

Cr r t qz k o c v g ' O g y q f u ' H q t ' O w n k e q o r q p g p v ' O w n k w c i g ' U g r c t c v k q p u < **M g { y q t f u <** Multistage Separation, Shortcut Method, FUG Method, Fenske-Underwood- Gilliland Method

Although rigorous computer methods are a variable for solving Multicomponent separation problems, approximate methods continue to be used in practice for various purposes, including preliminary design, parametric studies to establish optimum design conditions and for process synthesis studies to determine optimal separation sequences. In this lecture we will study the approximate method that is widely used for making preliminary design and optimization of simple distillation. The method is commonly known as the Fenske-Underwood-Gilliland or FUG method. Although these methods can be applied fairly readily by manual calculation if physical properties are independent of composition, otherwise computer calculations are preferred. IN most computer-aided process design programs, FUG(method) models are used.

H g p u n g / W p f g t y q q f / I k n k e p f ' O g y q f <

An algorithm for the empirical Fenske-Underwood-Gilliland Method is given in the following table for simple distillation column. The column can be equipped with a partial condenser or total condenser.

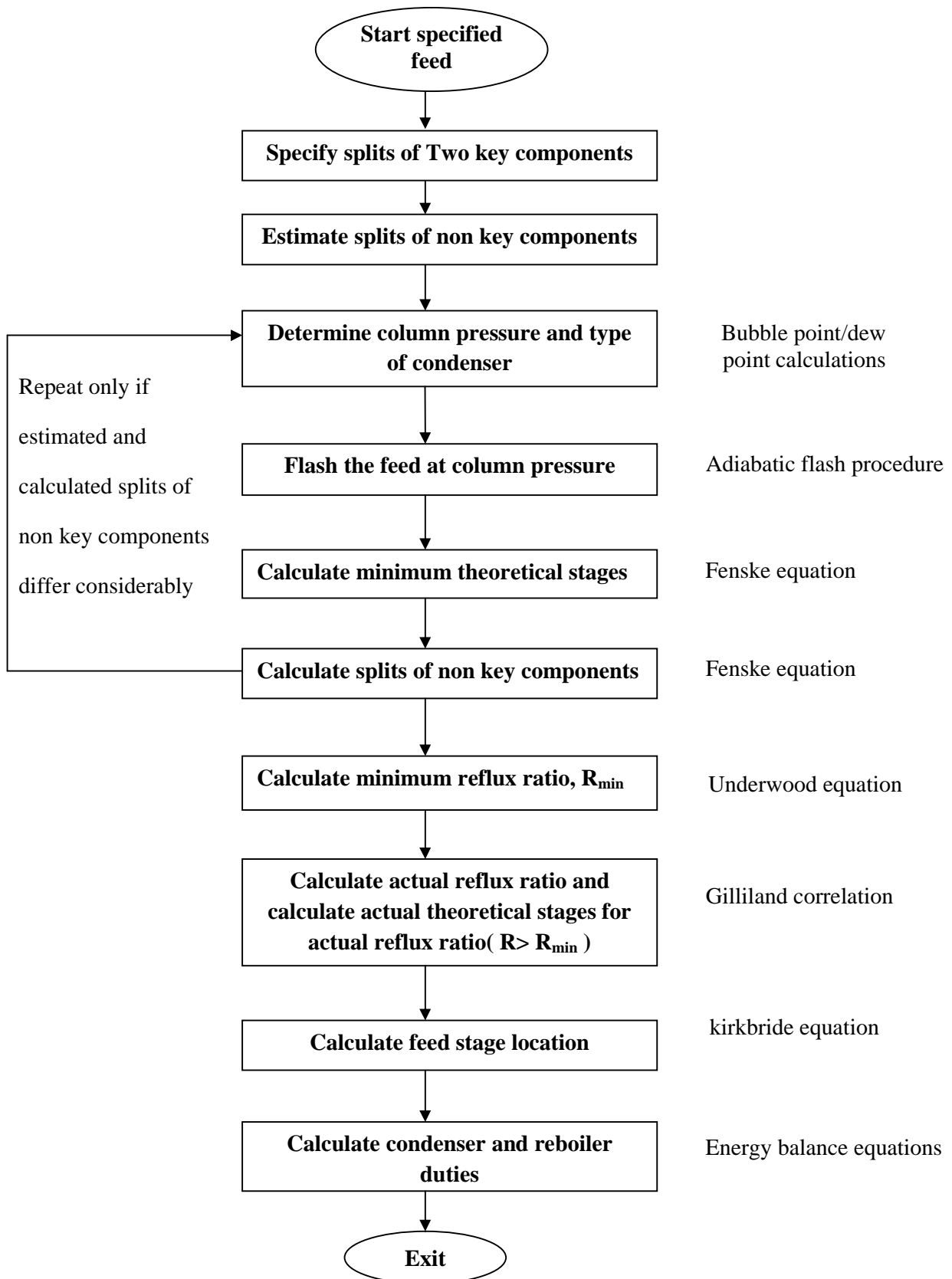


Fig. 27.1: Algorithm of FUG method

Variables in distillation columns:

For a total condenser following variables are generally specified

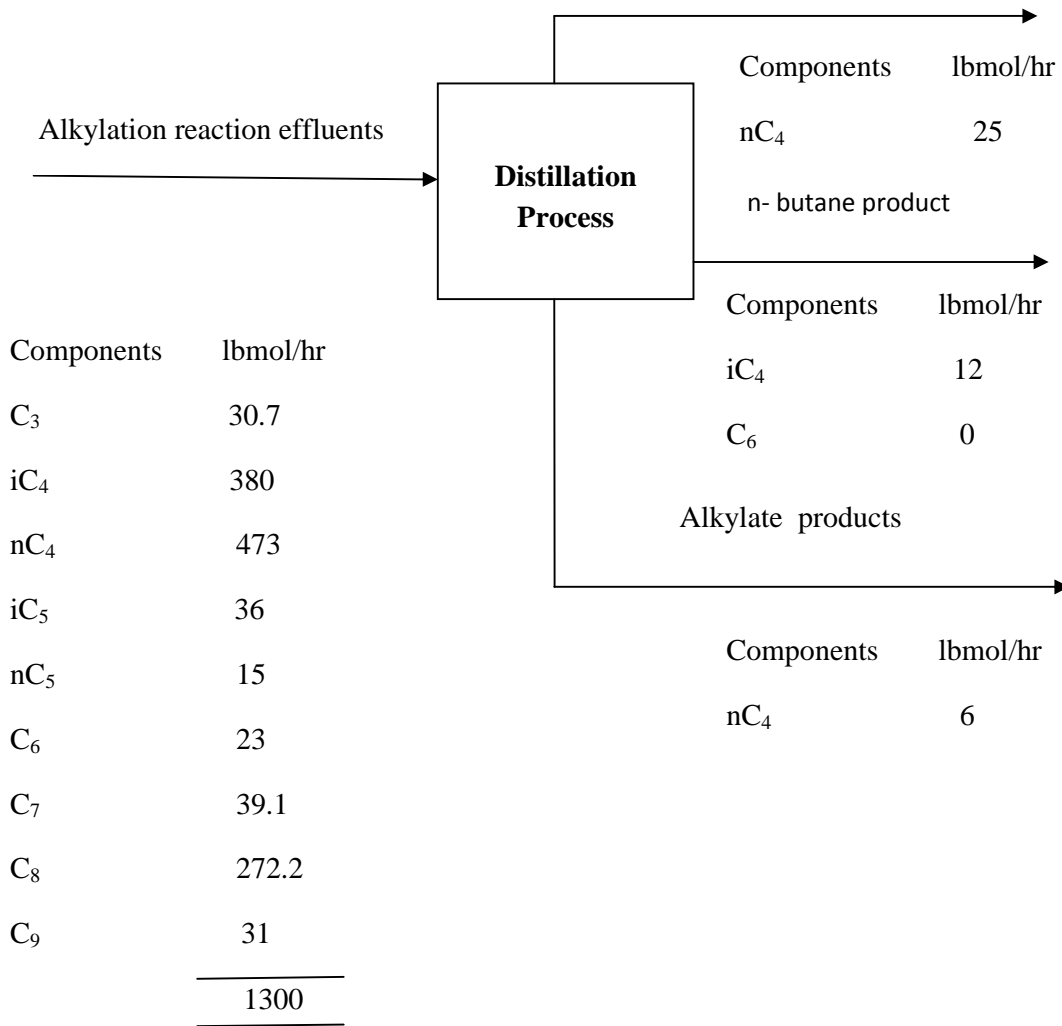
Feed flow rate	1
Feed mole fractions	C- 1
Feed temperature	1
Feed pressure	1
Adiabatic stages (excluding reboiler)	N- 1
Stage pressure (including reboiler)	N
Split of light key component	1
Split of heavy key component	1
Feed stage location	1
Reflux ratio (as multiple of R_{\min})	1
Reflux temperature	1
Adiabatic reflux divider	1
Pressure of total condenser	1
Pressure at reflux divider	1
	<hr/>
	<u>$2N + C + 9$</u>

The first step is to select the two key components.

Selection of two key components

For Multicomponent feeds, specification of two key components and their distribution between distillate and bottom is accomplished in a variety of ways. Preliminary estimation of the distribution of non key components can be sufficiently difficult to require the iterative procedure. Generally two or three iterations are required.

Consider the Multicomponent hydrocarbon feed as shown below. This mixture is typical of the feed to the recovery section of an alkylation plant. Components are listed in order of decreasing volatility. A sequence of distillation columns including a deisobutanizer and a deisobutanizer is to be used to separate this mixture into the three products indicated.



Case I: Deisobutanizer is selected as I column in the sequence. Since the allowable quantities of n-butane in the isobutene recycle and isobutane in the n-butane product are specified, i-butane is the light key and n-butane is the heavy key. These two keys are adjacent in order of volatility.

Case II: If the debutanizer is placed I in the sequence, specification in above figure shows that n-butane be selected as the light key. However, selection of the heavy key is uncertain because no recovery and purity is specified for any component less volatile than n-butane. Possible heavy key components for the debutanizer are iC_5 , nC_5 , or C_6 . The simplest way is to select iC_5 so that the two keys are again adjacent.

For example, suppose we specify that 13 mol/hr. of iC_5 in the feed is allowed to appear in the distillate. Because the split of iC_5 is not sharp and nC_5 is close in volatility to iC_5 , it is probable that the quantity of nC_5 in the distillate will not be negligible.

Light key ——— **LK** ——— **more volatile component**

Heavy key ——— **HK** ——— **less volatile component**

Column pressure

For preliminary design, column pressure and type of condenser can be established by the following procedure:

Total condenser: The overhead vapor leaving the top stage is totally condensed to give a liquid distillate product and liquid reflux.

Partial condenser: Some amount of vapor condensed in the condenser.

For preliminary design, column pressure and condenser type are established by the procedure shown in following figure which is formulated to achieve a reflux drum pressure, P_D , between 0 and 415 psia (2.86 Mpa) at a minimum temperature of 49°C (corresponding to the use of water as the coolant in the condenser). The pressure and the temperature limits are representative and depend on economic factors. A condenser pressure drop of 0 to 2 psi (0 to 14 Kpa) and an overall column pressure drop of 5 psia (35 Kpa) may be assumed. However, when column tray requirements are known, more refined computations should result in at approximately 0.1 psi/tray (0.7 Kpa/tray) pressure drop for atmospheric and subatmospheric pressure operation and 0.35 Kpa/tray for vacuum column operation. Column bottom temperature must not result in bottoms decomposition or corresponds to a near critical condition.

A total condenser is recommended for reflux drum pressure to 215 psia (1.48 Mpa). A partial condenser is appropriate from 215 psia to 365 psia (2.52 Mpa). However, a partial condenser

can be used below 1.48Mpa when a vapor distillate is desired. A mixed condenser can provide both vapor and liquid distillates. A refrigerant is used as a coolant in the condenser if pressure tends to exceed 2.52Mpa.

With column operating pressure established, the column feed can be flashed adiabatically at estimated feed tray pressure to determine feed- phase condition.

Source :

<http://nptel.ac.in/courses/103107096/30>