Propylene Distillation by means of Vapour Recompression

Davara Dharmik G., Pandav Mukund G., Devganiya Darshan I.

Government Engineering College, Valsad

(dgdavra29@gmail.com , mukundgpandav9586@gmail.com)

1. INTRODUCTION:

The separation of propane/propylene mixturesis very important commercially for the chemicalandpetrochemical industry. Propylene is used in theproduction of polypropylene, acrylonitrile, acrylicacid,isopropanol, cumene, phenol, gasoline blend,trimmers, tetramers for detergents, propyleneoxide, and oxo-alcohols. Nowadays, the propylene and propane are separated by distillation. Such process demandsa great amount of energy because of the resemblance in their relative volatilitiesPropylene in a purity degree above 99.5% is a first-generation basicpetrochemical that represents a vital link in refining-petrochemical integration. The strict specification of the product and the need to maximize the energy efficiency of the propylene/propane distillation process poses several challenges to the optimization of both the design and operation of the plant. Using a Petro-SIM (KBC) technology, a polymer grade general model from a propylene distillation unit was developed by means of vapor recompression. The sensitivityfor feeding with different propylene fractions was analyzed, reaching a value of 0.94, which is considered the minimum propylene fraction in the feed required to the tower to generate a product with polymer purity grade. Based on the data obtained in the simulation, the tower was designed and evaluated by means of vapor recompression, showing a potential alternative way to obtain propylene at polymer grade which could be cost saving in industrial processes. The property packages Peng-Robinson(PR) is used in this flowsheet.

2. DEVELOPMENT OF FLOWSHEET IN DWSIM:

All the specifications of the unit operations and thermodynamics are elaborated in theliterature. So we have used all the specifications as they are. Here, we have used UNIFAC asthe thermodynamic property package instead of UNIQUAC (used in literature).For more details about the unit operation specifications and the stream properties, please refer to the flowsheet and literature .

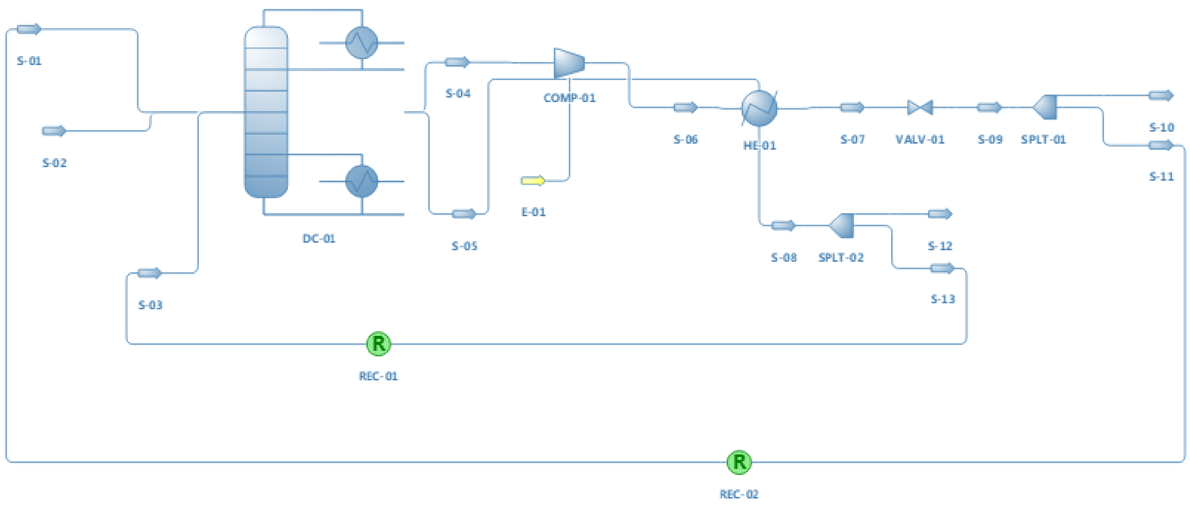

Fig.1 Flowsheet of Propylene Distillation by Vapour Recompression in DWSIM

3. PURPOSE OF STUDY:

The tower was designed considering valve trays. The sizing resulted in a diameter pursuant to that found in the literature for other processing systems with the same load, which shows that it is suitable for applications in processes already used in industrial operation.

4. DESCRIPTION OF FLOWSHEET:

Propane and propylene have similar molecularsizes and physical properties, which makes the process of separation problematic. The plant design was assembled according tothe vapor recompression distillation systemdiscussed by Kazemi et al. (2018). The distillationtower was simulated with 190 theoretical stageswith the main feeding into stage 121. Two recycles,one from the bottom stream fed into tray 190 andanother from the top stream fed into stage 1 wereconsidered. The thermodynamic package used wasPeng Robinson, The separation is generally performed in towers with a stage number between 150 and 200, with high reflux and high pressure (1600 to 2640 kPa), requiring high energy. This justifies the use of 190 stages at the tower andhigh pressure (2200 kPa). According to Roeentan et al. (2017), distillation columns up to 100 m height that include about 200 trays with very large reflux ratio are usually required. Besides that, the number of trays is related directly to the column capital cost. A higher tray number means higher capital invested in the tower and a reduction on the capital invested in the heat exchanger, also reducing energy costs. Likewise, high pressure values lead to a decrease in the column diameter, as the vapor density increases.The simulation was also studied by varying the propylene molar fraction in the main feed stream.

In this study, the main feed composition stream was considered to contain propylene and propane. This analysis was carried out to obtain, for the same processing conditions, the feed containinglower propylene molar fraction that still provided PGP as the product from the top stream. The more propylene at the feed also contributes to more propylene at the top and bottomstream.

5. RESULT:

Object	S-01	S-02	S-03	S-04	S-05	S-06
Temperature (K)	326.097	348.75	330.543	326.098	330.306	388.447
Pressure (kPa)	2200	2240	2240	2200	2240	5226.2
Mass Flow (kg/h)	203308	15867.5	203638	218259	204524	218259
Molar Flow (kmol/h)	4830.52	376.4	4725.84	5185.74	4746.4	5185.74
Mass Fraction (Mixture) / Propane	0.0044	0.039539	0.51299	0.0044	0.51299	0.0044
Mass Fraction (Mixture) / Propylene	0.9956	0.960461	0.48701	0.9956	0.48701	0.9956

S-07	S-08	S-09	S-10	S-11	S-12	S-13
351.85	330.543	326.097	326.097	326.097	330.543	330.543
5226.2	2240	2200	2200	2200	2240	2240
218259	204524	218259	14950.7	203308	885.792	203638
5185.74	4746.4	5185.74	355.223	4830.52	20.5567	4725.84
0.0044	0.51299	0.0044	0.0044	0.0044	0.51299	0.51299
0.9956	0.48701	0.9956	0.9956	0.9956	0.48701	0.48701

6. REFERENCE:

Fontana, M., Fernandes, L. M., & Souza, T. A. (2019). DESIGN AND EVALUATION OF A SYSTEM TO OBTAIN POLYMER GRADE PROPYLENE BY MEANS OF VAPOR RECOMPRESSION DISTILLATION. Brazilian Journal of Petroleum and Gas, 13(4).