

Q1. DSTWU Model

Properties asked in the question:

| | | |
|------------------------------------|-------------|---------|
| Minimum reflux ratio | 4.16625675 | |
| Actual reflux ratio | 4.87540192 | |
| Minimum number of stages | 15.2726594 | |
| Number of actual stages | 30 | |
| Feed stage | 18.7187939 | |
| Number of actual stages above feed | 17.7187939 | |
| Reboiler heating required | 0.270781464 | Gcal/hr |
| Condenser cooling required | 0.696507688 | Gcal/hr |
| Distillate temperature | -103.067749 | C |
| Bottom temperature | -87.847458 | C |
| Distillate to feed fraction | 0.399 | |

Streams:

| Heat and Material Balance Table | | | | |
|---------------------------------|---------|----------|----------|----------|
| Stream ID | | FEED | DISTLT | BOTTOMS |
| Temperature | C | 23.9 | -103.1 | -87.8 |
| Pressure | bar | 1.034 | 1.034 | 1.034 |
| Vapor Frac | | 1.000 | 0.000 | 0.000 |
| Mole Flow | kmol/hr | 90.718 | 36.197 | 54.522 |
| Mass Flow | kg/hr | 2654.721 | 1015.562 | 1639.158 |
| Volume Flow | cum/hr | 2151.037 | 1.789 | 3.016 |
| Enthalpy | Gcal/hr | -0.637 | 0.291 | -1.354 |
| Mole Flow | kmol/hr | | | |
| ETHANE | | 54.431 | 0.054 | 54.377 |
| ETHYLENE | | 36.287 | 36.142 | 0.145 |
| Mole Frac | | | | |
| ETHANE | | 0.600 | 0.002 | 0.997 |
| ETHYLENE | | 0.400 | 0.998 | 0.003 |

Q2. RadFrac Model

(a) Streams:

| Heat and Material Balance Table | | | | |
|---------------------------------|---------|----------|----------|----------|
| Stream ID | | FEED | BOTTOM | TOPPROD |
| Temperature | C | 23.9 | -87.8 | -103.1 |
| Pressure | bar | 1.034 | 1.034 | 1.034 |
| Vapor Frac | | 1.000 | 0.000 | 0.000 |
| Mole Flow | kmol/hr | 90.718 | 54.522 | 36.197 |
| Mass Flow | kg/hr | 2654.721 | 1639.183 | 1015.537 |
| Volume Flow | cum/hr | 2151.037 | 3.016 | 1.789 |
| Enthalpy | Gcal/hr | -0.637 | -1.354 | 0.292 |
| Mole Flow | kmol/hr | | | |
| ETHANE | | 54.431 | 54.389 | 0.042 |
| ETHYLENE | | 36.287 | 0.133 | 36.155 |
| Mole Frac | | | | |
| ETHANE | | 0.600 | 0.998 | 0.001 |
| ETHYLENE | | 0.400 | 0.002 | 0.999 |

(b) Comparison between Mole fractions on the basis of type of Column used: (Q1 vs Q2)

| Mole Fraction in Distillate | Using DSTWU | Using RadFrac |
|-----------------------------|-------------|---------------|
| ETHANE | 0.002 | 0.001 |
| ETHYLENE | 0.998 | 0.999 |
| Mole Fraction in Bottoms | | |
| ETHANE | 0.997 | 0.998 |
| ETHYLENE | 0.003 | 0.002 |

Discrepancy in product compositions obtained from RadFrac and DSTWU: Yes, certain minor deviations do exist. Reason – DSTWU uses relatively less rigorous and simpler calculations, like using Gilliland's, Winn's, Underwood's correlations for calculating stages and reflux ratios. Constant molar overflow and constant relative volatility are assumed, similar to McCabe Thiele method. It is more suited to performing calculations for simpler, binary systems. RadFrac column on the other hand is far more rigorous and uses a more advanced technique which relies less on correlations and more on actual calculations. (similar to the Ponchon Savarit method). Hence, the discrepancies exist.

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