ASPEN ASSIGNMENT - 5

Name : CH Govardhana sai srinivas

Roll no : ch19b052

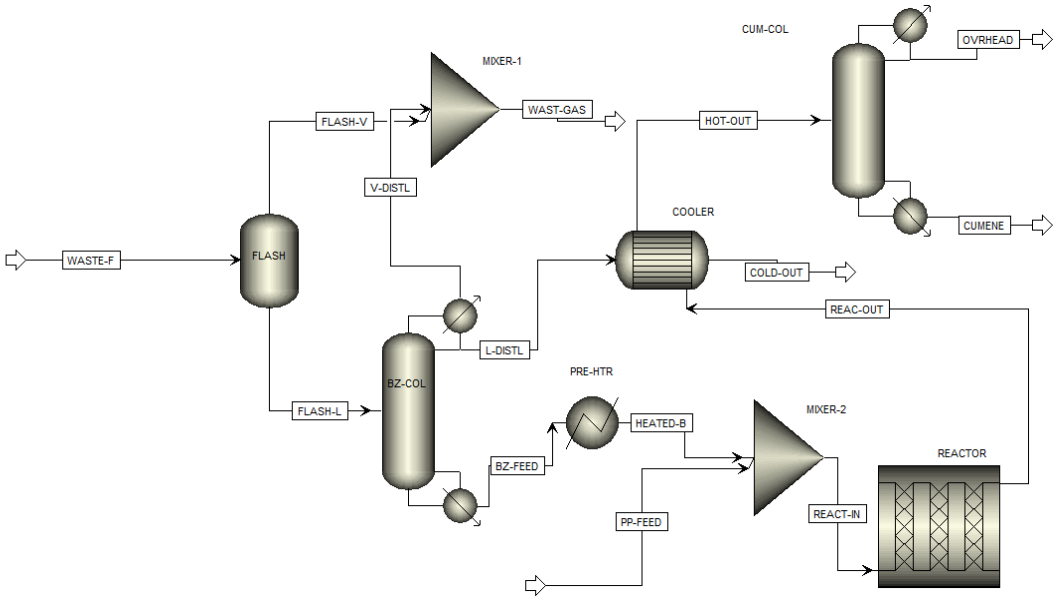
a=0 , b = 5 , c = 2

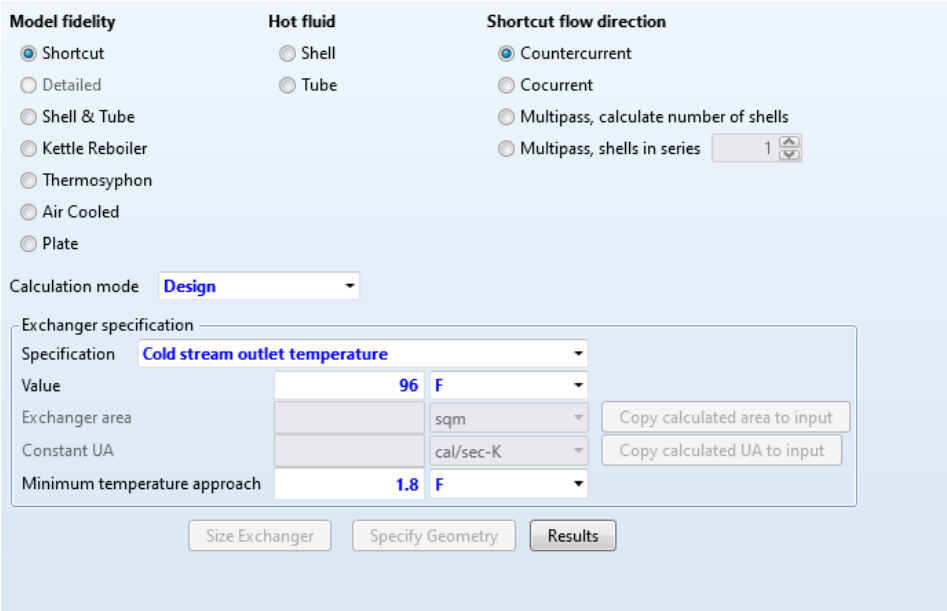
T = a + b + 10*c = 0+ 5 + 20 = 25

X = 25 mod 9 = 7

Y = 25 mod 19 = 6

Use ASPEN PLUS to simulate this cumene production process.

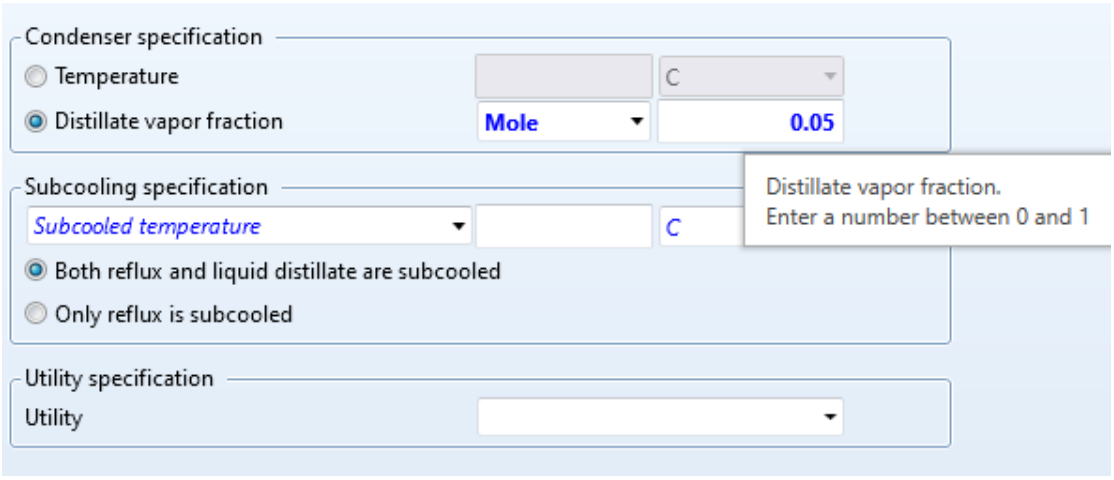




Exit temperature of cooler = 96F (90 + Y)

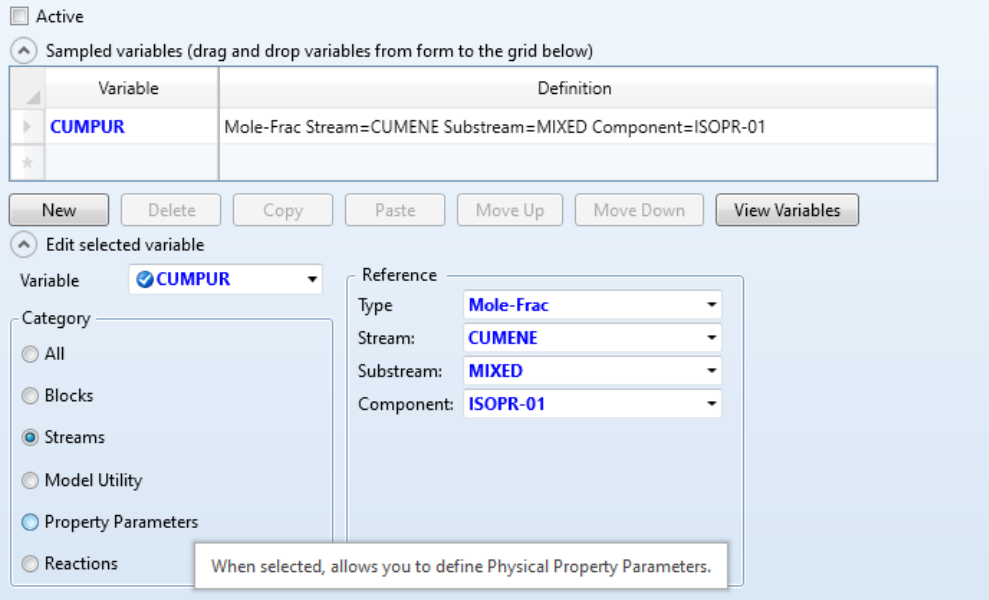
The specifications of maintaining the waste gas stream (WAST-GAS) has a maximum total flow rate of 37.0 lbmol/hr , to achieve 99% conversion and 99.x% => 99.7% purity of cumene in the output cannot be achieved directly .Varying the parameters such as

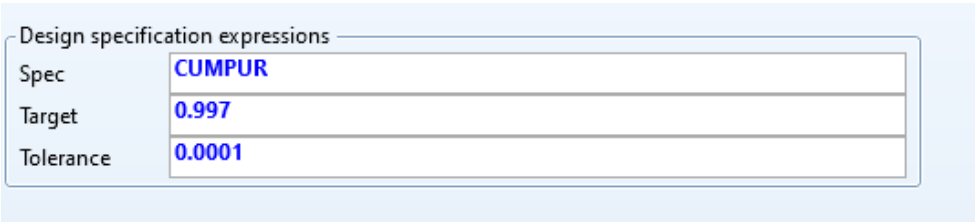
- Vapor fraction in the distillate = 0.05 of benzene distillation column to get the waste gas stream below 37 lbmol/hr

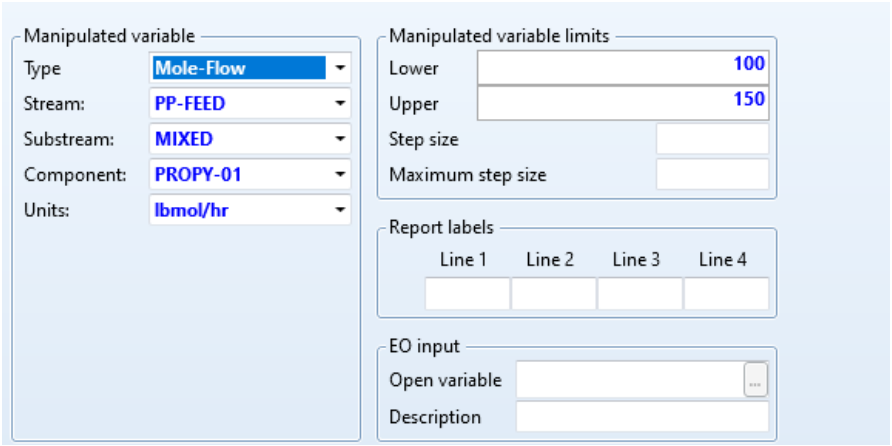


- **Propylene inlet flow rate to get the required purity of cumene i.e., 99.x% => 99.7%**
    - Using Design specifications (DS-1)

- Manipulated variable as flow rate of propylene
- Design variable as mole fraction of cumene

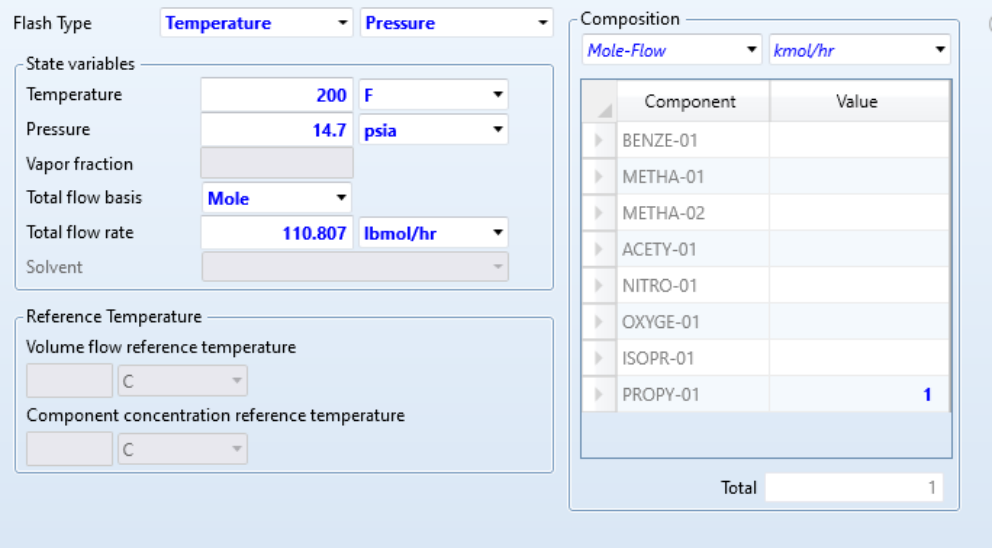




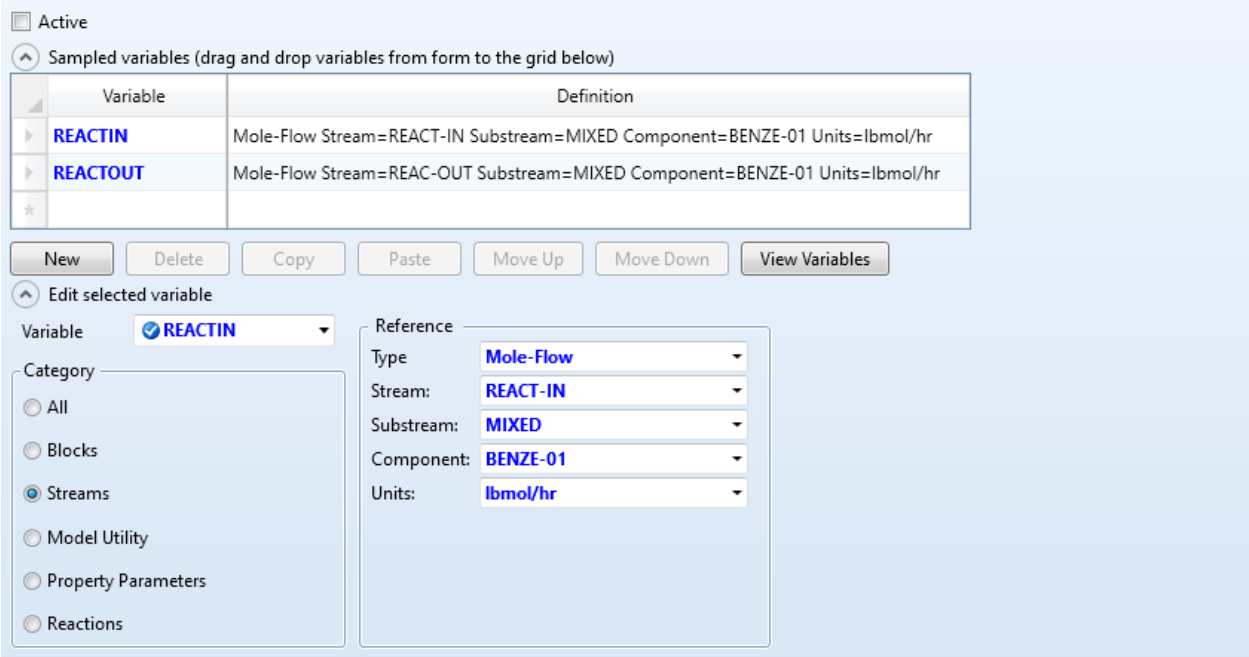


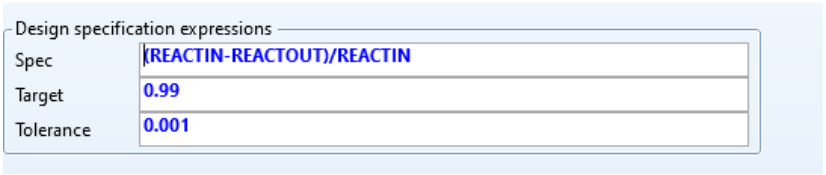
	Variable	Initial value	Final value	Units
▶	MANIPULATED	50.2613	50.2613	KMOL/HR
	CUMPUR	0.997018	0.997018	

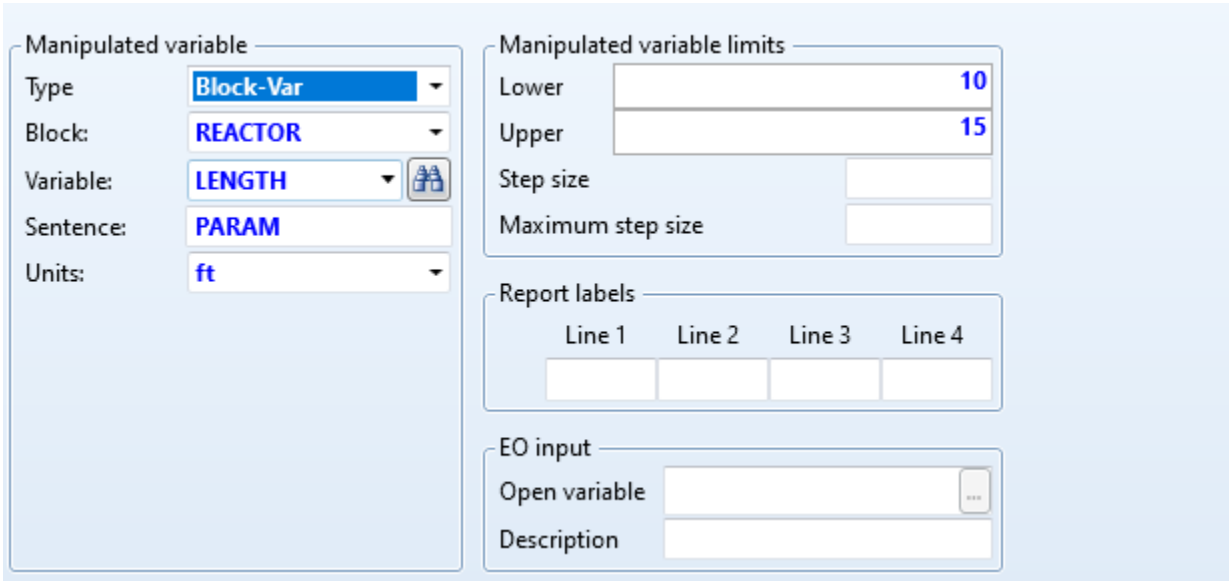
- **Flow Rate = 50.2613 kmol/hr = 110.807 lbmol/hr**



- Length of the reactor to get required conversion of 99%
  - Using Design specifications (DS-2)
    - Manipulated variable as Reactor length
    - Design variable as conversion of benzene= (React Inlet concentration - Reactor outlet concentration) / reactor inlet concentration

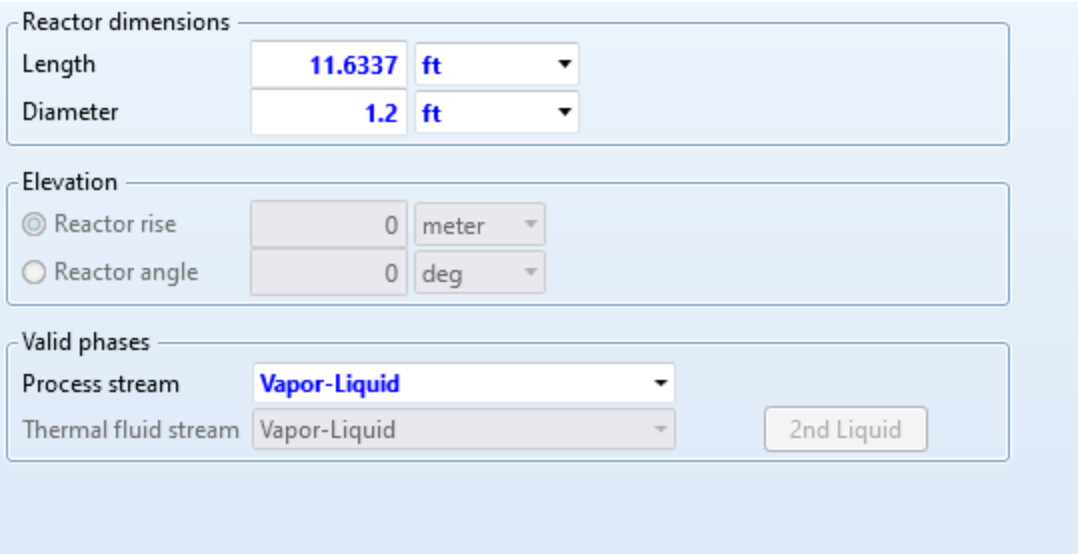






	Variable	Initial value	Final value	Units
▶	MANIPULATED	3.54594	3.54594	METER
	REACTIN	90	90	LBMOL/HR
	REACTOUT	0.900337	0.900337	LBMOL/HR

- **Length of the reactor = 3.54594 m = 11.633 ft**



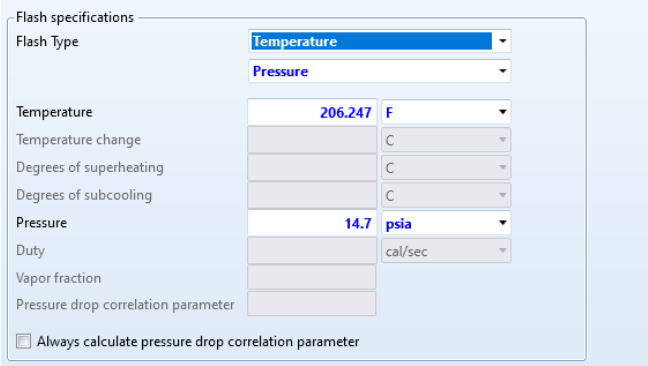
- **After using the above specifications we get**

	Units	CUMENE	WAST-GAS	REACT-IN	REAC-OUT	
Molar Density	mol/cc	0.00619536	4.62979e-05	3.35535e-05	0.000160802	
Mass Density	gm/cc	0.74387	0.000984669	0.00195383	0.016832	
Enthalpy Flow	cal/sec	-28345.1	-5259.16	325368	-44997.6	
Average MW		120.069	21.2681	58.2303	104.676	
− Mole Flows	**lbmol/hr**	**89.3659**	**36.2852**	**200.807**	**111.707**	
BENZE-01	lbmol/hr	0.266247	0.281348	90	0.900326	
METHA-01	lbmol/hr	1.23198e-10	0.200768	1.41119e-06	1.41119e-06	
METHA-02	lbmol/hr	3.30115e-27	21.2805	8.17415e-13	8.17415e-13	
ACETY-01	lbmol/hr	1.0035e-19	6.52326	4.70417e-10	4.70417e-10	
NITRO-01	lbmol/hr	0	5.99973	1.40666e-22	1.40666e-22	
OXYGE-01	lbmol/hr	0	1.99962	2.30885e-21	2.30885e-21	
ISOPR-01	lbmol/hr	89.0996	0	0	89.0997	
PROPY-01	lbmol/hr	4.05347e-07	0	110.807	21.7073	
− Mole Fractions						
BENZE-01		0.00297929	0.00775378	0.448192	0.00805968	
METHA-01		1.37858e-12	0.00553305	7.0276e-09	1.26329e-08	
METHA-02		3.69398e-29	0.586478	4.07065e-15	7.31747e-15	
ACETY-01		1.12291e-21	0.179777	2.34263e-12	4.21115e-12	
NITRO-01		0	0.165349	7.00502e-25	1.25923e-24	
OXYGE-01		0	0.0551083	1.14978e-23	2.06687e-23	
ISOPR-01		0.997021	0	0	0.797617	
PROPY-01		4.53582e-09	0	0.551808	0.194323	

- Mole fraction of cumene(purity) = 0.997021
- Waste gas stream flow rate = 36.2852 < 37 lbmol/hr
- Conversion of benzene
    - Reactor input = 90 lbmol/hr

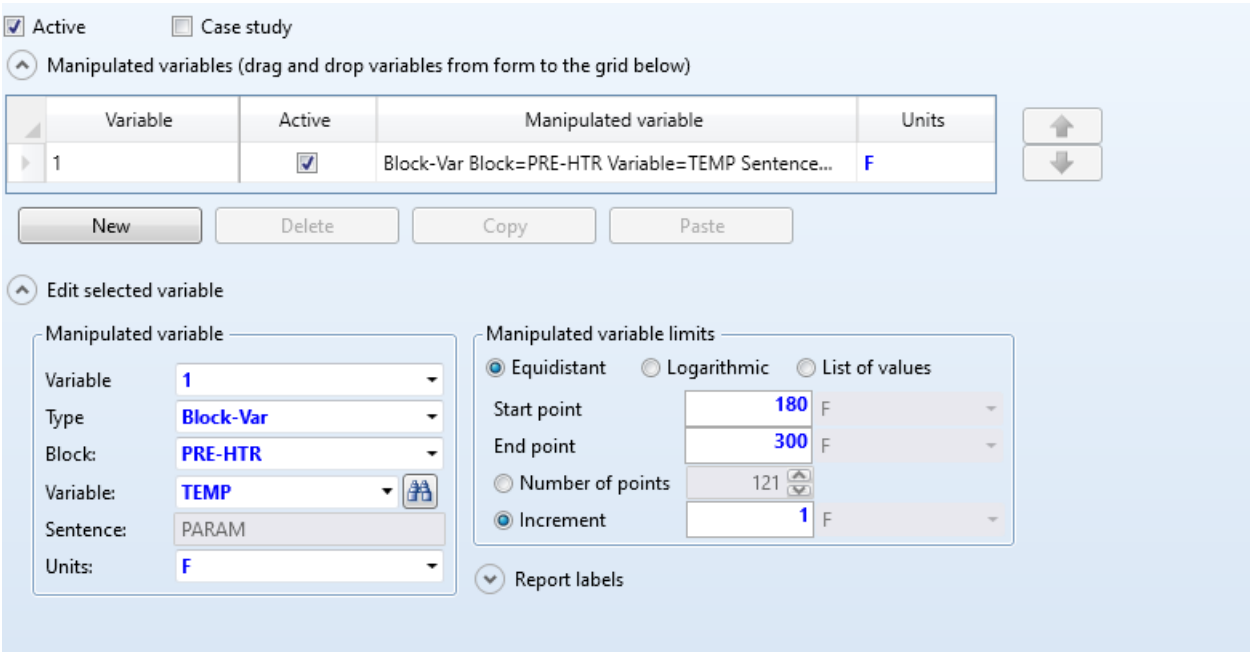
- Reactor output = 0.900326 lbmol/hr
- Conversion = (90-0.900326)/90 = 98.99 % ~ 99%

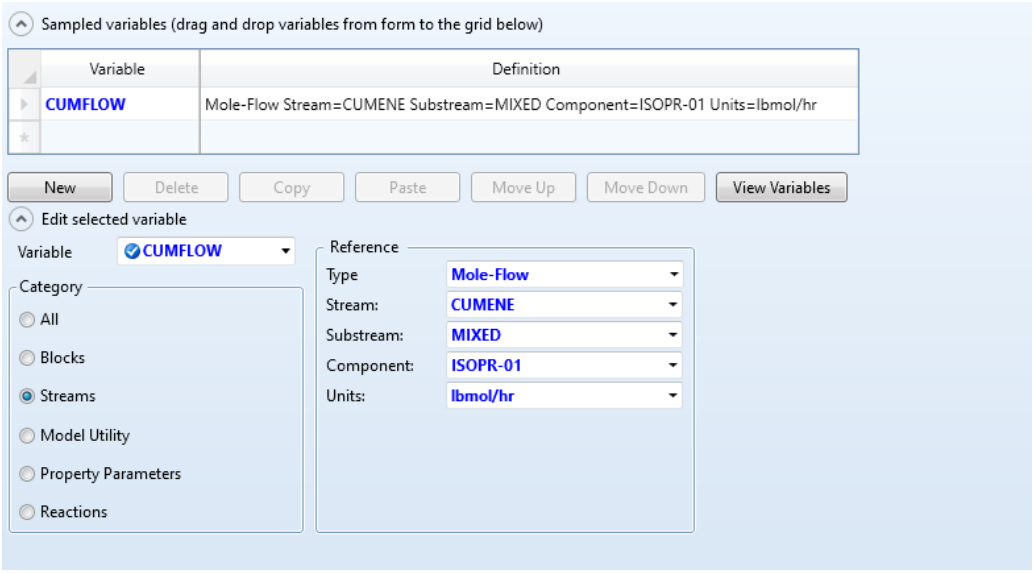
It is found that the temperature for 30 degrees superheating = 206.247 F

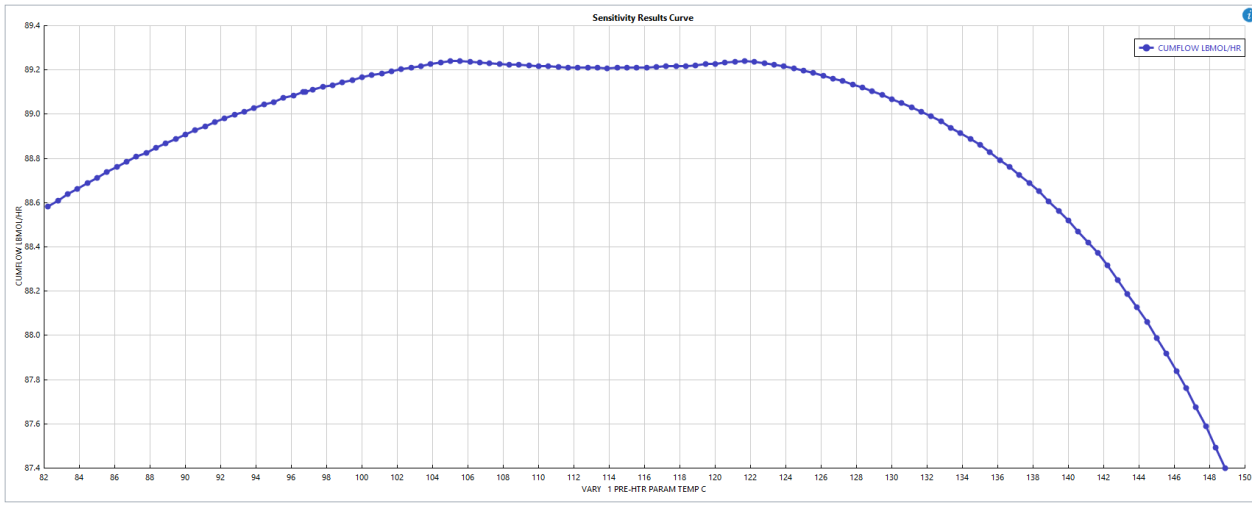


Conduct a sensitivity analysis and generate a plot of the variation of the cumene product flow rate with the preheater temperature.

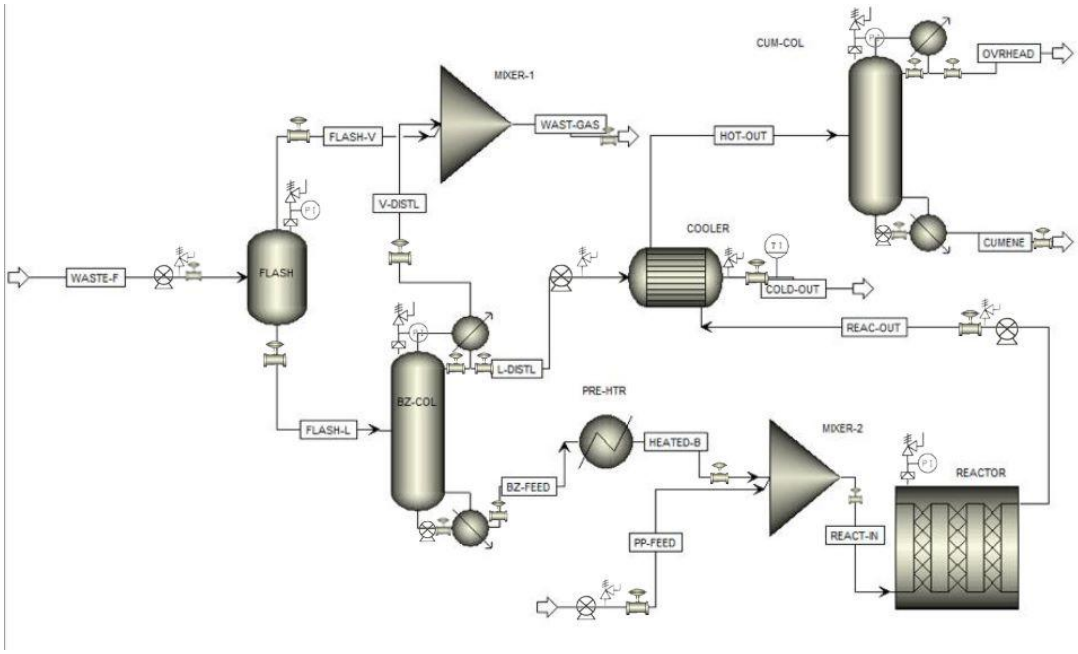
- Using the sensitivity analysis in aspen to generate the required plot







Create a PFD for the process clearly showing all the pumps that will be needed in the process. The PFD should include the stream table.



The stream table is attached along with the report as a excel file