

Optimization of NGL Recovery Process

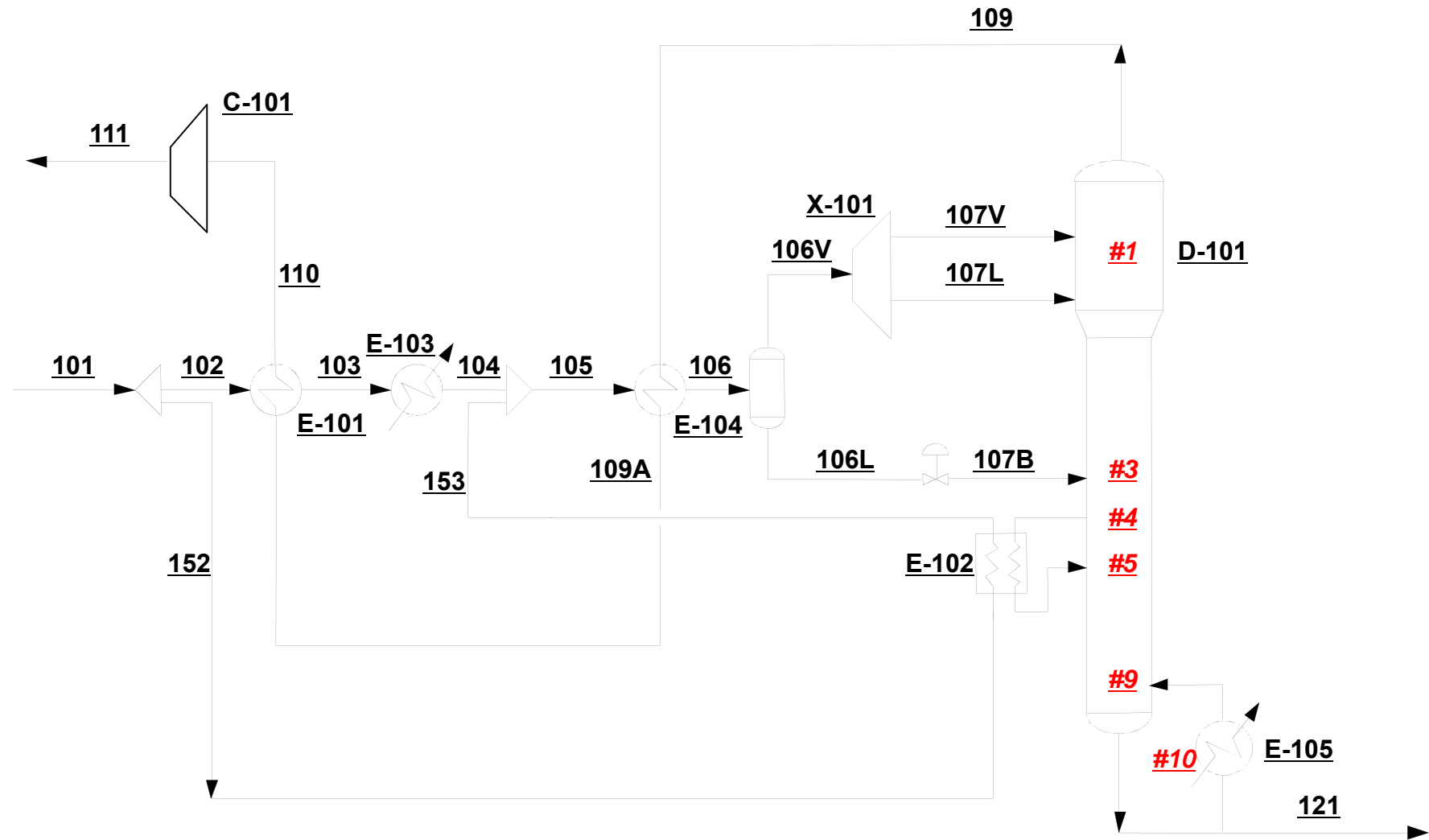
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조 정 호

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 Specifications

- 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

- Demethanizer 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

The screenshot shows the 'PRO/II - Feedback Controller' dialog box. It has a blue title bar and a menu bar with 'UOM', 'Range', 'Help', 'Overview', 'Status', and 'Notes'. The 'Unit' field is set to 'CN2' and the 'Description' field is empty. The 'Specification' section contains a blue hyperlink: 'Stream 121 Flowrate of component C2 on a Wet basis in lb-mol/hr / Stream 101 Flowrate of component C2 on a Wet basis in lb-mol/hr = 0.75000 within the default tolerance'. The 'Variable' section contains a blue hyperlink: 'Heat Exchanger E104 Hot Side Outlet Temperature in F' and a 'Limits and Step Sizes...' button. The 'Parameters' section includes 'Maximum Number of Iterations' set to 10, a checked 'Print Results for Each Iteration' checkbox, and three radio button options for 'Action if Minimum/Maximum Limits are reached': 'Accept as Solved if Limits are Reached' (selected), 'Fail Unit and Stop Calculations if Limits are Reached', and 'Fail Unit and Continue Calculations if Limits are Reached'. The 'Next Unit Calculated after Control Variable is Changed' dropdown is set to 'Calculated'. At the bottom are 'OK' and 'Cancel' buttons, and a footer text: 'Enter a brief description for the unit'.

PRO/II - Feedback Controller

UOM Range Help Overview Status Notes

Unit: CN2 Description:

Specification

[Stream 121 Flowrate of component C2 on a Wet basis in lb-mol/hr / Stream 101 Flowrate of component C2 on a Wet basis in lb-mol/hr = 0.75000 within the default tolerance](#)

Variable

[Heat Exchanger E104 Hot Side Outlet Temperature in F](#) Limits and Step Sizes...

Parameters

Maximum Number of Iterations: 10 Print Results for Each Iteration

Action if Minimum/Maximum Limits are reached

Accept as Solved if Limits are Reached

Fail Unit and Stop Calculations if Limits are Reached

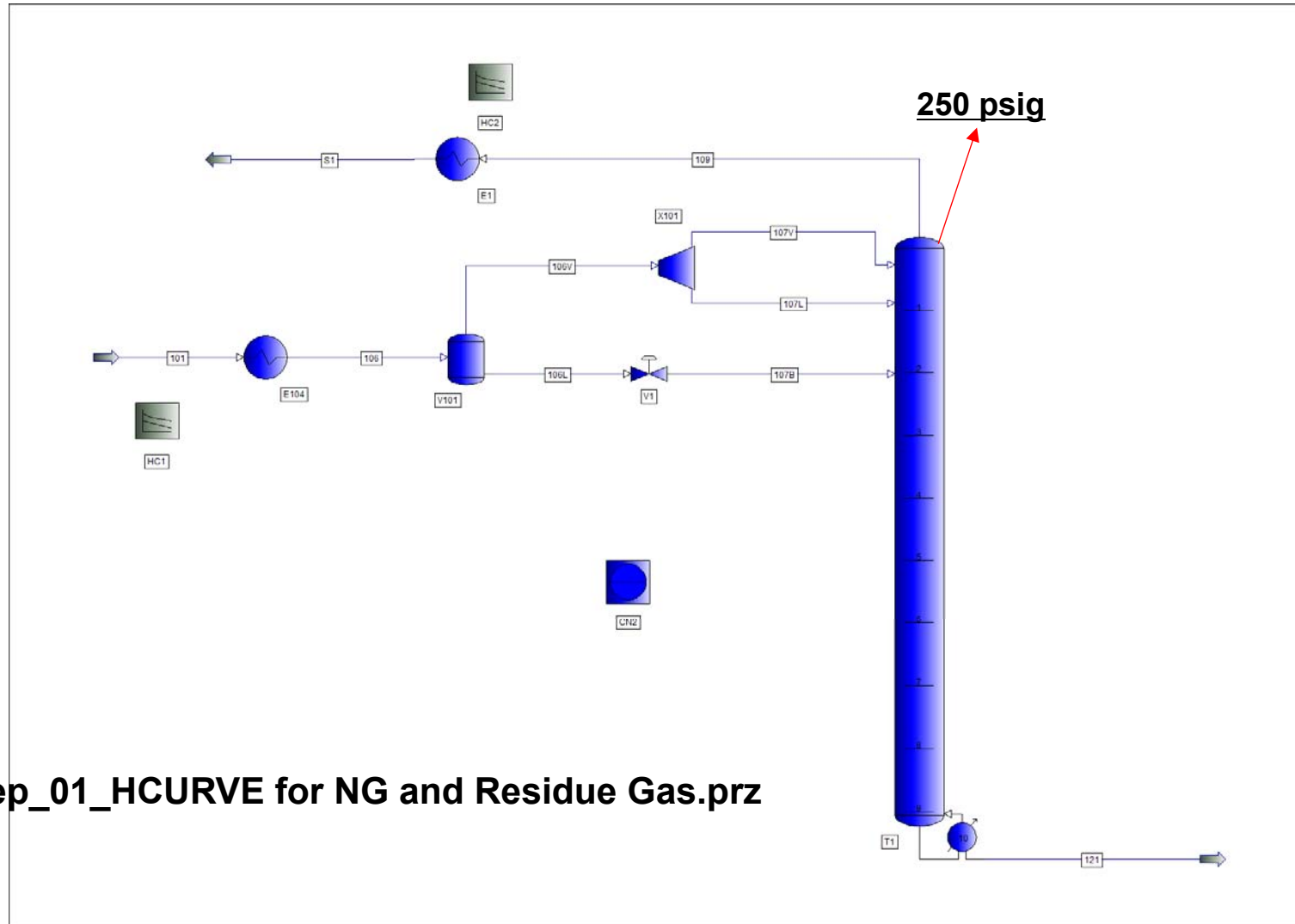
Fail Unit and Continue Calculations if Limits are Reached

Next Unit Calculated after Control Variable is Changed: Calculated

OK Cancel

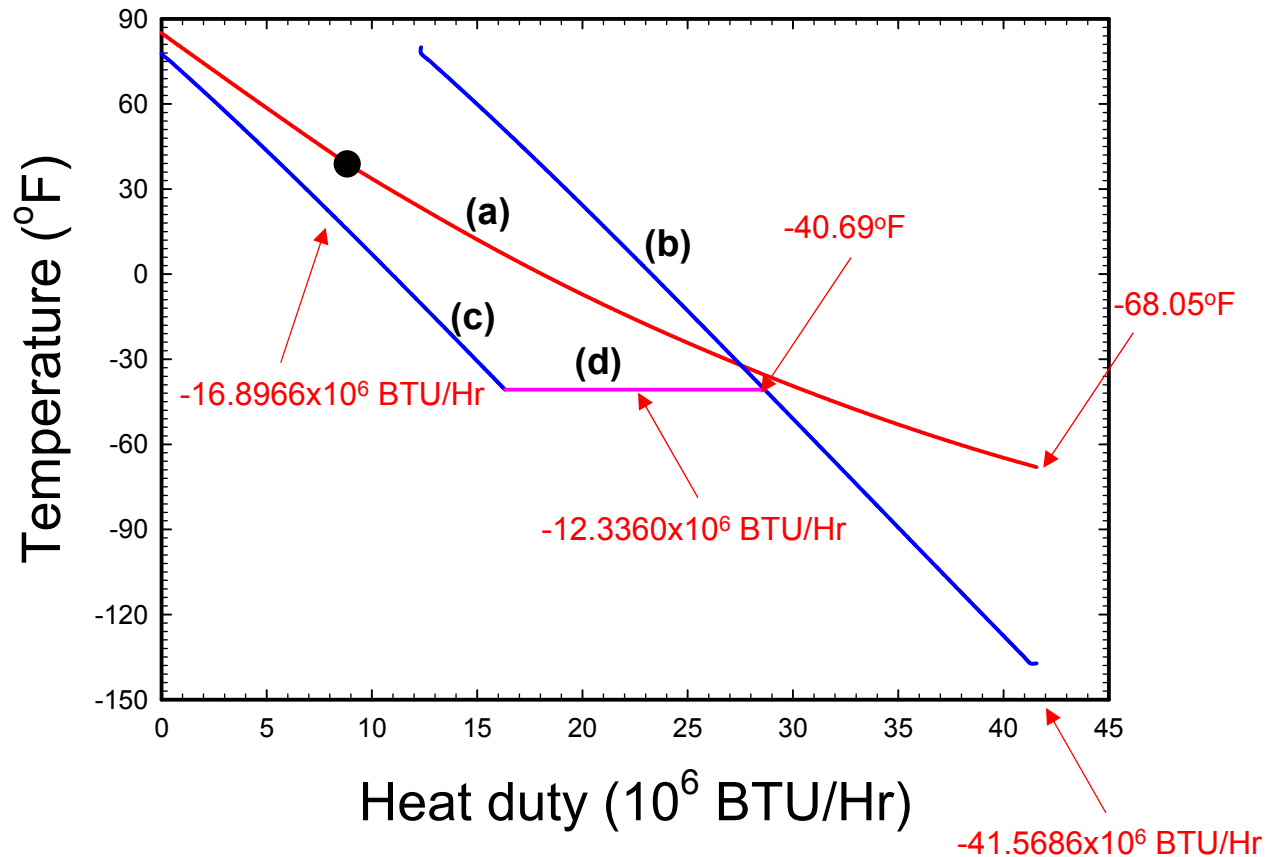
Enter a brief description for the unit

Flow Sheet Drawing Using PRO/II



Step_01_HCURVE for NG and Residue Gas.prz

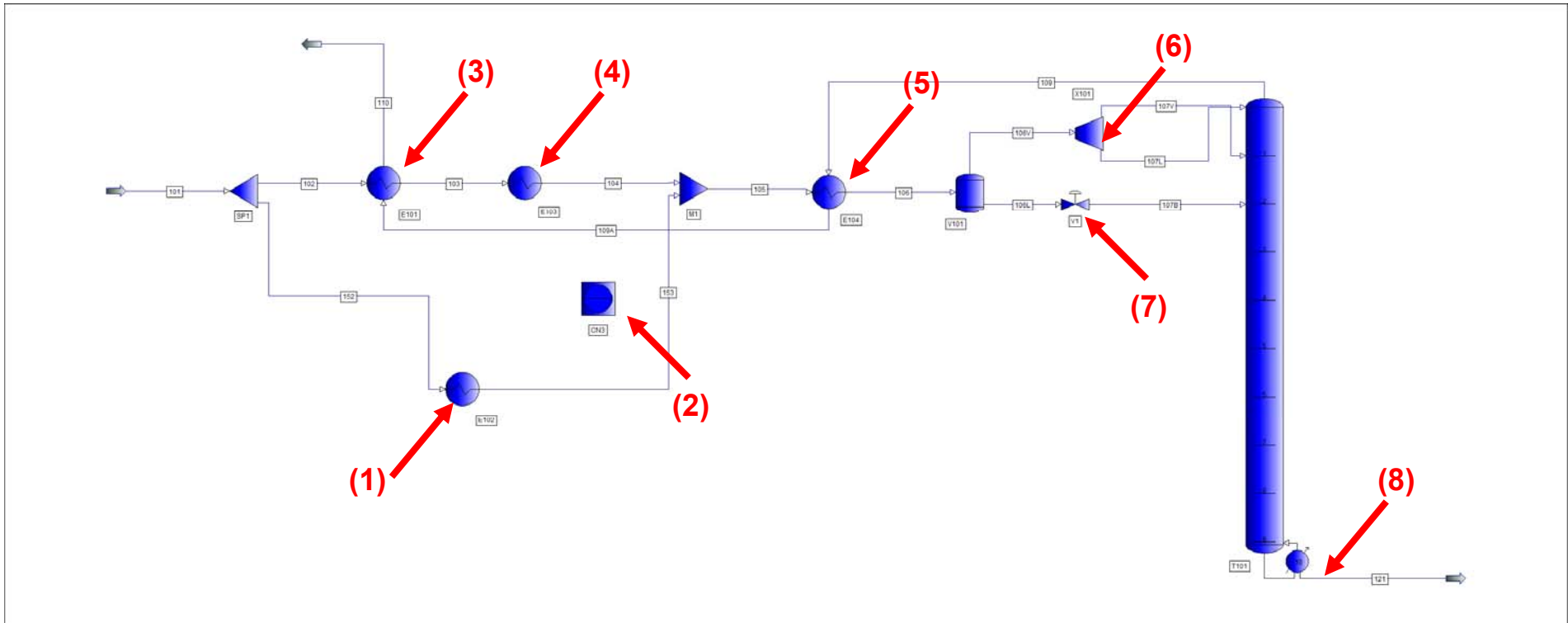
Step 1: Cooling Curve for Feed Stream



Step 1: Results

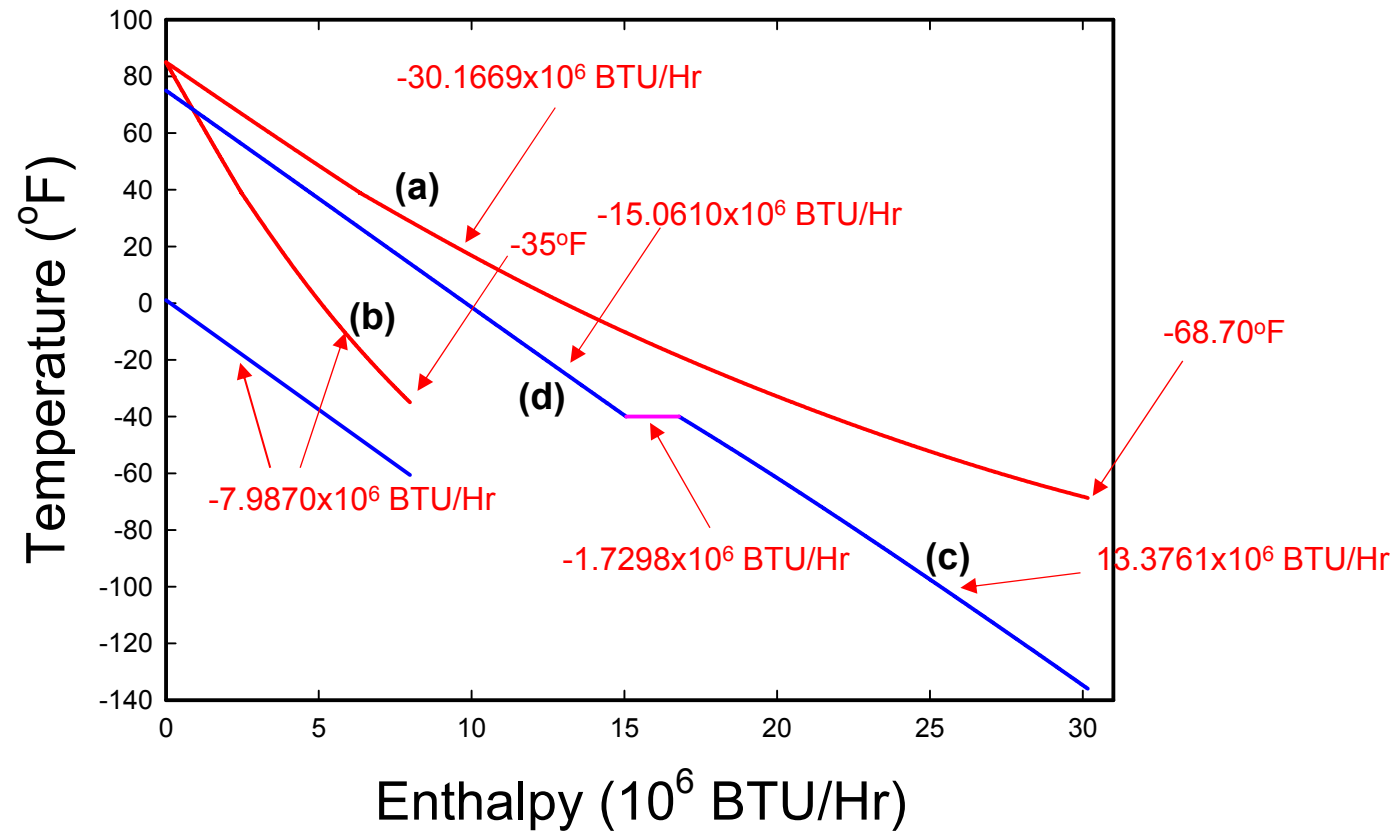
- Simulation results for step 1 are as follows:
 - Natural gas cooling duty: 41.5686 MM BTU/Hr
 - Natural gas cooler outlet temperature: -68.05°F
 - Recovered heat duty for residue gas: 29.2326 MM BTU/Hr
 - Propane refrigeration cycle heat duty: 12.3360 MM BTU/Hr
 - Bottom reboiler heat duty: 11.0272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

