

Lecture 8

Approximate methods for multicomponent, multistage separations

Although rigorous computer methods are available for solving multicomponent separation problems, approximate methods continue to be used in practice for various purposes, including preliminary design, parametric studies to establish optimal design conditions, process synthesis studies to determine optimal separation sequences, and for obtaining an initial approximation for a rigorous method.

This lecture presents an additional approximate method that is widely used for making preliminary designs and optimization of simple distillation. The method is commonly referred to as the Fenske-Underwood-Gilliland or FUG method. In addition, application of the Kremser method is extended to and illustrated for strippers and liquid-liquid extraction. Although these methods can be applied fairly readily by manual calculation if physical properties are independent of composition, computer calculations are preferred, and FUG models are included in most computer-aided process design programs.

An algorithm for the empirical Fenske-Underwood-Gilliland method, named after the authors of the three important steps in the procedure, is shown in Figure 1 for a simple distillation column of the type shown in Figure 2. The column can be equipped with a partial or total condenser. From Table 1, the number of degrees of freedom with a total condenser is $2N + C + 9$. In this case, the following variables are generally specified with the partial reboiler counted as a theoretical stage:

Number of Specifications	
Feed flow rate	1
Feed mole fractions	$C - 1$
Feed temperature ¹	1
Feed pressure ¹	1
Adiabatic stages (excluding reboiler)	$N - 1$
Stage pressures (including reboiler)	N
Number of Specifications	
Split of light key component	1
Split of heavy key component	1
Feed-stage location	1
Reflux ratio (as multiple of minimum-reflux ratio)	1
Reflux temperature	1
Adiabatic reflux divider	1
Pressure of total condenser	1
Pressure at reflux divider	1
	$2N + C + 9$

Similar specifications can be written for columns with a partial condenser.

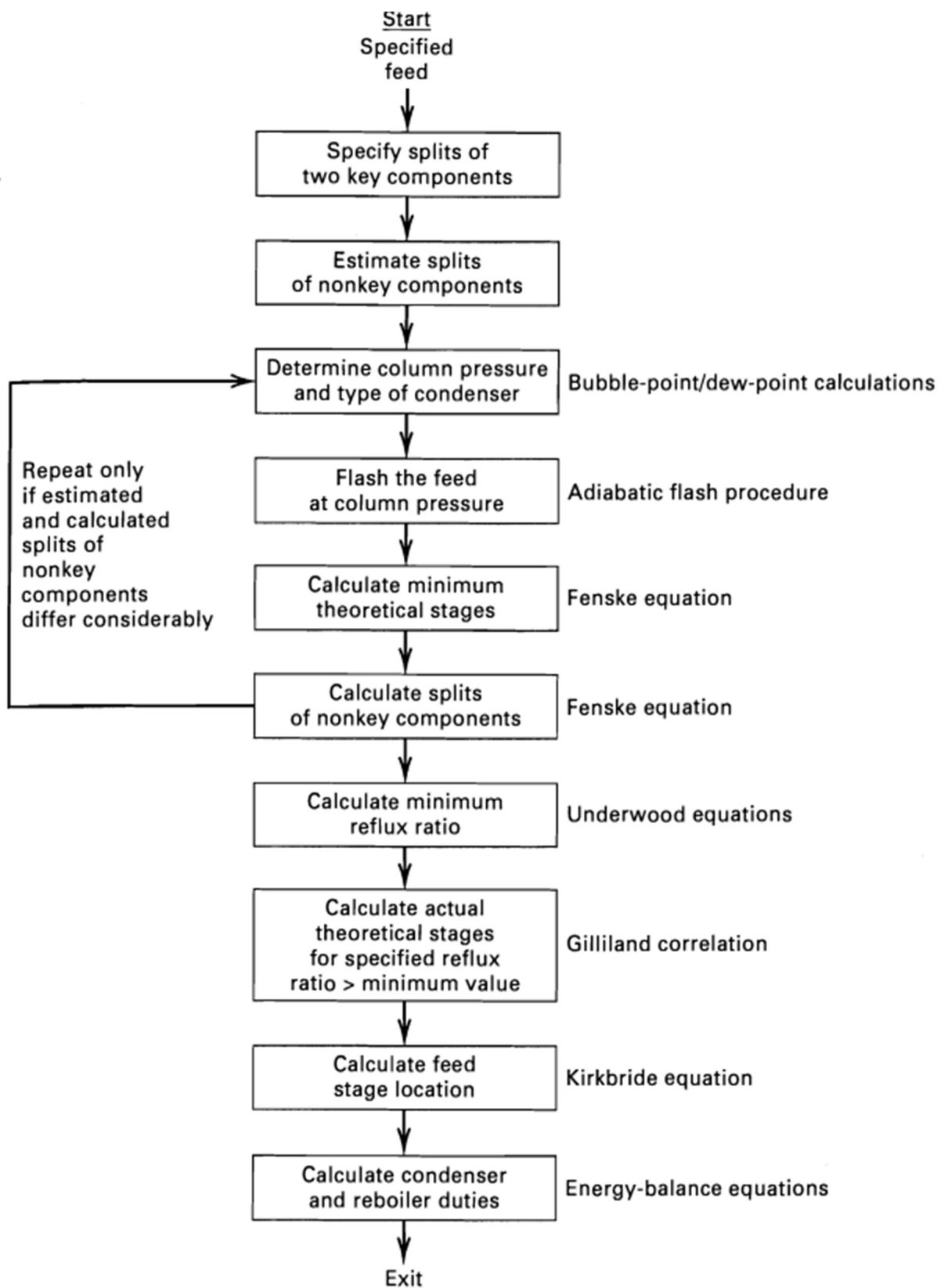


Figure 1 - Algorithm for multicomponent distillation by FUG method