Politecnico di Torino

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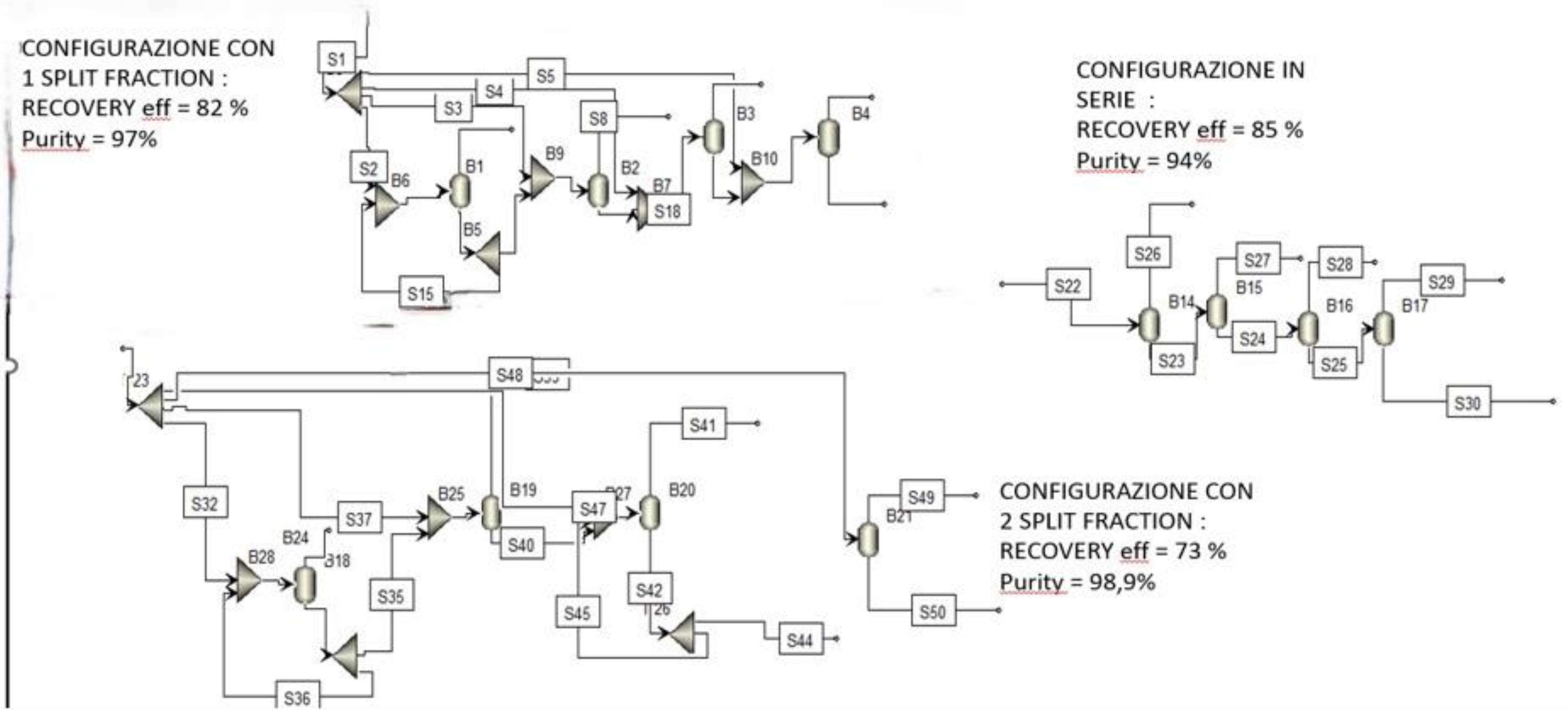
R134A configuration comparison



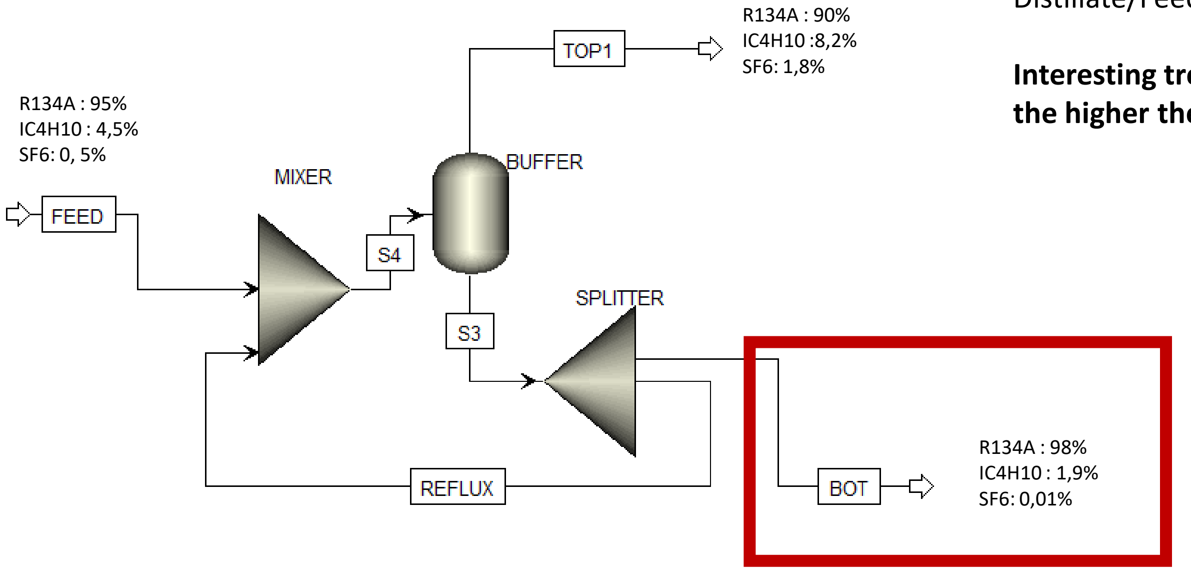
Three configuration of the R134a recovery system where simulated with ASPPEN to see what is the best configuration.

Inlet conditions :
Feed flowrate : 500 l/h
Temperature: -28.2 °C
Pressure : 1 bar

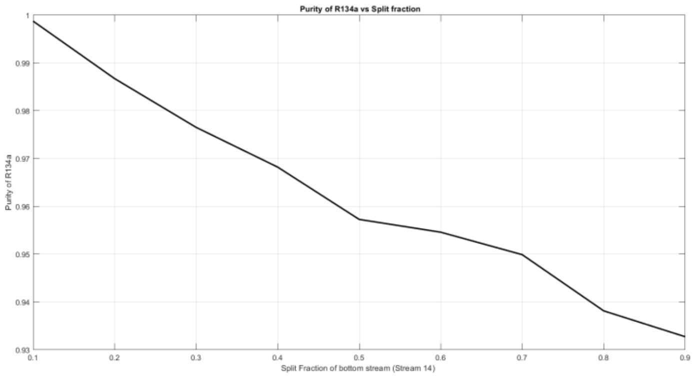
From the results of the simulations we can understand that:
The higher the number of recirculation loop, the higher the purity the lower the molar recovery.
BEST CONFIGURATION is with one recircuation loop to increase purity and to not loose to much on recovery.

Configuration of R134a BEST configuration with 1 recirculation:

Temperature of the Buffer : -28,2 °C
Pressure inside the Buffer : 1 bar
Split Fraction : 0.8(means that 80% of the S3 stream is reinjected in the buffer)
Purity achieved : 98 % of R134a
Molar recovery of R134a : 82 %
Thermal duty : -0,0377 KW
Bottom/Feed Ratio : 80%
Distillate/Feed Ratio : 20%



Interesting trend of the molar purity vs the split fraction by the more we reinject the higher the purity



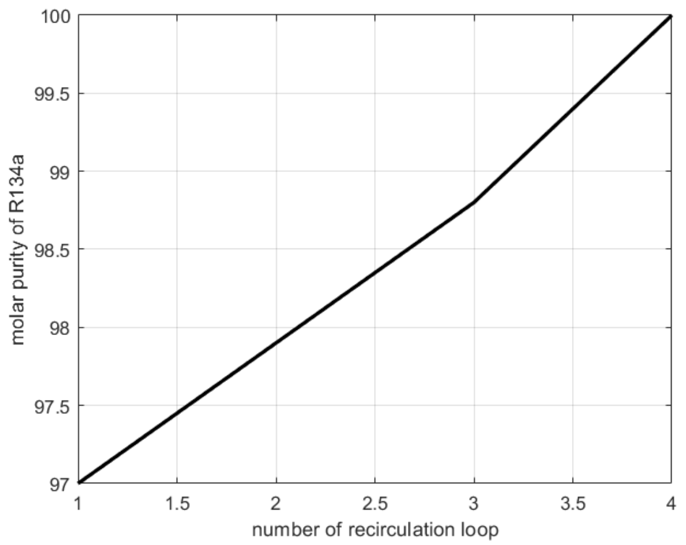
R134a configuration

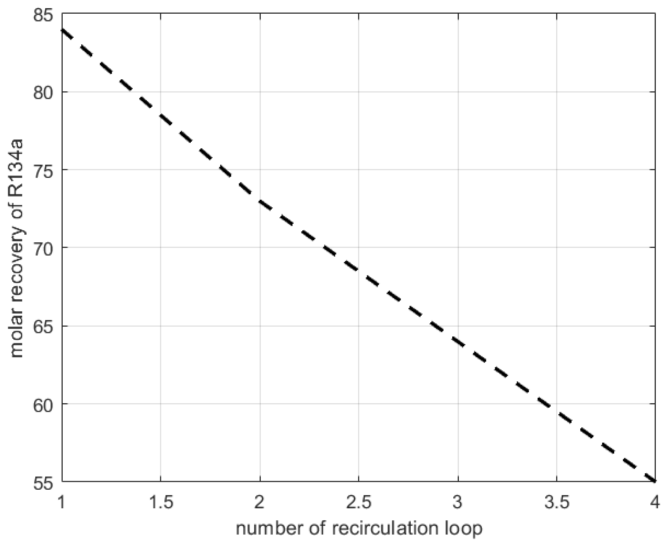
Results:

Configuration with split fraction:

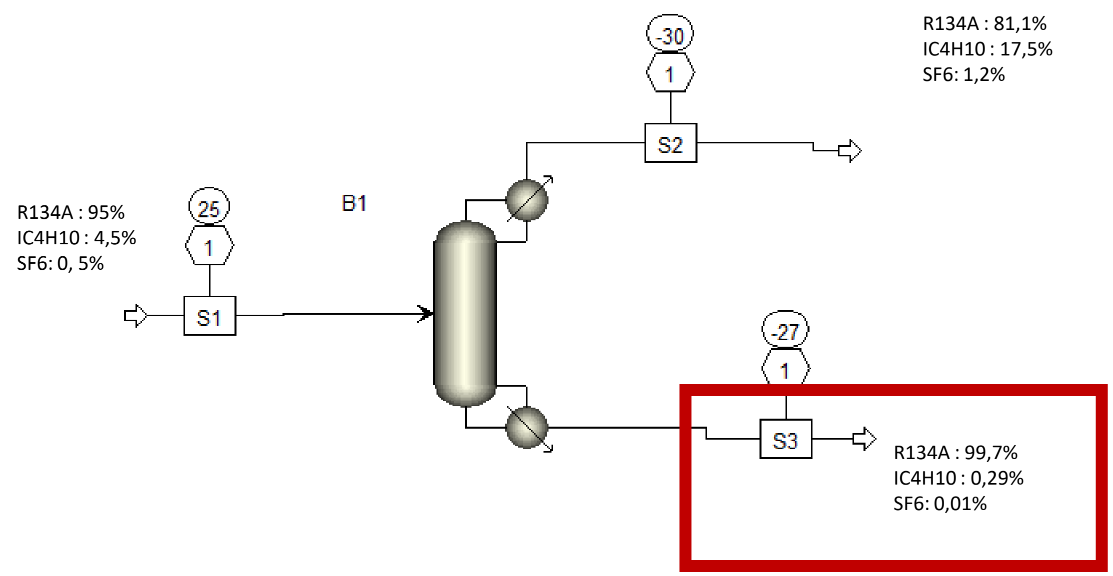
- For 1 recirculation loop purity level is 97% and molar recovery is 84%
- For 2 recirculation loop purity level is 97,9 %and molar recovery is 73%
- For each recirculation loop purity increases 1,8% while molar recovery decreases 13 % almost.

This means that by increasing the number of split fraction to 4 (1 for each column) we wil have a Purity of almost 99,98% and a molar recovery of 55%.





R134A with a single distillation column



Distillation column optimized performances for R134a system

Cond duty : -0,185 KW

Reb duty : 0,0767 KW

Reflux ratio : 6

Boilup ratio : 0,8

Feed stage : 4 above stage

N stage : 5

Purity : 99,7%

Recovery of R134a in bottom stream S3: 84 %

Bottom/Feed Ratio : 76%

Distillate/Feed Ratio : 24%

R134a COMPARISON Of the results

Comparison of the two systems

	R134A with 1 recirculation loop	R134A Distillation Column
Molar Recovery	82 %	84%
Molar Purity	98 %	99,7%
Thermal Duty required [KW]	-0,038	-0,251
Bottom/Feed Ratio	80%	76%
Distillate/Feed Ratio	20%	24%

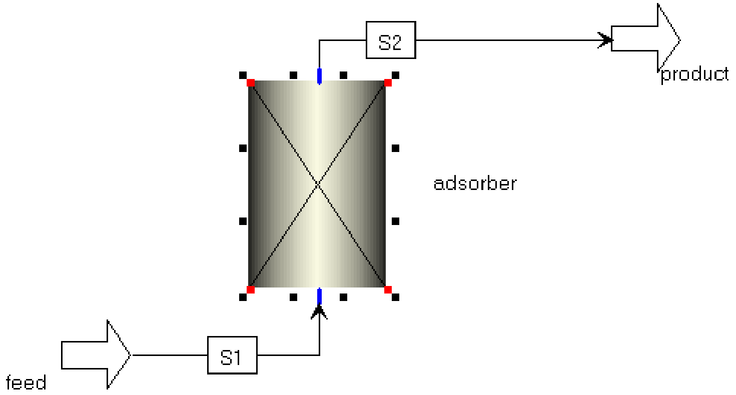
Distillation has higher performances but higher maintenance cost (Higher Thermal duty, required at the condenser) Huber unistat 915 w is suffficient to provide all the required frigories at the desired temperature.

R134a Conclusions

Conclusions:

- For current R134a system a recirculation loop could be tested in one line with the mentioned split fraction, to see if purity level is increased.
- For a possible new system of R134a -> results show that Distillation column with 5 stages is the best configuration, even if operational costs will be higher.

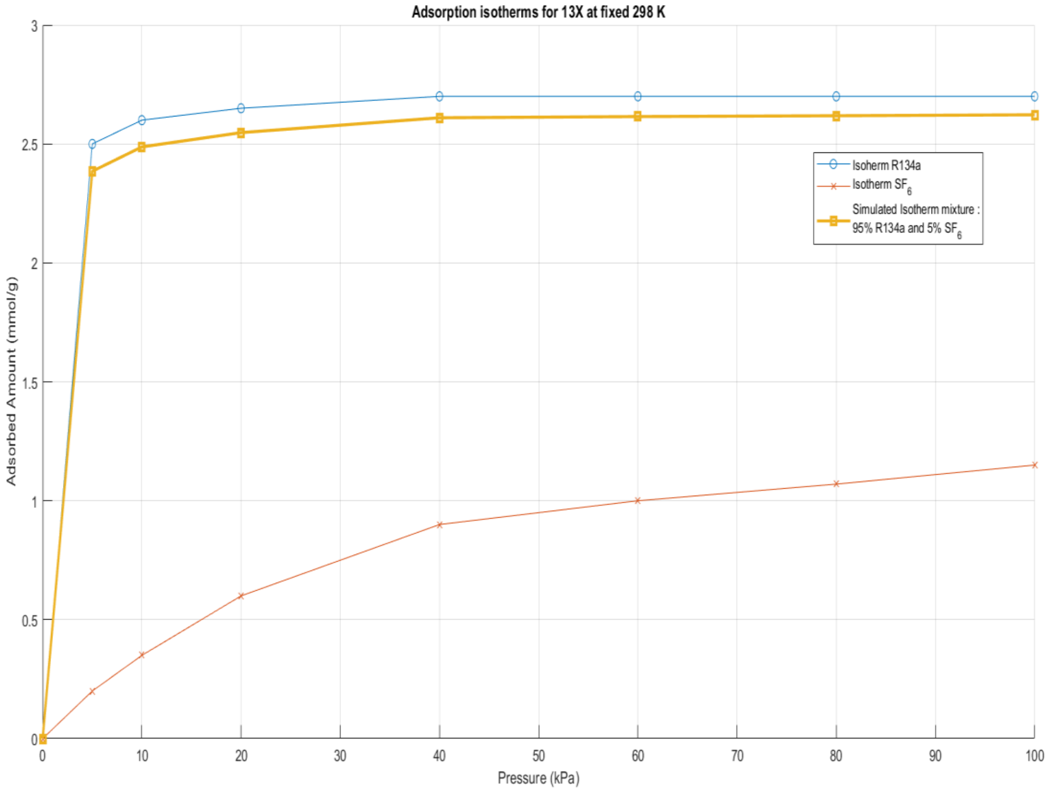
Aspen Adsorption Simulator



Setted conditions for the simulation:

- Temperature = 298 k
- Pressure ranges from 0 to 1 bar of pressure;
- Inlet composition: 95% R134a, 5%SF6 ;
- Flowrate = 2 -100 [l/h] ;
- Weight of the Adsorbent 13X: 100g
- Assumption of the model : dynamic gas model (unsteady condition)
- Number of layer 1
- 1D- spatial dimensions
- No internal heat exchange

Adsorption Simulation results



Results:

This graph, shows three isotherms. The three isotherms are
The yellow graph is a simulated one with Aspen Adsorption.
It tell as what are the mole of mixture gas adsorbed in molecular sieve 13 x respect to the pressure (kPa).

Result of simulated data:

At 1 bar of pressure the capacity of adsorption (C_{ads})of the 13x is :

$$C_{ads} = 2{,}62 \frac{mmol\ of\ gas\ adsorbed}{g\ of\ adsorbent}$$

We can easily calculate the time required for saturating 13x, t_{ads}:

$$t_{ads} = m_{adsorbent} \times \frac{C_{ads}}{n_{ads}}$$

Where:

- $m_{adsorbent}$ is the mass of the adsorbent 13X (g)
- C_{ads} is the capacity of Adsorption (mmol/g)
- n_{ads} is the molar flowrate in (mol/min)

Example:

if we use 100 g of 13x , with gas mixture compoused of 95% freon and 5% at 2 l/h (0,001371 mol/min) .
The molecular sieve will reach its maximum filling capacity after 3 hours.