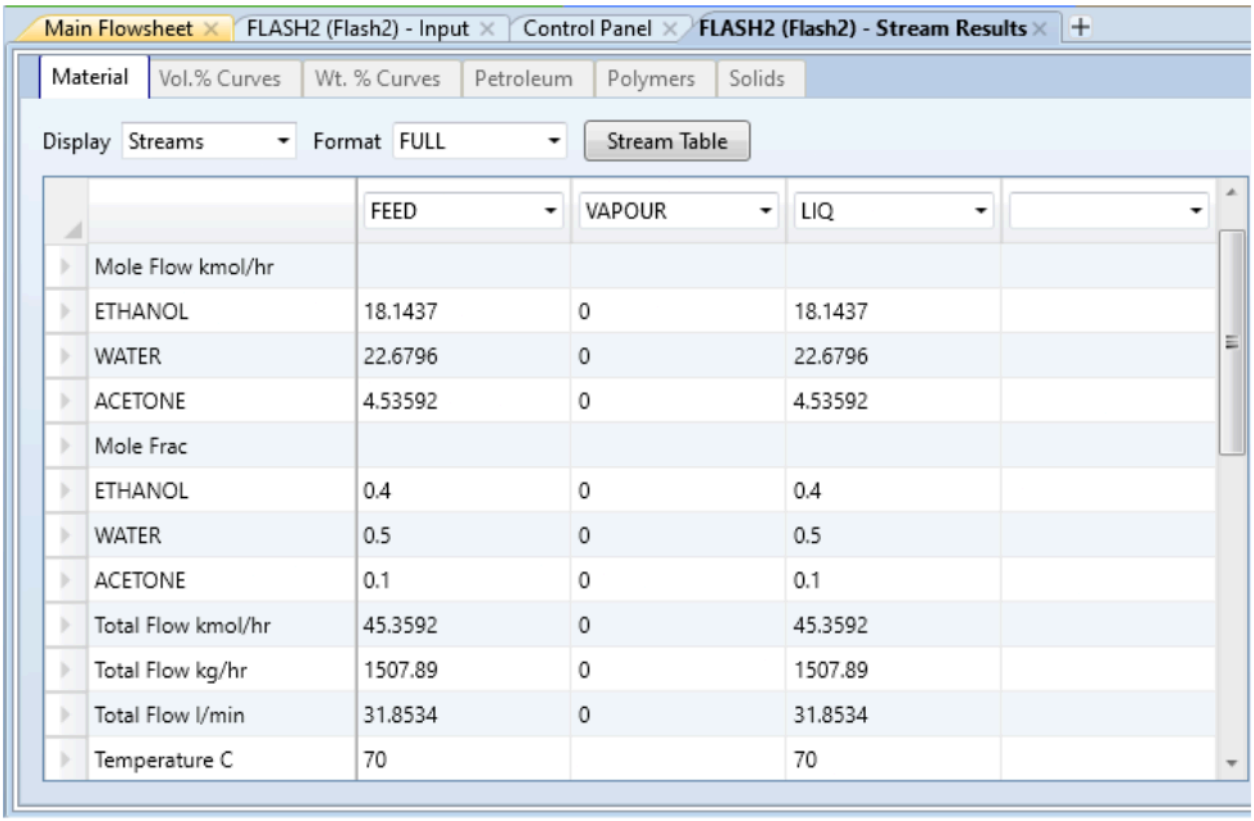
FEED INPUT



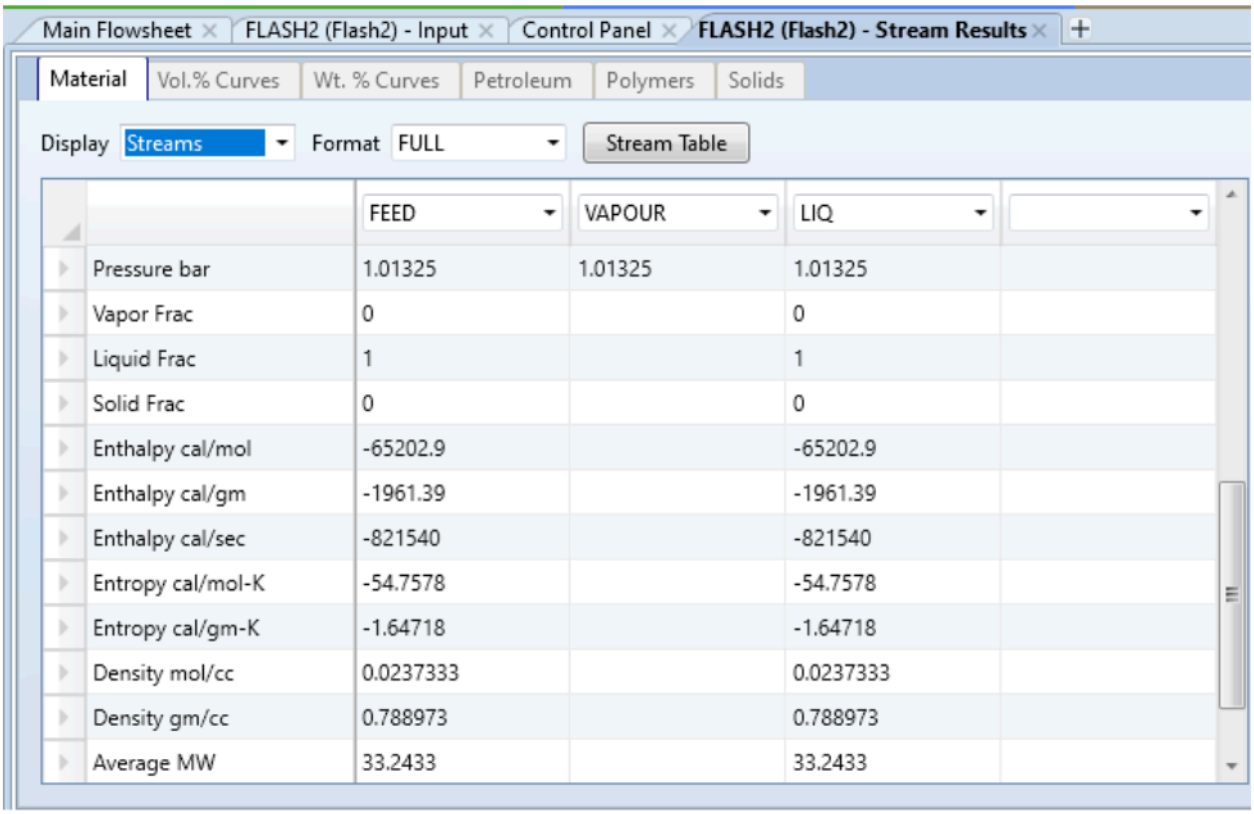
BLOCK (FLAS2) INPUT



RESULTS FOR UNIQUAC METHOD

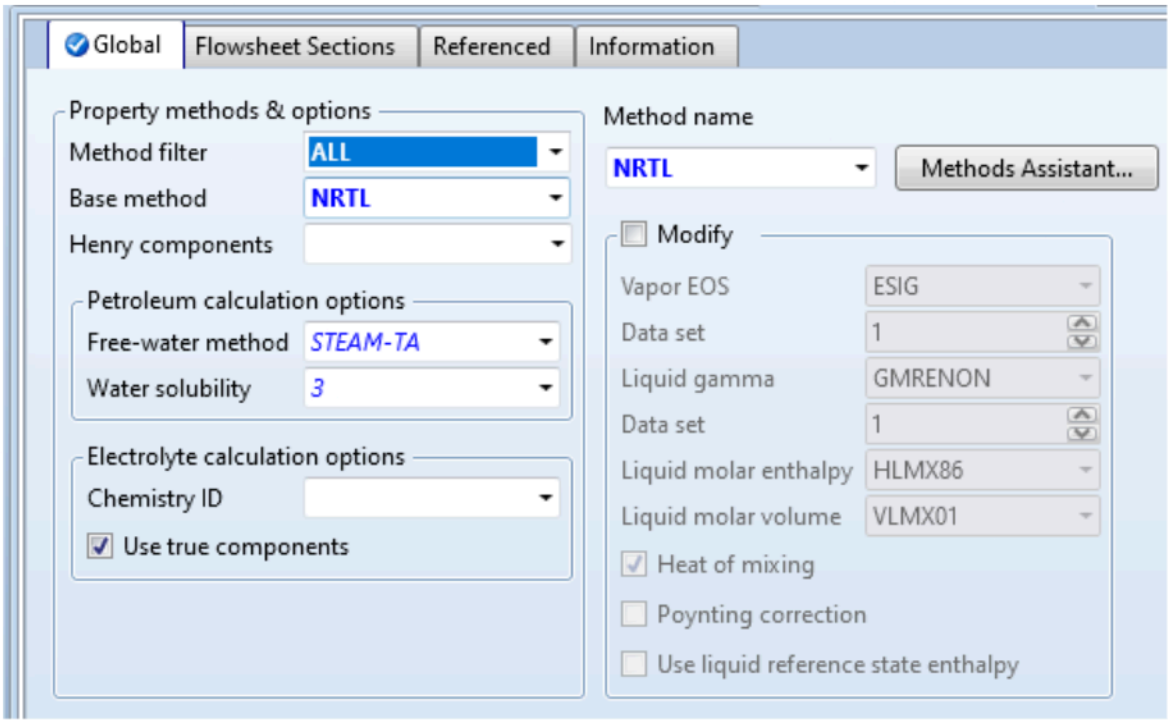


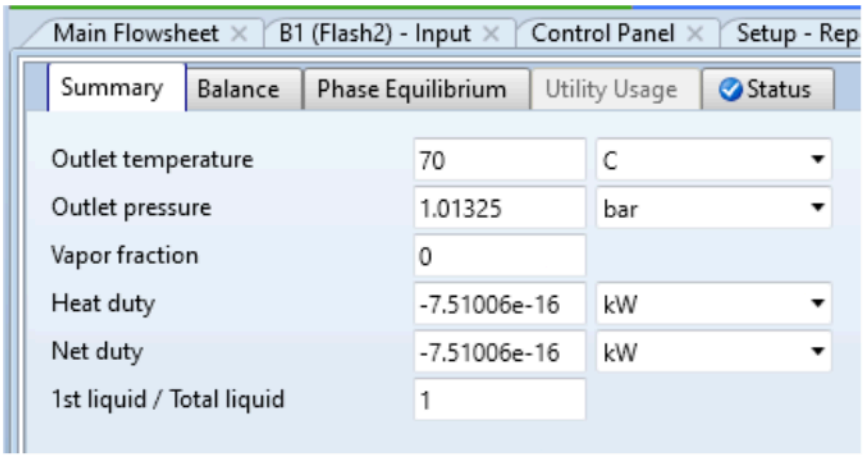
	FEED	VAPOUR	LIQ	
Mole Flow kmol/hr				
ETHANOL	18.1437	0	18.1437	
WATER	22.6796	0	22.6796	
ACETONE	4.53592	0	4.53592	
Mole Frac				
ETHANOL	0.4	0	0.4	
WATER	0.5	0	0.5	
ACETONE	0.1	0	0.1	
Total Flow kmol/hr	45.3592	0	45.3592	
Total Flow kg/hr	1507.89	0	1507.89	
Total Flow l/min	31.8534	0	31.8534	
Temperature C	70		70	



	FEED	VAPOUR	LIQ	
Pressure bar	1.01325	1.01325	1.01325	
Vapor Frac	0		0	
Liquid Frac	1		1	
Solid Frac	0		0	
Enthalpy cal/mol	-65202.9		-65202.9	
Enthalpy cal/gm	-1961.39		-1961.39	
Enthalpy cal/sec	-821540		-821540	
Entropy cal/mol-K	-54.7578		-54.7578	
Entropy cal/gm-K	-1.64718		-1.64718	
Density mol/cc	0.0237333		0.0237333	
Density gm/cc	0.788973		0.788973	
Average MW	33.2433		33.2433	

RESULTS FOR NRTL METHOD



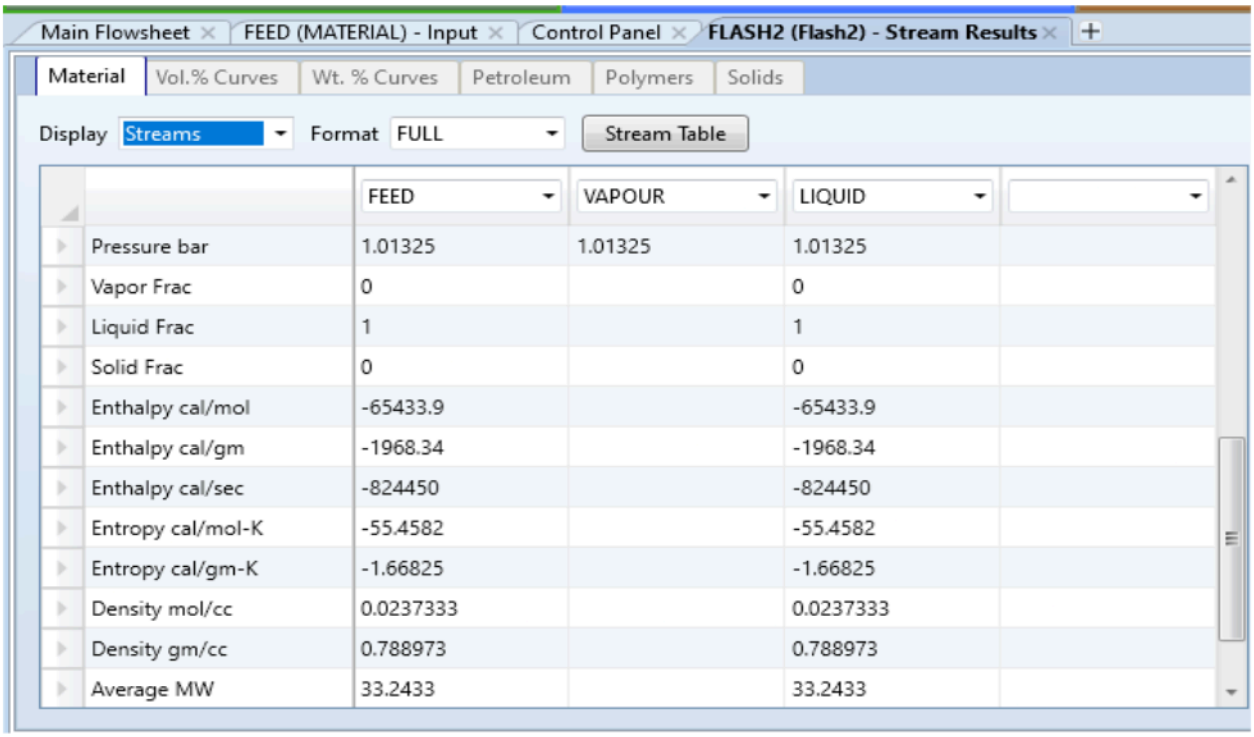


Main Flowsheet | FEED (MATERIAL) - Input | Control Panel | **FLASH2 (Flash2) - Stream Results**

Material | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

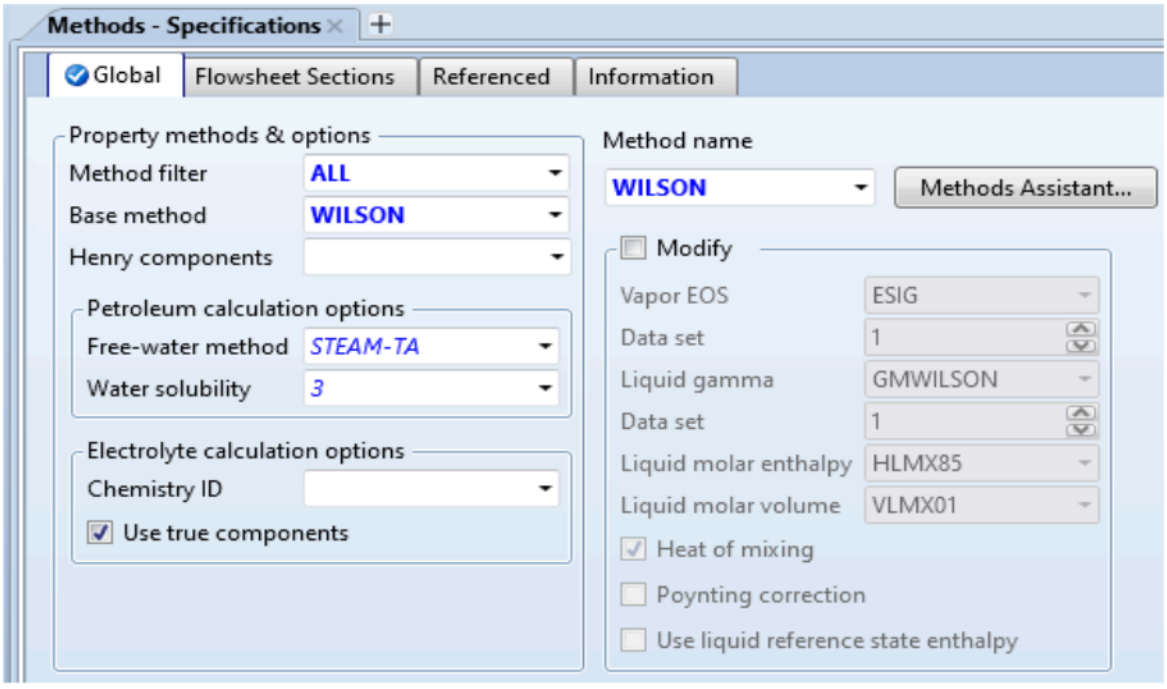
Display: Streams Format: FULL Stream Table

	FEED	VAPOUR	LIQUID	
Mole Flow kmol/hr				
ETHANOL	18.1437	0	18.1437	
WATER	22.6796	0	22.6796	
ACETONE	4.53592	0	4.53592	
Mole Frac				
ETHANOL	0.4	0	0.4	
WATER	0.5	0	0.5	
ACETONE	0.1	0	0.1	
Total Flow kmol/hr	45.3592	0	45.3592	
Total Flow kg/hr	1507.89	0	1507.89	
Total Flow l/min	31.8534	0	31.8534	
Temperature C	70		70	



	FEED	VAPOUR	LIQUID	
Pressure bar	1.01325	1.01325	1.01325	
Vapor Frac	0		0	
Liquid Frac	1		1	
Solid Frac	0		0	
Enthalpy cal/mol	-65433.9		-65433.9	
Enthalpy cal/gm	-1968.34		-1968.34	
Enthalpy cal/sec	-824450		-824450	
Entropy cal/mol-K	-55.4582		-55.4582	
Entropy cal/gm-K	-1.66825		-1.66825	
Density mol/cc	0.0237333		0.0237333	
Density gm/cc	0.788973		0.788973	
Average MW	33.2433		33.2433	

RESULTS FOR Wilson METHOD



Main Flowsheet | Control Panel | Setup - Report Options | FLASH2 (Flash2) - Input | **FLASH2 (Flash2) - Stream Results**

Material | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

Display: Streams | Format: FULL | Stream Table

	FEED	VAPOR	LIQUID	
Mole Flow kmol/hr				
ETHANOL	18.1437	0	18.1437	
WATER	22.6796	0	22.6796	
ACETONE	4.53592	0	4.53592	
Mole Frac				
ETHANOL	0.4	0	0.4	
WATER	0.5	0	0.5	
ACETONE	0.1	0	0.1	
Total Flow kmol/hr	45.3592	0	45.3592	
Total Flow kg/hr	1507.89	0	1507.89	
Total Flow l/min	31.8534	0	31.8534	
Temperature C	70		70	

Main Flowsheet | Control Panel | Setup - Report Options | FLASH2 (Flash2) - Input | **FLASH2 (Flash2) - Stream Results**

Material | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

Display: Streams | Format: FULL | Stream Table

	FEED	VAPOR	LIQUID	
Pressure bar	1.01325	1.01325	1.01325	
Vapor Frac	0		0	
Liquid Frac	1		1	
Solid Frac	0		0	
Enthalpy cal/mol	-65417.7		-65417.7	
Enthalpy cal/gm	-1967.85		-1967.85	
Enthalpy cal/sec	-824250		-824250	
Entropy cal/mol-K	-55.4186		-55.4186	
Entropy cal/gm-K	-1.66706		-1.66706	
Density mol/cc	0.0237333		0.0237333	
Density gm/cc	0.788973		0.788973	
Average MW	33.2433		33.2433	

Boiling temperature of water, ethanol, and acetone are 100, 78.37, and 56°C respectively. So separation of acetone starts almost 56°C, but the operating temperature (70°c) is greater than boiling temperature of Acetone (56°C). as a result we observed that separation of acetone is not achieved.

4. A ternary mixture having the following flowrates is fed to a separator (Sep2) at 50°C and 5bar. Solve the problem using Aspen Plus, the following specifications are provided along with a T/F ratio of 0.905478

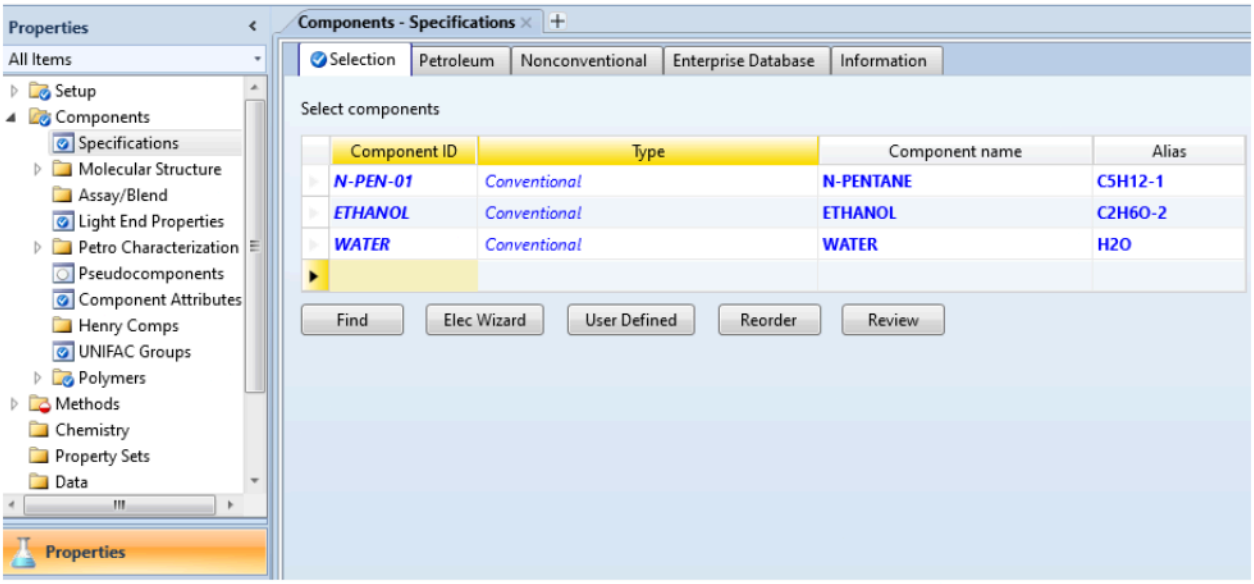
Component	*Flow rate* (kmol/hr)
n-pentane	33.623
ethanol	0.476
water	3.705

Component	*Split fraction in stream* T
n-pentane	0.999
ethanol	0.9
water	(calculated by Aspen)

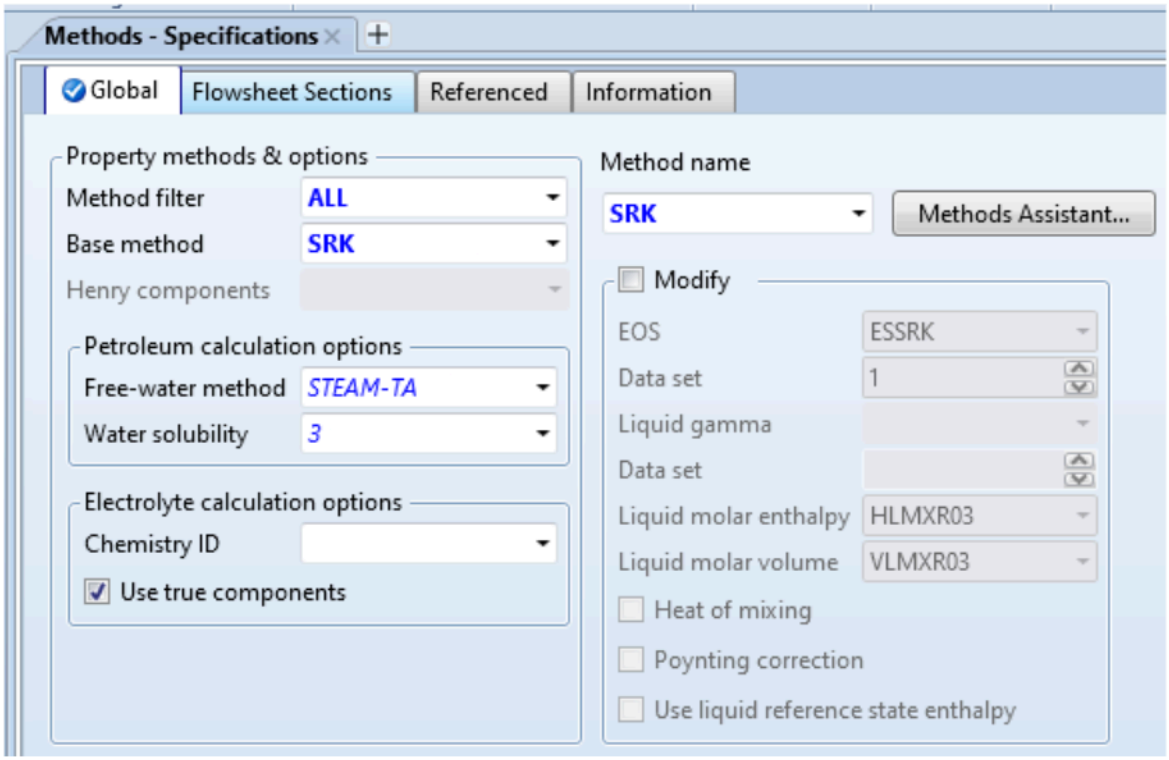
Applying the SRK property method, simulate the flow sheet, and determine the product compositions

SOLUTIONS;

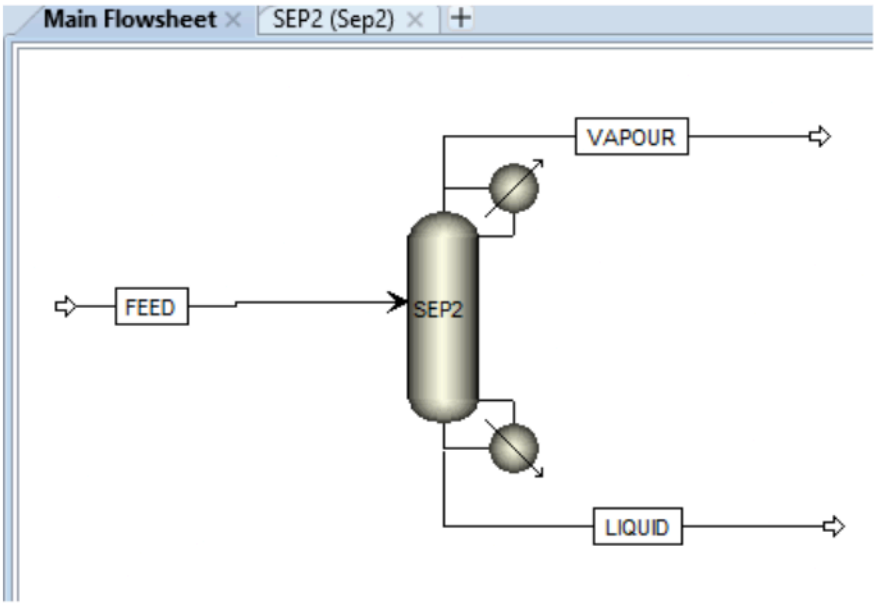
PROPERTIY SPESFICATION



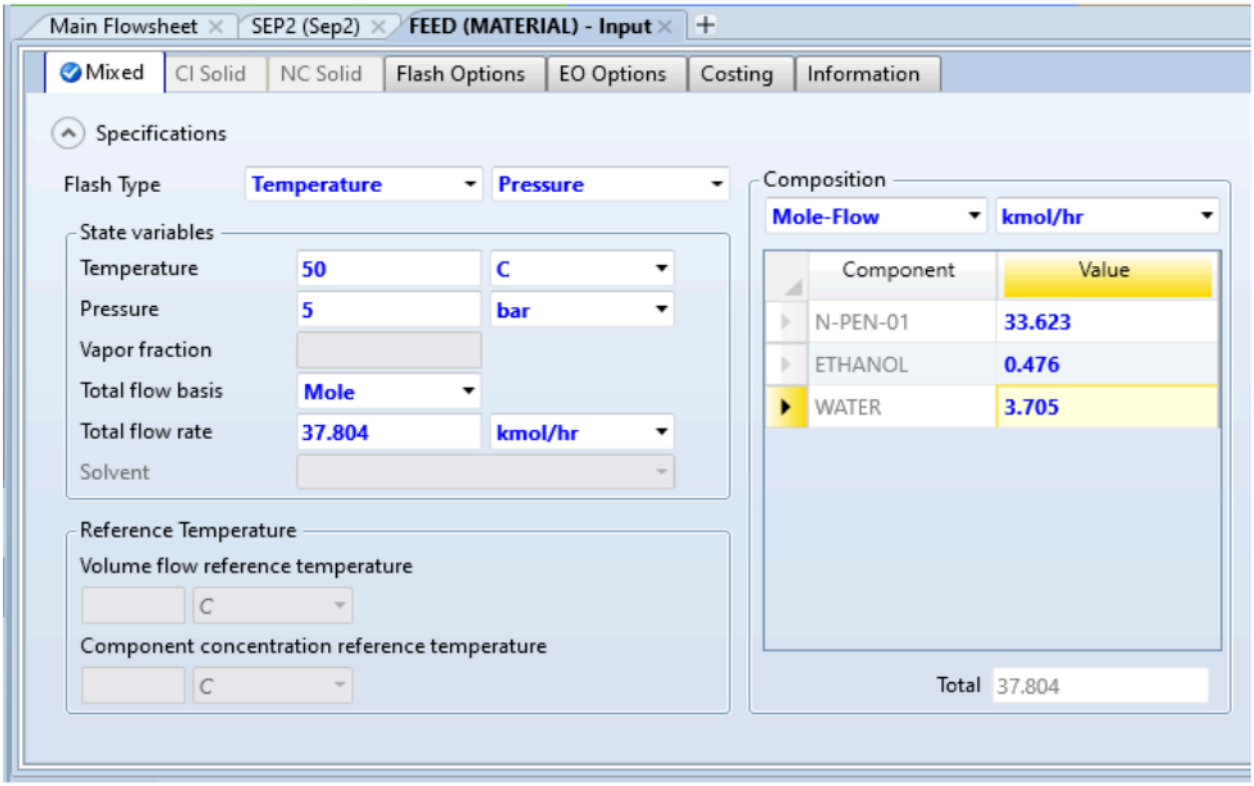
METHOD SPESFICATION



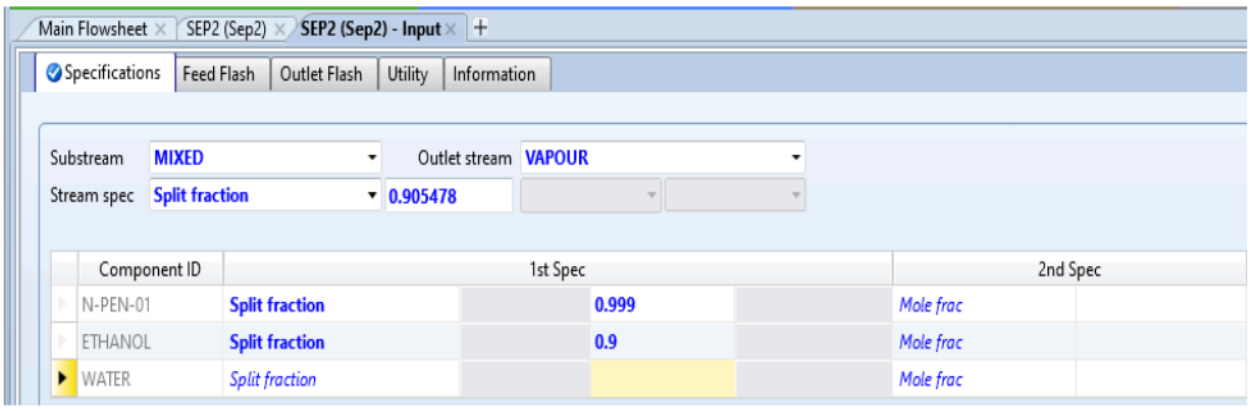
SIMULATION



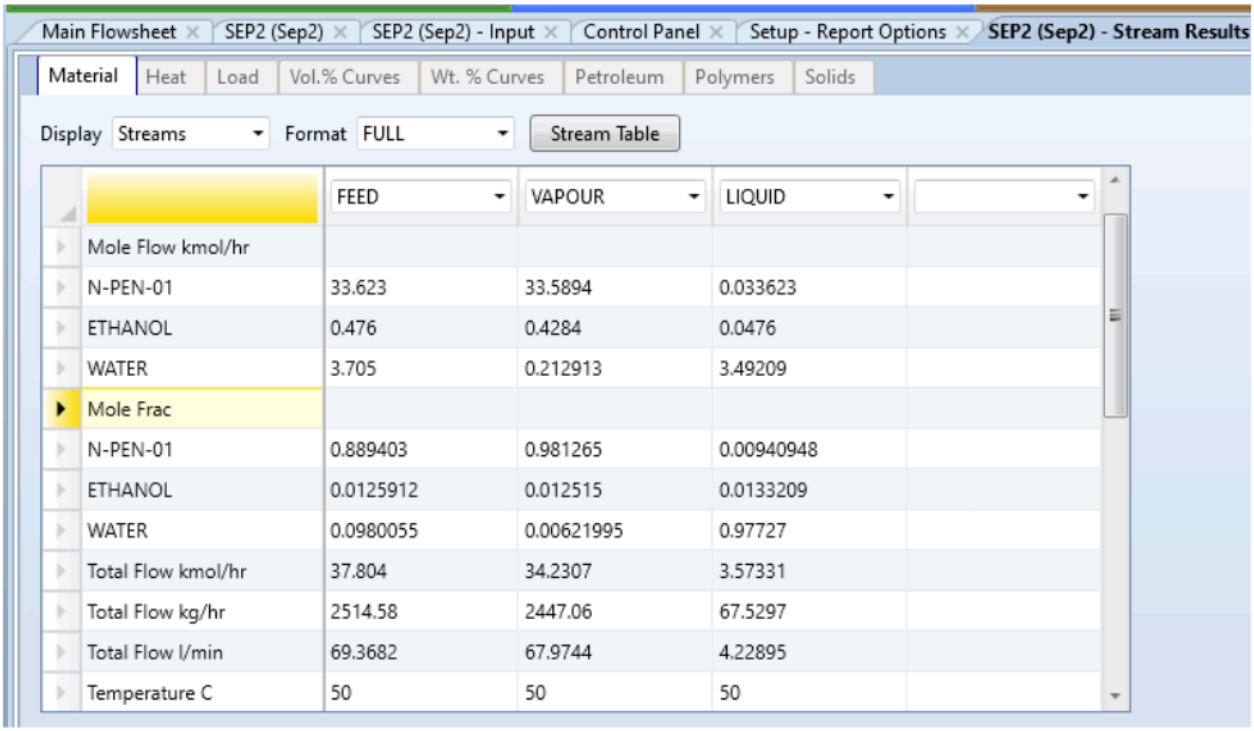
FEED INPUT



BLOCK (SEPARATOR2) INPUTS

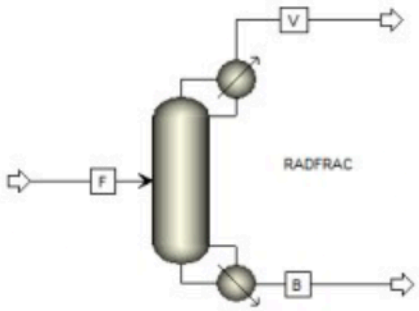


THE PRODUCT COMPOSITIONS



	FEED	VAPOUR	LIQUID	
Mole Flow kmol/hr				
N-PEN-01	33.623	33.5894	0.033623	
ETHANOL	0.476	0.4284	0.0476	
WATER	3.705	0.212913	3.49209	
Mole Frac				
N-PEN-01	0.889403	0.981265	0.00940948	
ETHANOL	0.0125912	0.012515	0.0133209	
WATER	0.0980055	0.00621995	0.97727	
Total Flow kmol/hr	37.804	34.2307	3.57331	
Total Flow kg/hr	2514.58	2447.06	67.5297	
Total Flow l/min	69.3682	67.9744	4.22895	
Temperature C	50	50	50	

5. A multicomponent distillation column, specified in Figure below, has total 20 stages (including condenser and reboiler) with 60% Murphree efficiency. A hydrocarbon feed mixture enters above tray 10 of the RadFrac column. Apply the Peng-Robinson correlation and consider 120 psia pressure throughout the column. A. Simulate the model and calculate the product compositions, and B. Produce a 'Temperature' (°F) vs. 'Stage' plot



Vapour Distillate Specifications

Flow rate = 50 lbmol/hr
Reflux rate = 125 lbmol/hr

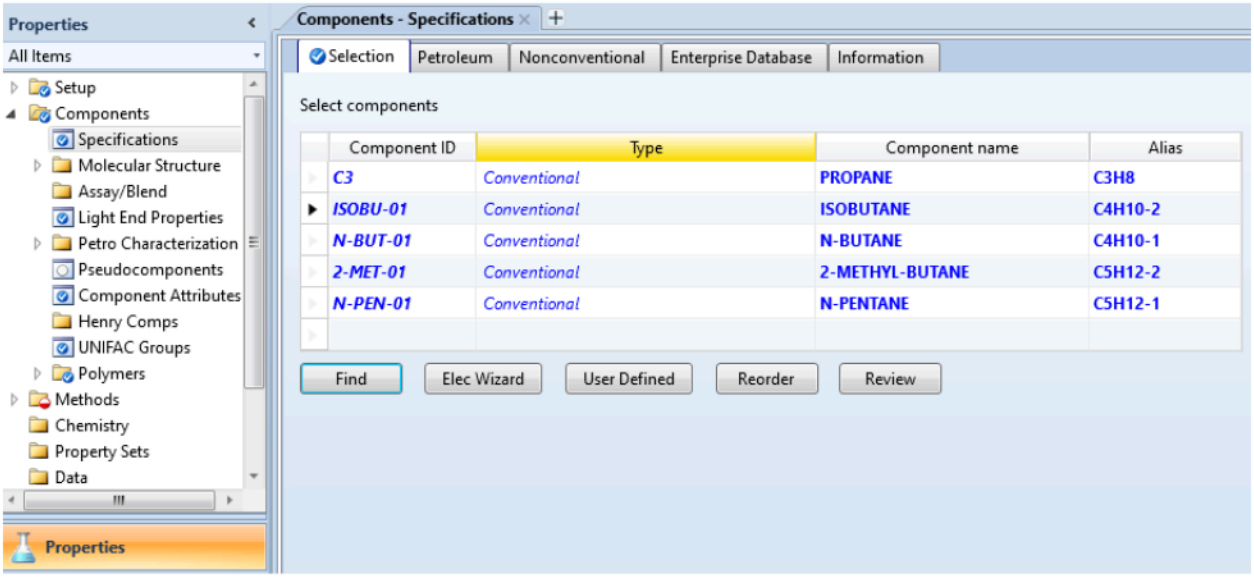
Feed Specifications

Flow rate = 100 lbmol/hr
Temperature = 12°F
Pressure = 120 psia

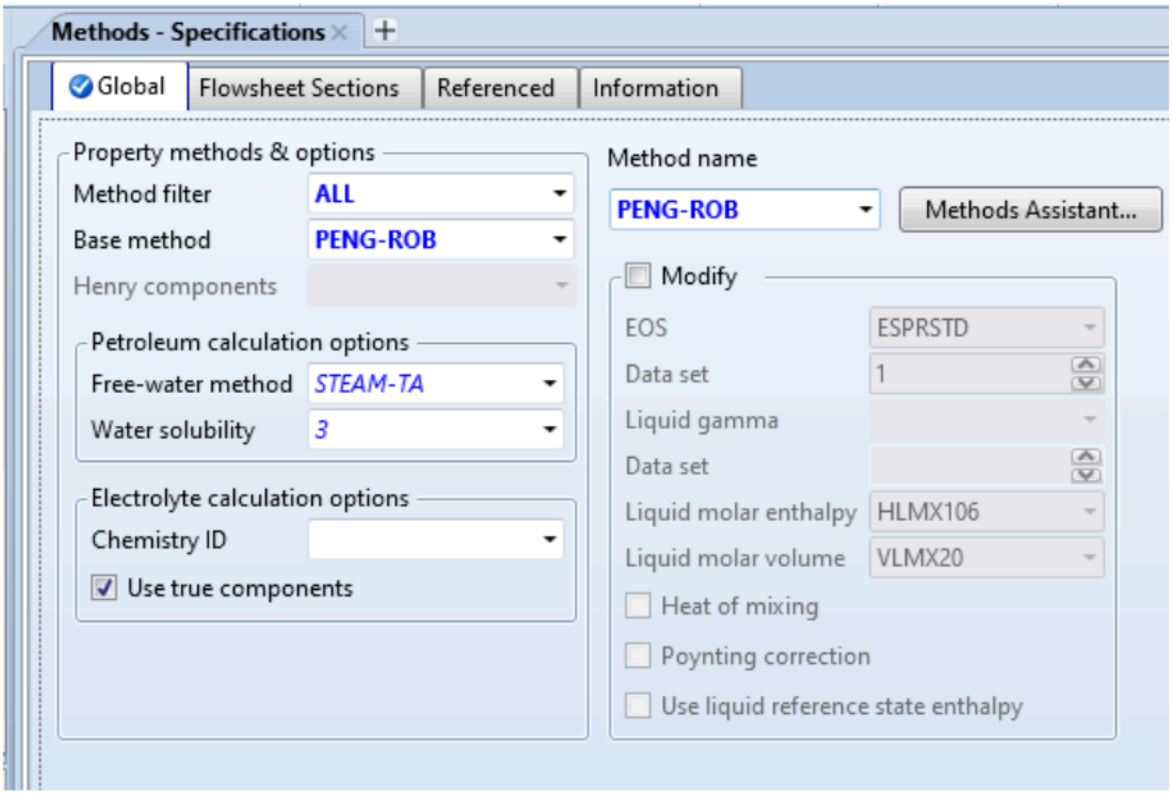
Component	Mole%
C_3	5
i-C_4	15
n-C_4	20
i-C_5	25
n-C_5	35

SOLUTIONS;

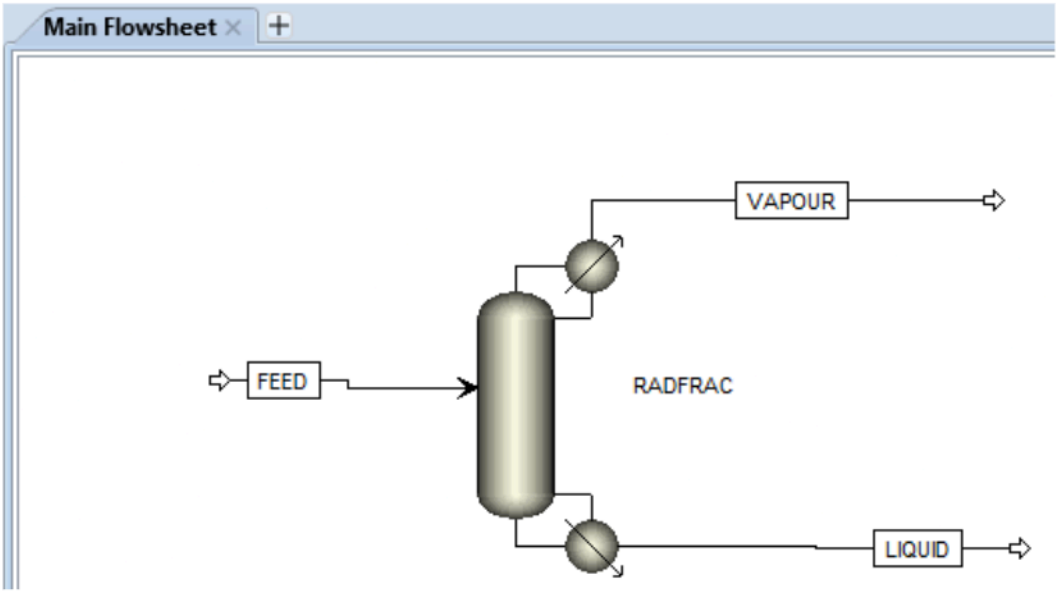
PROPERTIY SPESFICATION



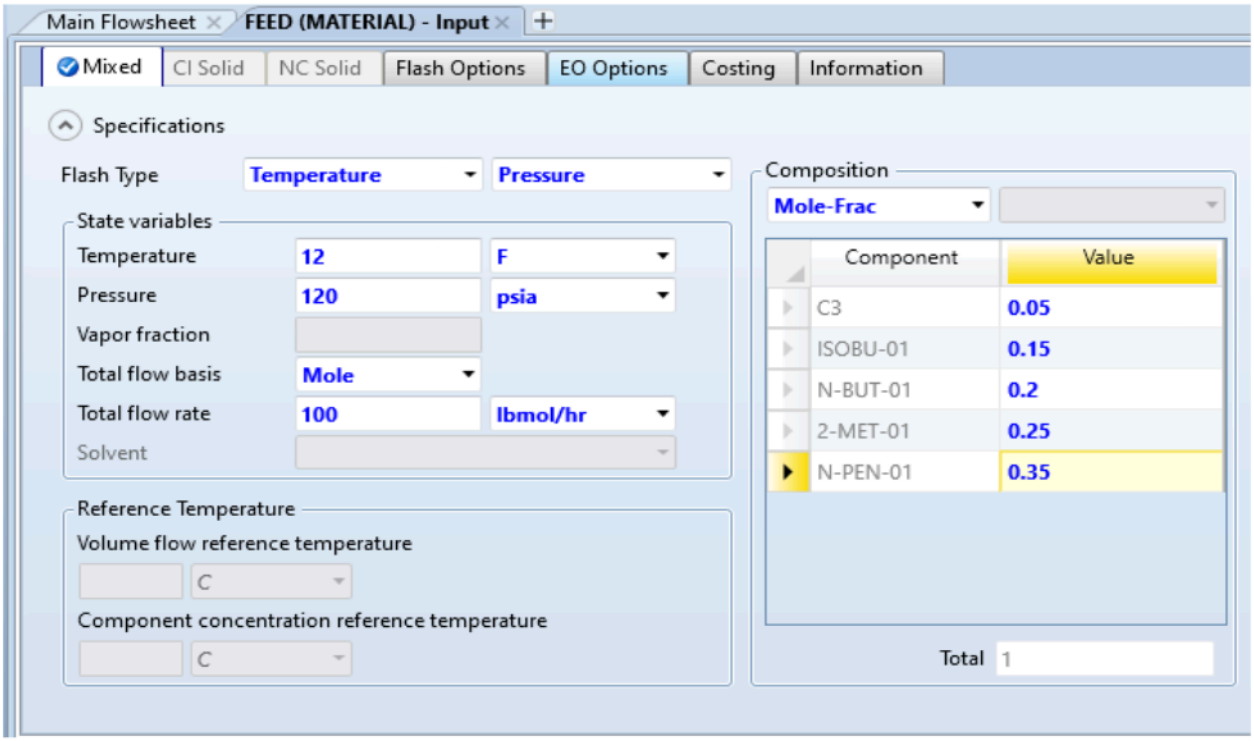
METHOD SPESFICATION



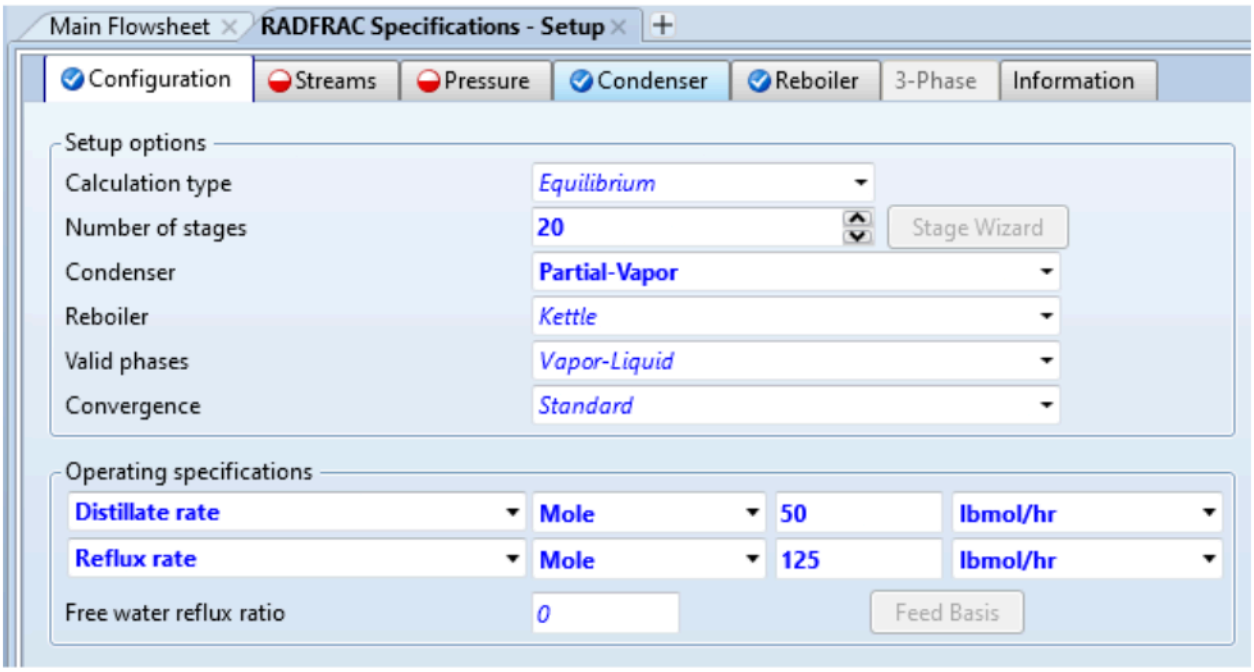
SIMULATION

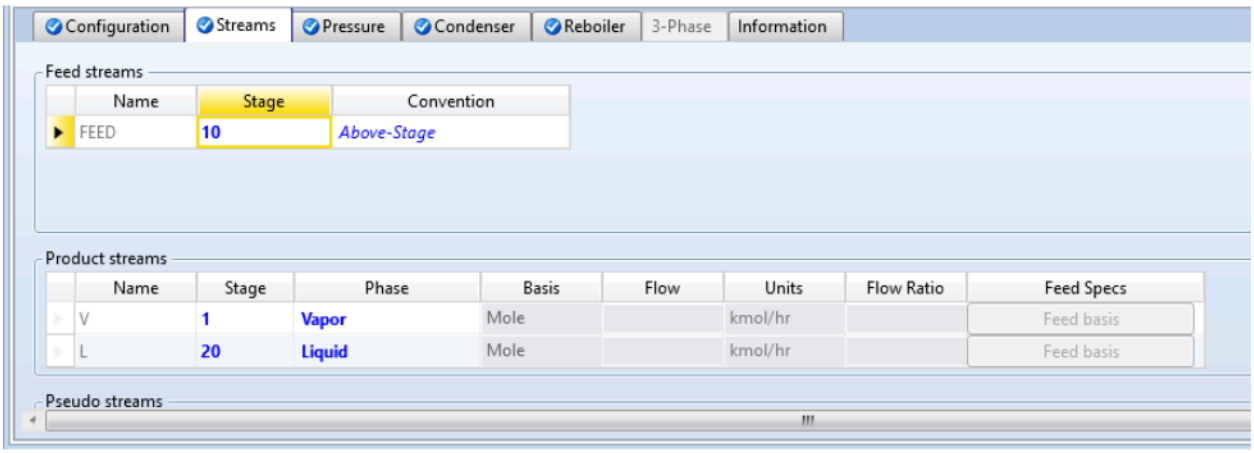


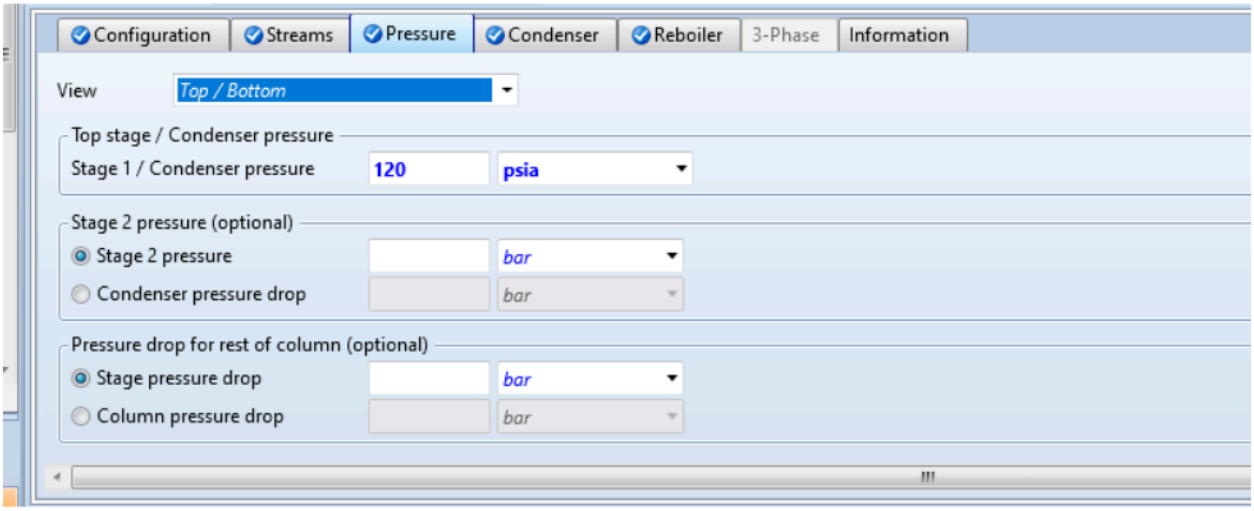
FEED INPUT

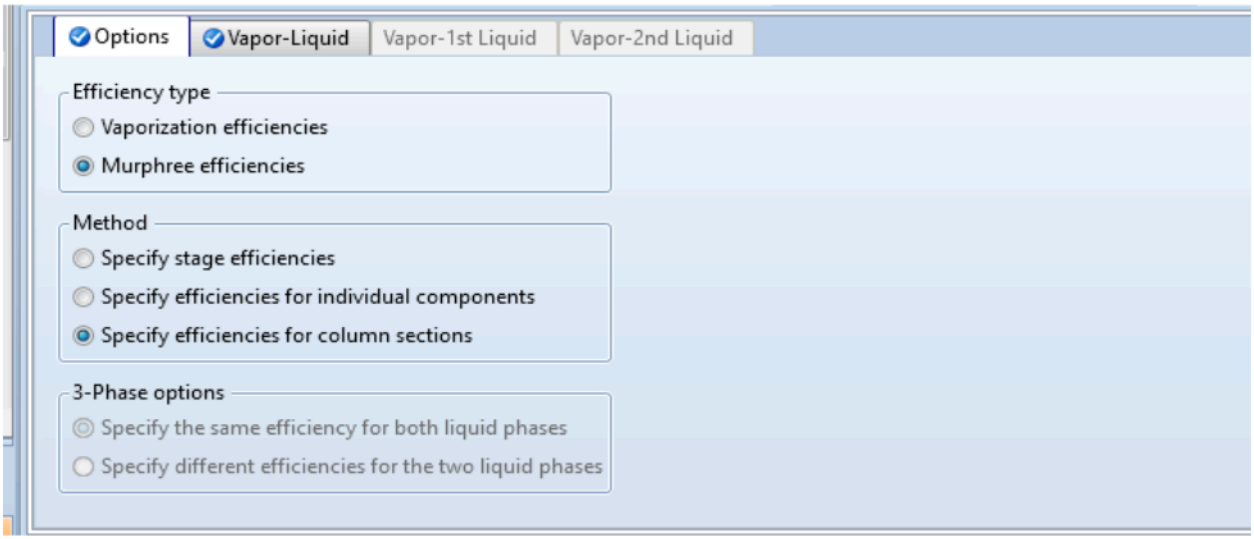


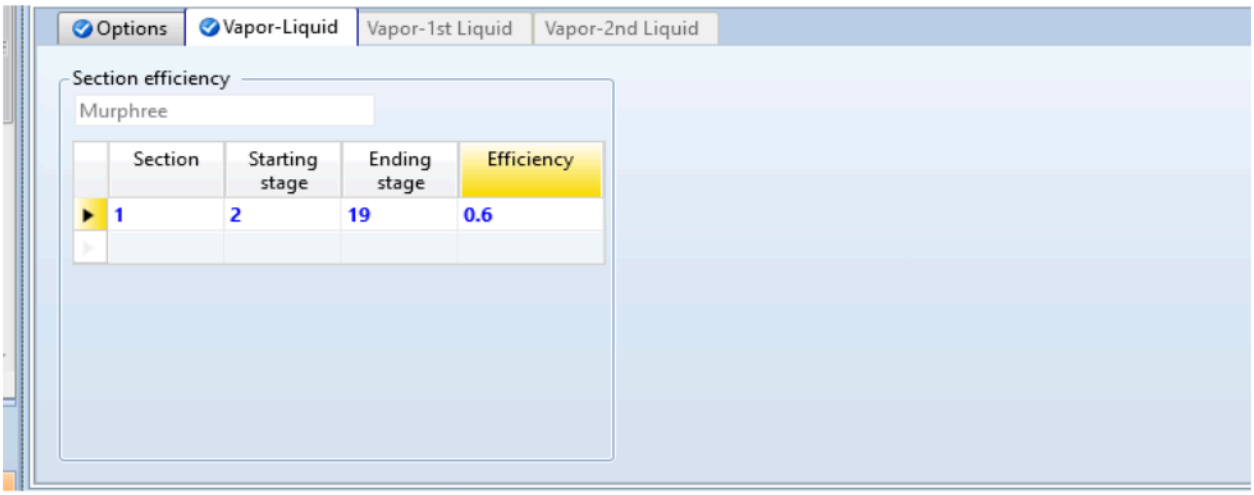
BLOCK (RADFRAC) INPUTS



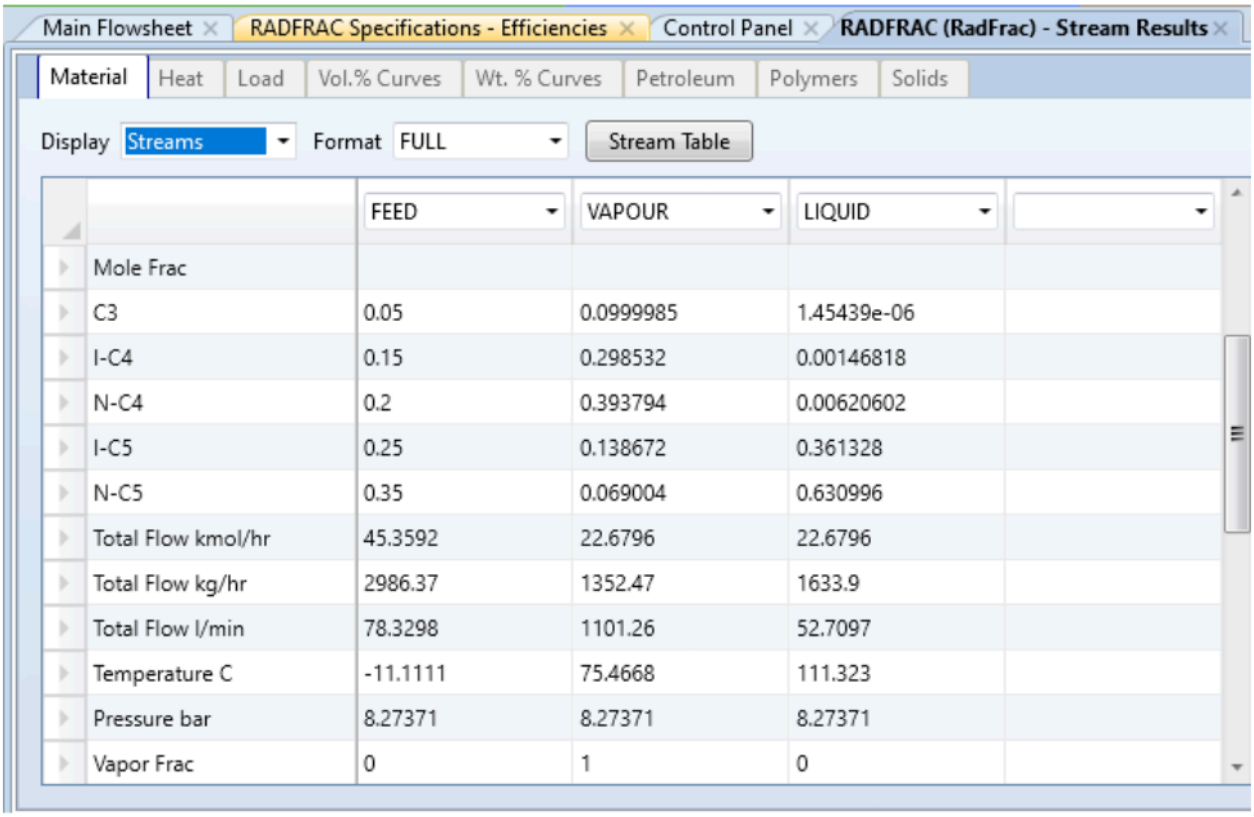

Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
Feed streams
Name
Stage
Convention
FEED
10
Above-Stage
Product streams
Name
Stage
Phase
Basis
Flow
Units
Flow Ratio
Feed Specs
V
1
Vapor
Mole
kmol/hr
Feed basis
L
20
Liquid
Mole
kmol/hr
Feed basis
Pseudo streams


Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
View
Top / Bottom
Top stage / Condenser pressure
Stage 1 / Condenser pressure
120
psia
Stage 2 pressure (optional)
Stage 2 pressure
bar
Condenser pressure drop
bar
Pressure drop for rest of column (optional)
Stage pressure drop
bar
Column pressure drop
bar


Options
Vapor-Liquid
Vapor-1st Liquid
Vapor-2nd Liquid
Efficiency type
Vaporization efficiencies
Murphree efficiencies
Method
Specify stage efficiencies
Specify efficiencies for individual components
Specify efficiencies for column sections
3-Phase options
Specify the same efficiency for both liquid phases
Specify different efficiencies for the two liquid phases



A. THE PRODUCT COMPOSITIONS



	FEED	VAPOUR	LIQUID	
Mole Frac				
C3	0.05	0.0999985	1.45439e-06	
I-C4	0.15	0.298532	0.00146818	
N-C4	0.2	0.393794	0.00620602	
I-C5	0.25	0.138672	0.361328	
N-C5	0.35	0.069004	0.630996	
Total Flow kmol/hr	45.3592	22.6796	22.6796	
Total Flow kg/hr	2986.37	1352.47	1633.9	
Total Flow l/min	78.3298	1101.26	52.7097	
Temperature C	-11.1111	75.4668	111.323	
Pressure bar	8.27371	8.27371	8.27371	
Vapor Frac	0	1	0	

B. TEMPERATURE AND 'TEMPERATURE' (° F) VS 'STAGE' PLOT.

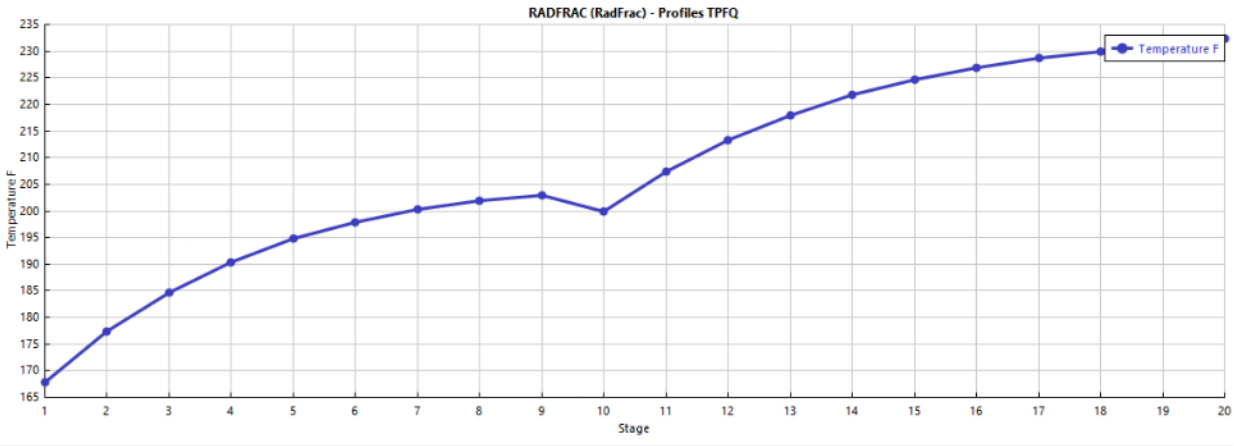
Main Flowsheet | RADFRAC Specifications - Efficiencies | Control Panel | RADFRAC (RadFrac)

TPFQ | Compositions | K-Values | Hydraulics | Reactions | Efficiencies | Properties | Key Comp

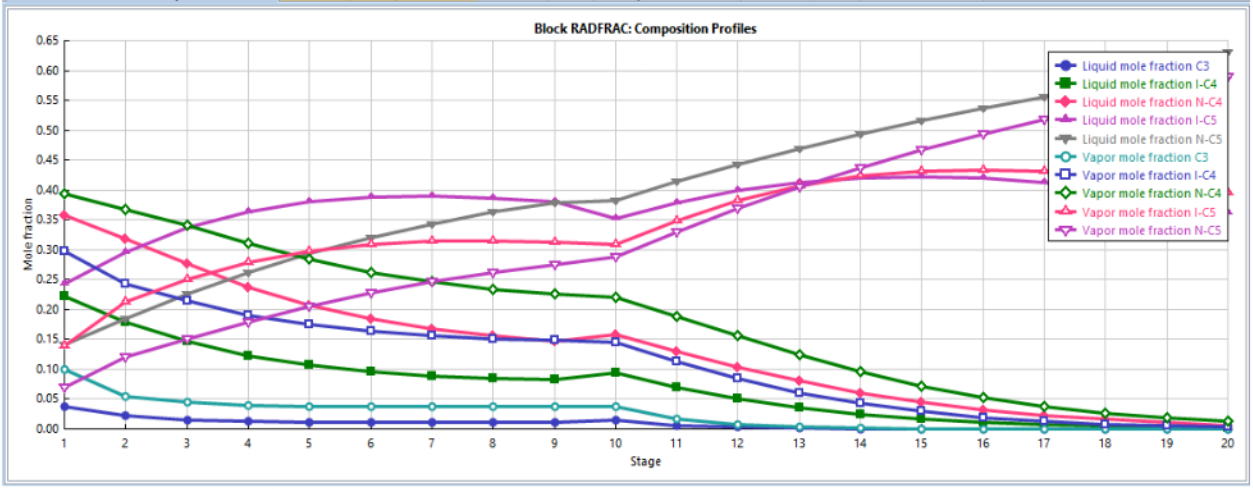
View: All Basis: Mole

Stage	Temperature	Pressure	Heat duty	Liquid from (Mole)	Vapor from (Mole)
	F	psia	kW	lbmol/hr	lbmol/hr
1	167.84	120	-307.057	125	50
2	177.292	120	0	122.895	175
3	184.673	120	0	121.321	172.895
4	190.406	120	0	120.219	171.321
5	194.757	120	0	119.483	170.219
6	197.966	120	0	119.002	169.483
7	200.277	120	0	118.668	169.002
8	201.921	120	0	118.468	168.668
9	202.992	120	0	120.943	168.468
10	199.886	120	0	294.254	170.943

Main Flowsheet | RADFRAC Specifications - Efficiencies | Control Panel | RADFRAC (RadFrac) - Profiles | RADFRAC (RadFrac) - Profiles TPFQ - Plot

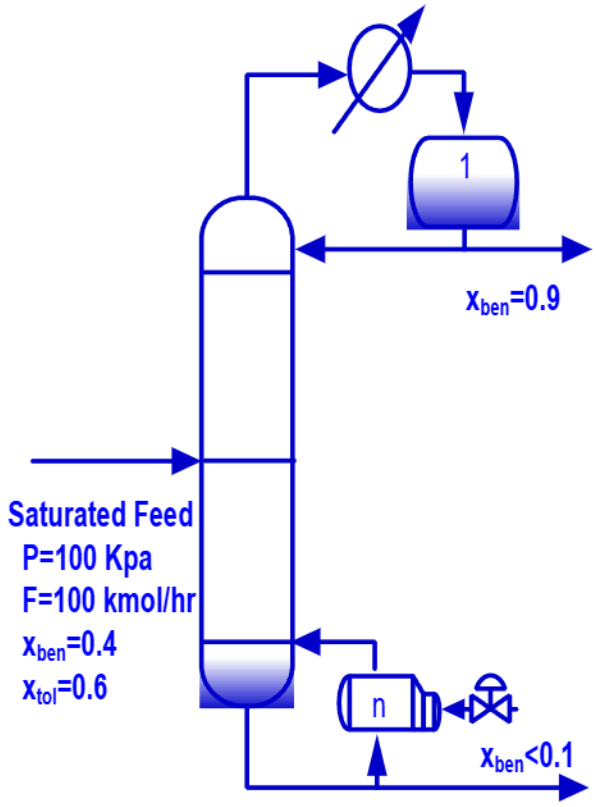


RADFRAC (RadFrac) - Composition - Plot | RADFRAC (RadFrac) - Profiles | RADFRAC (RadFrac) - Composition - Plot | RADFRAC (RadFrac) - Stream Results



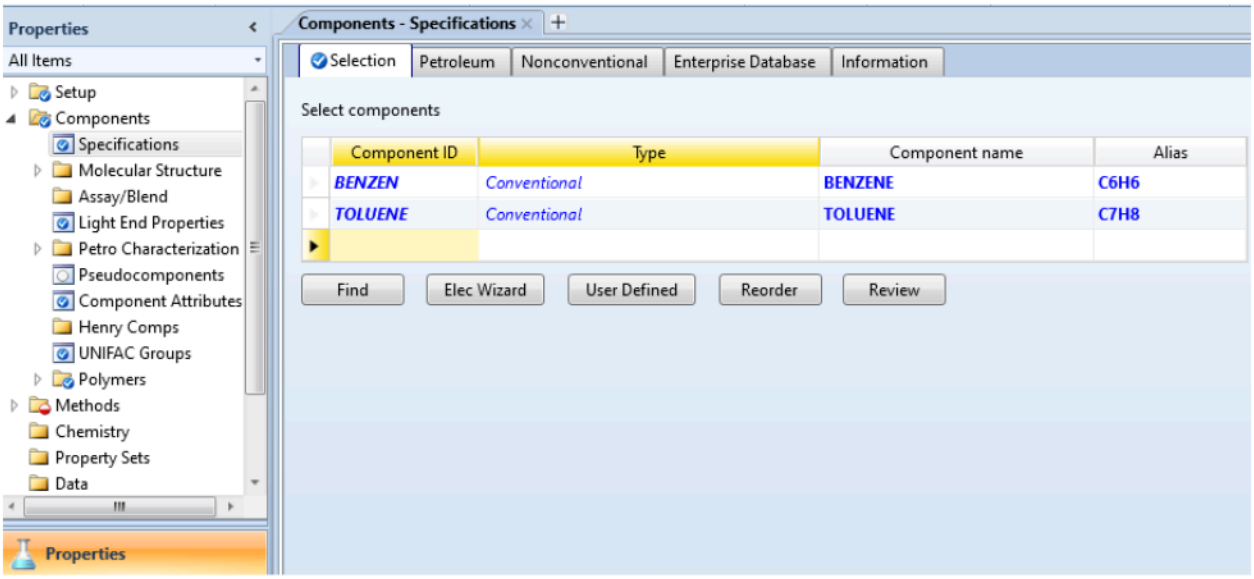
6. *FULL INFORMATION IS NOT GIVEN*

7. Steady-state Simulation of Benzene and Toluene Separation. Pressure at top is 1bar and assumes no pressure drop in the column Distillate is completely condensed. Use the NRTL model and Calculate:
    a. Calculate the minimum reflux ratio, the location of the feed stage and the minimum number of stages to accomplish the separation using DSTWU
    b. Use these results from part A as an initial estimate for RadFrac model and compute the product mole fraction, reboiler and condenser heat duty and temperature.
    c. Calculate the actual number of stages and the location of the feed stage if the column is operated at 1.2 times the minimum reflux ratio using DSTWU

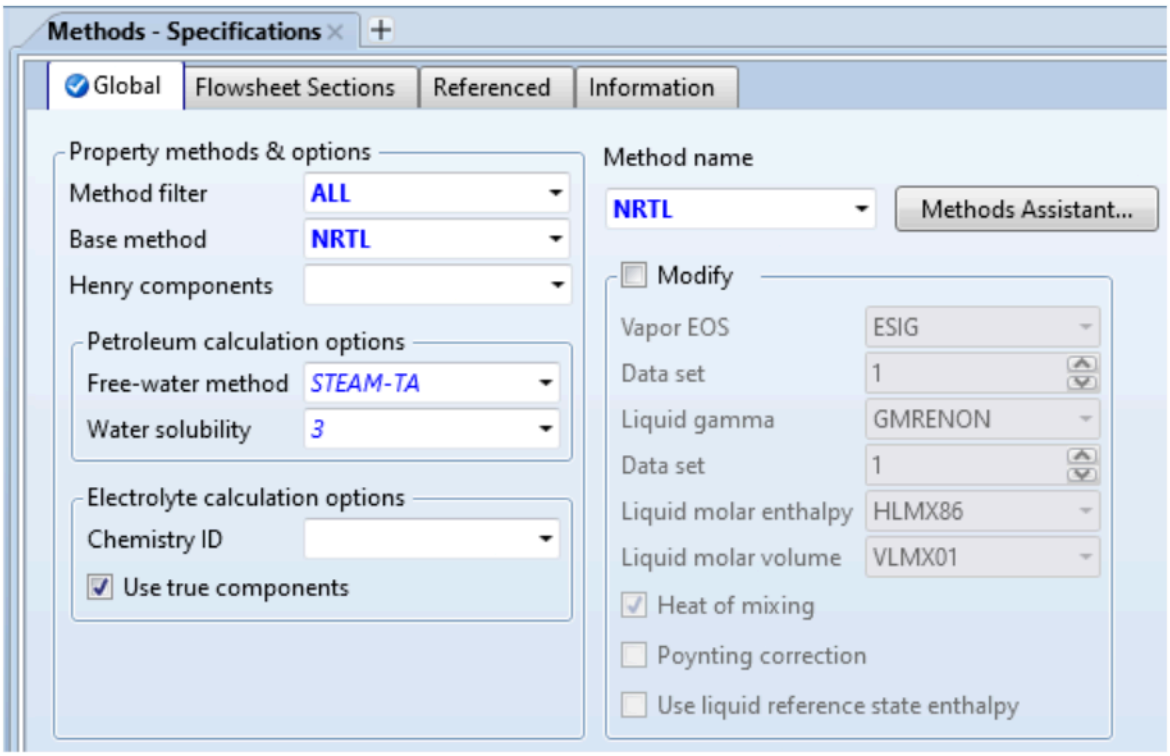


SOLUTIONS;

PROPERTIY SPESFICATION

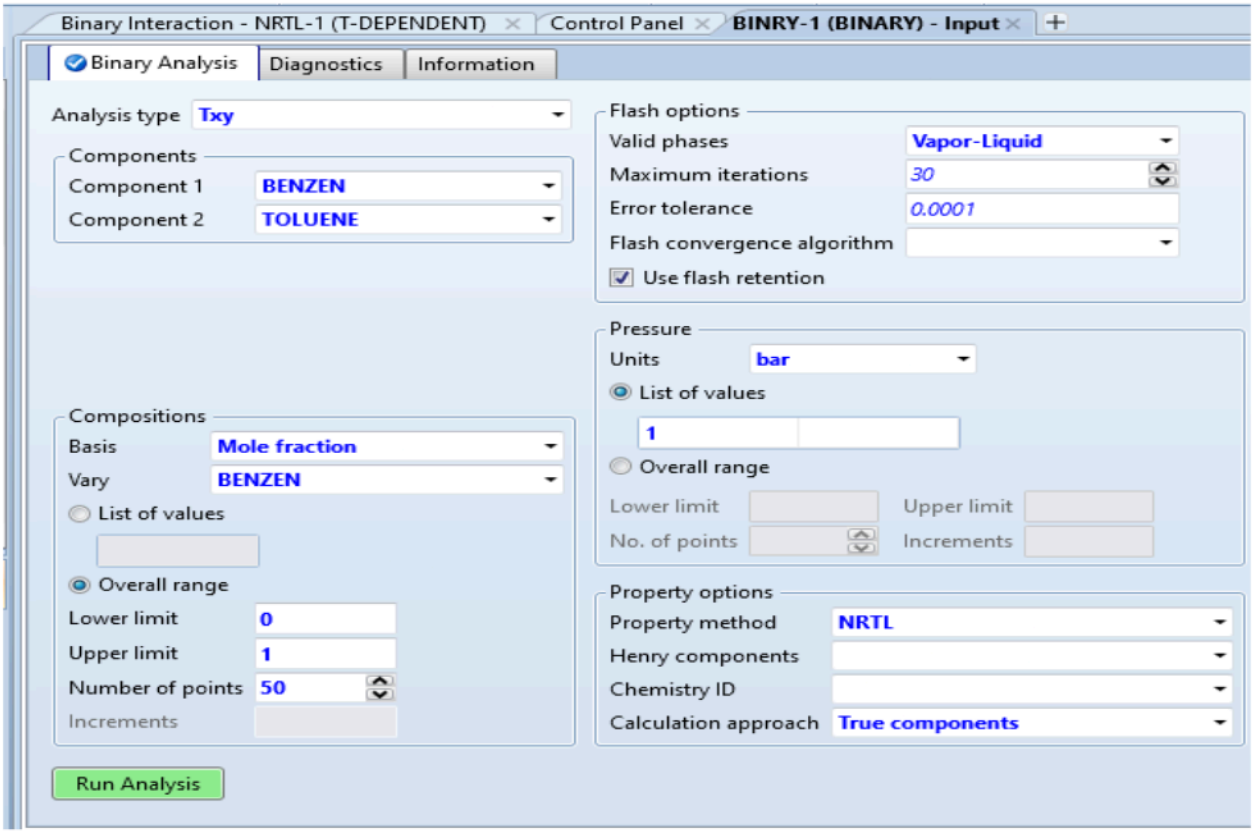


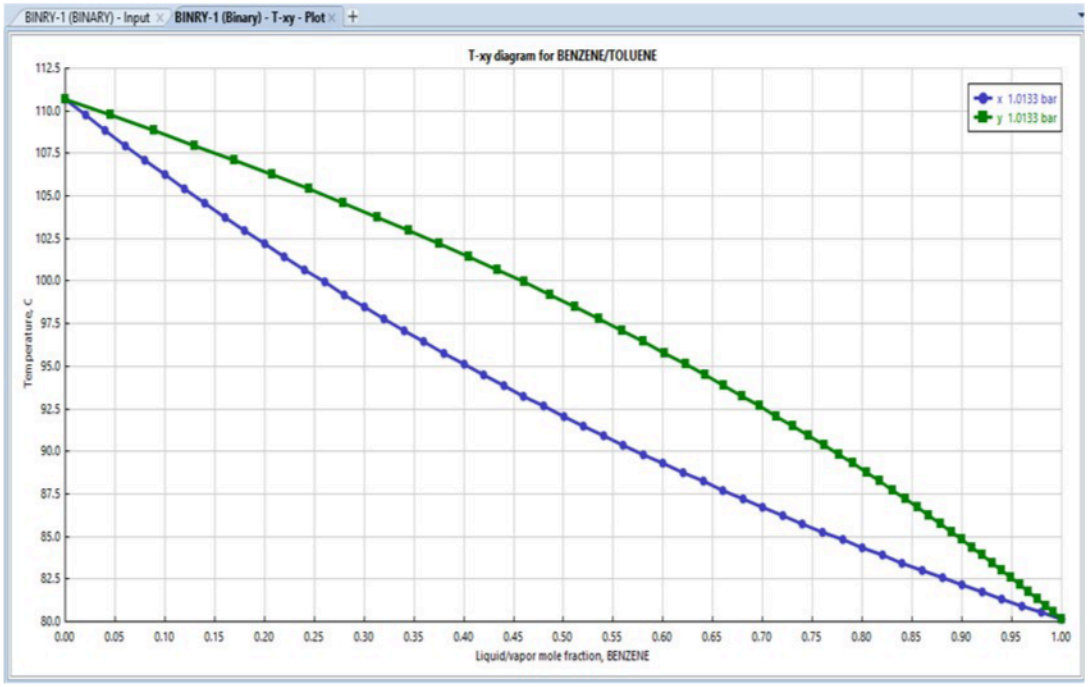
METHOD SPESFICATION



FINDING FEED INPUT TEMPRATURE

@1 bar and benzene mole fraction (0.5)



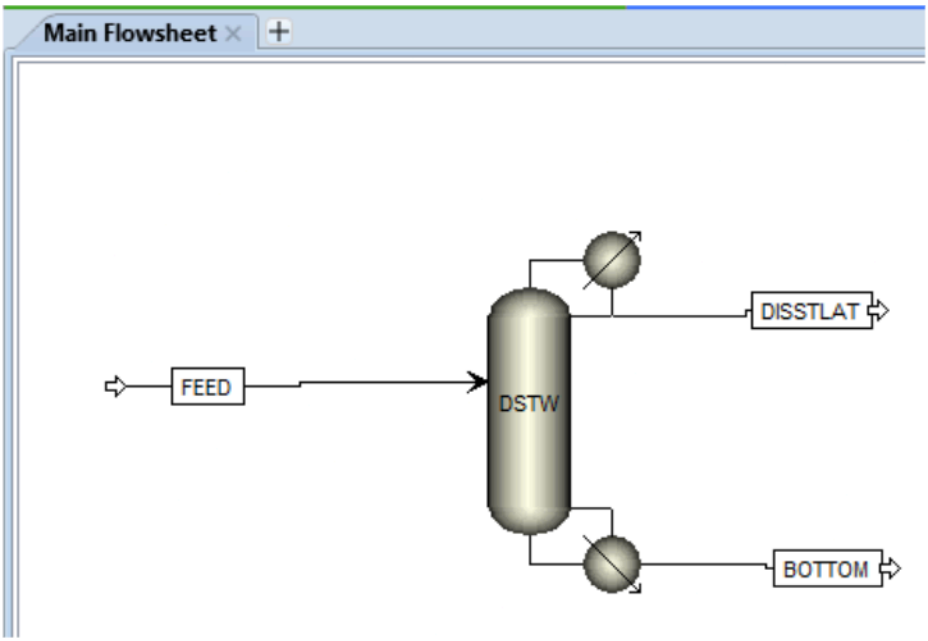


BINRY-1 (BINARY) - Input | BINRY-1 (Binary) - T-xy - Pl

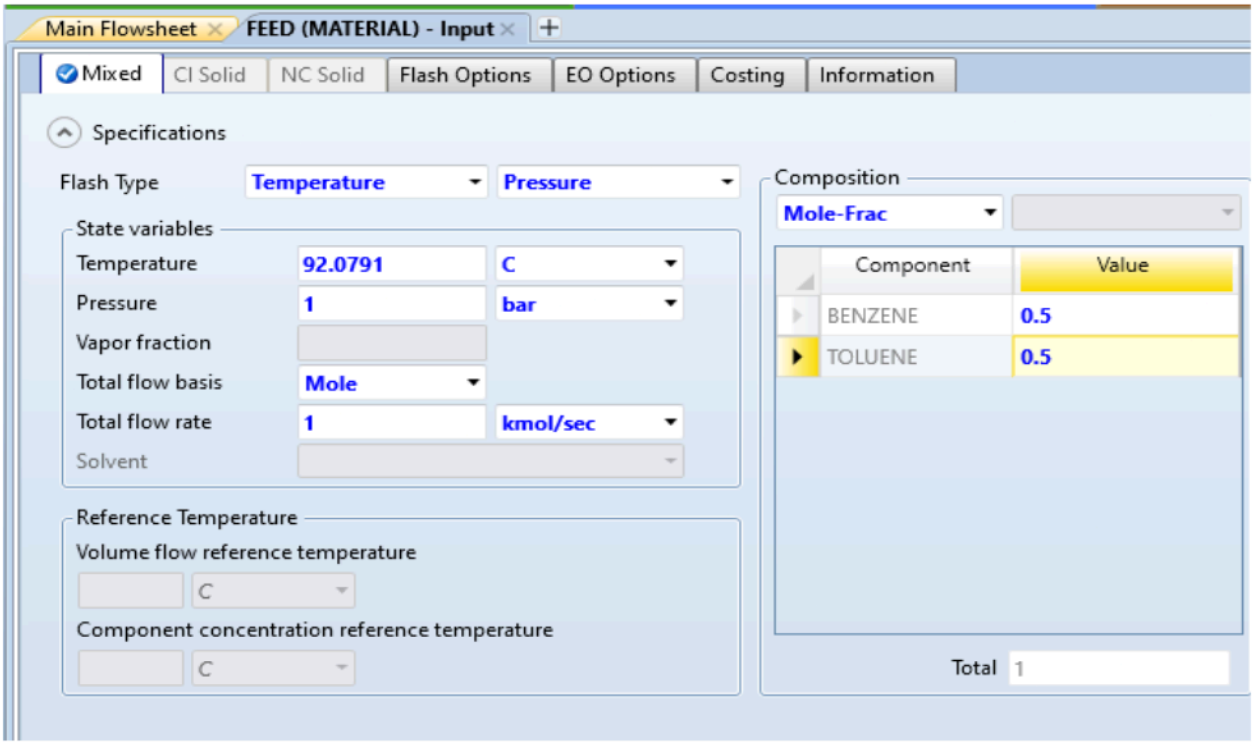
Results | Status

PRES	MOLEFRAC BENZENE	TOTAL TEMP
bar		C
1.01325	0.42	94.5043
1.01325	0.44	93.8811
1.01325	0.46	93.2694
1.01325	0.48	92.6689
1.01325	0.5	92.0791
1.01325	0.52	91.5
1.01325	0.54	90.9312
1.01325	0.56	90.3724
1.01325	0.58	89.8233
1.01325	0.6	89.2838

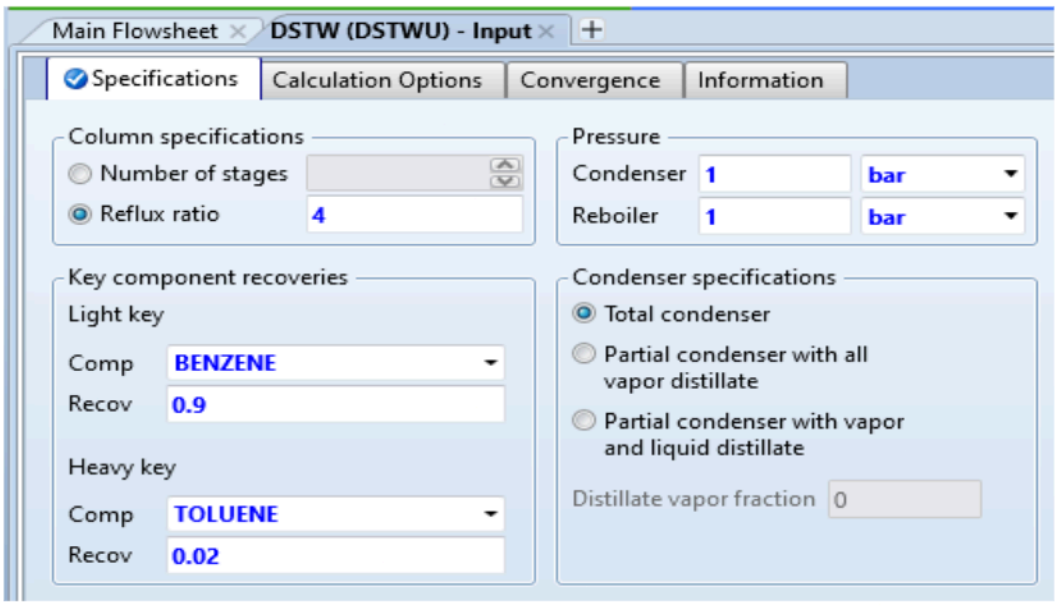
SIMULATION FOR #A



FEED INPUT



BLOCK (DSTW) INPUTS



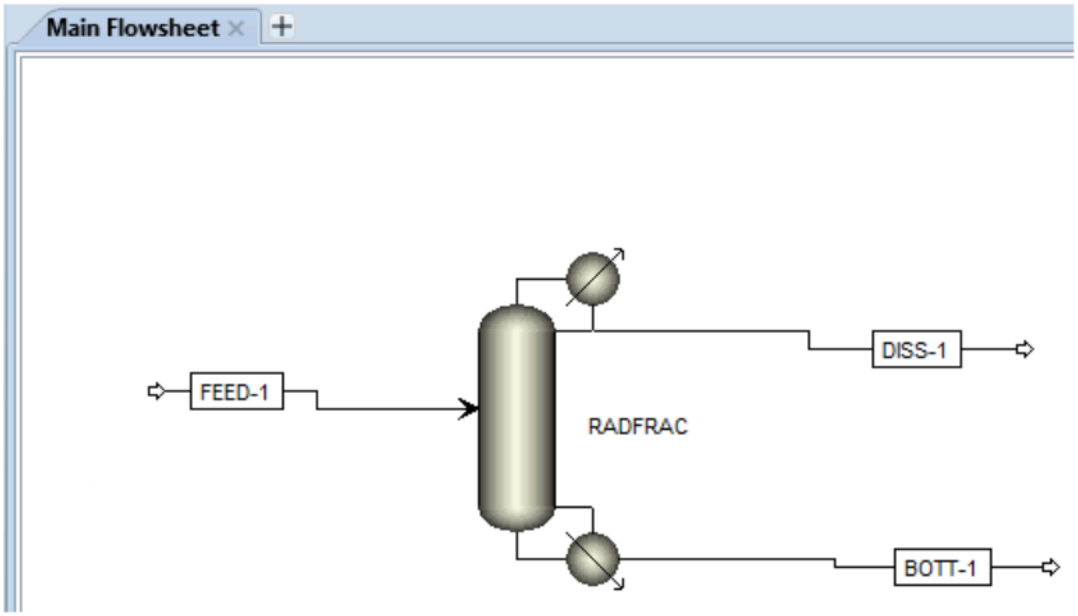
A. *RESULTS FOR #A*

Main Flowsheet | DSTW (DSTWU) - Input | Control Panel | DSTW

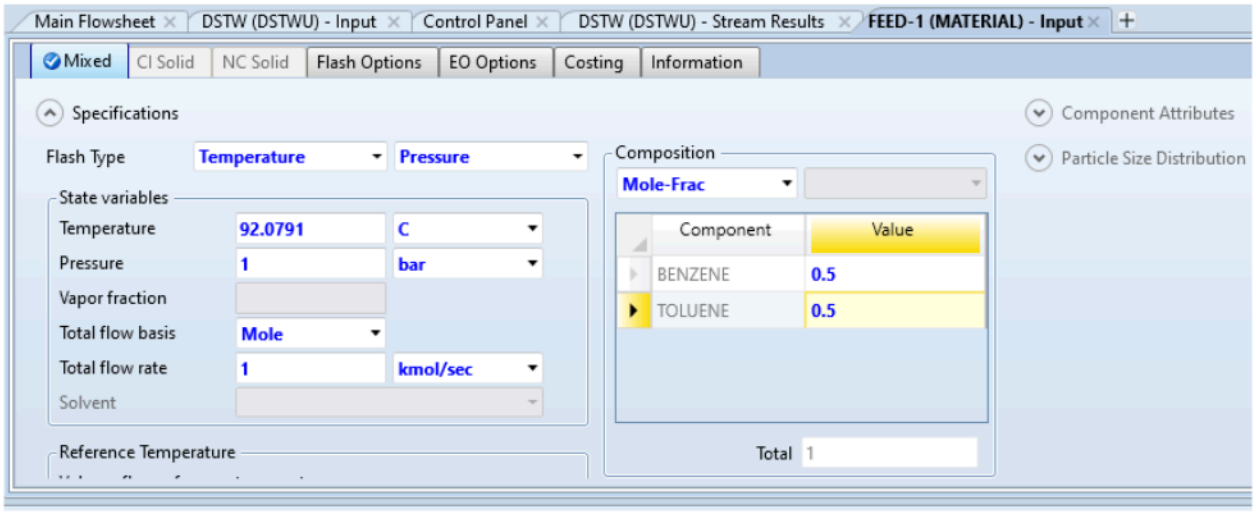
Summary | Balance | Reflux Ratio Profile | Status

Minimum reflux ratio	1.31529	
Actual reflux ratio	4	
Minimum number of stages	6.75743	
Number of actual stages	8.6276	
Feed stage	6.36774	
Number of actual stages above feed	5.36774	
Reboiler heating required	69753.8	kW
Condenser cooling required	71640.6	kW
Distillate temperature	80.1326	C
Bottom temperature	106.103	C
Distillate to feed fraction	0.46	
HETP		

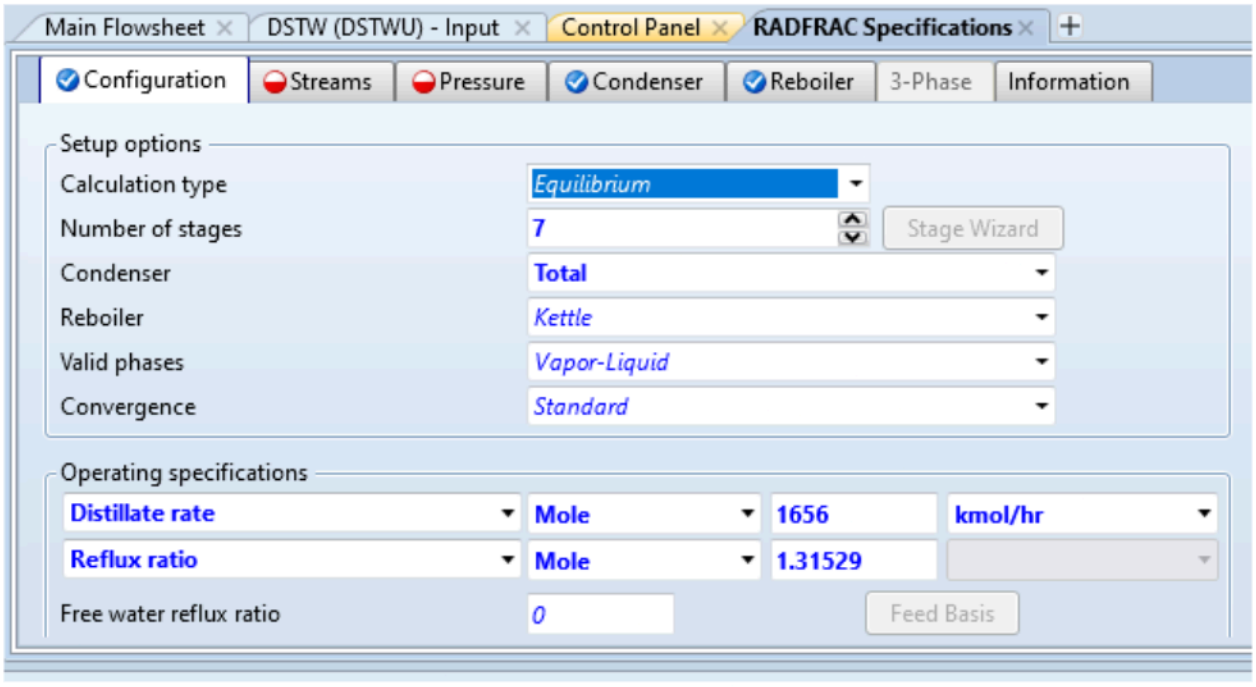
SIMULATION FOR #B

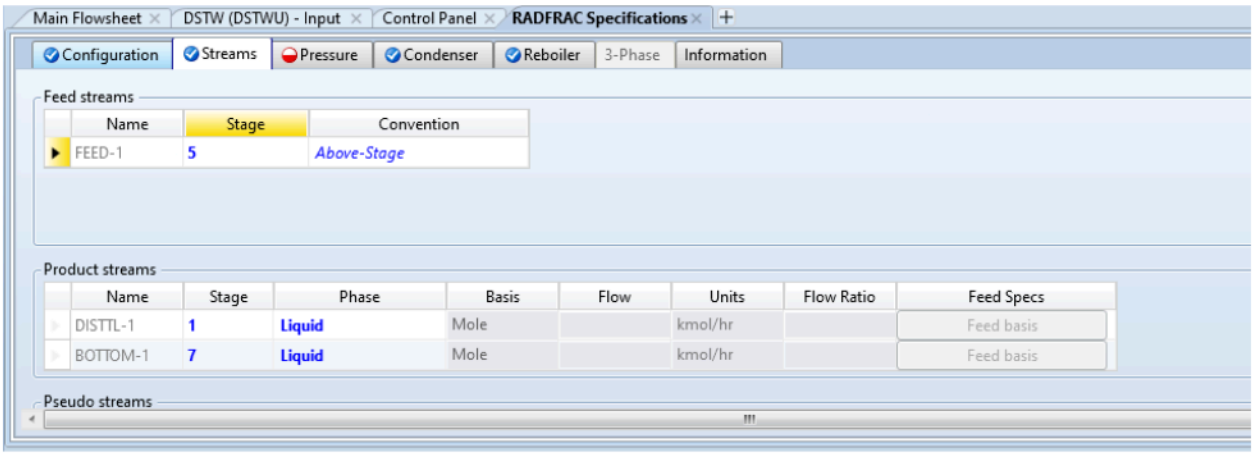


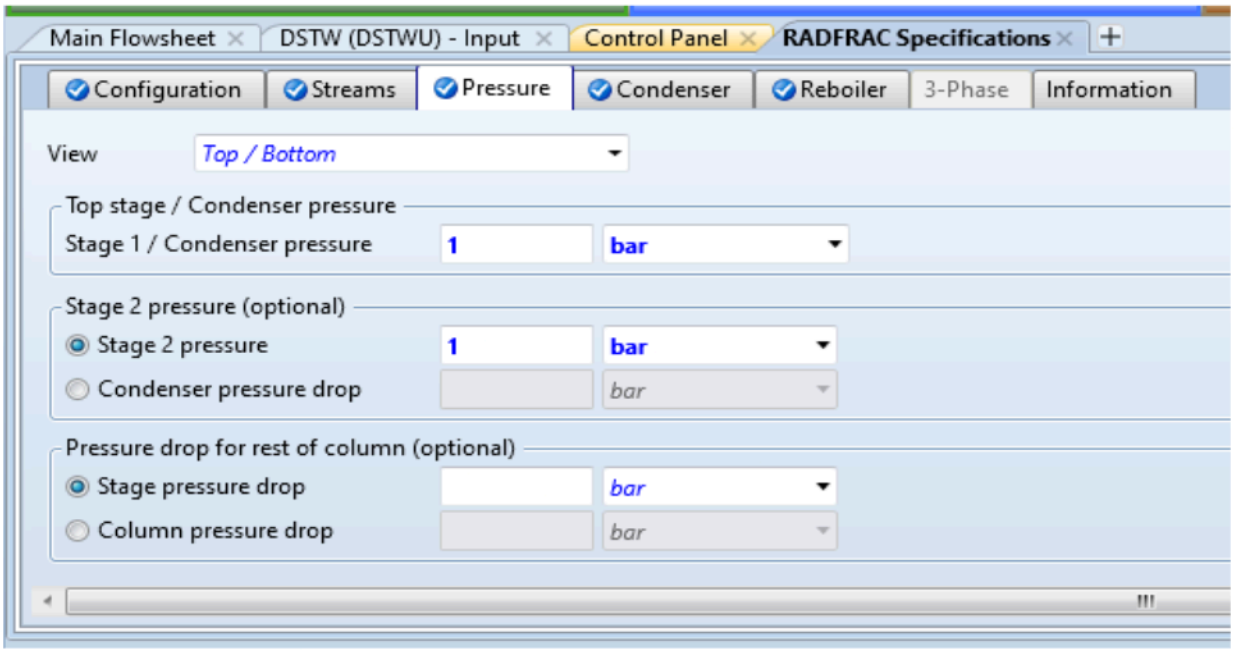
FEED INPUT



BLOCK (RADFRAC) INPUTS




Main Flowsheet
DSTW (DSTWU) - Input
Control Panel
RADFRAC Specifications
Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
Feed streams
Name
Stage
Convention
FEED-1
5
Above-Stage
Product streams
Name
Stage
Phase
Basis
Flow
Units
Flow Ratio
Feed Specs
DISTTL-1
1
Liquid
Mole
kmol/hr
Feed basis
BOTTOM-1
7
Liquid
Mole
kmol/hr
Feed basis
Pseudo streams


Main Flowsheet
DSTW (DSTWU) - Input
Control Panel
RADFRAC Specifications
Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
View
Top / Bottom
Top stage / Condenser pressure
Stage 1 / Condenser pressure
1
bar
Stage 2 pressure (optional)
Stage 2 pressure
1
bar
Condenser pressure drop
bar
Pressure drop for rest of column (optional)
Stage pressure drop
bar
Column pressure drop
bar

B. RESULT FOR #B

Main Flowsheet | RADFRAC Specifications - Setup | Control Panel | RADFRAC (RadFrac) - Stream Results

Material | Heat | Load | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

Display: Streams Format: FULL Stream Table

	FEED-1	DISS-1	BOTT-1	
Mole Frac				
BENZENE	0.5	0.850919	0.201069	
TOLUENE	0.5	0.149081	0.798931	
Total Flow kmol/hr	3600	1656	1944	
Total Flow kg/hr	306458	132819	173638	
Total Flow l/min	134898	2731.83	3666.74	
Temperature C	92.0791	82.7886	101.69	
Pressure bar	1	1	1	
Vapor Frac	0.070771	0	0	
Liquid Frac	0.929229	1	1	
Solid Frac	0	0	0	
Enthalpy cal/mol	10482.9	12516.3	7839.38	

Main Flowsheet | DSTW (DSTWU) - Input | Control Panel | RADFRAC Specifications

Summary | Balance | Split Fraction | Reboiler | Utilities | Stage Utilities | Status

Basis: Mole

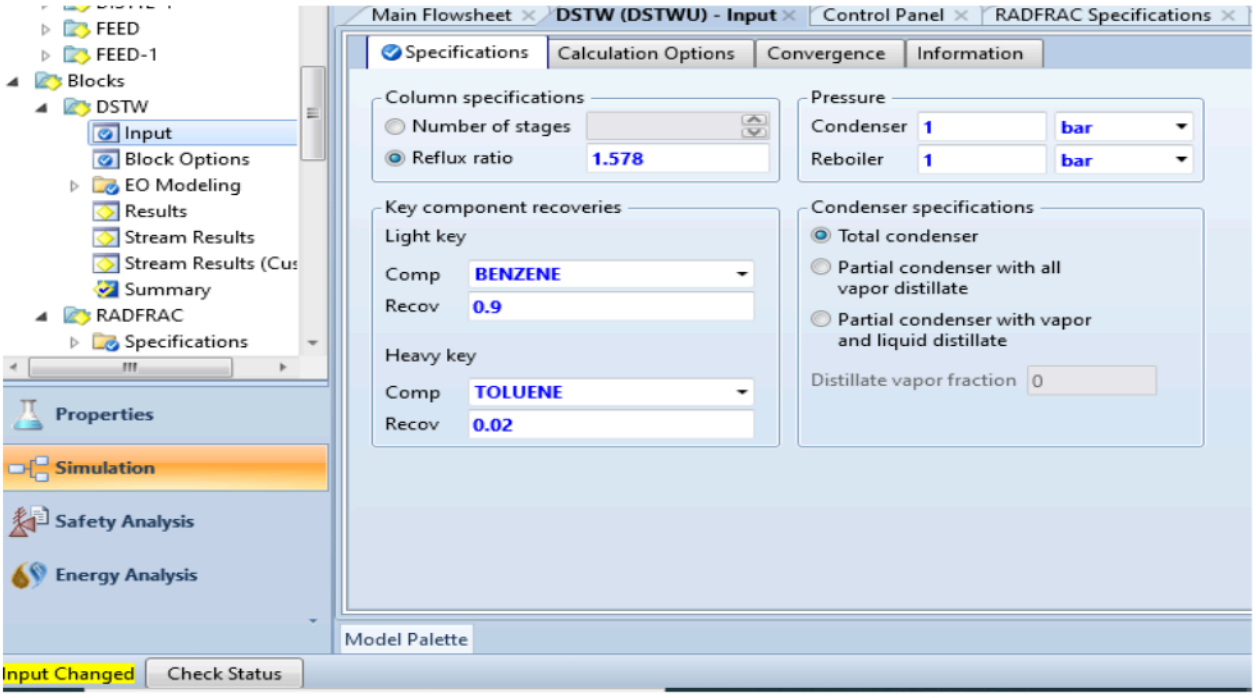
Condenser / Top stage performance

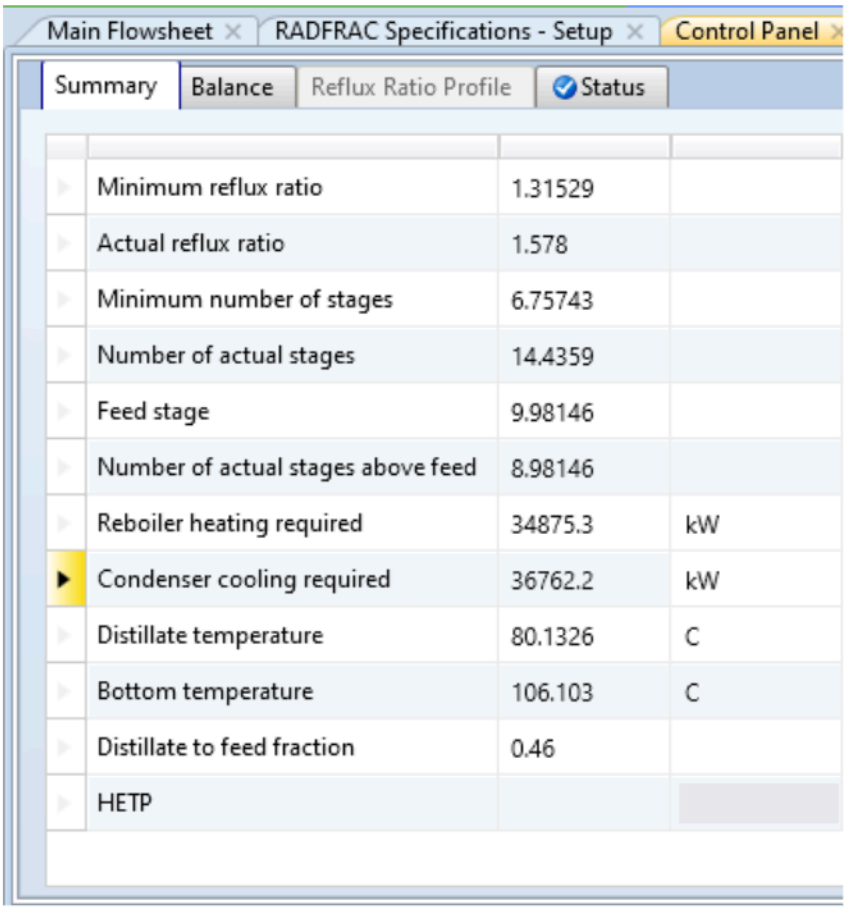
Name	Value	Units
Temperature	82.7885	C
Subcooled temperature		
Heat duty	-33516	kW
Subcooled duty		

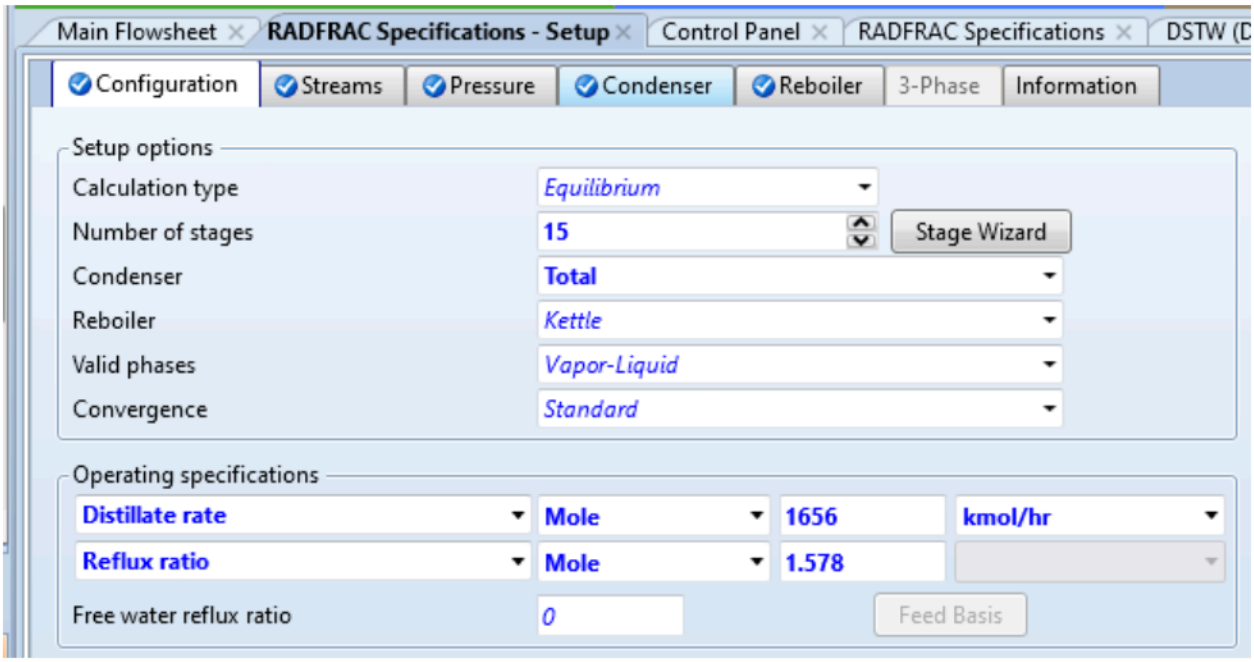
Reboiler / Bottom stage performance

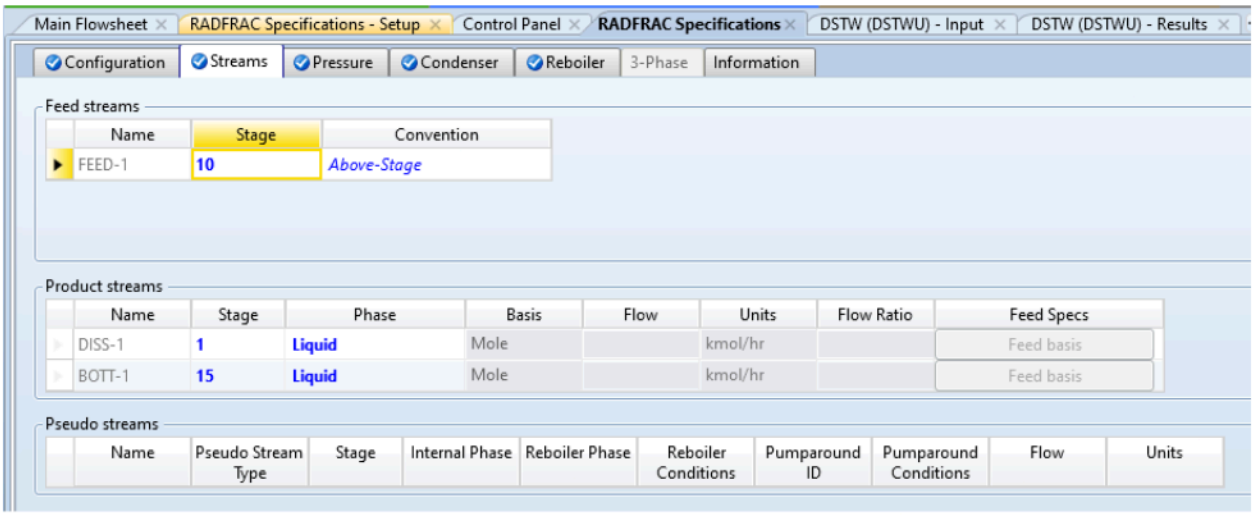
Name	Value	Units
Temperature	101.69	C
Heat duty	31455.1	kW
Bottoms rate	1944	kmol/hr
Boilup rate	3432.13	kmol/hr

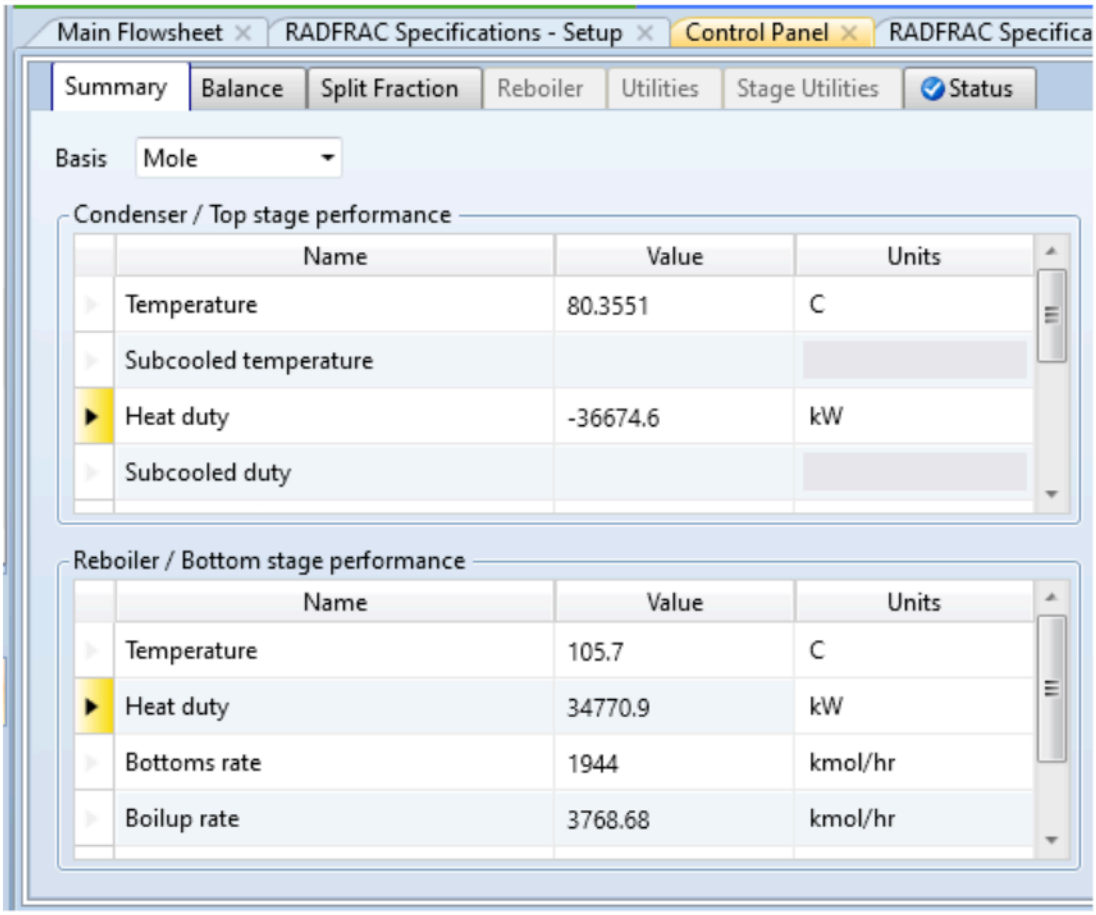
C.


FEED
FEED-1
Blocks
DSTW
Input
Block Options
EO Modeling
Results
Stream Results
Stream Results (Cus
Summary
RADFRAC
Specifications
Properties
Simulation
Safety Analysis
Energy Analysis
Main Flowsheet
DSTW (DSTWU) - Input
Control Panel
RADFRAC Specifications
Specifications
Calculation Options
Convergence
Information
Column specifications
Number of stages
Reflux ratio
1.578
Pressure
Condenser
1
bar
Reboiler
1
bar
Key component recoveries
Light key
Comp
BENZENE
Recov
0.9
Heavy key
Comp
TOLUENE
Recov
0.02
Condenser specifications
Total condenser
Partial condenser with all vapor distillate
Partial condenser with vapor and liquid distillate
Distillate vapor fraction
0
Model Palette
Input Changed
Check Status

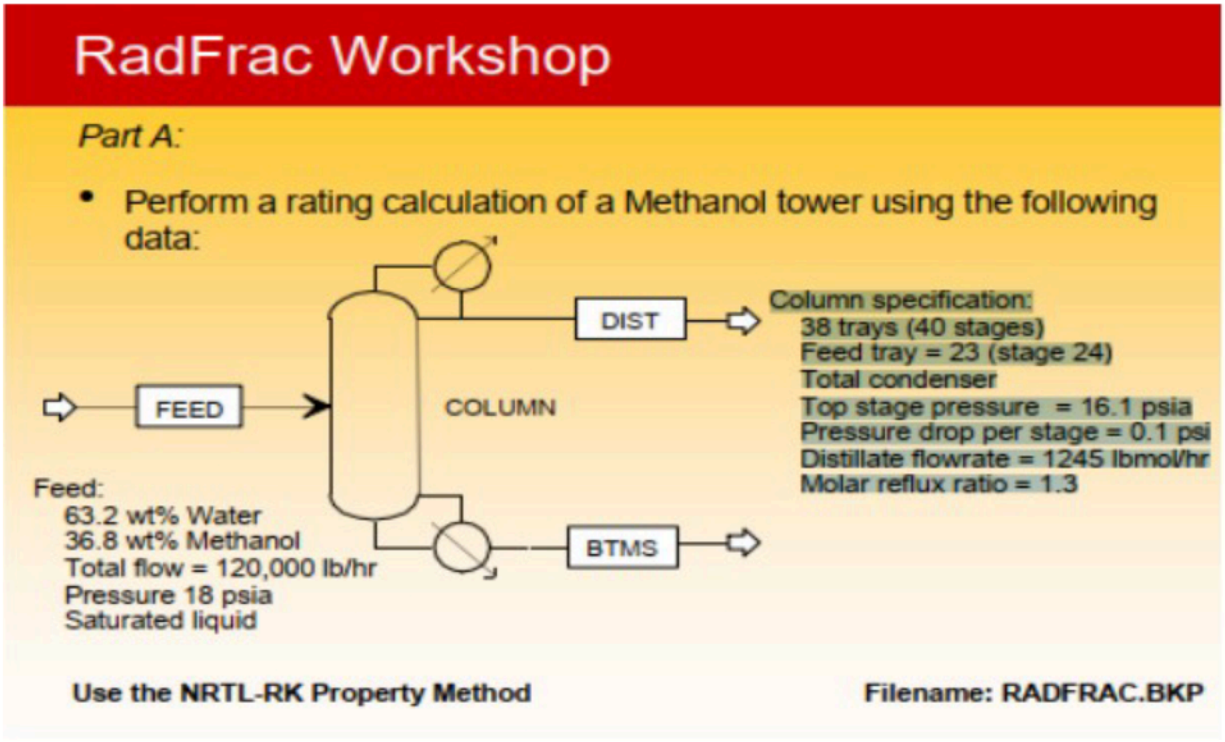

Main Flowsheet
RADFRAC Specifications - Setup
Control Panel
Summary
Balance
Reflux Ratio Profile
Status
Minimum reflux ratio 1.31529
Actual reflux ratio 1.578
Minimum number of stages 6.75743
Number of actual stages 14.4359
Feed stage 9.98146
Number of actual stages above feed 8.98146
Reboiler heating required 34875.3 kW
Condenser cooling required 36762.2 kW
Distillate temperature 80.1326 C
Bottom temperature 106.103 C
Distillate to feed fraction 0.46
HETP


Main Flowsheet
RADFRAC Specifications - Setup
Control Panel
RADFRAC Specifications
Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
Setup options
Calculation type Equilibrium
Number of stages 15
Stage Wizard
Condenser Total
Reboiler Kettle
Valid phases Vapor-Liquid
Convergence Standard
Operating specifications
Distillate rate Mole 1656 kmol/hr
Reflux ratio Mole 1.578
Free water reflux ratio 0
Feed Basis


Main Flowsheet
RADFRAC Specifications - Setup
Control Panel
RADFRAC Specifications
DSTW (DSTWU) - Input
DSTW (DSTWU) - Results
Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
Feed streams
Name
Stage
Convention
FEED-1
10
Above-Stage
Product streams
Name
Stage
Phase
Basis
Flow
Units
Flow Ratio
Feed Specs
DISS-1
1
Liquid
Mole
kmol/hr
Feed basis
BOTT-1
15
Liquid
Mole
kmol/hr
Feed basis
Pseudo streams
Name
Pseudo Stream Type
Stage
Internal Phase
Reboiler Phase
Reboiler Conditions
Pumparound ID
Pumparound Conditions
Flow
Units

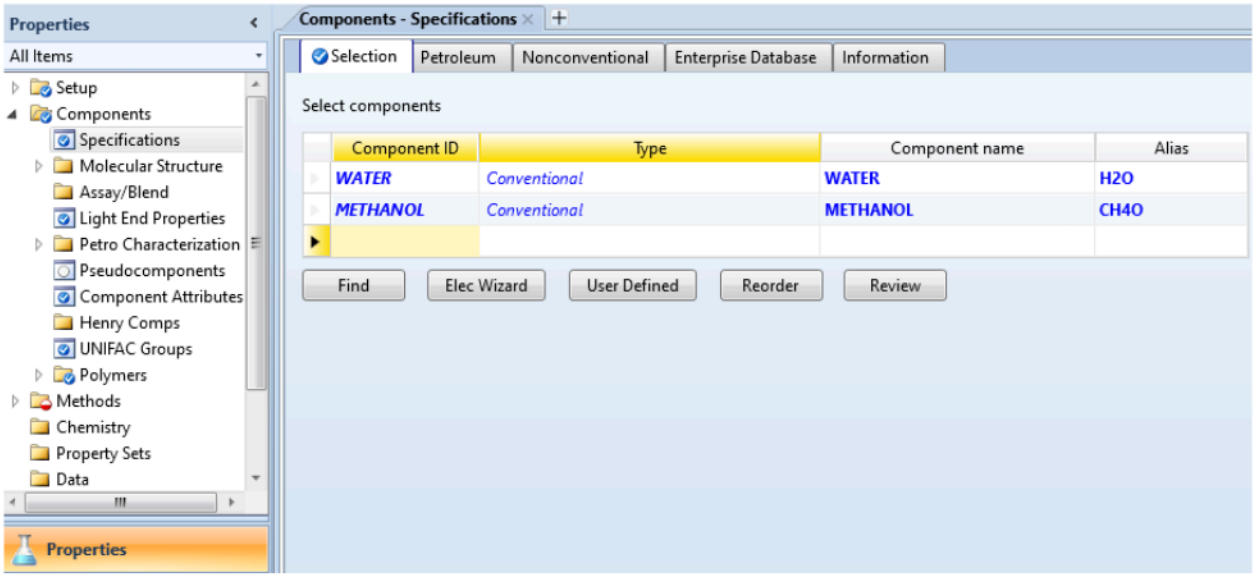

Main Flowsheet
RADFRAC Specifications - Setup
Control Panel
RADFRAC Specifica
Summary
Balance
Split Fraction
Reboiler
Utilities
Stage Utilities
Status
Basis
Mole
Condenser / Top stage performance
Name
Value
Units
Temperature
80.3551
C
Subcooled temperature
Heat duty
-36674.6
kW
Subcooled duty
Reboiler / Bottom stage performance
Name
Value
Units
Temperature
105.7
C
Heat duty
34770.9
kW
Bottoms rate
1944
kmol/hr
Boilup rate
3768.68
kmol/hr

8.

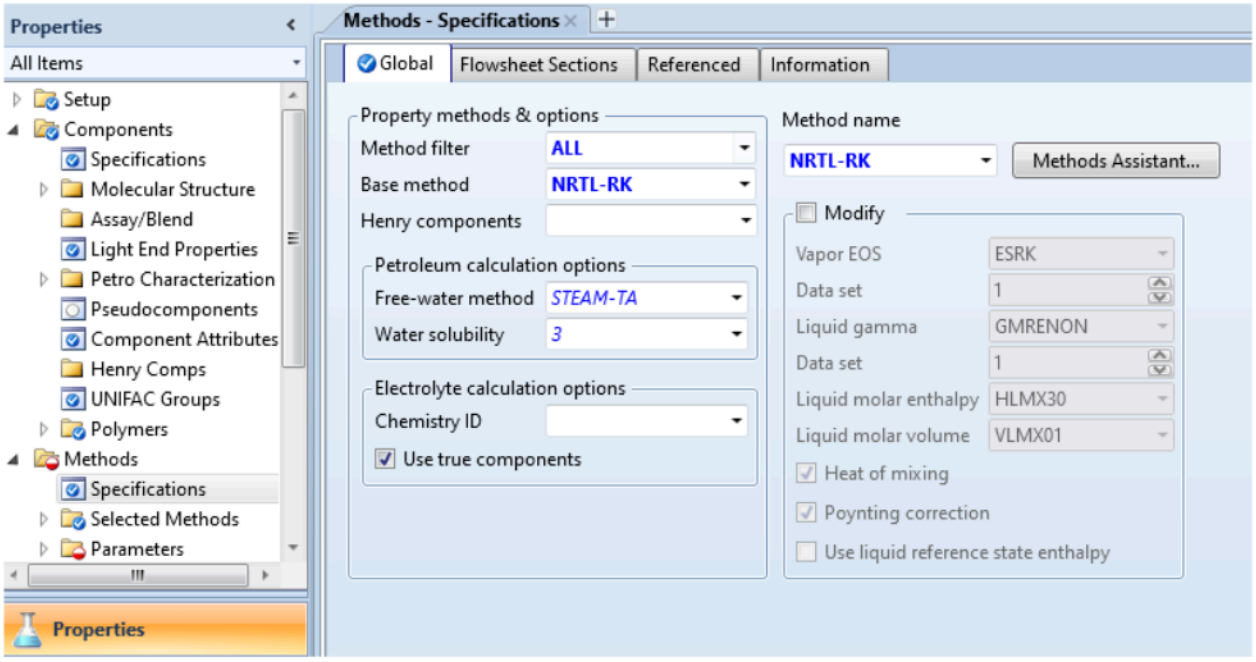


SOLUTIONS;

PROPERTY (COMPONENT SPESFICSTION)

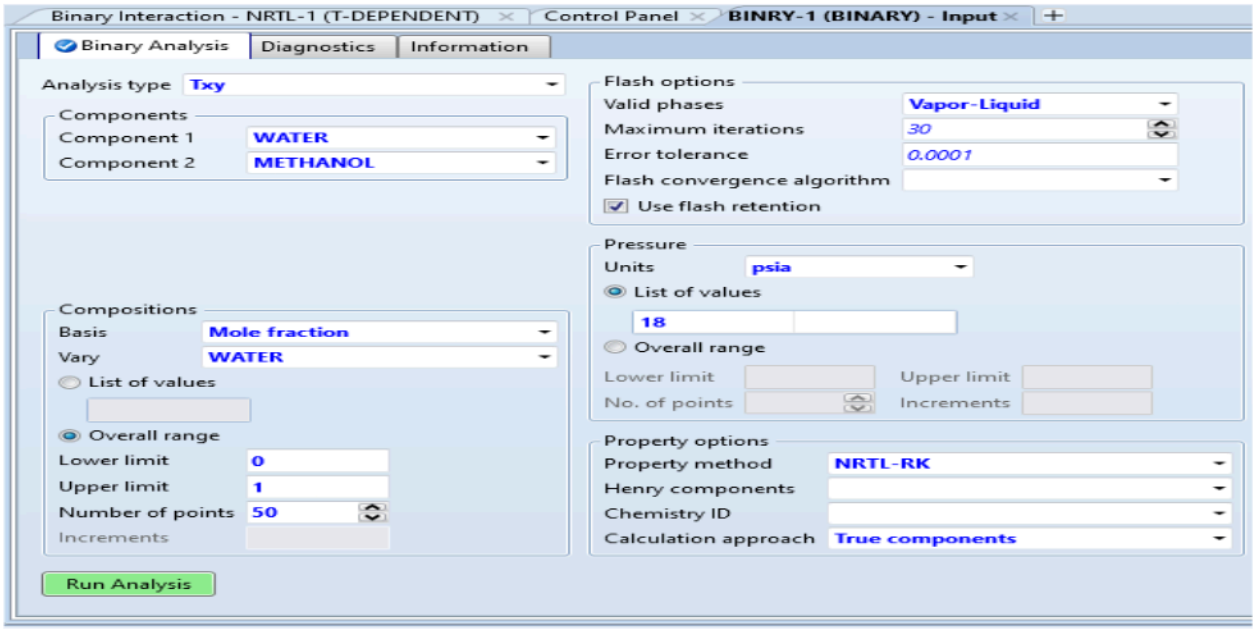


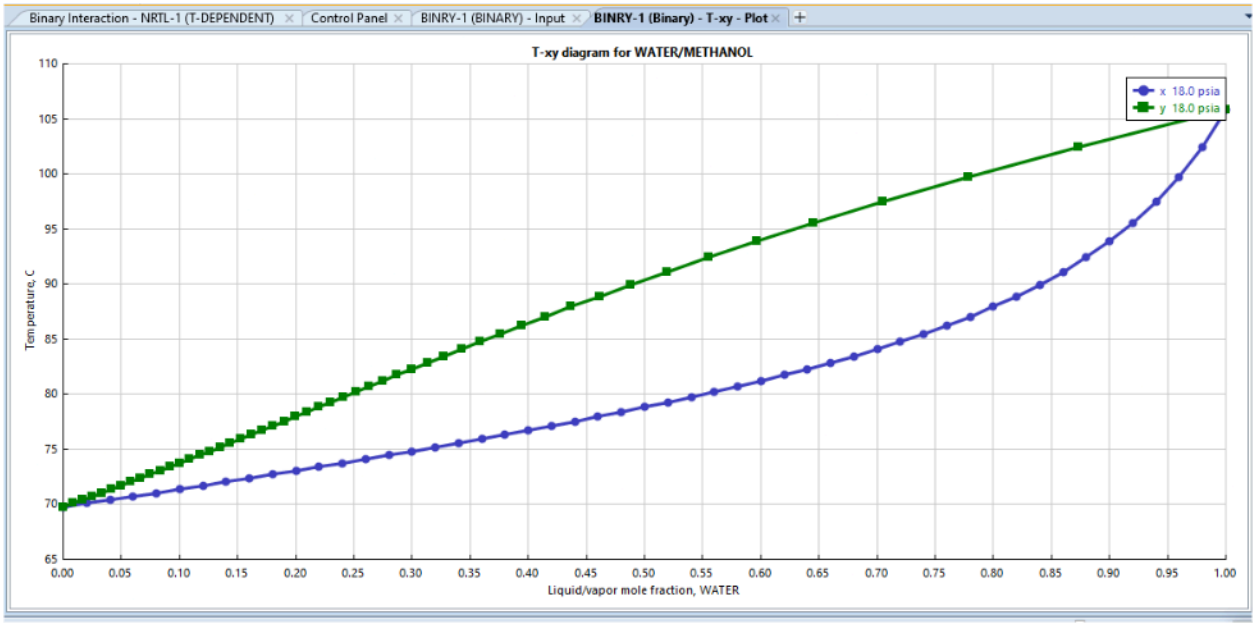
METHOD SPESFICATION



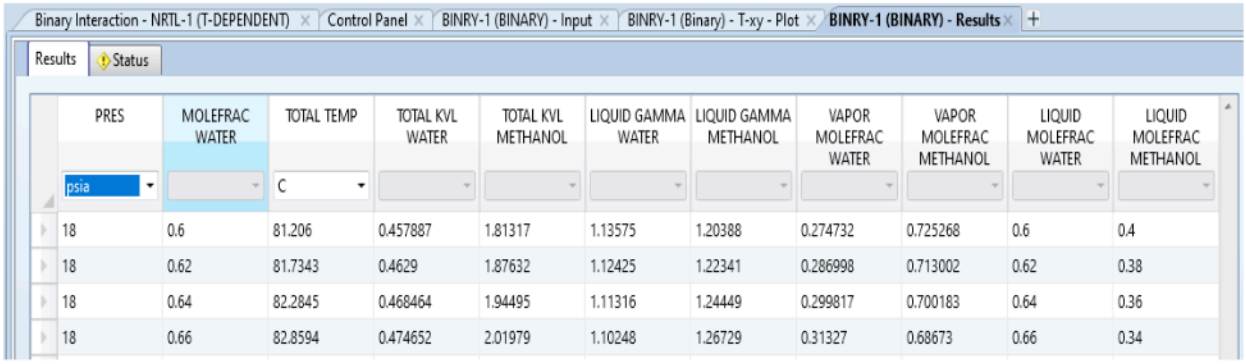
FINDING FEED INPUT TEMPRATURE

@1 bar and water mole fraction (0.632)





By interpolation the temperature is=82.0644^{o}C

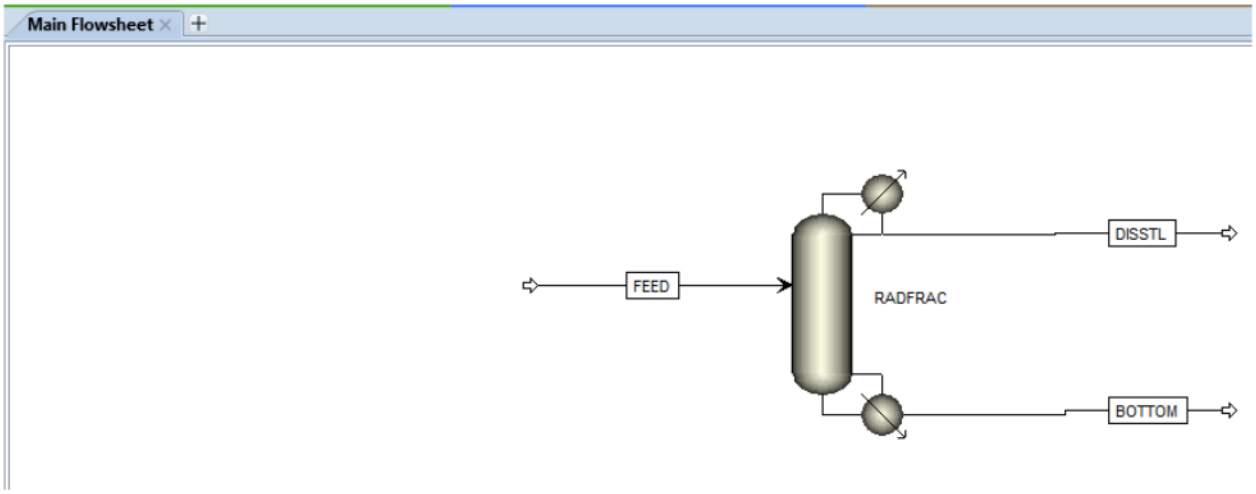


Binary Interaction - NRTL-1 (T-DEPENDENT) | Control Panel | BINRY-1 (BINARY) - Input | BINRY-1 (Binary) - T-xy - Plot | BINRY-1 (BINARY) - Results

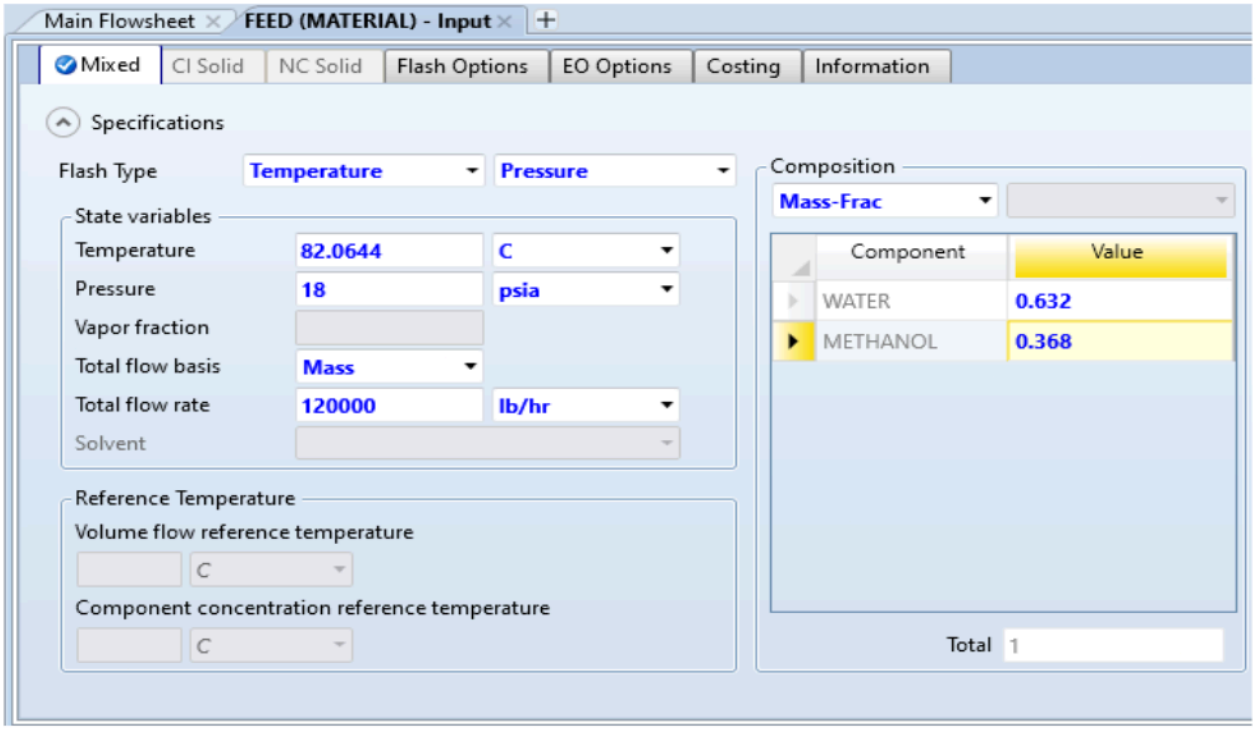
Results | Status

PRES	MOLEFRAC WATER	TOTAL TEMP	TOTAL KVL WATER	TOTAL KVL METHANOL	LIQUID GAMMA WATER	LIQUID GAMMA METHANOL	VAPOR MOLEFRAC WATER	VAPOR MOLEFRAC METHANOL	LIQUID MOLEFRAC WATER	LIQUID MOLEFRAC METHANOL
psia		C								
18	0.6	81.206	0.457887	1.81317	1.13575	1.20388	0.274732	0.725268	0.6	0.4
18	0.62	81.7343	0.4629	1.87632	1.12425	1.22341	0.286998	0.713002	0.62	0.38
18	0.64	82.2845	0.468464	1.94495	1.11316	1.24449	0.299817	0.700183	0.64	0.36
18	0.66	82.8594	0.474652	2.01979	1.10248	1.26729	0.31327	0.68673	0.66	0.34

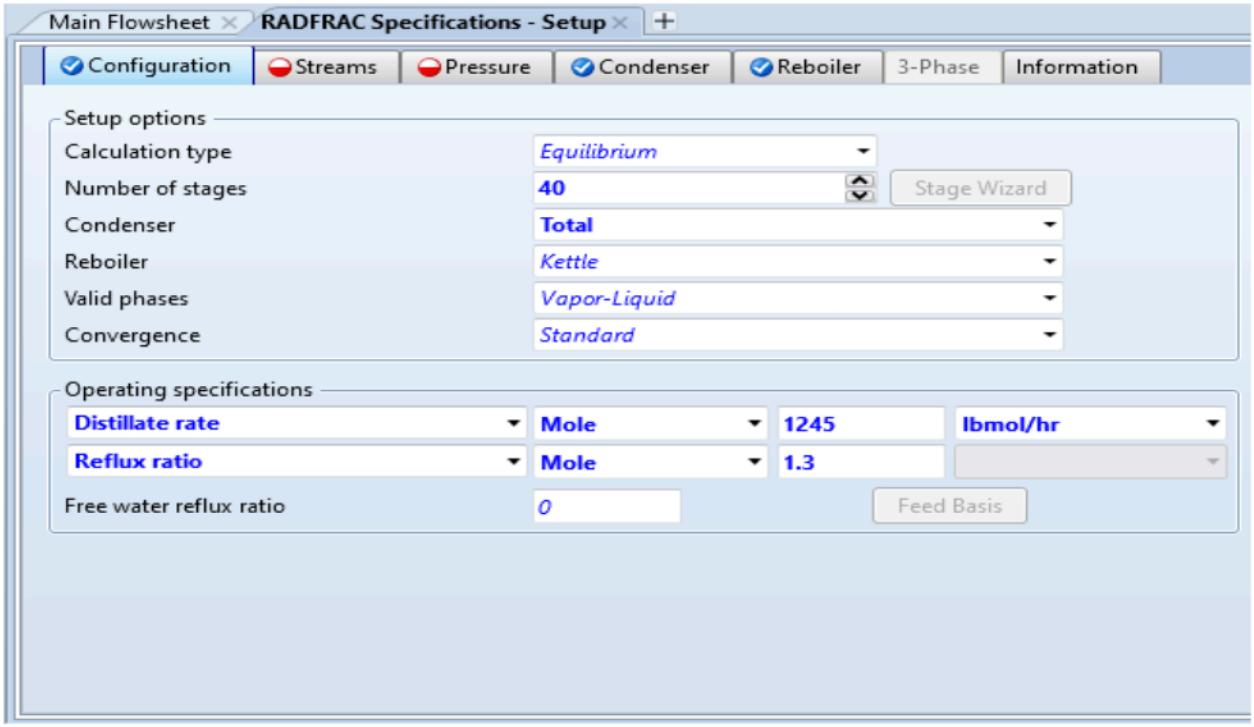
SIMULATION

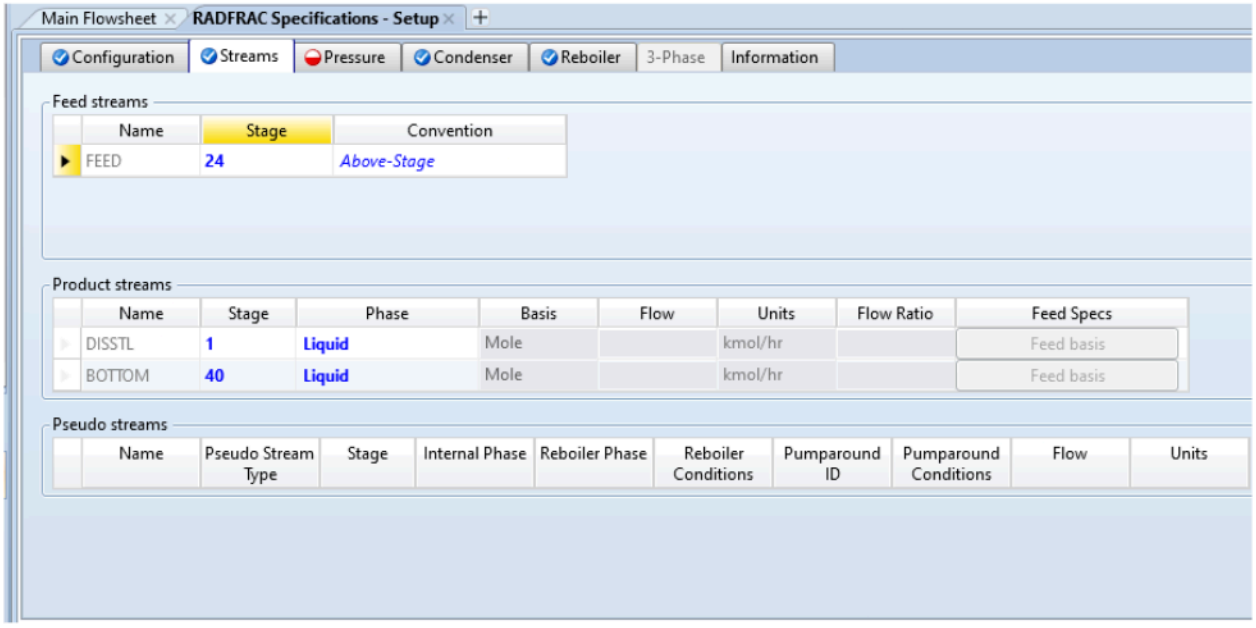


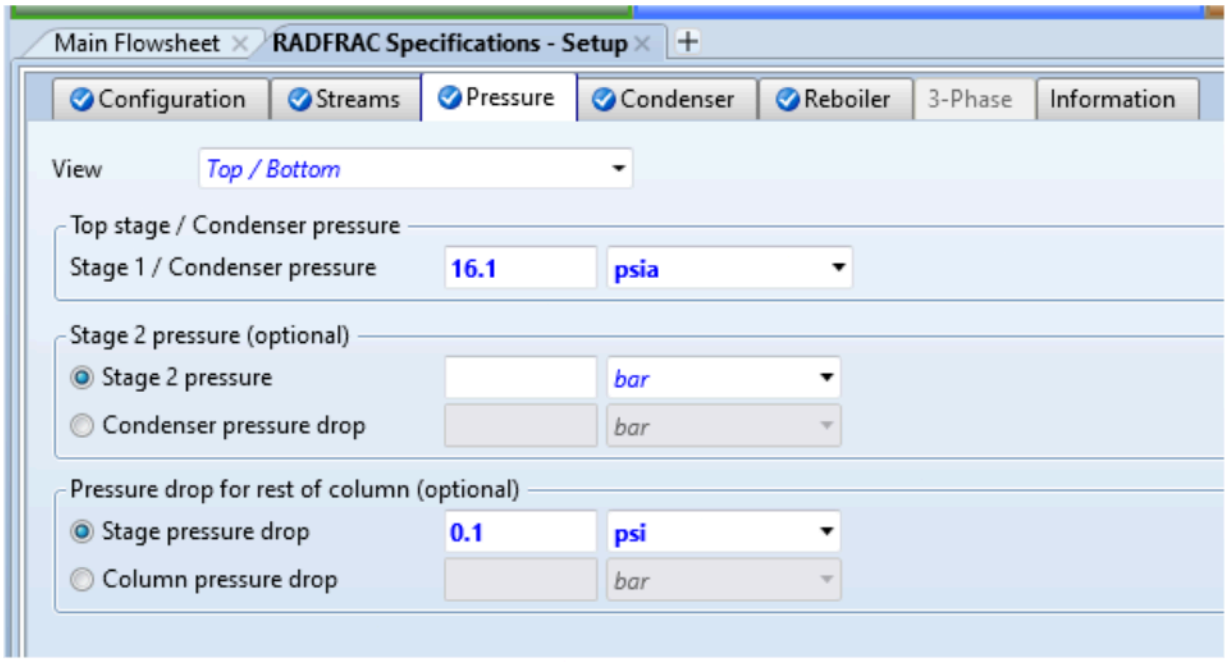
FEED INPUT

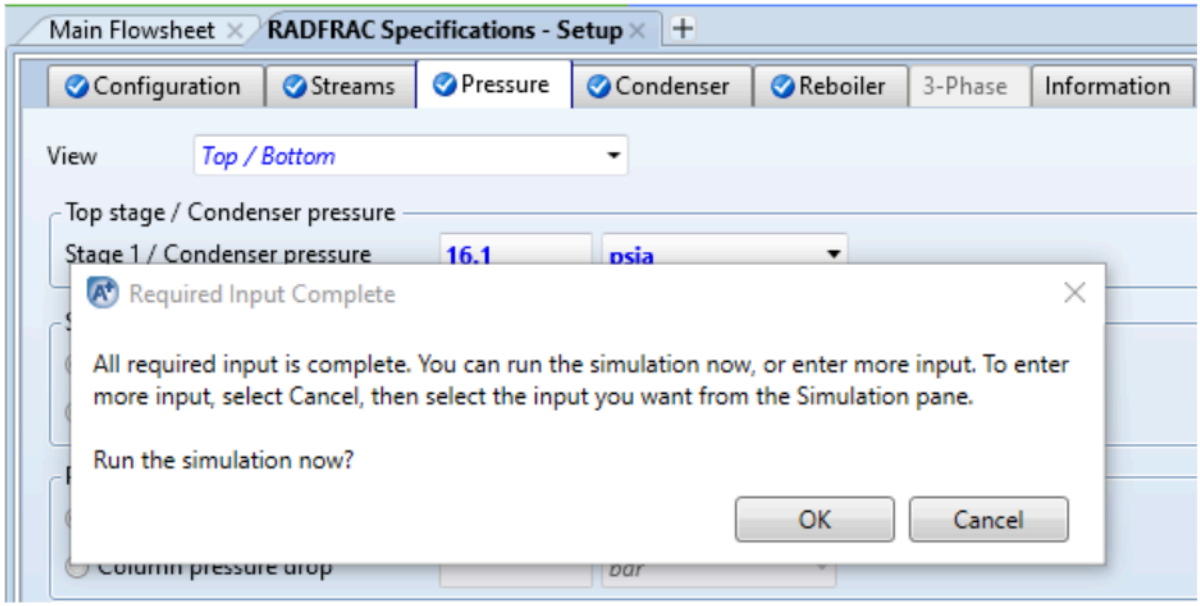


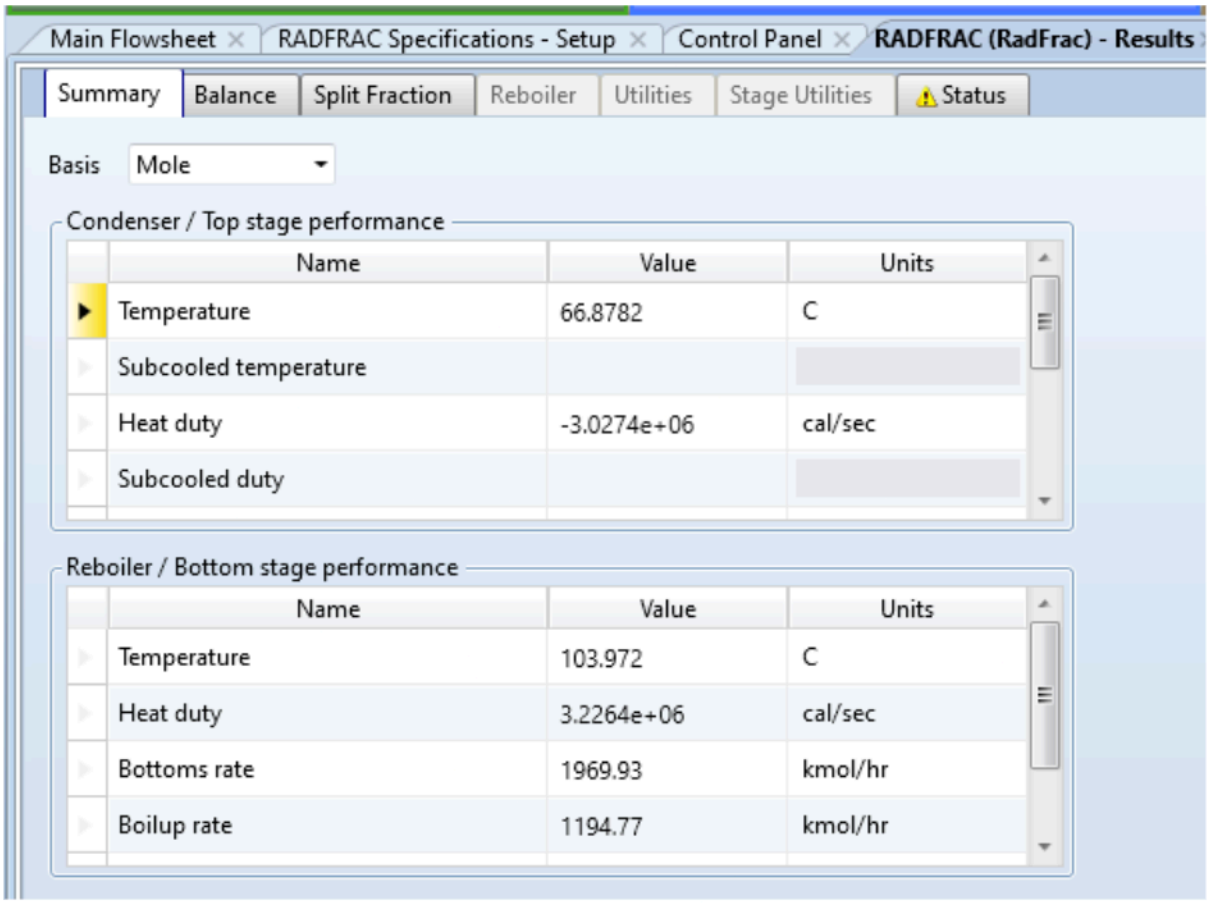
BLOCK (RADFRAC) INPUT

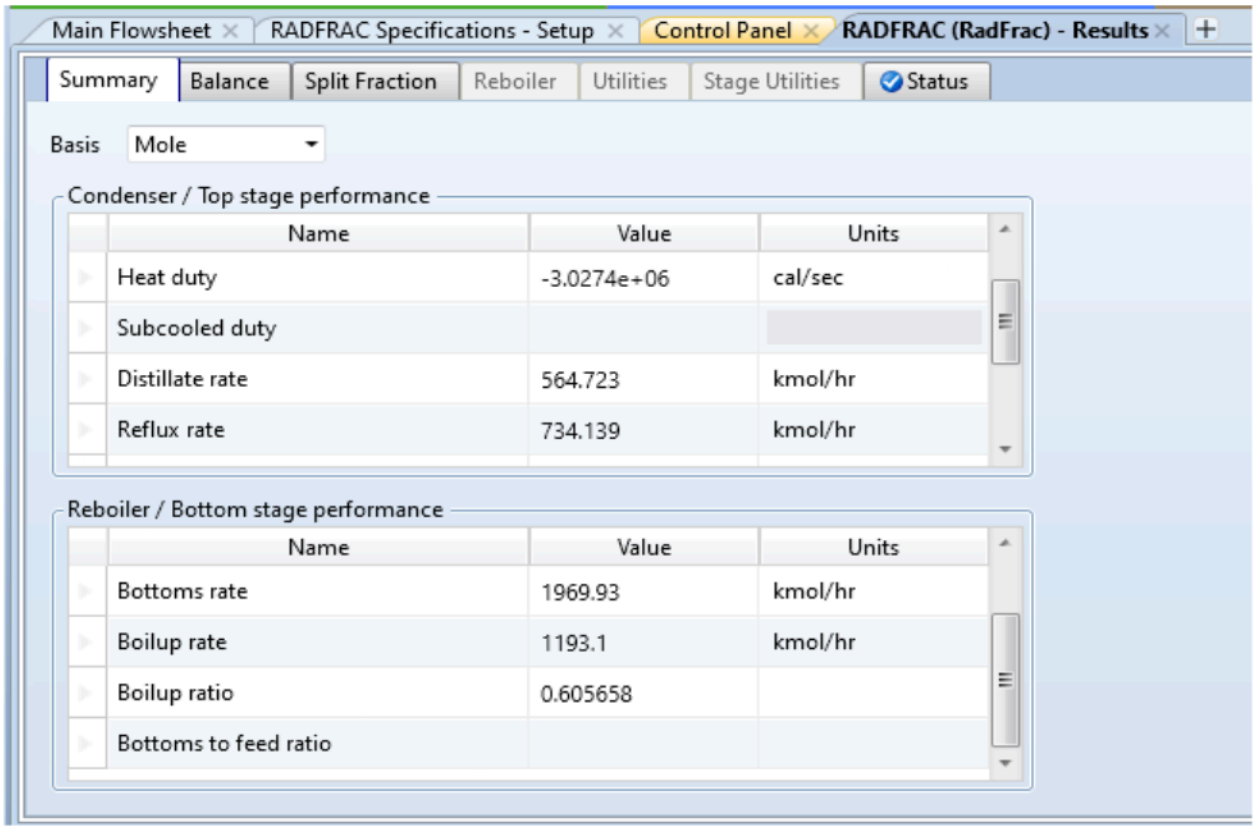


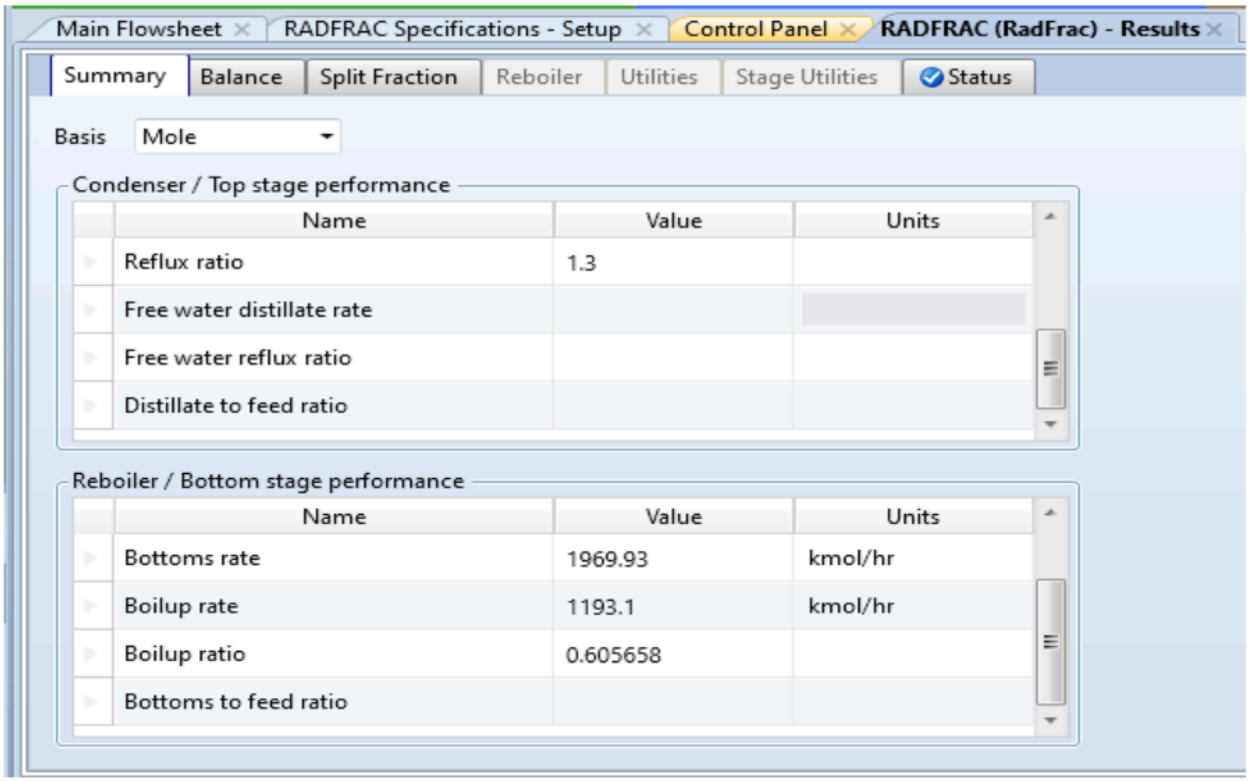



Main Flowsheet
RADFRAC Specifications - Setup
Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
View
Top / Bottom
Top stage / Condenser pressure
Stage 1 / Condenser pressure
16.1
psia
Stage 2 pressure (optional)
Stage 2 pressure
bar
Condenser pressure drop
bar
Pressure drop for rest of column (optional)
Stage pressure drop
0.1
psi
Column pressure drop
bar


Main Flowsheet
RADFRAC Specifications - Setup
Configuration
Streams
Pressure
Condenser
Reboiler
3-Phase
Information
View
Top / Bottom
Top stage / Condenser pressure
Stage 1 / Condenser pressure
16.1
psia
Required Input Complete
All required input is complete. You can run the simulation now, or enter more input. To enter more input, select Cancel, then select the input you want from the Simulation pane.
Run the simulation now?
OK
Cancel


Main Flowsheet
RADFRAC Specifications - Setup
Control Panel
RADFRAC (RadFrac) - Results
Summary
Balance
Split Fraction
Reboiler
Utilities
Stage Utilities
Status
Basis
Mole
Condenser / Top stage performance
Name
Value
Units
Temperature
66.8782
C
Subcooled temperature
Heat duty
-3.0274e+06
cal/sec
Subcooled duty
Reboiler / Bottom stage performance
Name
Value
Units
Temperature
103.972
C
Heat duty
3.2264e+06
cal/sec
Bottoms rate
1969.93
kmol/hr
Boilup rate
1194.77
kmol/hr


Main Flowsheet
RADFRAC Specifications - Setup
Control Panel
RADFRAC (RadFrac) - Results
Summary
Balance
Split Fraction
Reboiler
Utilities
Stage Utilities
Status
Basis
Mole
Condenser / Top stage performance
Name
Value
Units
Heat duty
-3.0274e+06
cal/sec
Subcooled duty
Distillate rate
564.723
kmol/hr
Reflux rate
734.139
kmol/hr
Reboiler / Bottom stage performance
Name
Value
Units
Bottoms rate
1969.93
kmol/hr
Boilup rate
1193.1
kmol/hr
Boilup ratio
0.605658
Bottoms to feed ratio


Main Flowsheet
RADFRAC Specifications - Setup
Control Panel
RADFRAC (RadFrac) - Results
Summary
Balance
Split Fraction
Reboiler
Utilities
Stage Utilities
Status
Basis
Mole
Condenser / Top stage performance
Name
Value
Units
Reflux ratio
1.3
Free water distillate rate
Free water reflux ratio
Distillate to feed ratio
Reboiler / Bottom stage performance
Name
Value
Units
Bottoms rate
1969.93
kmol/hr
Boilup rate
1193.1
kmol/hr
Boilup ratio
0.605658
Bottoms to feed ratio

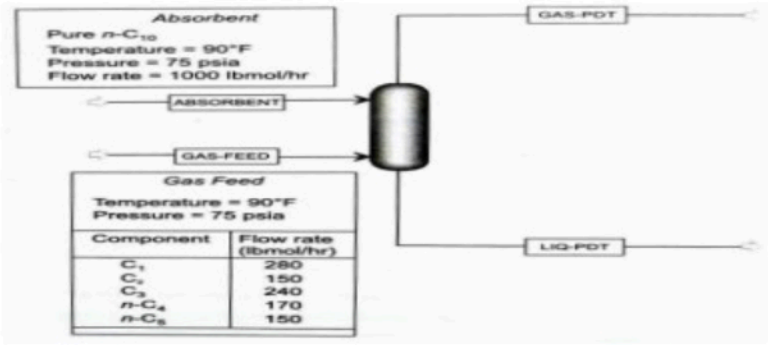
Main Flowsheet | RADFRAC Specifications - Setup | Control Panel | RADFRAC (RadFrac) - Stream Results

Material | Heat | Load | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

Display: Streams Format: FULL Stream Table

	FEED	BTMS	DISSTL	
Substream: MIXED				
Mole Flow kmol/hr				
WATER	1909.52	1909.29	0.221951	
METHANOL	625.134	60.6333	564.501	
Total Flow kmol/hr	2534.65	1969.93	564.723	
Total Flow kg/hr	54431.1	36339.3	18091.8	
Total Flow l/min	1078.42	673.999	406.918	
Temperature C	82.0644	103.972	66.8782	
Pressure bar	18	1.37895	1.11006	
Vapor Frac	0	0	0	
Liquid Frac	1	1	1	
Solid Frac	0	0	0	

9. A hydrocarbon vapour enters an absorption column below the bottom stage and the absorbent enters above the top stage. The column operates at 75 psia with no pressure drop and it has four equilibrium stages. The absorber is specified in Figure below.

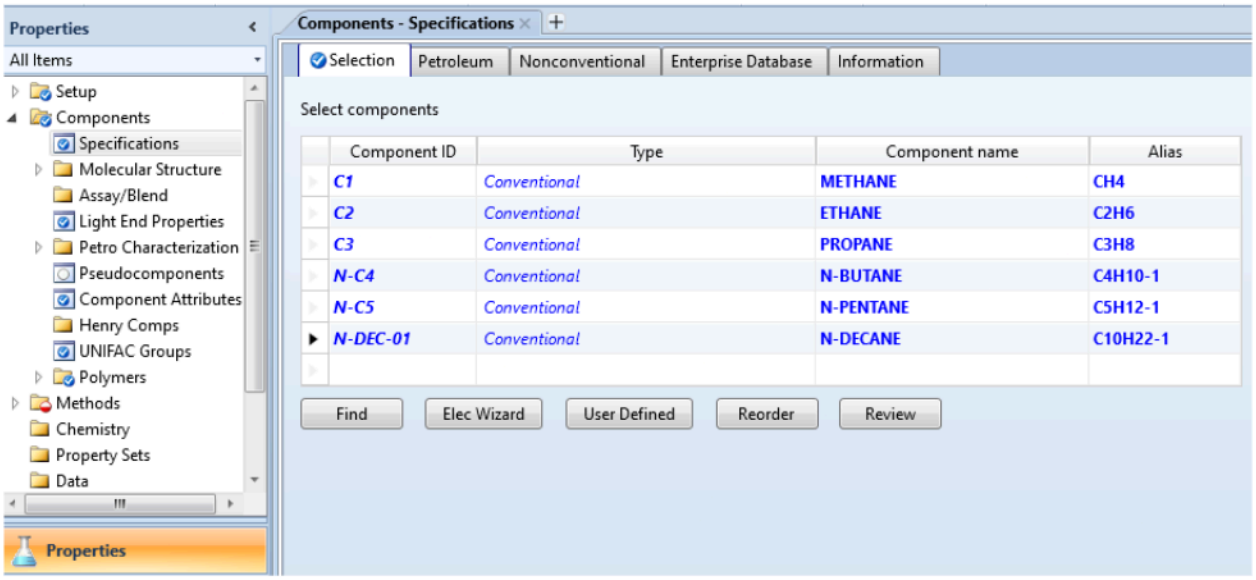


Apply the Peng-Robinson equation of state model in the simulation.

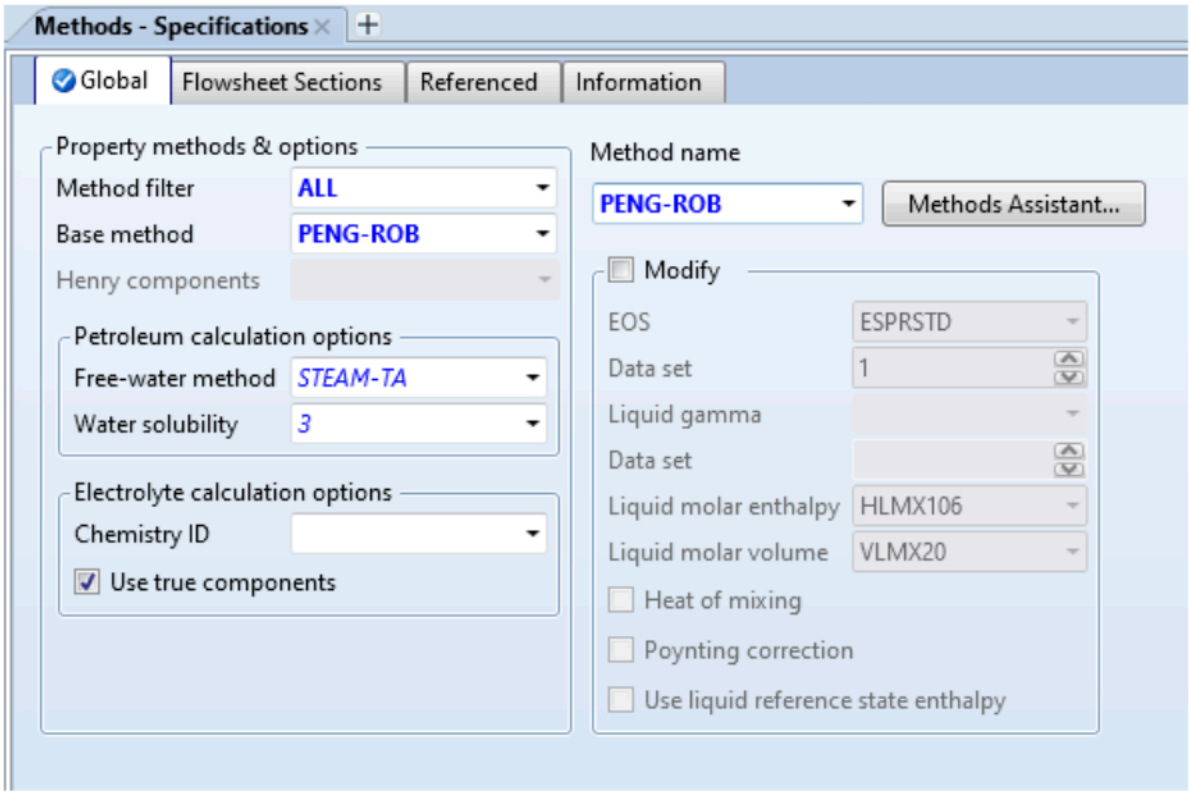
a) Simulate the absorber model (ABSBR2 under RadFrac) and compute the product compositions.
b) Perform the sensitivity analysis by examining the effect of absorbent flow rate on the exiting C2 concentration in the top product.
c) Compute the absorbent flow rate to keep 15 mole% of C2, in the gas product (GASPDT).

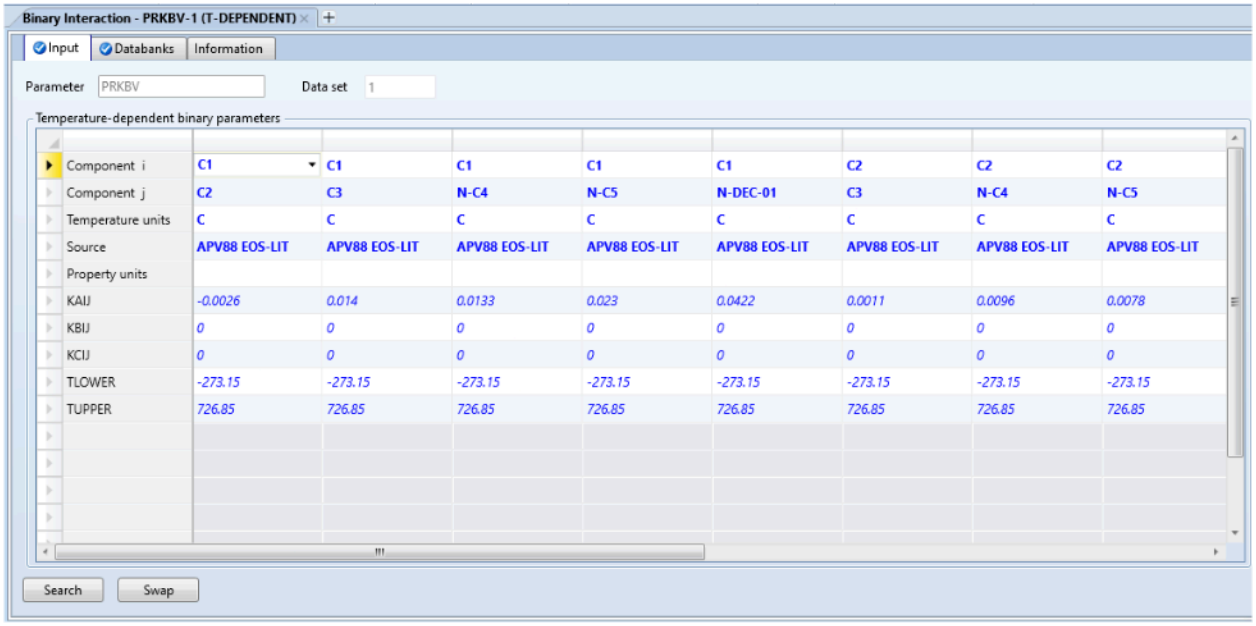
SOLITIONS;

PROPERTY SPESFICATIONS



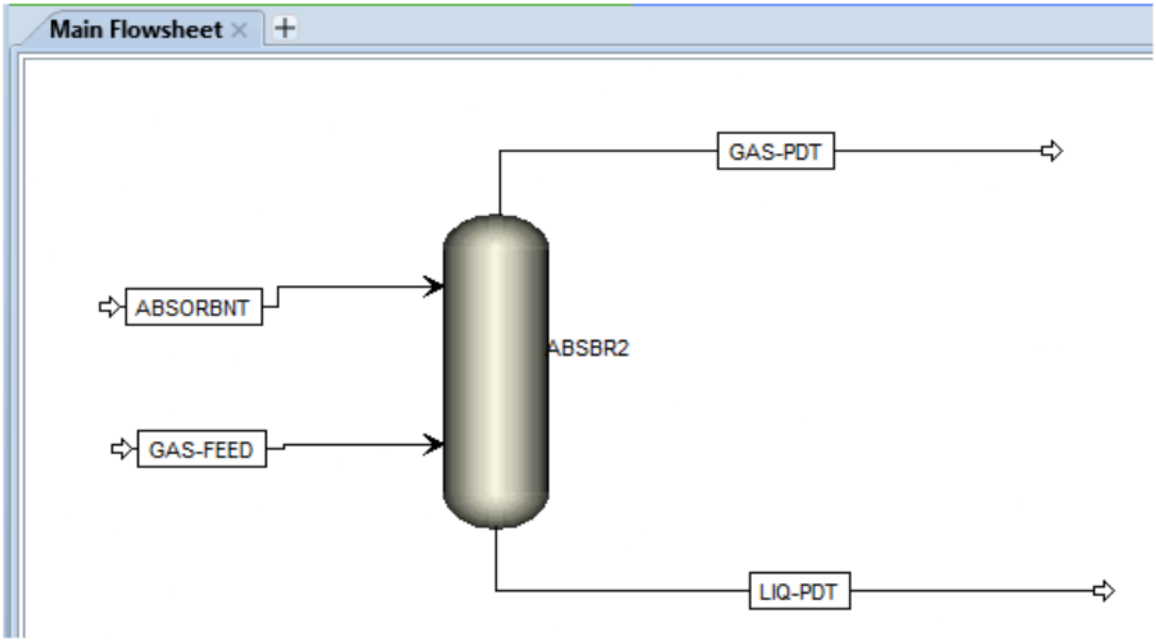
METHOD SPESFICATION



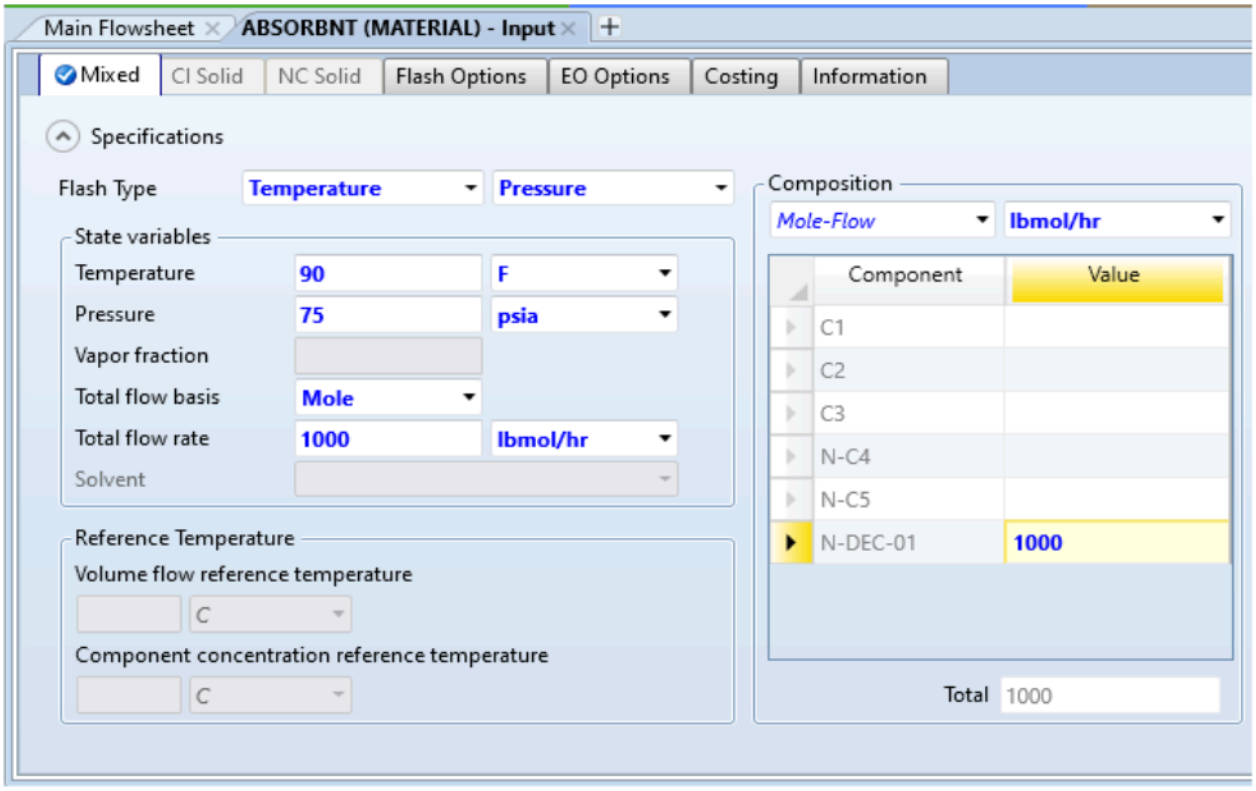


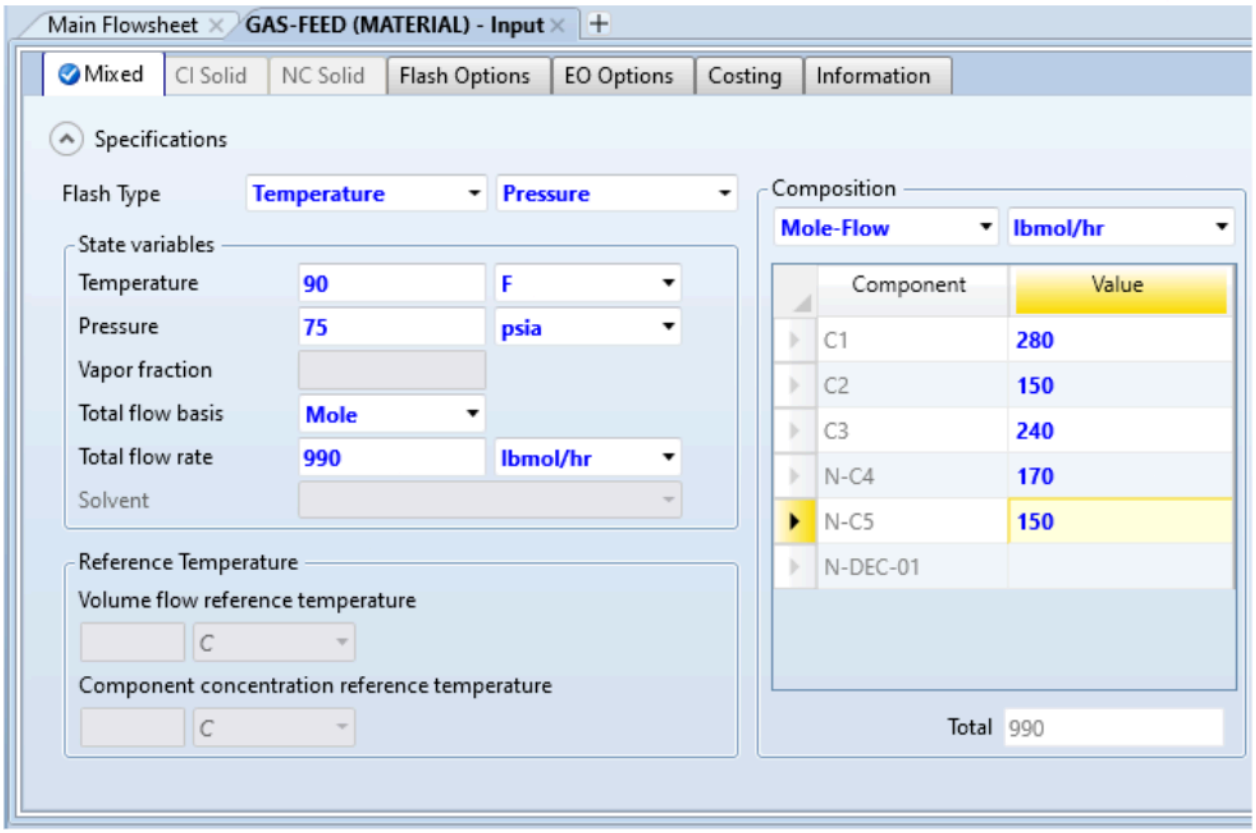
Component i	C1	C1	C1	C1	C1	C2	C2	C2
Component j	C2	C3	N-C4	N-C5	N-DEC-01	C3	N-C4	N-C5
Temperature units	C	C	C	C	C	C	C	C
Source	APV88 EOS-LIT	APV88 EOS-LIT	APV88 EOS-LIT	APV88 EOS-LIT	APV88 EOS-LIT	APV88 EOS-LIT	APV88 EOS-LIT	APV88 EOS-LIT
Property units								
KAIJ	-0.0026	0.014	0.0133	0.023	0.0422	0.0011	0.0096	0.0078
KBIJ	0	0	0	0	0	0	0	0
KCIJ	0	0	0	0	0	0	0	0
TLOWER	-273.15	-273.15	-273.15	-273.15	-273.15	-273.15	-273.15	-273.15
TUPPER	726.85	726.85	726.85	726.85	726.85	726.85	726.85	726.85

SIMULATION

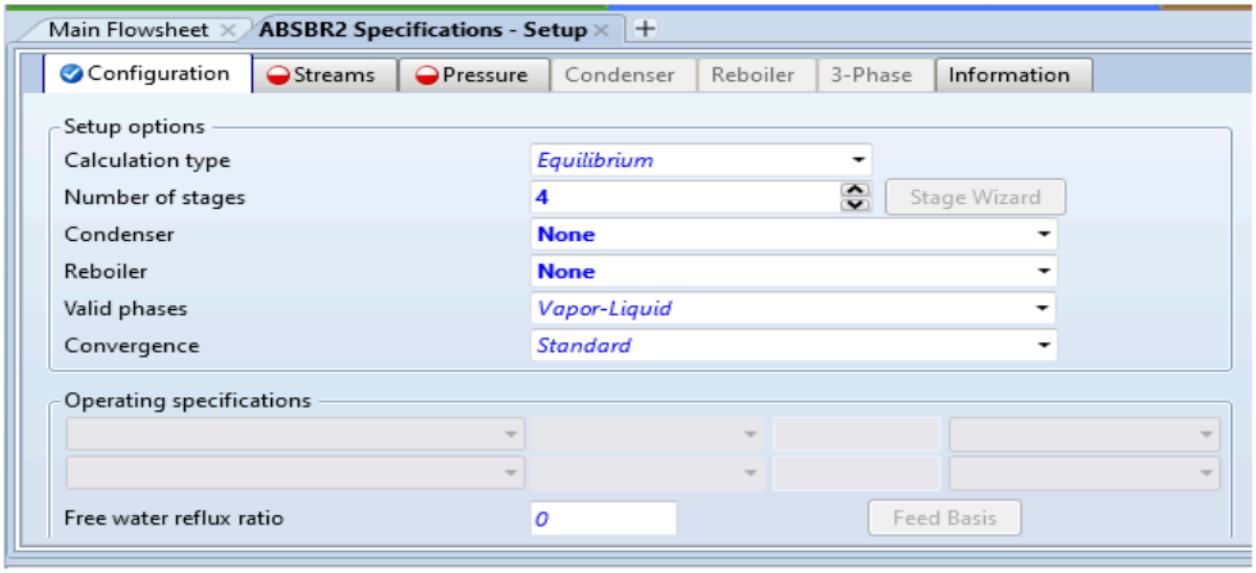


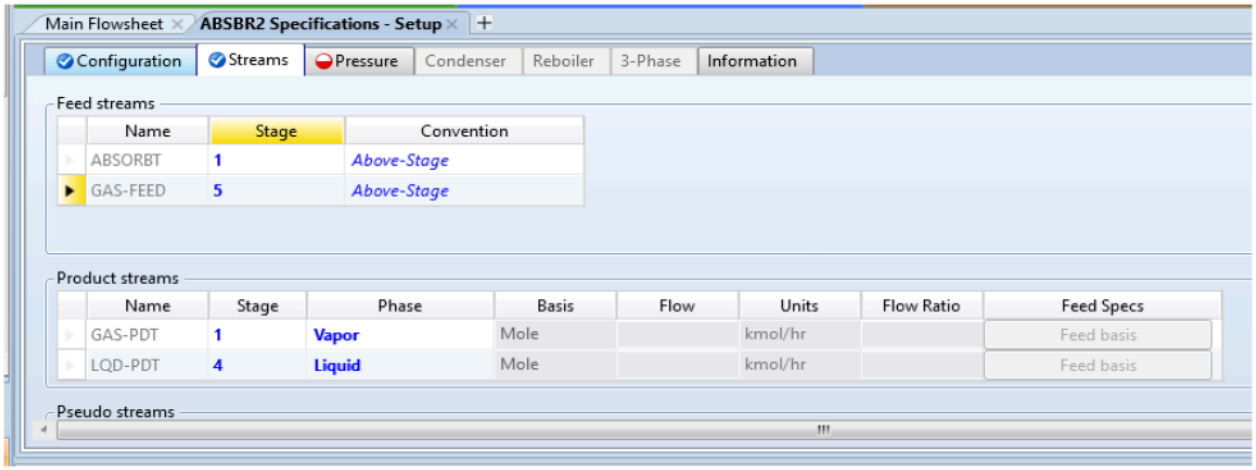
FEED INPUT

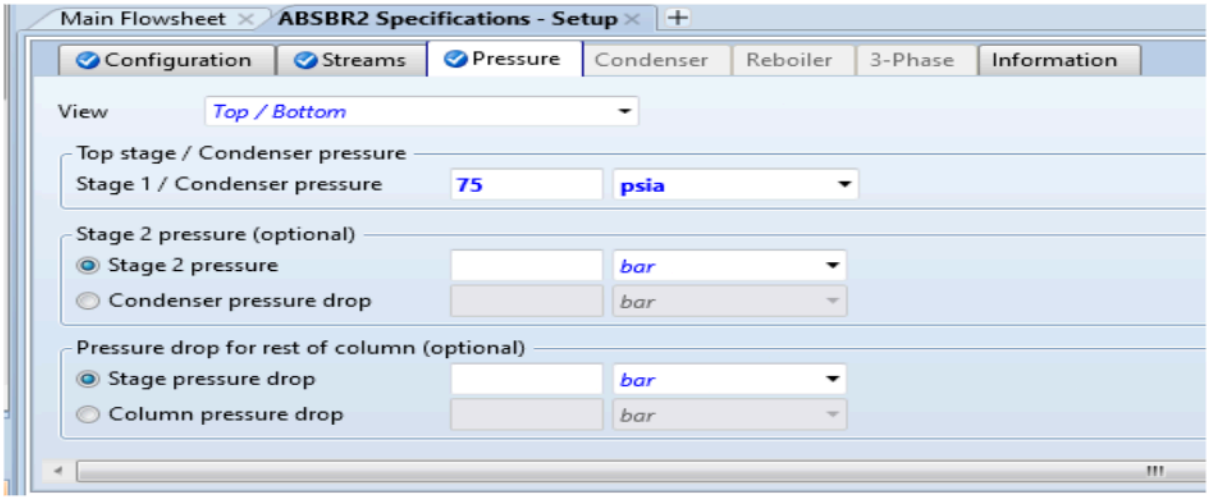

Main Flowsheet
ABSORBNT (MATERIAL) - Input
Mixed
CI Solid
NC Solid
Flash Options
EO Options
Costing
Information
Specifications
Flash Type
Temperature
Pressure
State variables
Temperature 90 F
Pressure 75 psia
Vapor fraction
Total flow basis Mole
Total flow rate 1000 lbmol/hr
Solvent
Reference Temperature
Volume flow reference temperature
C
Component concentration reference temperature
C
Composition
Mole-Flow
lbmol/hr
Component
Value
C1
C2
C3
N-C4
N-C5
N-DEC-01 1000
Total 1000


Main Flowsheet
GAS-FEED (MATERIAL) - Input
Mixed
CI Solid
NC Solid
Flash Options
EO Options
Costing
Information
Specifications
Flash Type
Temperature
Pressure
State variables
Temperature 90 F
Pressure 75 psia
Vapor fraction
Total flow basis Mole
Total flow rate 990 lbmol/hr
Solvent
Reference Temperature
Volume flow reference temperature
C
Component concentration reference temperature
C
Composition
Mole-Flow
lbmol/hr
Component
Value
C1 280
C2 150
C3 240
N-C4 170
N-C5 150
N-DEC-01
Total 990

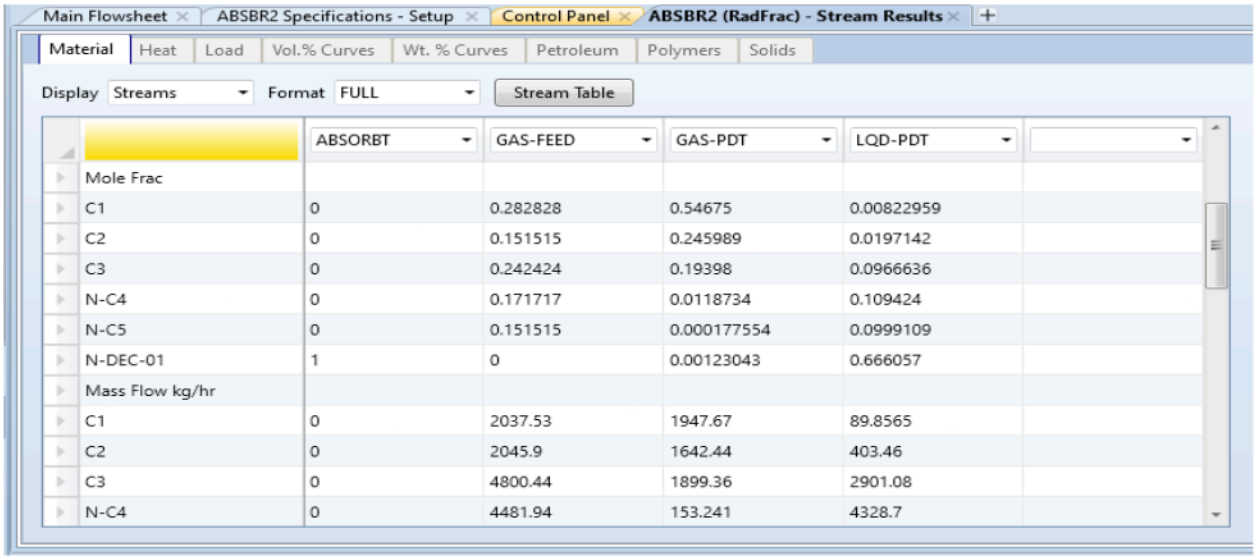
BLOCK (ABSBR2) INPUT





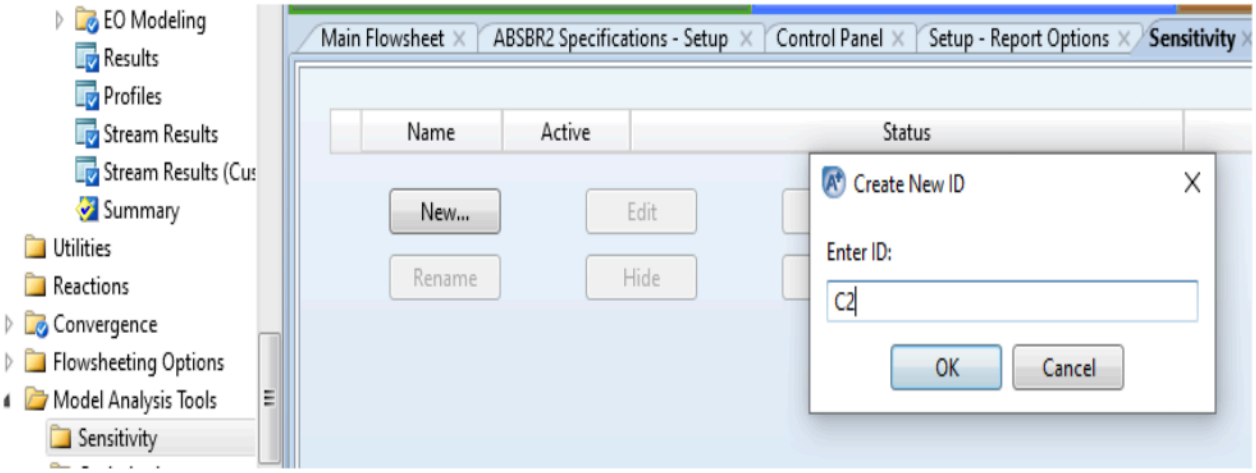


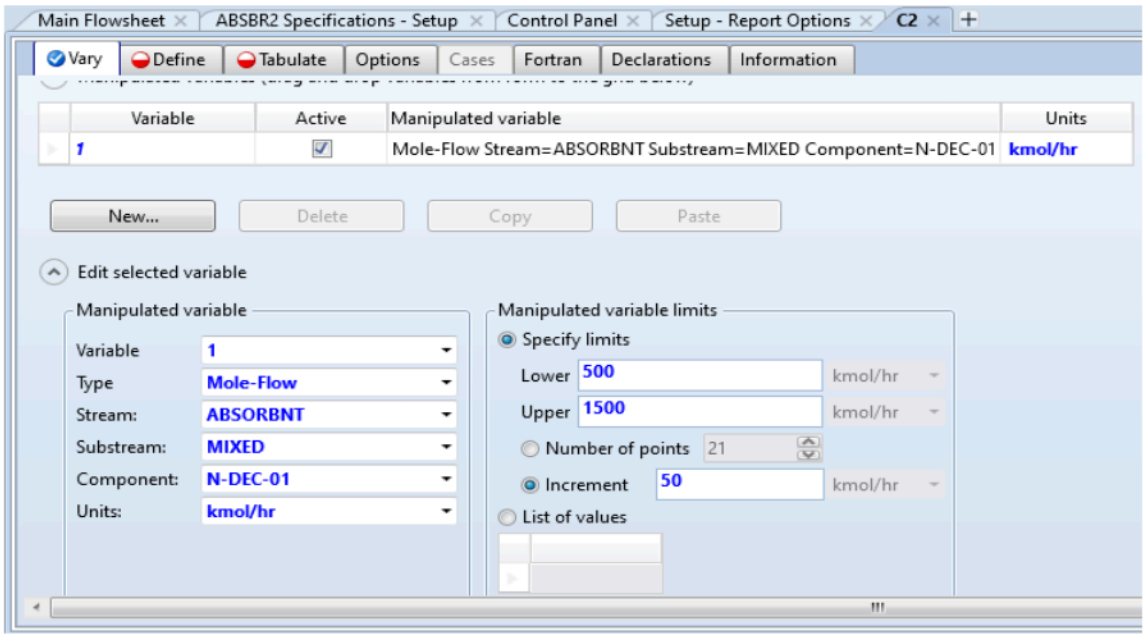
PRODUCT MOLE COMPOSITIONS ARE:

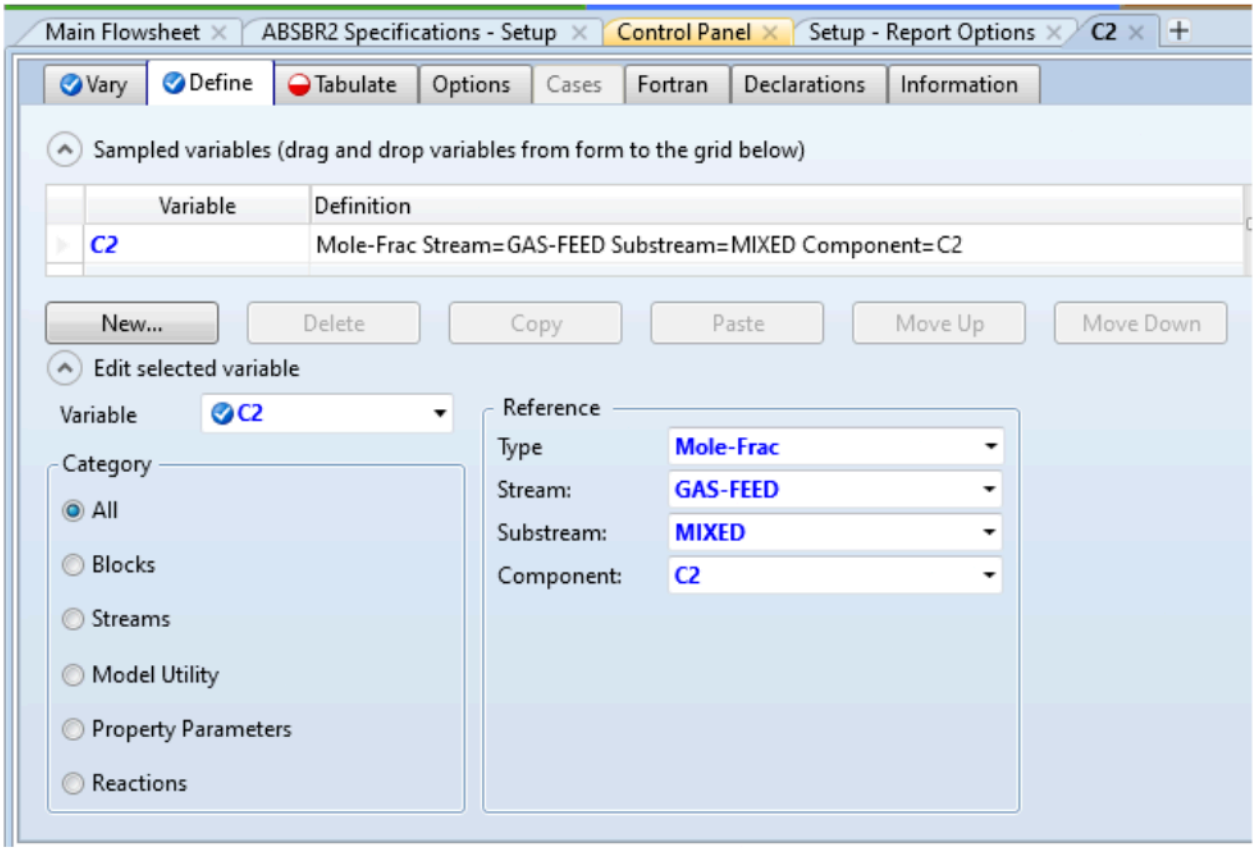


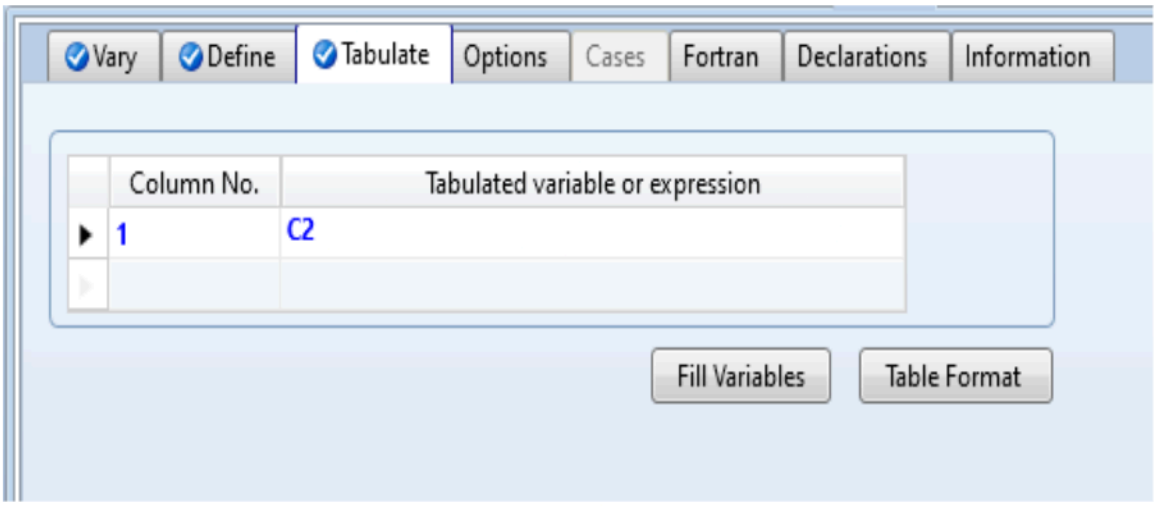
	ABSORBT	GAS-FEED	GAS-PDT	LQD-PDT	
Mole Frac					
C1	0	0.282828	0.54675	0.00822959	
C2	0	0.151515	0.245989	0.0197142	
C3	0	0.242424	0.19398	0.0966636	
N-C4	0	0.171717	0.0118734	0.109424	
N-C5	0	0.151515	0.000177554	0.0999109	
N-DEC-01	1	0	0.00123043	0.666057	
Mass Flow kg/hr					
C1	0	2037.53	1947.67	89.8565	
C2	0	2045.9	1642.44	403.46	
C3	0	4800.44	1899.36	2901.08	
N-C4	0	4481.94	153.241	4328.7	

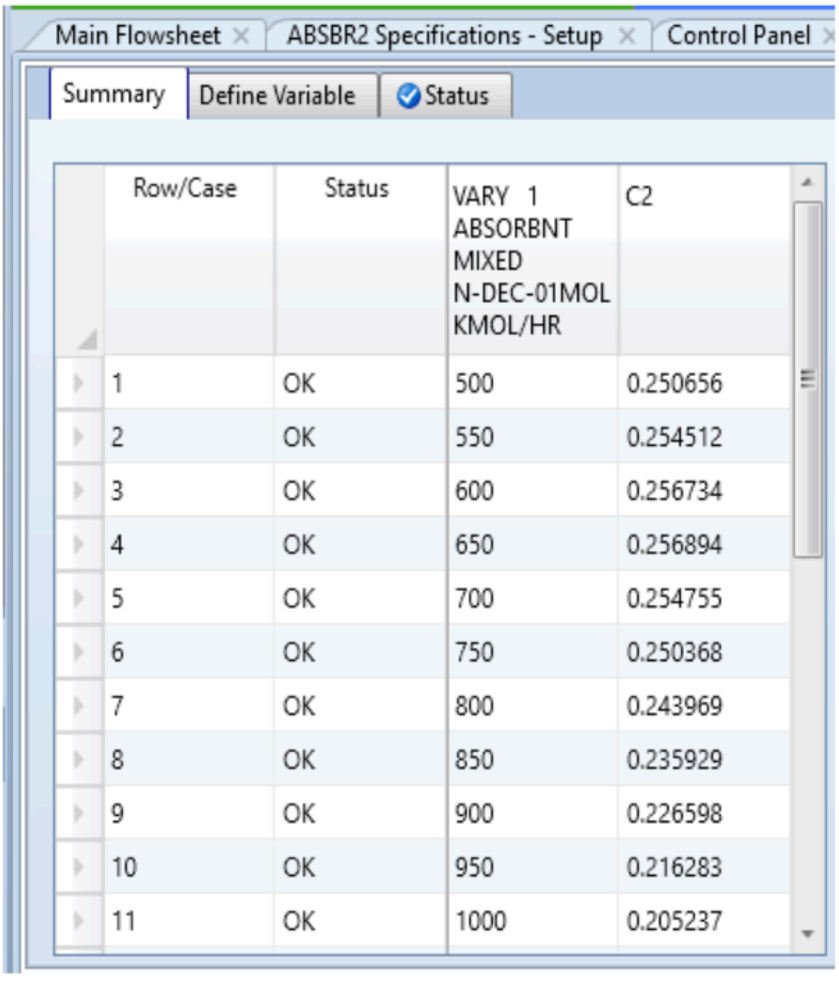
SENSETIVITY ANALYSIS: INPUTS



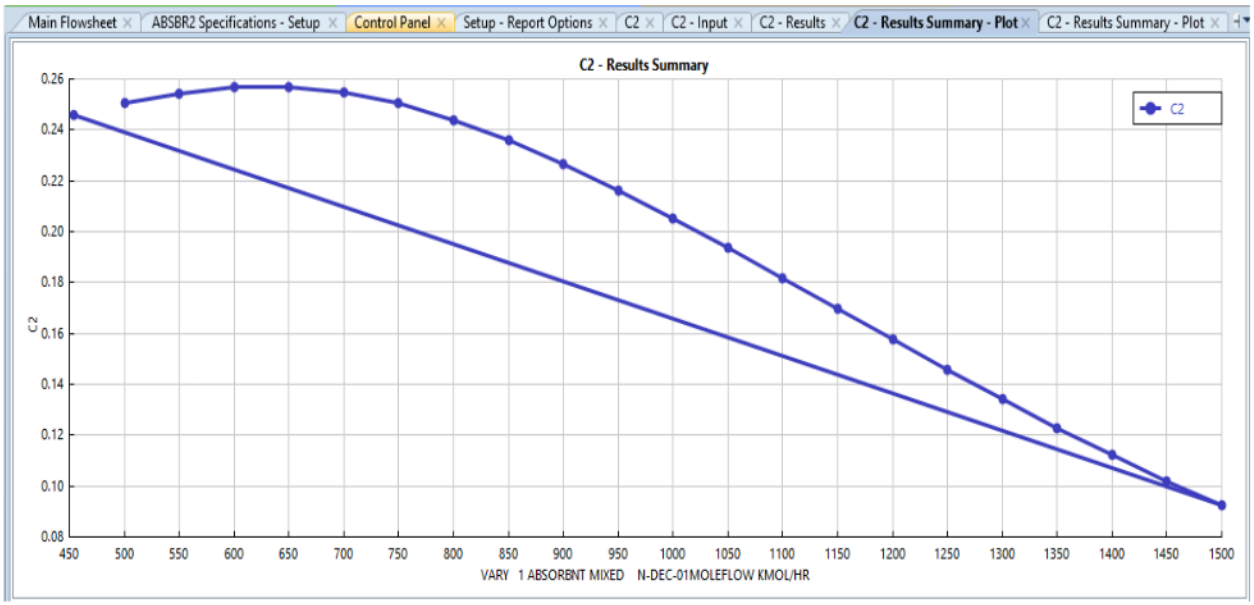

Main Flowsheet
ABSBR2 Specifications - Setup
Control Panel
Setup - Report Options
C2
Vary
Define
Tabulate
Options
Cases
Fortran
Declarations
Information
Variable
Active
Manipulated variable
Units
1
Mole-Flow Stream=ABSORBNT Substream=MIXED Component=N-DEC-01
kmol/hr
New...
Delete
Copy
Paste
Edit selected variable
Manipulated variable
Variable 1
Type Mole-Flow
Stream: ABSORBNT
Substream: MIXED
Component: N-DEC-01
Units: kmol/hr
Manipulated variable limits
Specify limits
Lower 500 kmol/hr
Upper 1500 kmol/hr
Number of points 21
Increment 50 kmol/hr
List of values


Main Flowsheet
ABSBR2 Specifications - Setup
Control Panel
Setup - Report Options
C2
Vary
Define
Tabulate
Options
Cases
Fortran
Declarations
Information
Sampled variables (drag and drop variables from form to the grid below)
Variable
Definition
C2
Mole-Frac Stream=GAS-FEED Substream=MIXED Component=C2
New...
Delete
Copy
Paste
Move Up
Move Down
Edit selected variable
Variable C2
Category
All
Blocks
Streams
Model Utility
Property Parameters
Reactions
Reference
Type Mole-Frac
Stream: GAS-FEED
Substream: MIXED
Component: C2

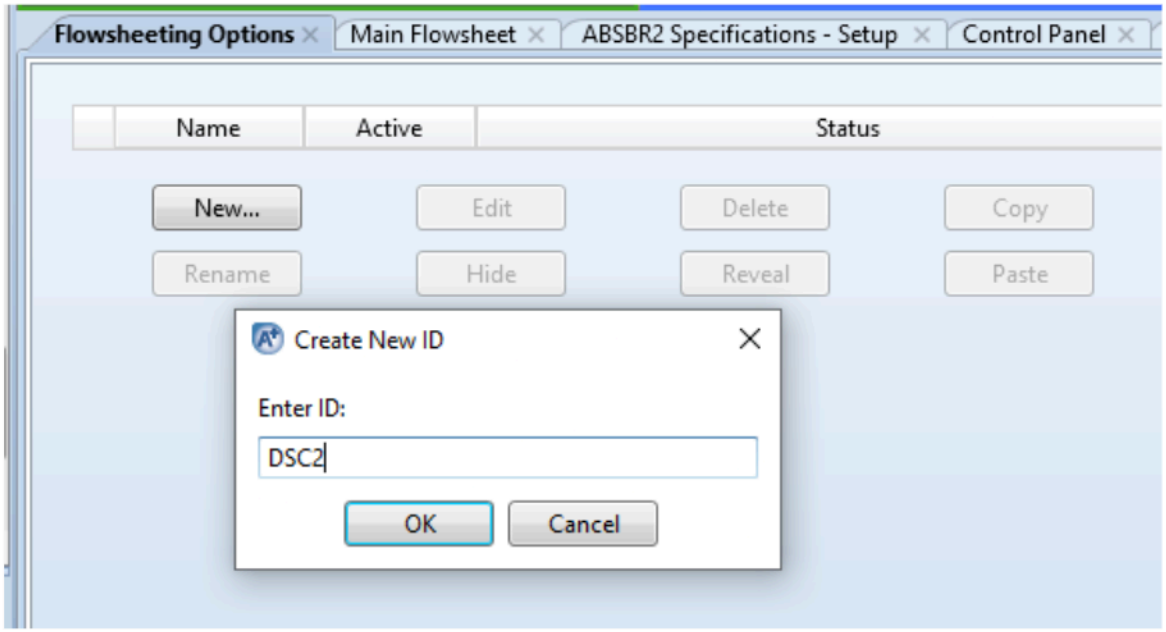


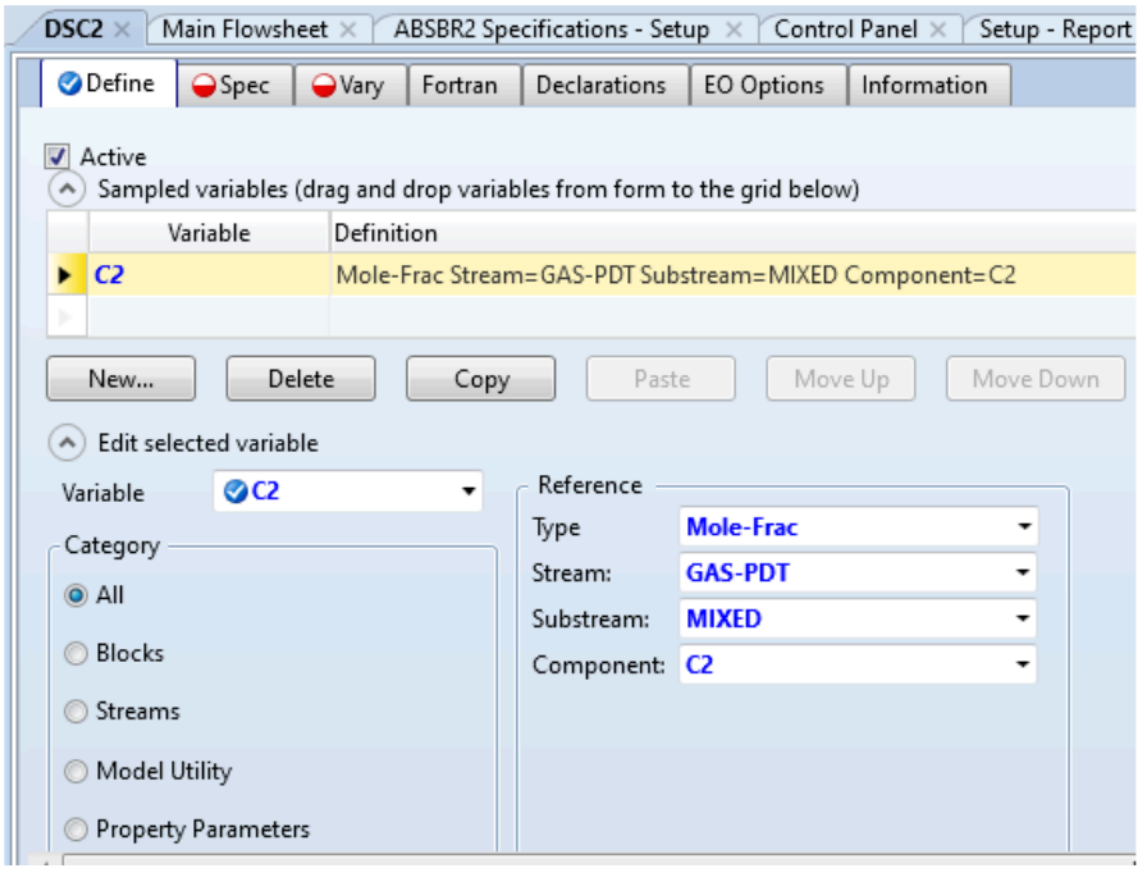


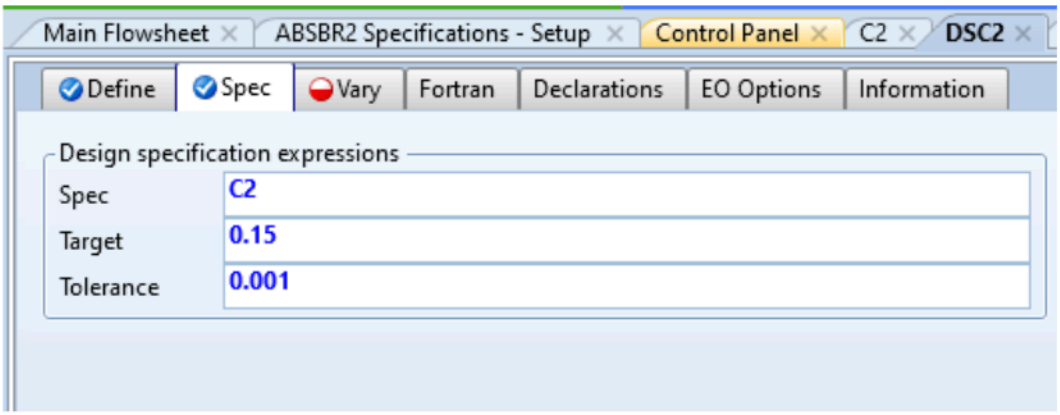
Row/Case	Status	VARY 1 ABSORBNT MIXED N-DEC-01MOL KMOL/HR	C2
1	OK	500	0.250656
2	OK	550	0.254512
3	OK	600	0.256734
4	OK	650	0.256894
5	OK	700	0.254755
6	OK	750	0.250368
7	OK	800	0.243969
8	OK	850	0.235929
9	OK	900	0.226598
10	OK	950	0.216283
11	OK	1000	0.205237

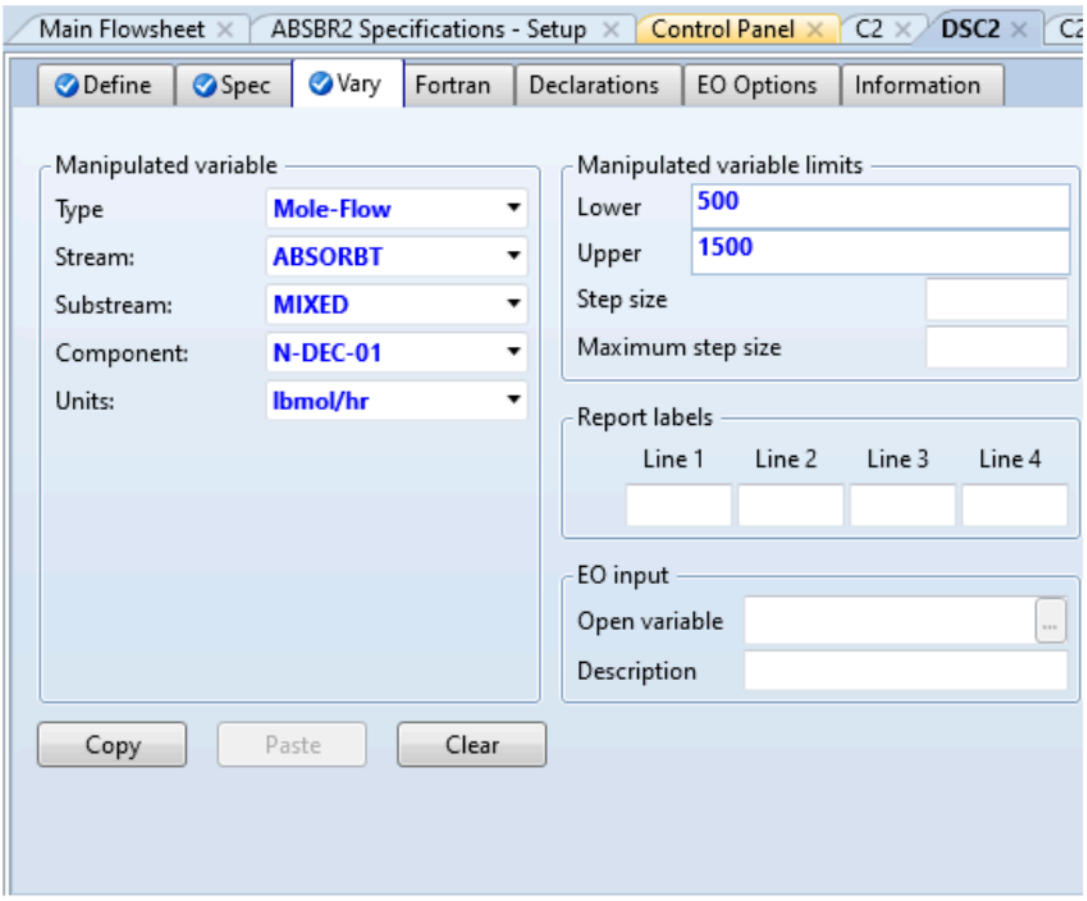


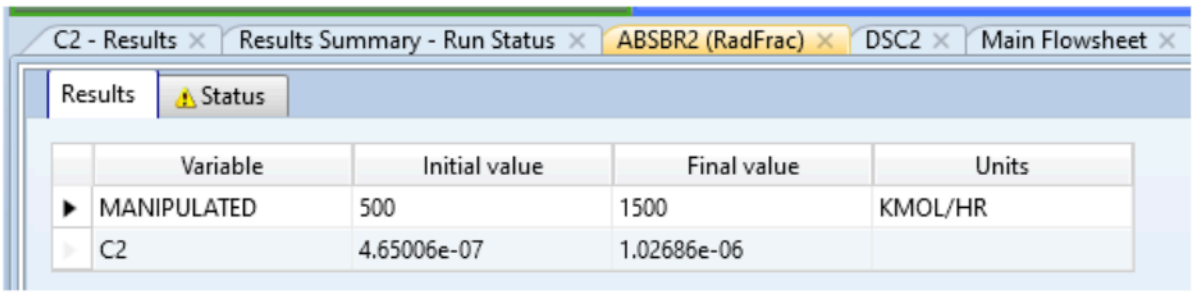
C) THE ABSORBENT FLOW RATE TO KEEP 15 MOLE% OF C2, IN THE GAS PRODUCT (GASPDT)




DSC2
Main Flowsheet
ABSBR2 Specifications - Setup
Control Panel
Setup - Report
Define
Spec
Vary
Fortran
Declarations
EO Options
Information
Active
Sampled variables (drag and drop variables from form to the grid below)
Variable
Definition
C2
Mole-Frac Stream=GAS-PDT Substream=MIXED Component=C2
New...
Delete
Copy
Paste
Move Up
Move Down
Edit selected variable
Variable
C2
Reference
Type
Mole-Frac
Stream:
GAS-PDT
Substream:
MIXED
Component:
C2
Category
All
Blocks
Streams
Model Utility
Property Parameters


Main Flowsheet
ABSBR2 Specifications - Setup
Control Panel
C2
DSC2
Define
Spec
Vary
Fortran
Declarations
EO Options
Information
Design specification expressions
Spec
C2
Target
0.15
Tolerance
0.001





Variable	Initial value	Final value	Units
MANIPULATED	500	1500	KMOL/HR
C2	4.65006e-07	1.02686e-06	

Variable	Initial value	Final value	Units
MANIPULATED	1490	1500	KMOL/HR
C2	1.01936e-06	1.02596e-06	