We are looking to make modifications to our initial design for a DPC (dew point control) gas processing facility for 100 MMscfd (dry) feed. Your assignment is to analyze the current design and determine the impact of any proposed changes. Depending on the magnitude of these changes we may need to make capital expenditures, so we need to start planning as soon as possible.

The report describing the expected operational changes will be due to me no later than 6:00 PM on Thursday, May 11, 2017. I expect a memo report consisting of:

- An Executive Summary describing the problem and summarizing the results (no more than one page).
- An Appendix with any tables, charts, and descriptions of the assumptions made in the simulations to support these results.

In addition, please turn in the following with your report:

- Any simulation files used to generate the values in your report (HYSYS files in HSC format or Aspen Plus files in BKP format).

As mentioned you should start looking at this as soon as possible. I’m planning on a 3-week vacation to Outer Mongolia right as your deadline is approaching. I will have no ability to answer questions after May 3rd. Please plan your time wisely.
You have been using something similar to the existing DCP facility as a sample problem in your Gas Processing class. The preceding figure shows the arrangement of the process: a propane chiller to reduce the temperature of the feed gas, ethylene glycol (EG) injection to inhibit the formation of hydrates & ice in the chiller & cold separator, a distillation column to stabilize the produced liquids, compression for the recycled gas from the stabilizer & for the product gas, and a stripping column to regenerate the EG solution.

The design basis for this base case design is attached as Appendix A.

ANALYSIS OF INITIAL DESIGN

We would like to determine the operations from the base case design. Please use the following table as a guideline for tabulating the results.

| Product Gas | Rate [MMscfd]  
| Delivery pressure [psia] & temperature [°F]  
| HHV & LHV [Btu/scf]  
| Maximum dew point temperature between 0 to 1000 psig [°F]  
| C2+ & C3+ liquids content [GPM] |
| Product Liquid | Rate at standard conditions [bpd]  
| Delivery pressure [psia] & temperature [°F]  
| Actual volumetric rate at delivery pressure & temperature [gpm]  
| TVP @ 100°F [psia]  
| RVP [psi]  
| C3+ recovery in stabilized liquid [mol%] |
MODIFIED OPERATIONS

Multiple changes have been suggested to improve the operations. You should evaluate each individually and compare by adding values to the table of results started in the previous section.

1. **Use a two stage refrigeration loop.** It has been suggested that using a two stage refrigeration loop would drastically reduce the required power. Evaluate the optimal intermediate pressure. Include the intermediate conditions (psia & °F) in your results table.

2. **Recover refrigeration from the cold separator’s gas.** It has been suggested that the gas from the cold separator should be routed back to the chiller to try to recover some of its refrigeration. Warm this gas to such a temperature that the outlet of the product gas compressor does not exceed its maximum delivery temperature. Use a pressure drop through the chiller similar to that of the process gas.

3. **Reduce pressure of the cold separator.** The base case has minimal pressure drop between the feed to the process and the cold separator. Introducing a pressure drop would provide some JT (Joule-Thomson) cooling & reduce the need for refrigeration to get the cold separator to -30°F. However, it will increase the compression power needed to supply the product gas at the pipeline spec. Evaluate the total facility power requirements for cold separator operating pressures of 500, 400, & 300 psia.

4. **Increase the pressure of the NGL stabilizer.** The base case has a relatively low operating pressure so that the reboiler temperature can be low (allowing the reboiler heat to come from condensing 50 psig steam). However, even though the reboiler temperature will increase with increasing tower pressure, the compression ratio in the recycle gas compressor will decrease and probably decrease its power requirement. Evaluate the total power requirements for NGL stabilizer operating pressures of 300, 400, & 500 psia. Make a note if the reboiler gets too hot (i.e., goes above 260°F).
APPENDIX A – DESIGN BASIS FOR INITIAL DESIGN

A gas plant is processing 100 MMscfd (dry basis) to produce a spec pipeline gas as well as a pipeline raw mix liquid product.

The following are known conditions for the feedstock and specification for the products:

- The composition of the dry feed gas is shown in the following table.
- The gas enters the plant at 600 psia & 120°F and saturated with water at these conditions.

<table>
<thead>
<tr>
<th>Component</th>
<th>Mol%</th>
</tr>
</thead>
<tbody>
<tr>
<td>N2</td>
<td>0.357</td>
</tr>
<tr>
<td>CO2</td>
<td>0.194</td>
</tr>
<tr>
<td>C1</td>
<td>80.980</td>
</tr>
<tr>
<td>C2</td>
<td>13.238</td>
</tr>
<tr>
<td>C3</td>
<td>3.438</td>
</tr>
<tr>
<td>i-C4</td>
<td>0.431</td>
</tr>
<tr>
<td>n-C4</td>
<td>0.742</td>
</tr>
<tr>
<td>i-C5</td>
<td>0.199</td>
</tr>
<tr>
<td>n-C5</td>
<td>0.156</td>
</tr>
<tr>
<td>n-C6</td>
<td>0.163</td>
</tr>
<tr>
<td>n-C7</td>
<td>0.065</td>
</tr>
<tr>
<td>n-C8</td>
<td>0.026</td>
</tr>
<tr>
<td>n-C9</td>
<td>0.010</td>
</tr>
</tbody>
</table>

The following are parameters for the operation of the gas plant:

- The gas plant is near sea level & the ambient pressure is 1 atm.
- Air coolers will be used to cool gases & liquids to 120°F.
- Compressors will have an adiabatic efficiency of 75% & a mechanical efficiency of 95%.
- Pumps will have an adiabatic efficiency of 80% & a mechanical efficiency of 90%.
- Propane refrigeration will be used to provide the chilling duty. The condenser will operate at the temperature appropriate for air cooling. The minimum approach temperature within the chiller will be 10°F.
- The refrigerant side cold separator should operate no lower than -40°F.
- The stabilizer should have a reboiler but not condenser. It should operate at a top pressure of 200 psia. Assume a negligible pressure drop through the column (reboiler to top). Use 10 trays with tray efficiencies of 75%.
- Heat exchanger pressure drops:
  - The condenser in the propane refrigeration loop will have a 10 psi pressure drop.
  - The process gas through the chiller will have a 10 psi pressure drop. The refrigerant through the chiller will have a zero pressure drop.
- Electricity to power the compressors, pumps, & air coolers’ motors will be purchased.
- Heat for the stabilizer’s reboiler & glycol regenerator will come from condensing saturated 50 psig steam.
  - The steam will be produced in a boiler using fuel gas from the process. The fuel gas will be withdrawn from the cold separator’s gas before final compression. The steam boiler will be 80% efficient (on a LHV basis).
- Lean ethylene glycol is to be injected to prevent ice/hydration formation down to the temperature of the refrigerant in the cooler -40°F.
  - The cold water from the Cold Separator should be 80 wt% ethylene glycol.
The EG Stripper should operate at 10 psig and return EG at 83 wt% ethylene glycol.
The EG returned to the process should be no warmer than 120°F.

The following are specifications on the produced gas & liquids:
- The produced pipeline gas should have a gross heating value between 905 to 1050 Btu/scf\(^1\) & a hydrocarbon dew point no higher than 15°F.
- The produced pipeline gas should be delivered to the pipeline at 1000 psia and no higher than 120°F.
- The produced liquids shall be exported via pipeline & stabilized to have a TVP (true vapor pressure) @ 100°F no greater than 103 psia.
- The produced stabilized liquid should be delivered to the pipeline at 150 psig & between 0 to 120°F.

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1 If the gross heating value spec cannot be achieved set the Cold Separator to the lowest reasonable temperature, -30°F.