Problem on optimization of distillation column

By: Hemang Tailor

3700 kg/hr mixture of Tetrahydrofuran (THF) and Toluene (44 mass % of THF) at 10 degrees Celsius and 140 Kpa is to be separated by distillation to get each of them with purity of 99.5 mass % of THF and 94% mass % of Toluene.

Fluid package - Wilson

Condenser and reboiler pressure - 103 Kpa and 107 Kpa

Condenser - Total Condenser

Number of stages - 10

Feed cost - 0.05 $/kg

Pure toluene selling price - 0.136 $/kg

Pure THF selling price - 0.333 $/kg

Cooling cost - 0.471 $/Kw.hr

Heating Cost - 0.737 $/kw.hr

Use a range of 0.99 to 0.999 for THF limit and 0.9 to 0.99 for Toluene to optimize distillation unit

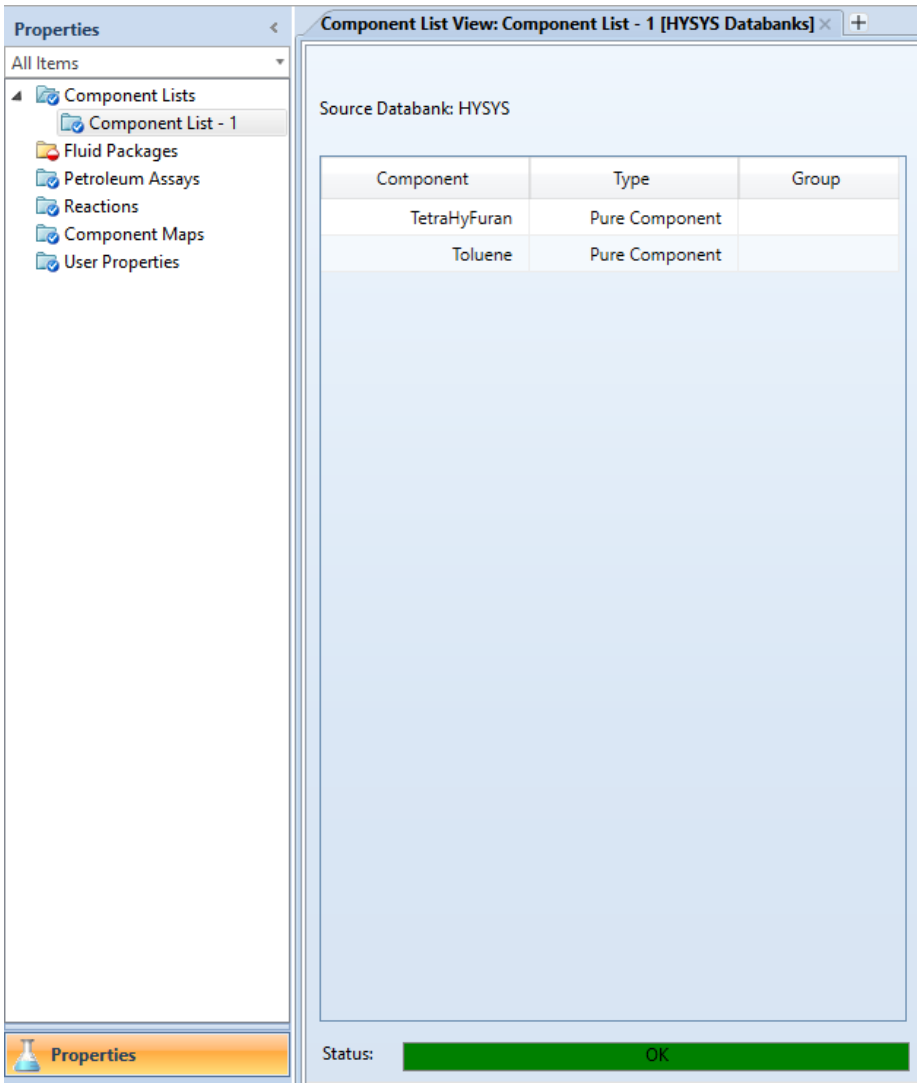
CALCULATE

- Reflux Ratio
- Distillate Rate

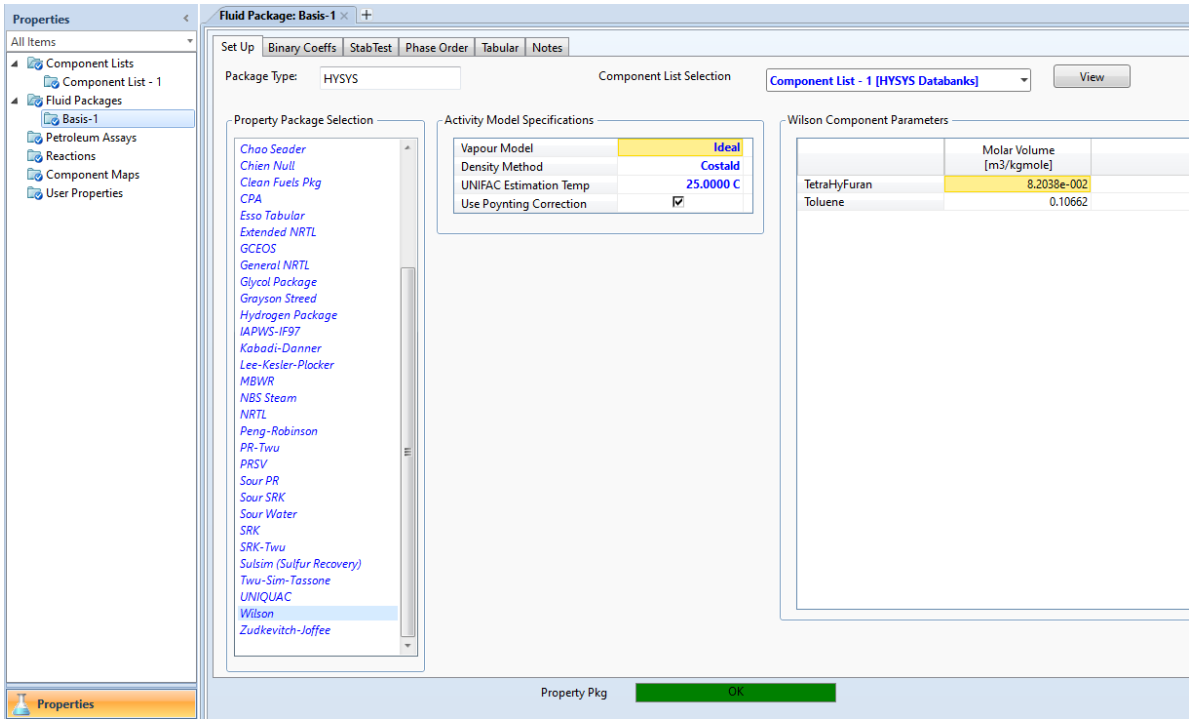
Under the condition that we have maximum profit

We are using **Aspen Hysys** to optimize the distillation column and will find reflux ratio and distillate rate at maximum profit condition.

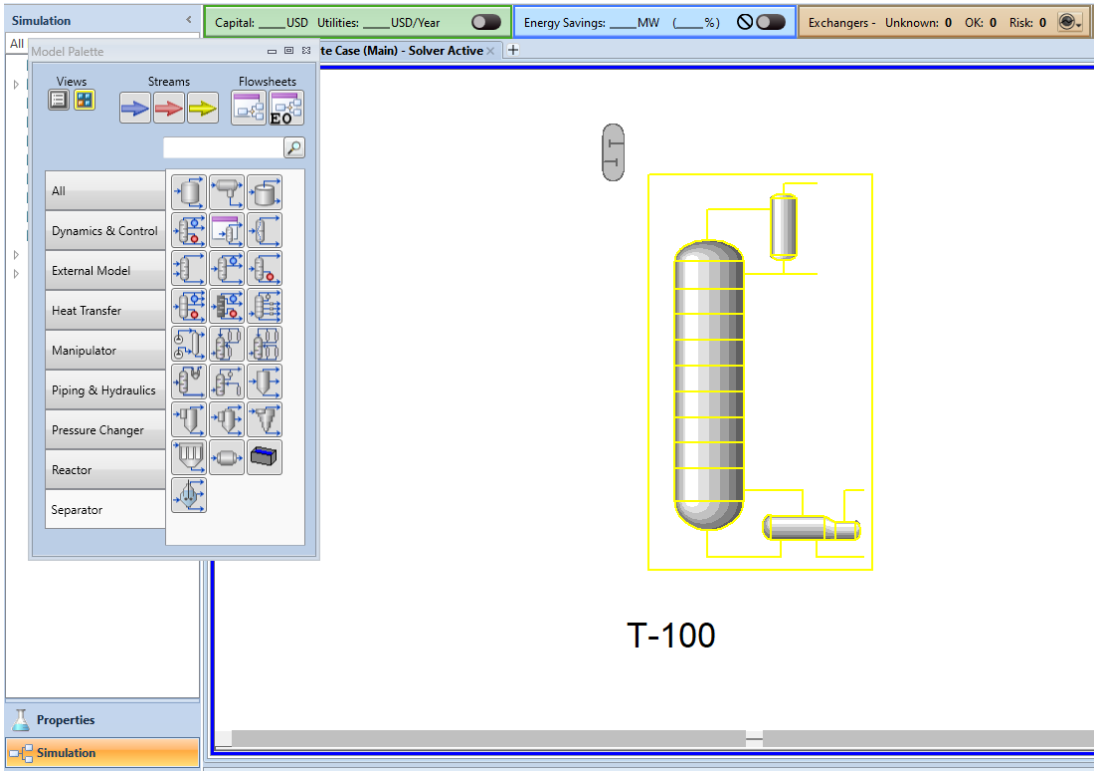
1. We start with choosing the components:



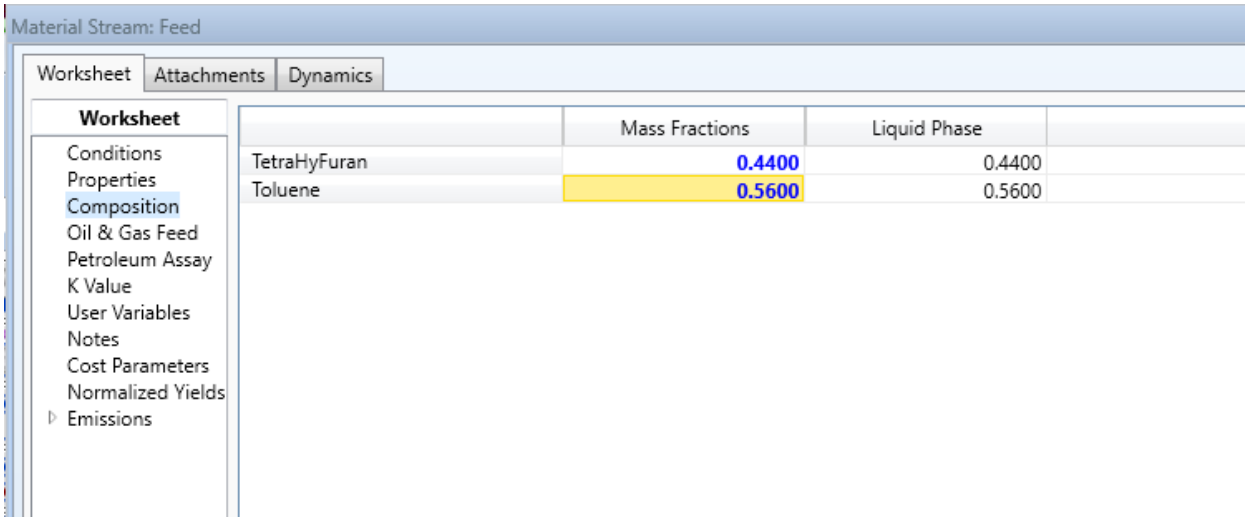
2. We choose the Wilson fluid package, then start simulation.

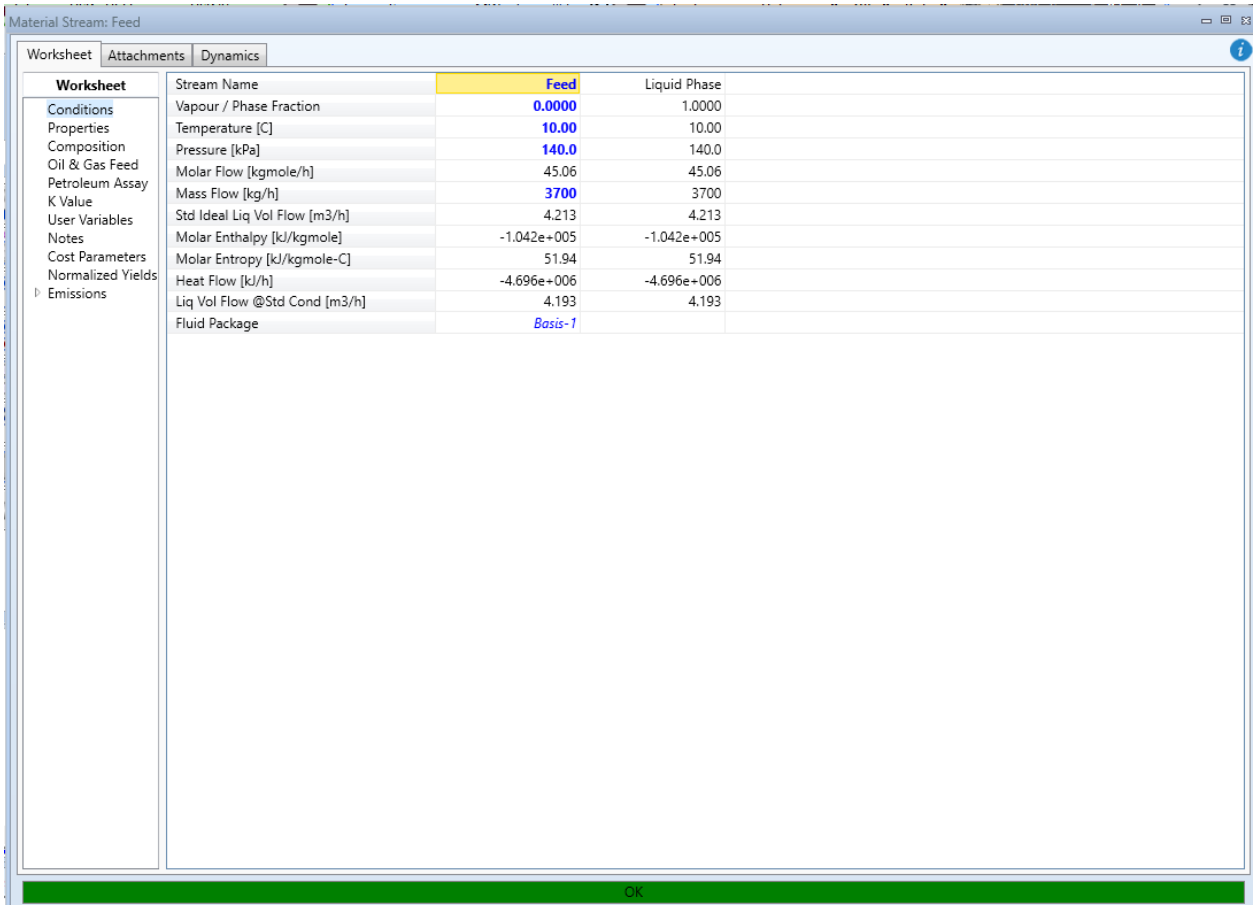


3. We brought out a distillation column.

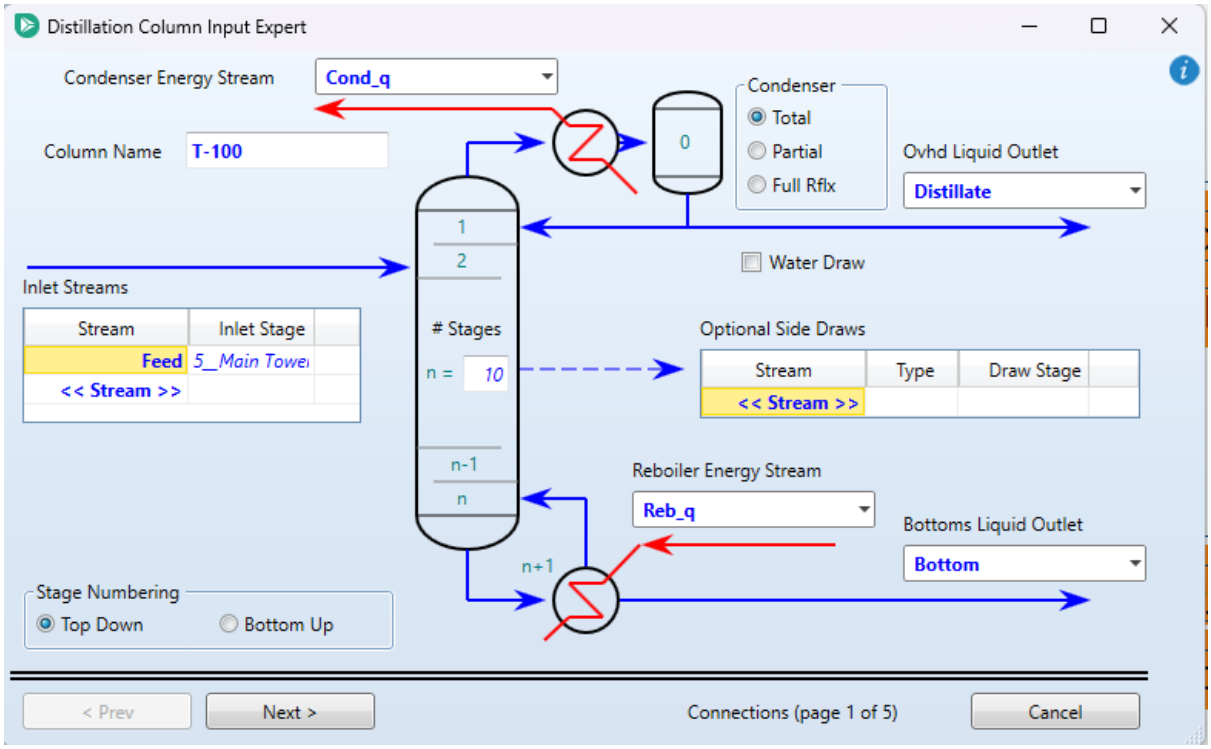


4. Set the initial conditions at feed, composition of feed etc.

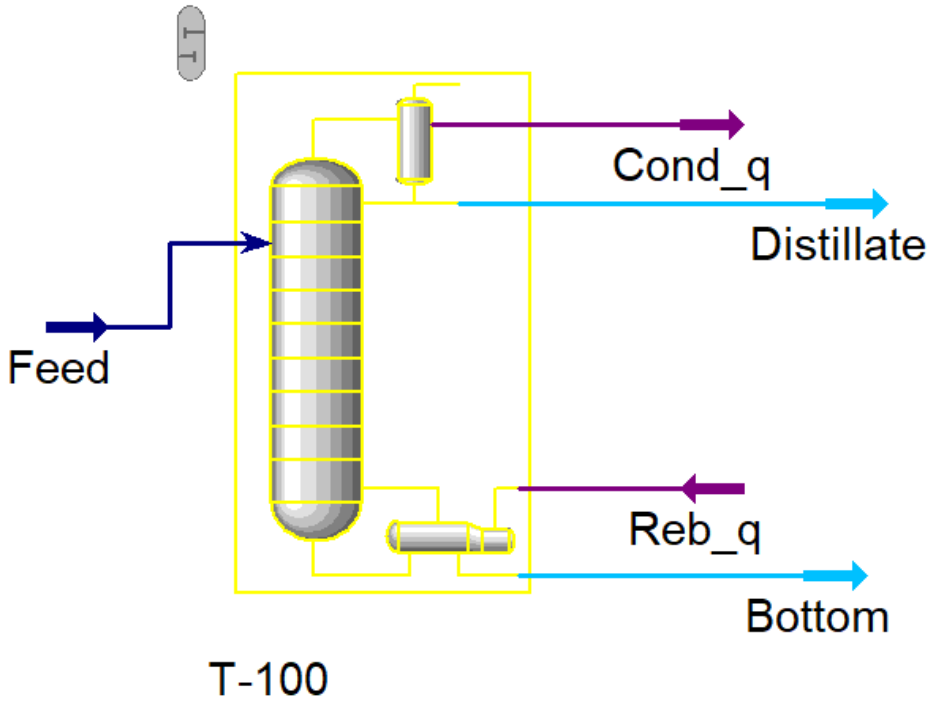




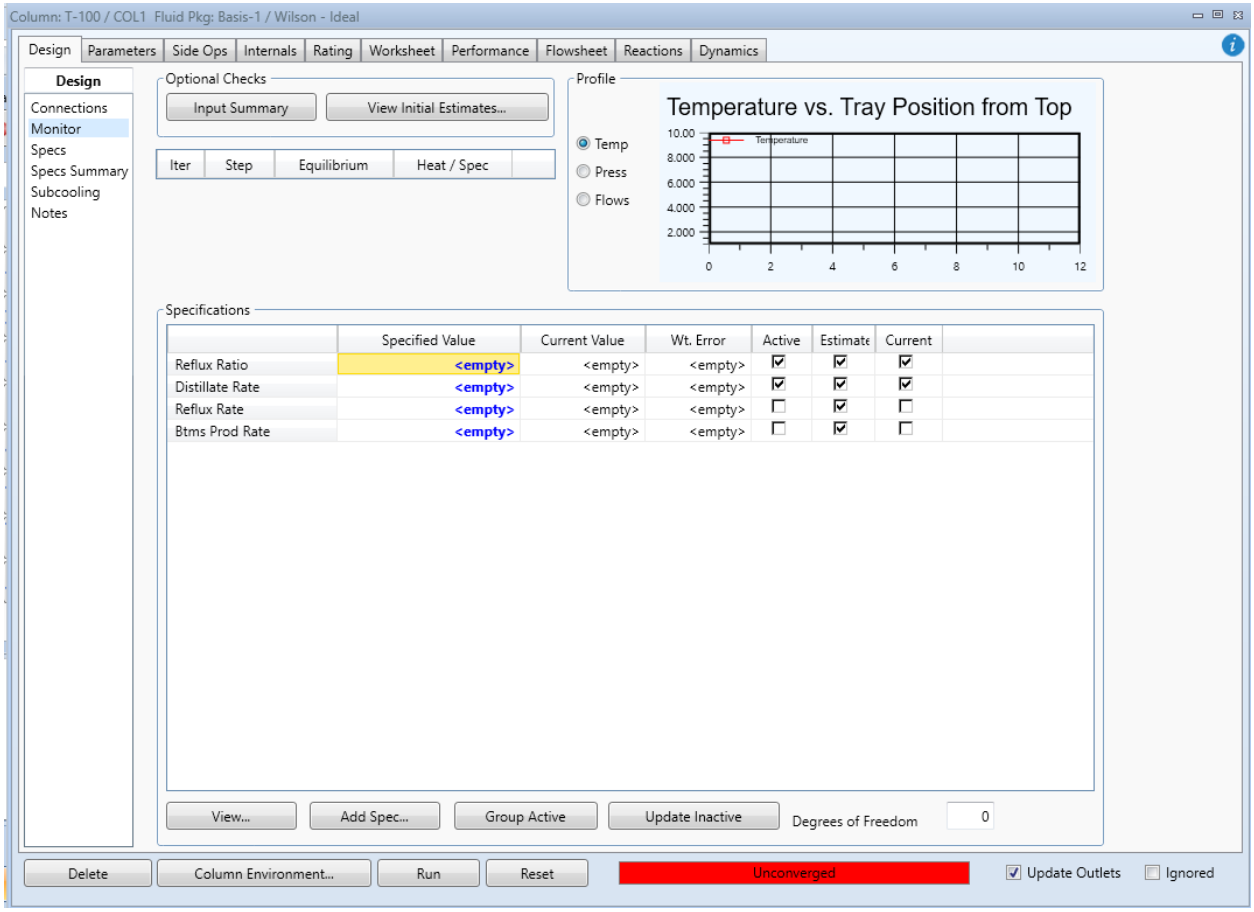
5. We are using 10 trays and total condenser here.



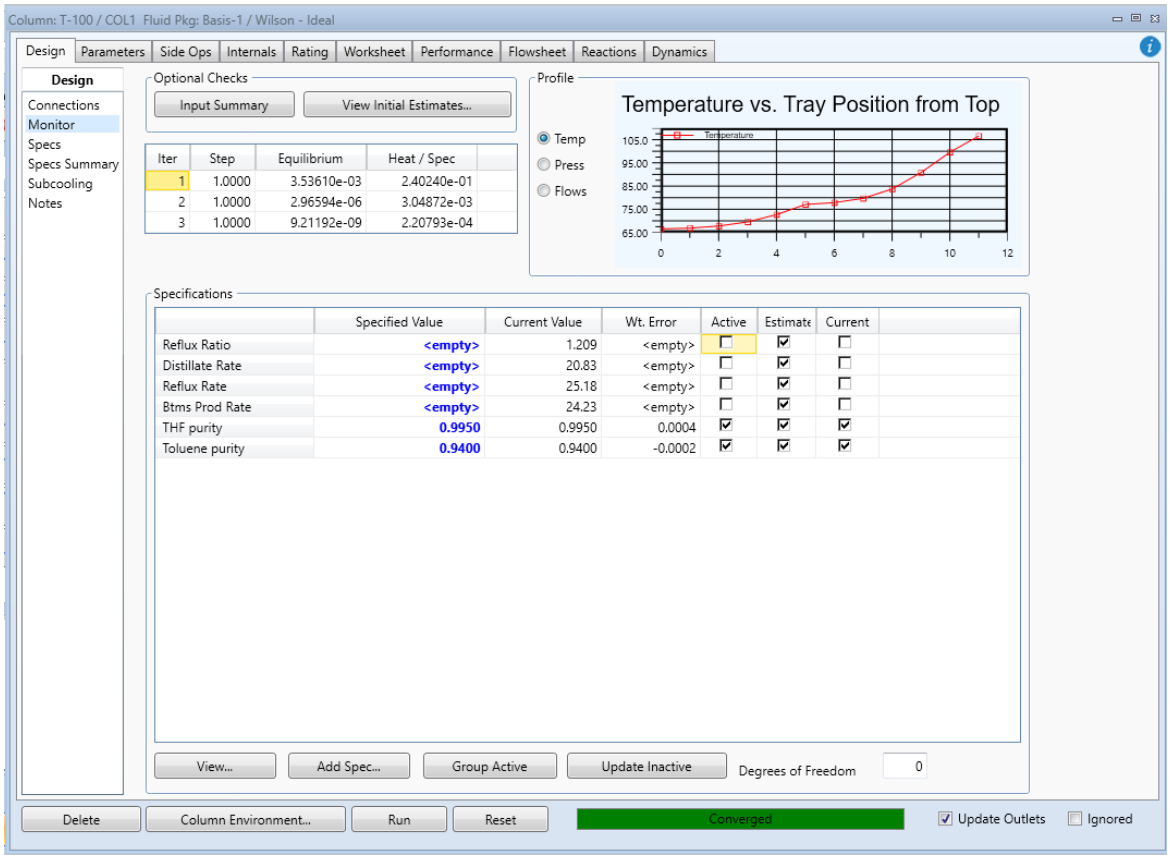
6. This is how our distillation column will look like with feed stream, distillate stream, bottom stream, condenser energy stream and reboiler energy stream.



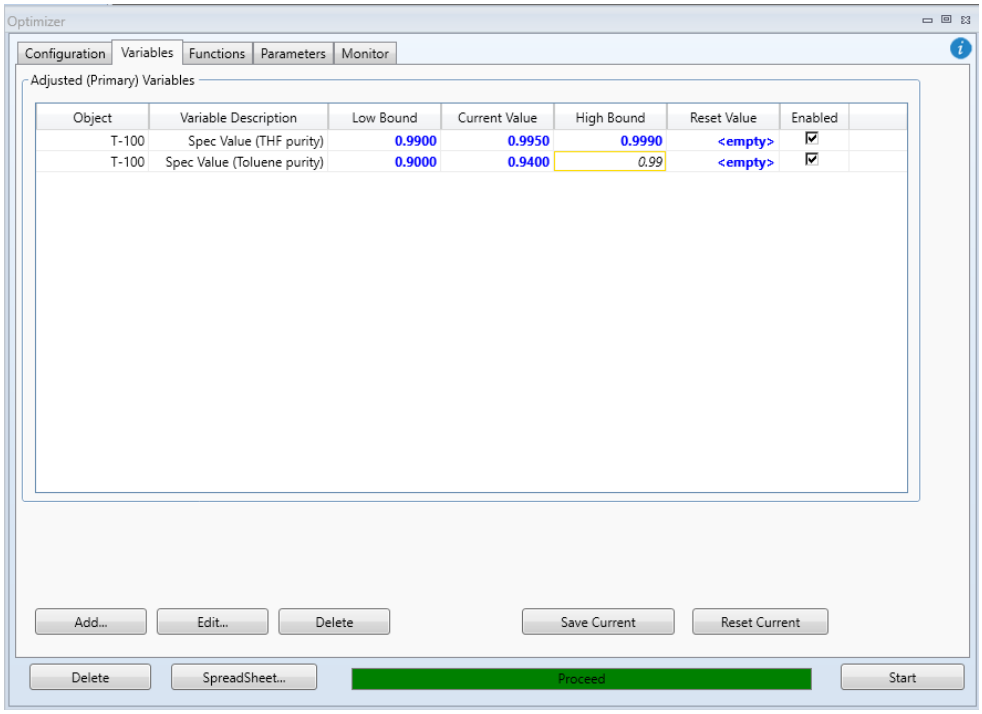
7. Initially we don’t have reflux ratio, distillate rate, etc. So we need to calculate that.



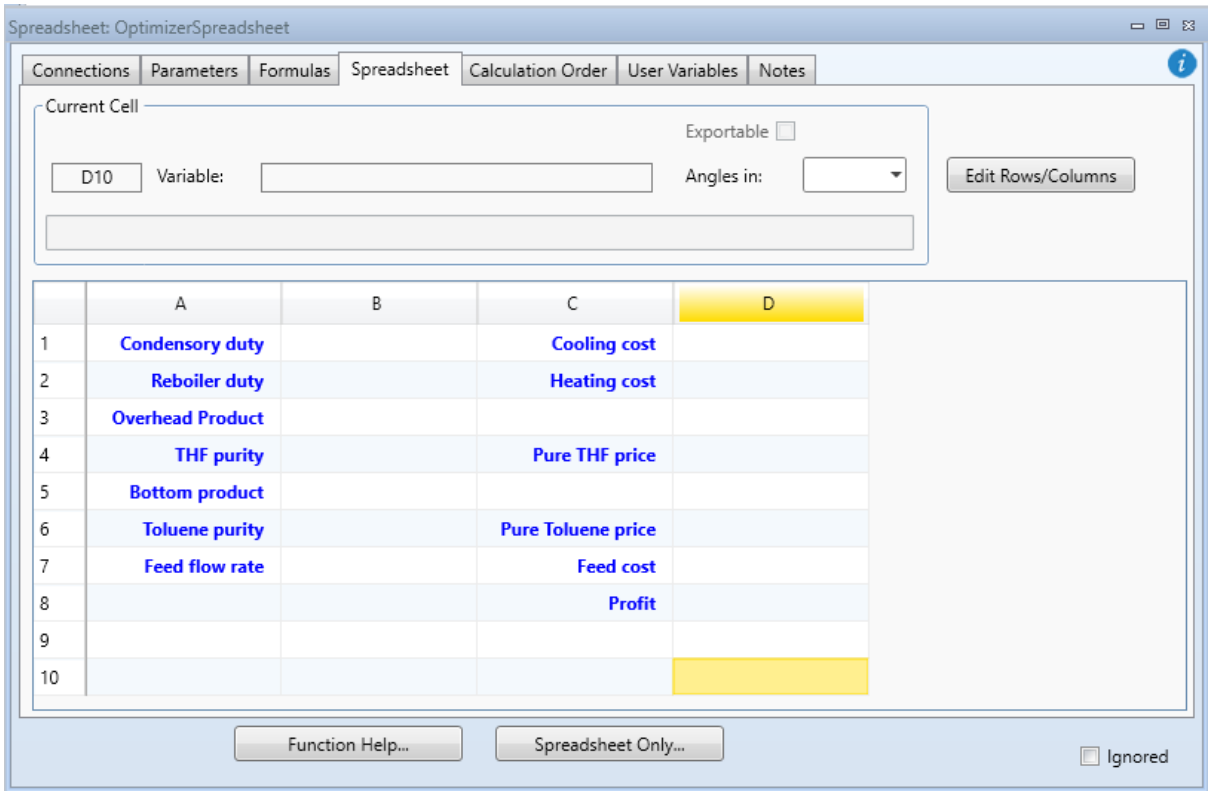
8. We add 2 new specifications i.e. the THF purity and Toluene purity which is given at 0.995 and 0.94 respectively.



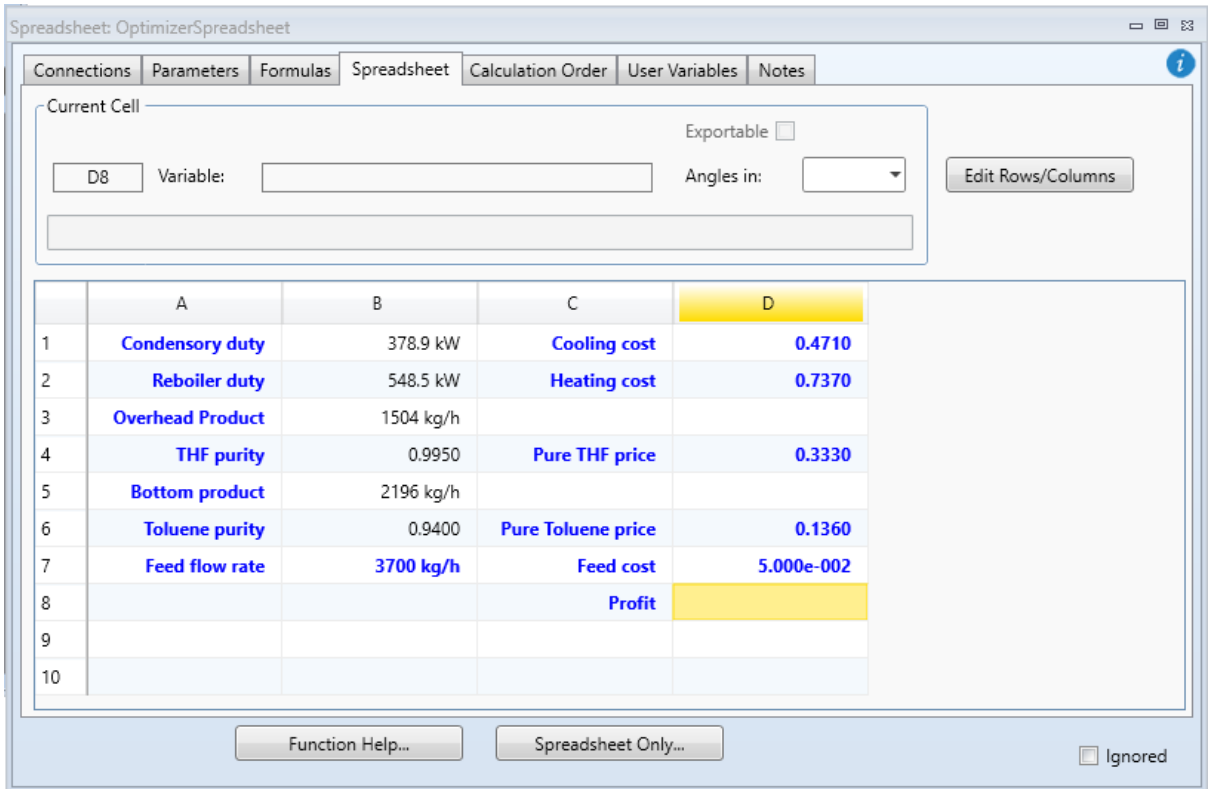
9. We set the upper and lower bounds for purity in optimizer.



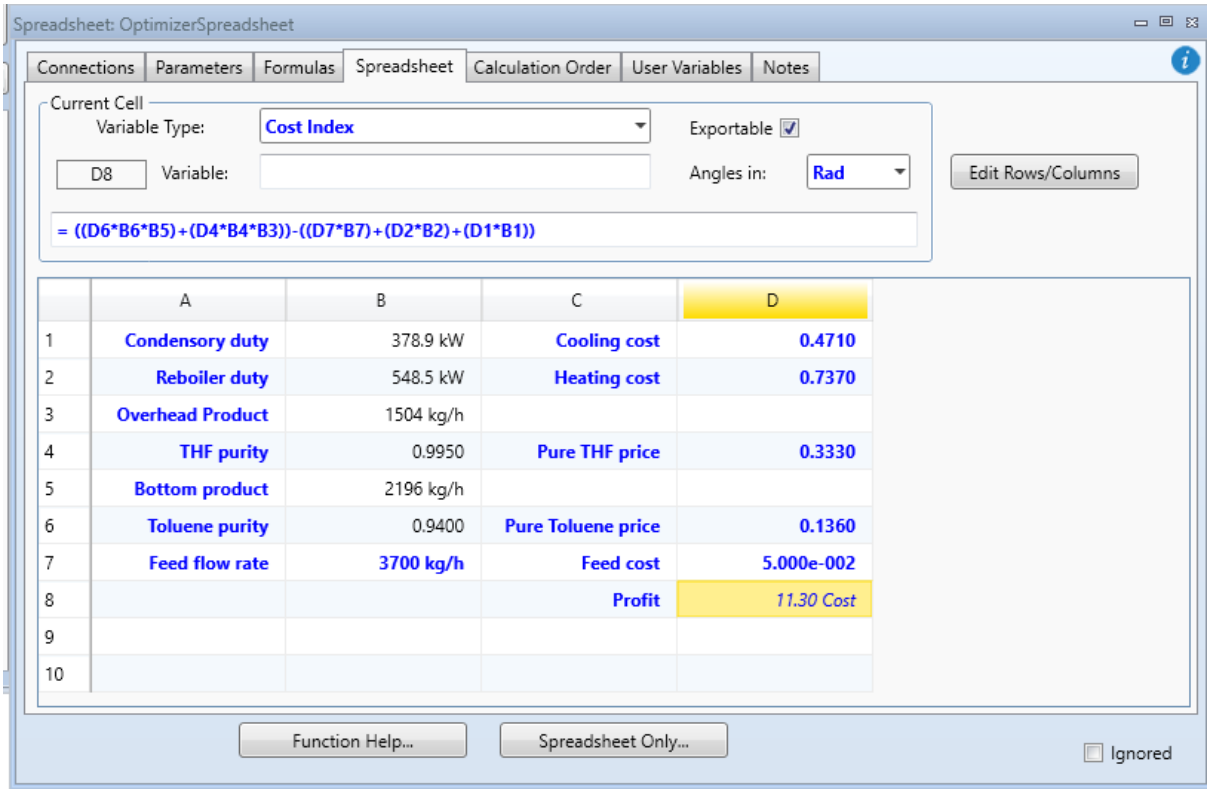
10. We form a spreadsheet with all necessary variables.



11. Exported the values of all variables.

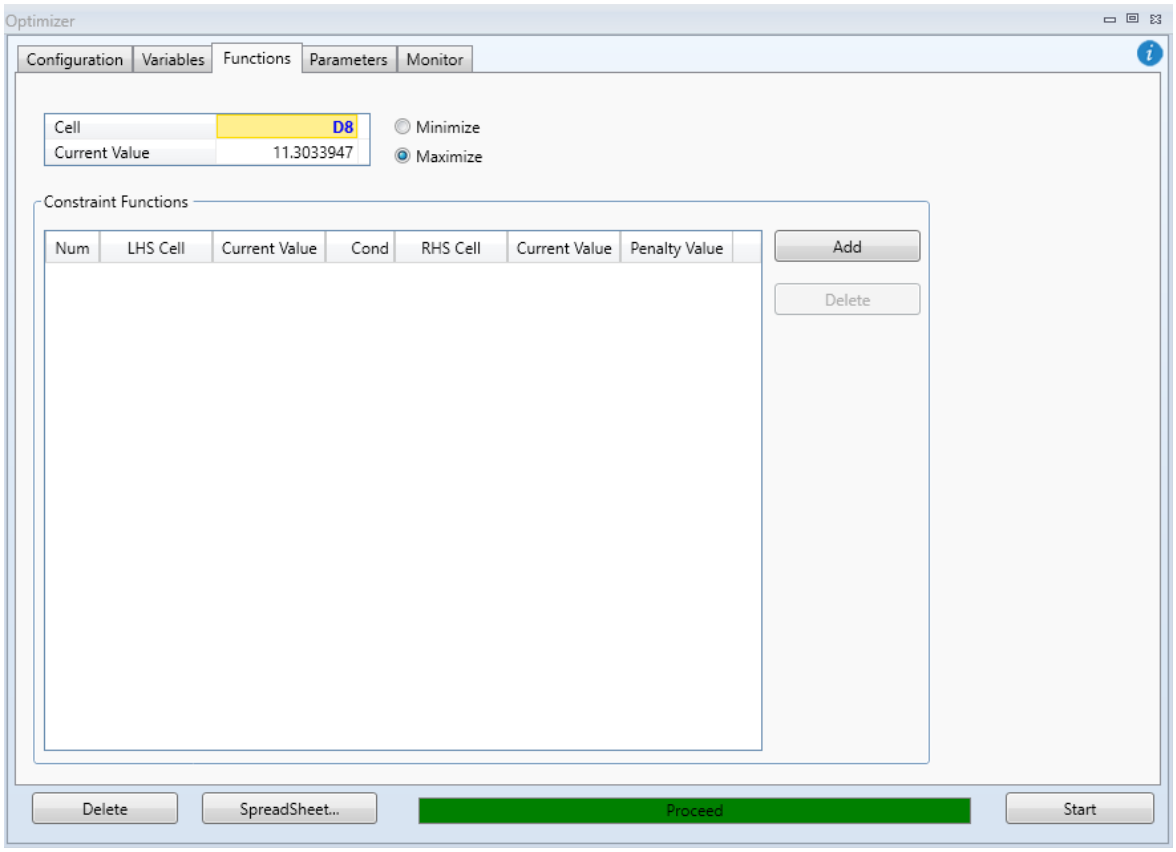


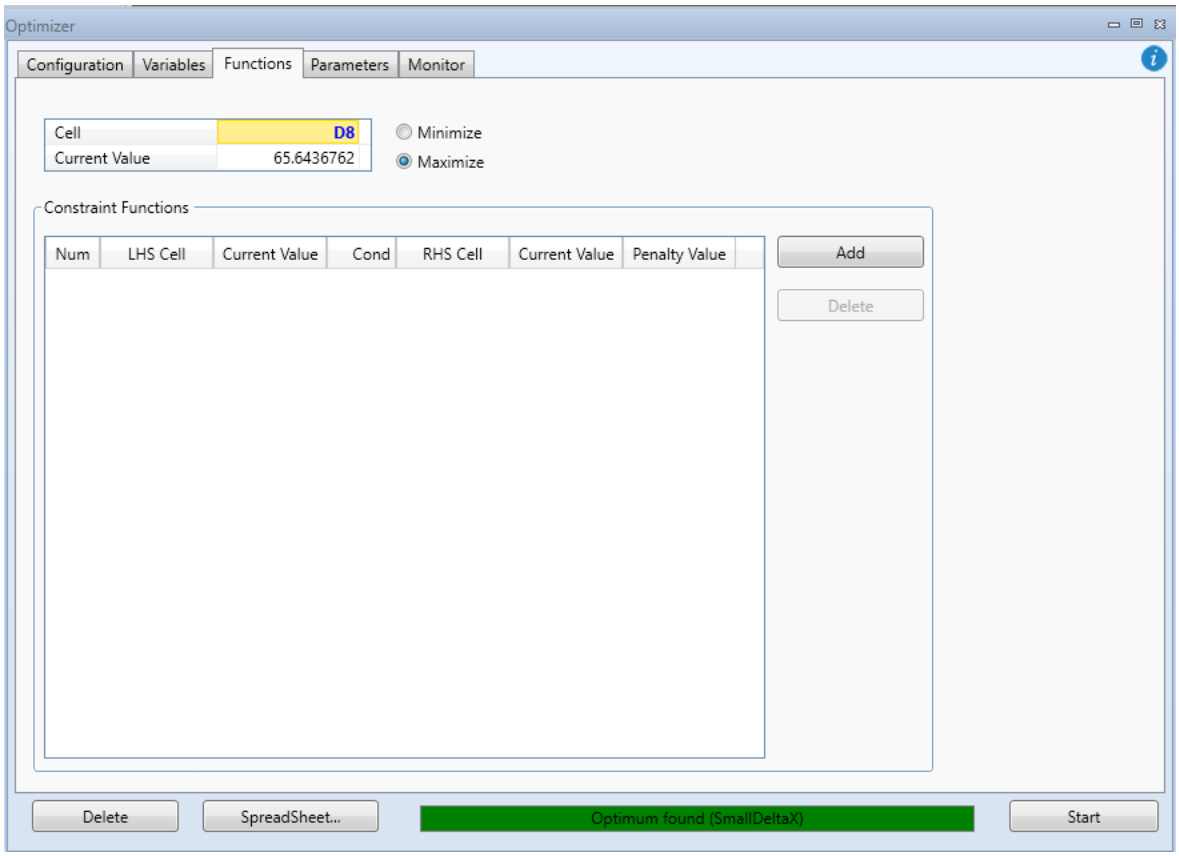
12. Calculate the profit by selling the pure THF and Tolune produced from distillation minus the cost of feed and hot utility and cold utility.



Initially the cost is coming out to be 11.3 $/hr.

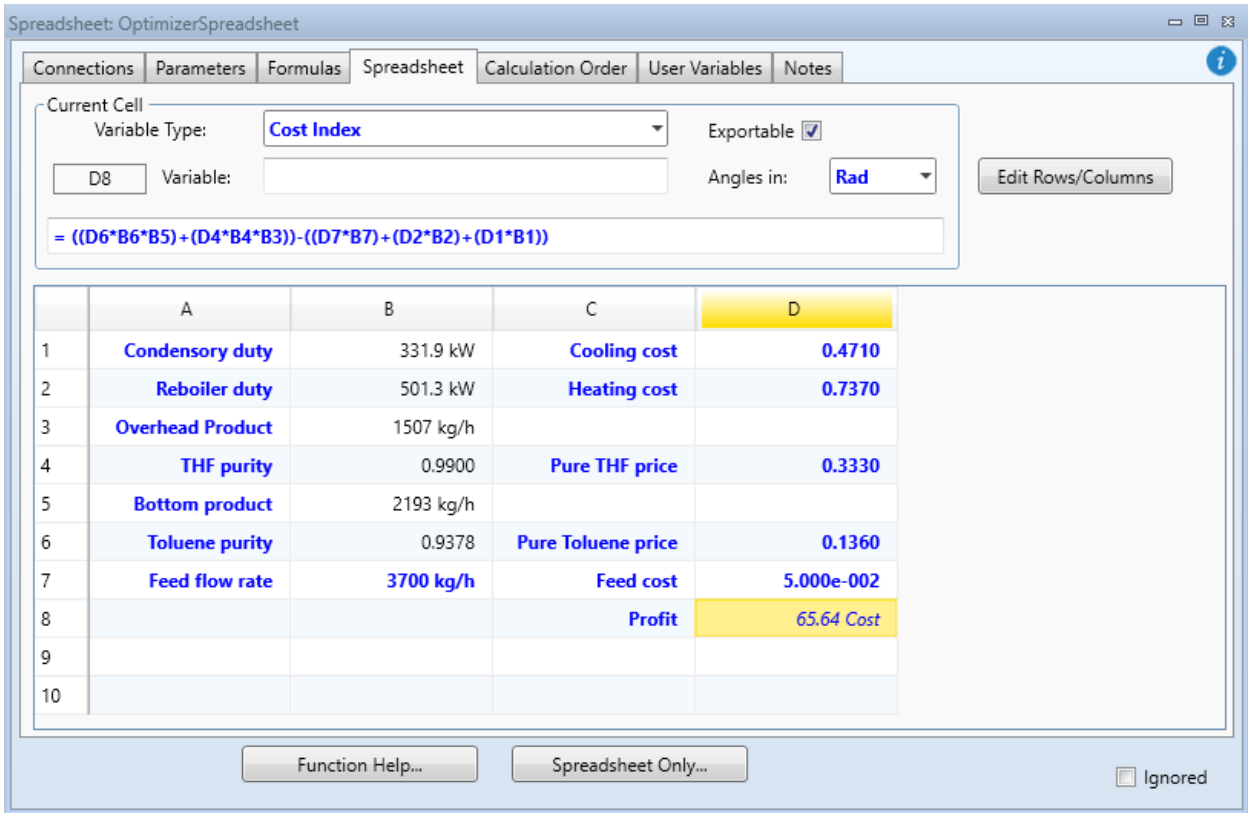
13. Then we go to the optimizer selected the profit cell and maximise it.



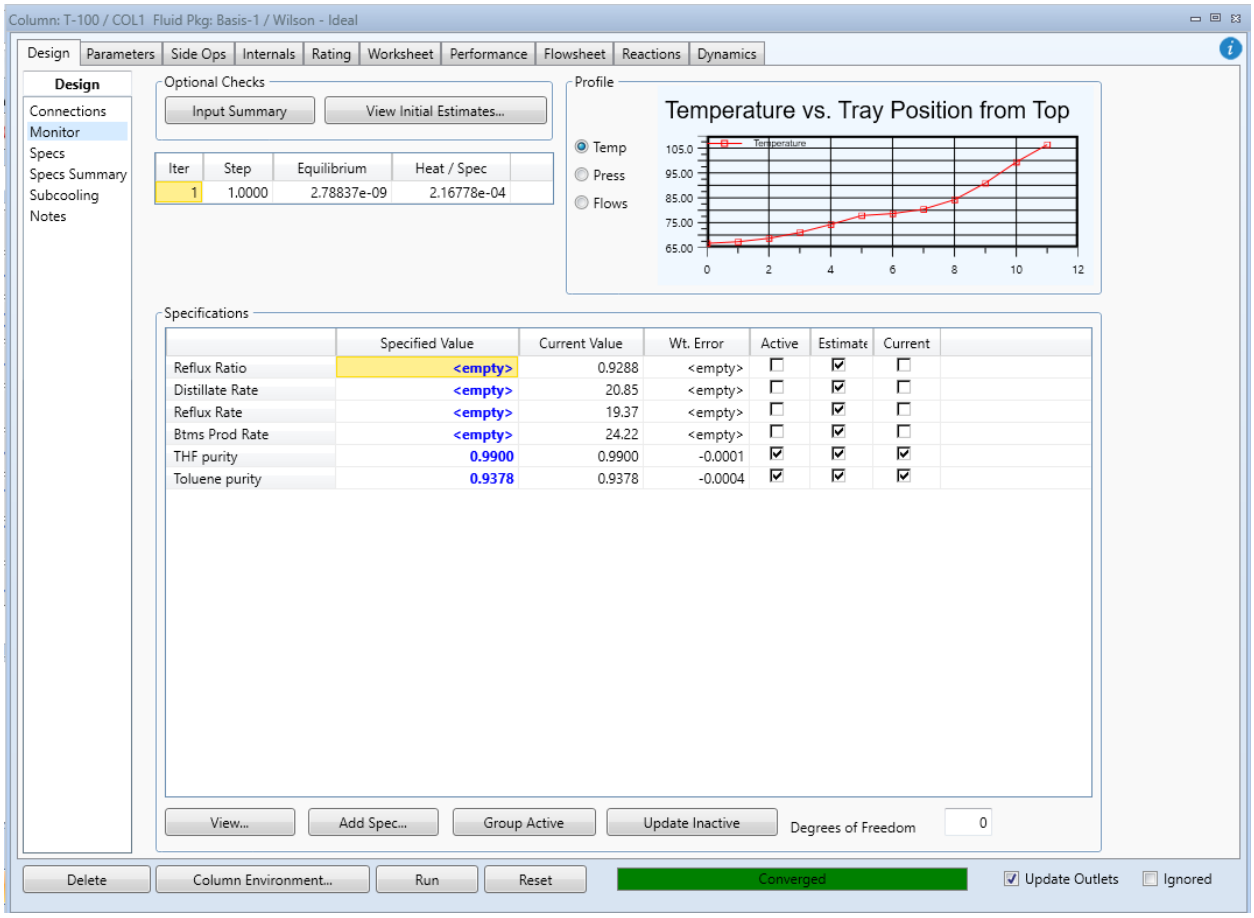


14. On maximizing the profit, the purity of THF and Toluene changes accordingly to give maximum profit.

Now the profit becomes **65.64 $/hr** from 11.3 $/hr initially.



15. Now we can take the values of reflux ratio, distillate rate at maximum profit condition.



At maximum profit condition:

- **Reflux ratio = 0.9288**
- **Distillate rate = 20.85**

THANK YOU