***Temperature drop over stage 7 during 2nd steady state***

* Lower down the column, one would ideally feed a mixture that is more concentrated in the less volatile component (water). This would ensure a greater separation because the flashing temperature increases as one goes down the column. The less volatile component flashes at a higher temperature than the more volatile component.
* Feeding in a mixture, lower down the column, that is more concentrated in the more volatile component (ethanol) reduces the driving force for separation at that point in the column.
* That is why a greater separation is achieved in the 1st steady state instead of the second.
* The flashing temperature of the feed mixture is a function of its composition, pressure and equilibrium (T-xy diagram)
* A feed composition of about 21% ethanol has a flashing temperature of 83 °C and is independent of the position at which it is fed. This is observed in both steady state 1 and 2

***Composition spike at stage 7 in 2nd steady state***

* A subcooled feed mixture that is more concentrated in ethanol is fed at stage 7. The temperature at this plate should be closer to the boiling point of water and thus it should be more concentrated in water than ethanol.
* The concentration gradient between the feed and the liquid on the plate is much greater than it should be which results in a greater driving force for mass transfer
* Thus, most of the ethanol in the feed joins the liquid on the feed plate to achieve an equilibrium

***Why does stage 1 experience a drop in ethanol concentration in both steady states?***

* An important observation is that the liquid ethanol composition is lower at stage 1 in the 1st steady state than in the second
* This could be attributed to a higher reflux ratio in the 1st steady state than in the second.
* Since the reflux is subcooled, the equilibrium vapour leaving stage 1 would have to condense to bring the reflux to a state of saturation to be in equilibrium with plate 1
* Since the 1st steady state has a higher reflux, more vapour would have to condense onto the plate than in the 2nd steady state.
* This would effectively dilute the liquid on the plate resulting in a lower ethanol concentration? (Not sure about this)

***Why is the efficiency of the 1st steady state greater than the 2nd?***

* The feed composition to stage 7 in the 2nd steady state is more concentrated in ethanol than it should be.
* The ideal feed plate would be higher up in the column.
* By feeding in at a lower position in the column, a new equilibrium must be achieved that would flash the mixture.
* This results in a temperature drop over stage 7 which affects the overall separation.
* In an ideal column, the feed plate temperatures should increase down the column in order to increase separation of the water from ethanol.
* Another possible reason is that in the 2nd steady state, the reflux ratio is less than in the 1st steady state.
* By returning less ethanol to the column via the reflux, there is less opportunity for greater separation (less residence time in the column) ? (Not sure if this makes sense)



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| --- | --- | --- | --- |
| Description | Value SS1 | Value SS2 | Units |
| Feed |  |  |  |
| Distillate |  |  |  |
| Reflux |  |  |  |
| Bottoms |  |  |  |
| Partial Reboiler |  |  |  |
| Bottoms Condenser |  |  |  |
| Utility Water |  |  |  |
| Steam |  |  |  |
| Ethanol Fraction [xD] |  |  |  |
| Ethanol Fraction [xF] |  |  |  |
|  |  |  |  |
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| --- | --- | --- | --- |
| Description | Value SS1 | Value SS2 | Units |
| UD (heat trans. Coeff.) |  |  |  |
| UB |  |  |  |
| UR |  |  |  |
| Qr |  |  |  |
| Qr (Aspen) |  |  |  |
| Qc |  |  |  |
| Qc (Aspen) |  |  |  |
| Total Qloss |  |  |  |
| QlossB |  |  |  |
| QlossC |  |  |  |
| QlossR |  |  |  |
| Qloss Column |  |  |  |