Optimization of NGL Recovery Process

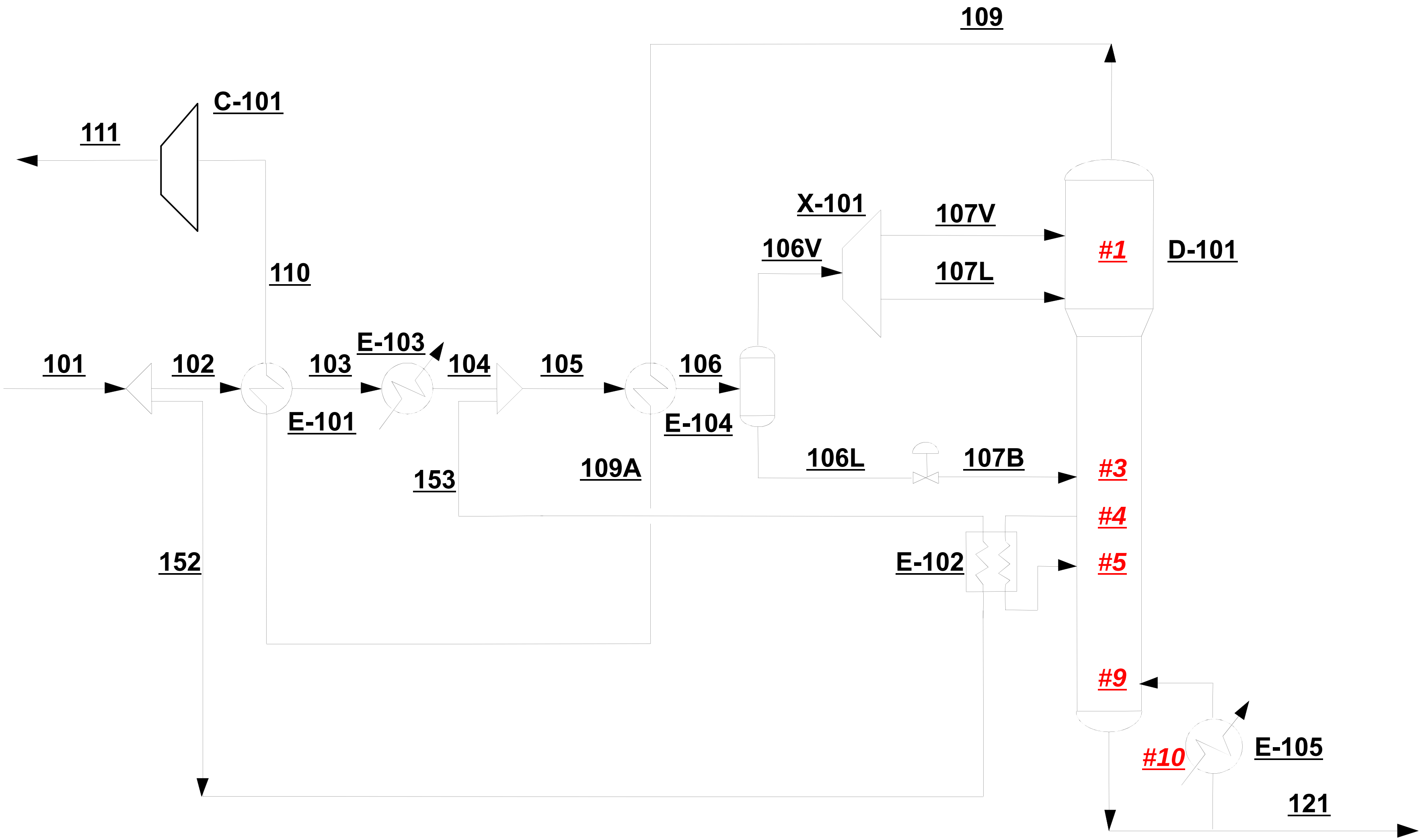
공주대학교 화학공학부

<u>조 정 호</u>

NGL Recovery Process Problem:

- In this problem you will design the Turbo-Expander Gas Plant shown in Figure 1.
- The purpose of this process is to recovery NGL from a natural gas feed. This is accomplished by cooling the natural gas stream through a combination of combined heat exchangers and expander to a temperature low enough to condense the heavier compounds from the gas stream and then final separation of methane and lighter from NGL is done in demethanizer.

Schematic Diagram of NGL Fractionator



Process Description

- Gas is dehydrated usually by molecular sieve.
- Gas is partially chilled by back-exchange with residue gas.
- Gas is further chilled by refrigeration system
- Gas is further chilled demethanizer overhead gas.
- Extremely low temperature stream is obtained by letting-down the pressure using turbo-expander.
- Ethane & heaviers are obtained by fractionation.

Feedstock Information

Component	Mole%
1. N2	1.61
2. CO2	0.20
3. C1	84.80
4. C2	8.86
5. C3	3.05
6. IC4	0.49
7. NC4	0.53
8. IC5	0.12
9. NC5	0.09
10. NC6	0.25
Temperature, F	85.0
Pressure, psig	753.0
Flow, lb/hr	312,674

Product Specifiations

- C1/C2 molar ratio: 0.0119
  - Methane molar flow divided by ethane molar flow at demethanizer bottom stream
- Ethane recovery at DeC1 column bottom: 75%
  - 75% or higher ethane recovery ratio at demethanizer bottom stream is required.

Determine the Followings

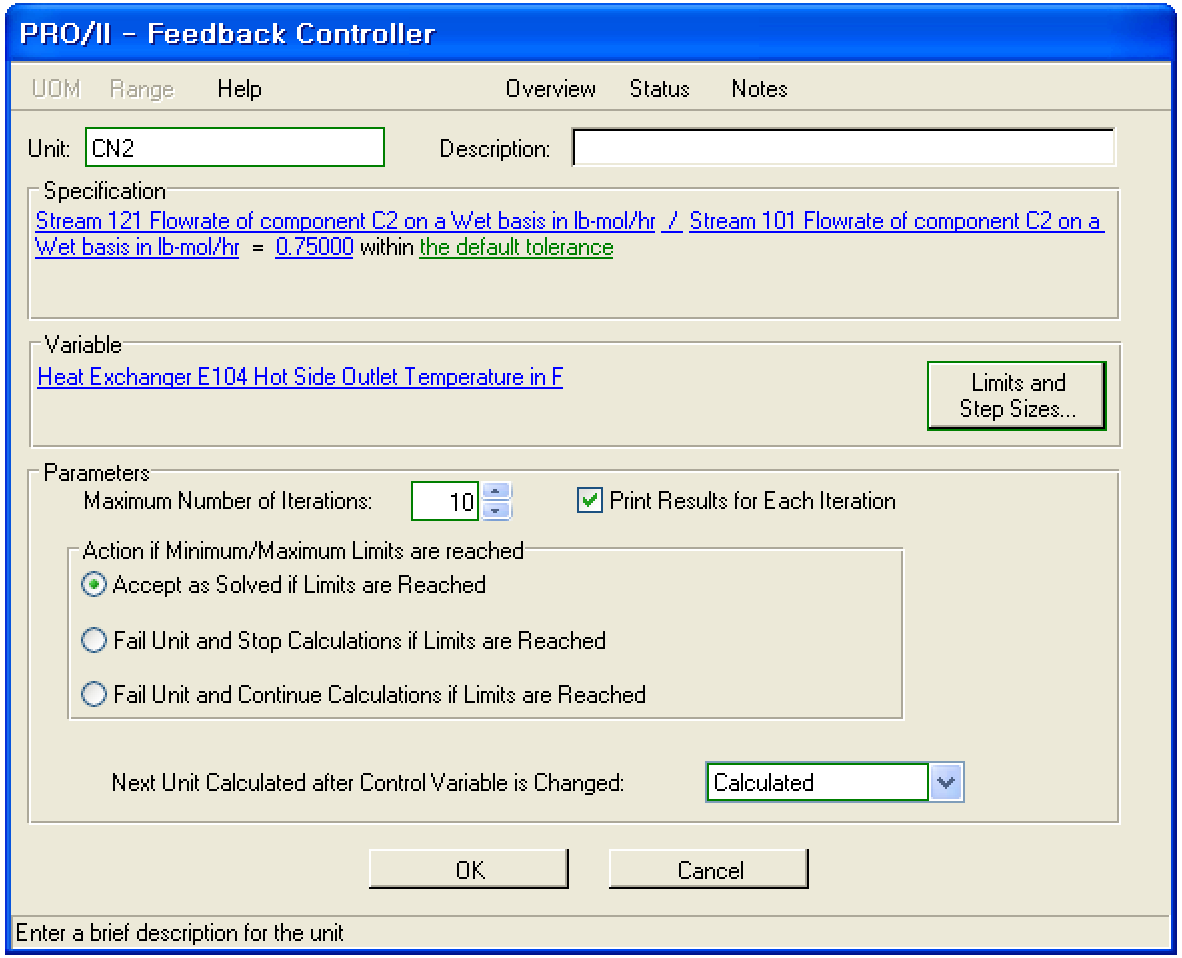
- Demethanizier Top Pressure
  - If it is too low, compressor power consumption will be increased.
  - If it is too high, additional refrigeration duty will be increased.
- Natural Gas Feeding Temperature to the Flash Drum
- Maximize the Side Reboiler Duty and Minimize the Refrigeration Duty

Thermodynamic Model

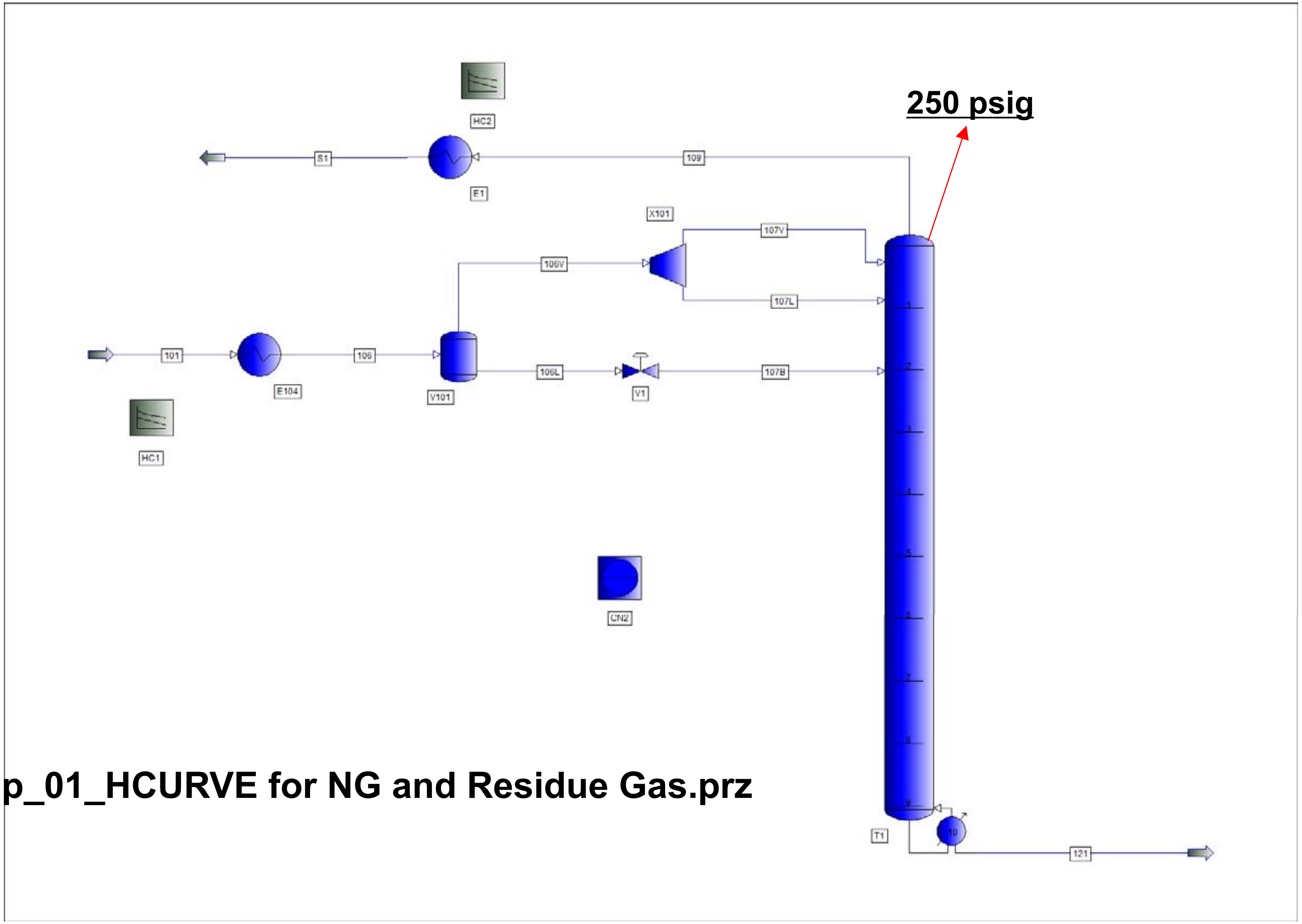
- Equation of State Approach:
  - Soave-Redlich-Kwong
  - Peng-Robinson
  - Benedict-Webb-Rubin-Starling

Step 1:

Flash Drum Temperature Estimation at 250 psig of DeC1

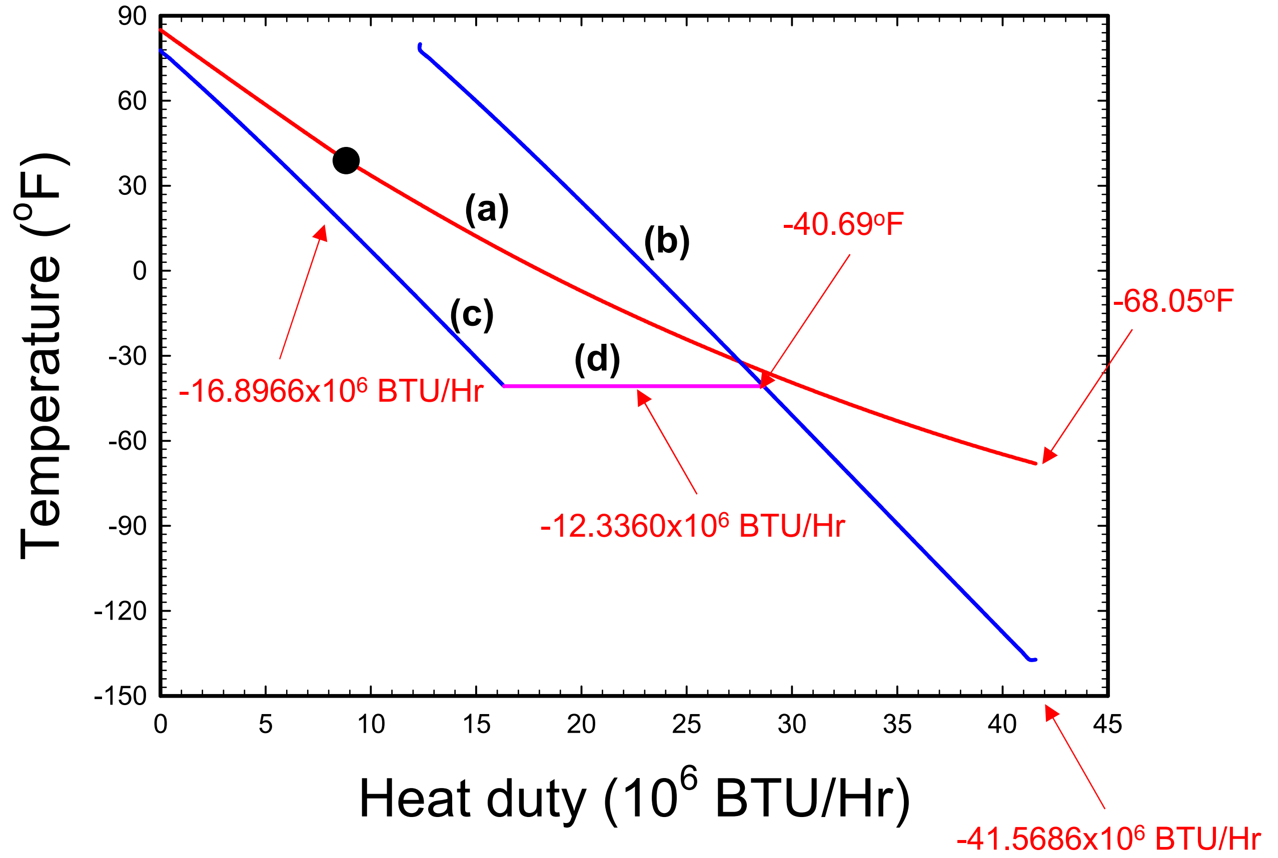


Flow Sheet Drawing Using PRO/II



Step_01_HCURVE for NG and Residue Gas.prz

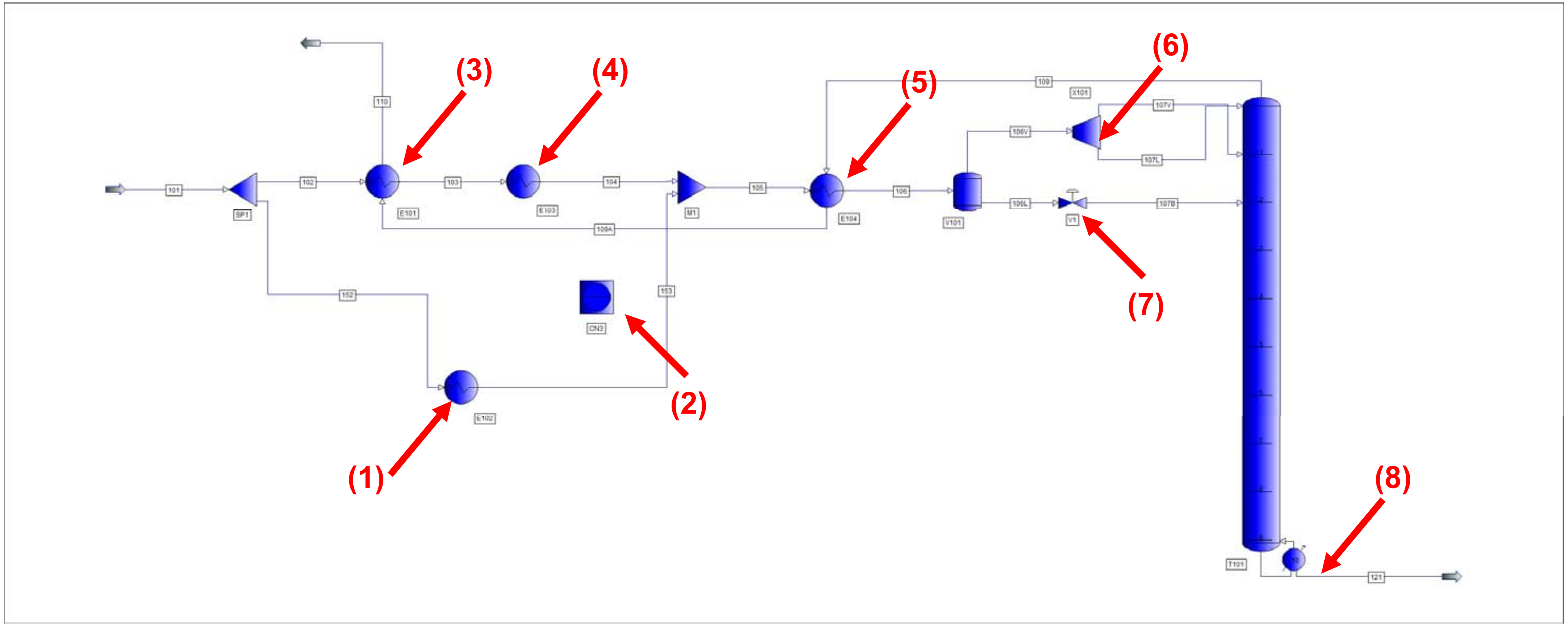
Step 1: Cooling Curve for Feed Stream



Step 1: Results

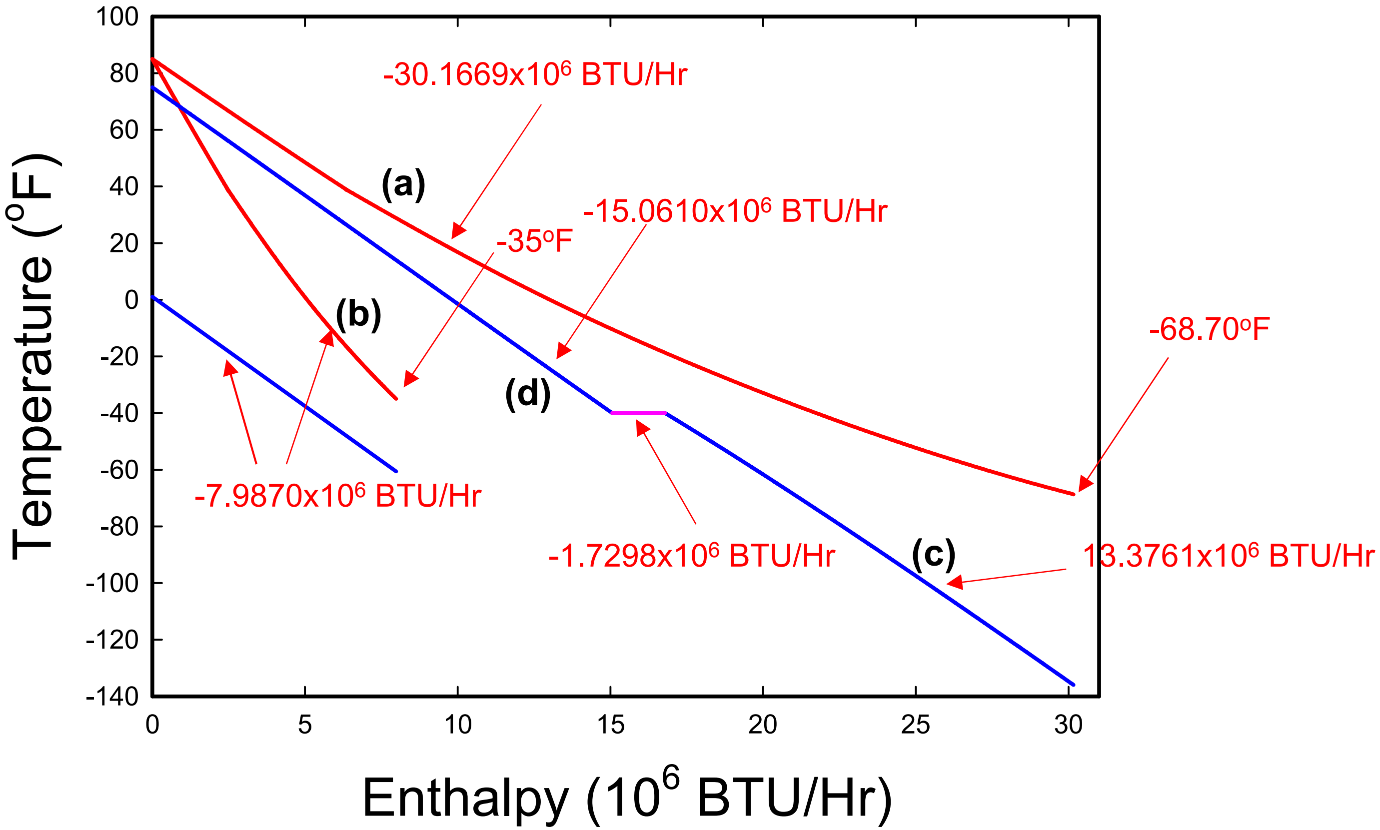
- Simulation results for step 1 are as follows:
  - Natural gas cooling duty: 41.5686 MM BTU/Hr
  - Natural gas cooler outlet temperature: -68.05^{o}F
  - Recovered heat duty for residue gas: 29.2326 MM BTU/Hr
  - Propane refrigeration cycle heat duty: 12.3360 MM BTU/Hr
  - Bottom reboiler heat duty: 11.0272 MM BTU/Hr

Step 2:



Step_02_Side Heat and Feed Split Steam HX.prz

Step 2: Heat Integration



Result Summary

Item	Value
Ethane Flow at Feed (lbmole/hr)	1,449.4863
Ethane Flow at BTMS (lbmole/hr)	1,094.1380
Ethane Recovery %	75.48
C1/C2 Molar Ratio at BTMS	0.0119
Total Cooling Duty (10^6 Kcal/hr)[1]	-41.5686
Total Cooling Duty (10^6 Kcal/hr)[2]	-38.1539
C3 Refrigeration Duty (10^6 Kcal/hr)[1]	-12.3360
C3 Refrigeration Duty (10^6 Kcal/hr)[2]	-1.7298
Side Reboiler Duty (10^6 Kcal/hr)	-7.9870
Bottom Reboiler Duty (10^6 Kcal/hr)	3.6000

THANK YOU