Continuous Distillation

UTC
ENGR 435
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Topics of Interest

- Heat Loss
- Material Balance
- Column Efficiency
- Operating Variables
- Flooding Behavior
- Optimal Operating Conditions
Steady State Heat Loss

Technique:

- The control loop attempts to hold a constant tray temperature by varying reboiler power.
- All power supplied to the system is lost to the environment as steady state is reached.
- Collect power losses at varying stage heights.
Steady State Heat Loss

<table>
<thead>
<tr>
<th>Stage of Column</th>
<th>Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reboiler</td>
<td>300</td>
</tr>
<tr>
<td>Trays 12-7</td>
<td>250</td>
</tr>
<tr>
<td>Feed Tray</td>
<td>200</td>
</tr>
<tr>
<td>Trays 6-1</td>
<td>150</td>
</tr>
</tbody>
</table>

**Column Efficiency**

- Data is based on 100% reflux, which is represented as a feed line coincident with the 45 degree line. \( x = y \)
- The number of required stages must be equal to that of the equipment, which is 12.
- The efficiency will be what is required to attain 12 stages.
Operating Variables

- Distillate Composition will depend on each of the following variables:
  - Reboiler Power
  - Reflux Ratio
  - Feed Flow Rate

Reboiler Power

- Feed = 2
- Reflux = 50%
- Power = Variable

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We investigated the dependence (which means boil-up ratio).

(later make a conclusion slide about what you observed)

Am skeptical about this.
1. Steady state?
2. Flooding?

Omit decimal places.
Reboiler Power

- Feed = 3
- Reflux = 50%
- Power = Variable

Steady state?

Reflux

- Feed = Constant
- Reflux = Variable
- Power = Constant

Step Response 0-100% Reflux
Reflux

- Feed = Constant
- Reflux = Variable
- Power = Constant

**Step Response 66-33 % Reflux**

**Step Response 33-15 % Reflux**
Reflux

- Feed = Constant
- Reflux = Variable
- Power = Constant

Step Response 50-10 \% Reflux

Step Response 10-50 \% Reflux
Feed Flow Rate

- Feed Flow Rate has a direct relationship to the power required to operate the system.
- Feed Flow Rate is also known to contribute to Flooding.
Flooding

- Flooding is a phenomenon that can be witnessed by individual trays filling with liquid.

- Problem:
  - VLE validity is lost.
  - No separation takes place.
Optimal Operating Conditions

- Feed rate of 2 or 3.
- Reflux less than 50%.
- Reboiler Power based on Feed rate:
  Range: 1500-2500 W
Operational Warning Signs

- Temperatures below boiling point of light component.
- Pressure above 2 indicates risk of flooding.