J. Basic. Appl. Sci. Res., 3(1s)473-476, 2013
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ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

The New Way and Result in Combination of Distillation Columns

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Received: June 11 2013
Accepted: July 2 2013

ABSTRACT

In this research, famous Brugma's configurations are presented to be the sole subgroup of a much larger projected group of simultaneously heat and mass integrated configurations. Also, a systematic arrangement that permits the investigation of the entire set of simultaneously heat and mass integrated distillation configurations is explained. The classification can be utilized as an fundamental standard of any synthesis algorithm and aids classify several novel simultaneously heat and mass integrated distillation configurations for separating a multicomponent feed. A previously unidentified class of simultaneously heat and mass integrated configurations categorized by strategic side-stream extractions is also explained.

KEYWORDS: distillation, distillation sequences, distillation configurations, brugma`s column

1. INTRODUCTION

Distillation, the technique of choice for 90–95% of all separations in the US chemical and petrochemical plants, utilizes more than 40% of the energy exploited by the chemical and refining industry.[1]One or more distillation columns can be used in distillation procedures. For example, to proficiently divide multicomponent mixtures into more than two product torrents using distillation, a sequence of distillation columns is generally needed. A sequence of distillation columns is also denoted to as a distillation configuration or a distillation scheme. Several efforts have been made to produce all possible distillation configurations for a multicomponent separation difficulty. Initial efforts to solve this obstacle goes back to the 1940s,[2,3] and the problem continues to be addressed even in the present. It is vital to classify the complete set of alternative arrangements of distillation columns as stress by the statement , 'If the optimum alternative is not predefined it will not be found' [4]

Figure 1a illustrates a two-column configuration for disjointing of a four-component feed combination. In this outline and in all others in this paper, the instabilities of components decline in alphabetical order with A being the most instable substance followed by B and so on. Likewise, reboilers are characterized by non-filled circles, and condensers are presented by filled circles. Further, we mention streams of intermediate compositions that are shifted between distillation columns as ''sub-mixtures''. As an example, streams AB and CD are sub-mixtures in the configuration of Figure 1a.

It implied that other components such as C and D are completely absent. They may be present but in an suitably small quantity. The configuration shown in Figure 1a is equal to the configuration developed by Brugma,[2] except that the liquid transfer of stream AB is swapped by vapor transfer, since such a vapor transfer would regularly decrease the total heat duty of the configuration.

Based on the number of distillation pillars in a configuration, a distillation configuration to detach an n-component feed into n product torrents has been caegorized as a ''plus-column,'' a ''regular-column'' or a ''sub-column'' configuration [5]. Distillation configurations with more than (n – 1) distillation columns are plus-column; with precisely (n – 1) columns are regular-column; and with less than (n – 1) columns are sub-column configurations. The Brugma configuration 2 of Figure 1a is a sub-column configuration, as it utilizes two distillation columns for a four-component separation.

Sometimes thermal coupling links are presented among distillation columns in a configuration to decrease the total heat duty prerequisite of distillation.[6] Thermal coupling links are two-way liquid–vapor communications between distillation columns of a configuration. Reboilers or condensers that include one-way transfers of sub-mixtures in a configuration can be substituted with thermal coupling links. Thus, distillation configurations can be categorized as partly or completely thermally coupled configurations based on the number of reboilers or condensers in these configurations that are substituted by thermal coupling links.

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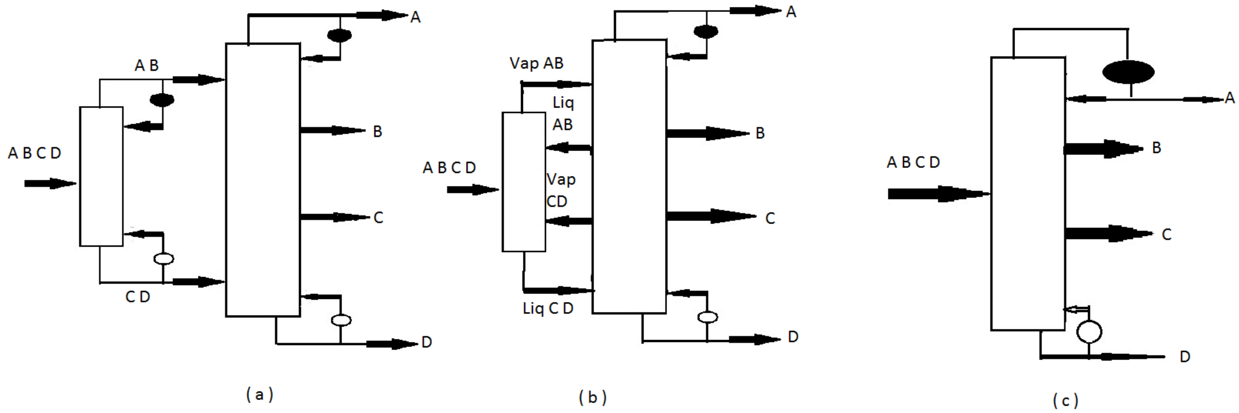
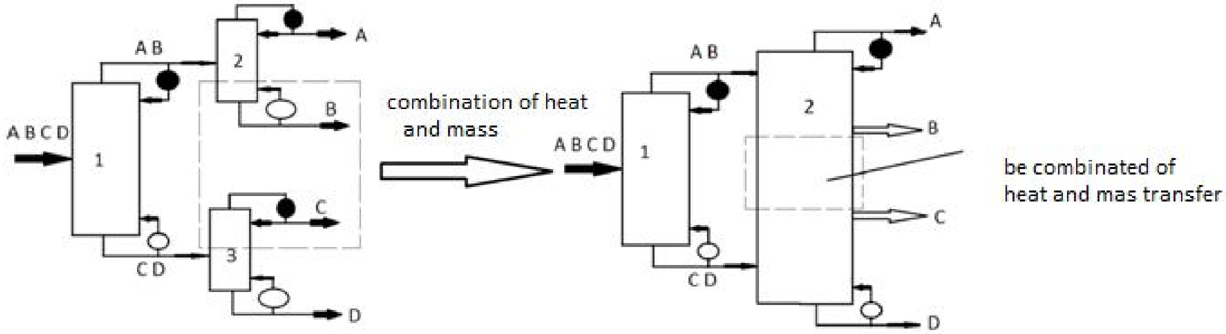
All of the substitutable reboilers and condensers have thermal coupling links in configurations with complete thermal coupling. In configurations with partial thermal coupling, at least one of the substitutable reboilers or condensers does not have a thermal coupling link. The configuration shown in Figure 1b



Fiq 1 information of component in distillation towers

is a completely thermally coupled analog of the Brugma configuration2 of Figure 1a and was depicted by Cahn and DiMiceli.10 It is proven that two or more thermally coupled column scan be fundamentally joined into a single shell using a dividing wall column.[6,] For instance, the distillation columns in Figure 1b is capable to be combined into a single shell as displayed in Figure 1c. The distinguished Kaibel column configuration of Figure 1c is therefore a separating wall column version of the Cahn and Di Miceli configuration. For nonazeotropic mixtures, basic distillation configurations 9 are regular-column configurations with each column having one reboiler and one condenser. Basic configurations have the capability to yield all the products of any prespecified purity. The sub-column Brugma configuration2 (Figure 1a) is taken from a basic regular-column distillation configuration by concurrent heat and mass integration of distillation columns as demonstrated in Figure 2. In the major configuration of Figure 2a, the end product of the second distillation column is stream B, whereas the top product of the third distillation column is stream C. As the bottom product of the second distillation column is more instable than the top product of the third distillation column, the two columns can be heat and mass integrated deprived of disturbing the arrangement profiles in the individual distillation columns by presenting an added column section with adequate parting stages. The additional section removes reboiler related with stream B and condenser related with stream C. It also attaches the two distillation columns ‘‘2’’ and ‘‘3’’ of the basic configuration in Figure 2a to deliver one column in Figure 2b, which does the same complete separation. The task of the additional heat and mass integrated unit is to do mass conversation between the ascending C-rich vapor from the bottom section of the column and the inclining B-rich liquid from the top section of the column to provide B-rich vapor stream for the top segment and C-rich liquid stream for the bottom column segment. The sub-column configuration holds the capability of the basic regular-column configuration from which it is resulting in making randomly high purity products if there are adequate separation phases in the additional column section. Simultaneous heat and mass integration of distillation columns not only decreases the number of distillation columns and reboiler/condenser heat exchangers in a configuration but also declines the overall heat duty prerequisite of the configuration. The total vapor duty prerequisite of a configuration is the summation of the vapor flows produced at the reboilers of a configuration and is relative to the heat duty prerequisite of a configuration. Via simultaneous heat and mass integration, the sum of the heat duty requirements of the two separate distillation columns is substituted by the greater of the two heat duties. The distillation column with the lower heat duty requirement functions for ‘‘free,’’ because its needed vapor flow is borrowed from the other distillation column with which it is heat and mass integrated. To illustrate, for a given separation



fiq 2 : use combination of heat and mass for convert the regular column to brugma`s subcolum

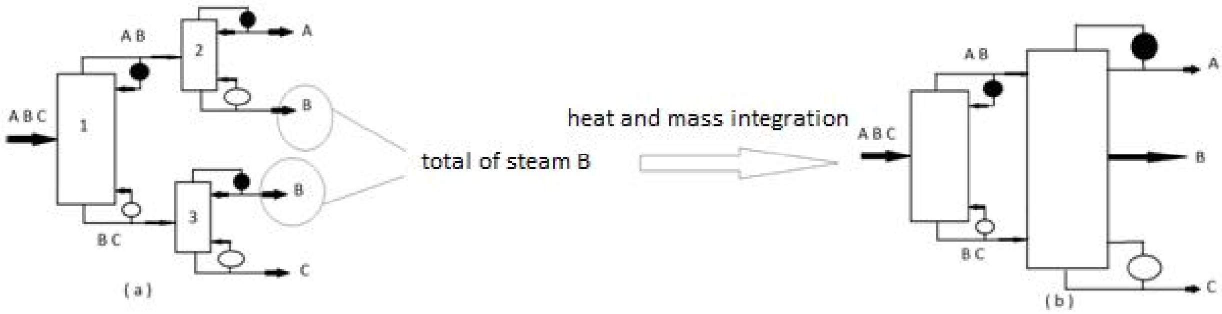


fig 3. indication of combination heat and mass integration of distillation columns

let V_1, V_2, and V_3 be the vapor flow necessities of distillation columns ‘‘1,’’ ‘‘2,’’ and ‘‘3,’’ individually, of the configuration shown in Figure 2a. The total vapor flow prerequisite of the configuration of Figure 2a is thus given by

$$V_{(\text{ Before Combination})} = V_1 + V_2 + V_3 \qquad (1)$$

Because of concurrent heat and mass integration of the second and third distillation columns of the configuration shown in Figure 2a, the total minimum vapor flow requirement of the configuration of Figure 2b is

$$V_{(\text{After Combination})} = V_1 + \max (V_2 , V_3) \qquad (2)$$

It is obvious from Eqs. 1 and 2 that

$$V_{(\text{ Before Combination})} > V_{(\text{After Combination})} \qquad (3)$$

Another example of a concurrently heat and mass integrated configuration is illustrated in Figure 3. Petlyuk et al.[7] demonstrated that distillation columns producing final product streams of same configuration can be concurrently heat and mass integrated. Figure 3a shows a three-column distillation configuration for separating a three-component feed. In the configuration of Figure 3a, final product stream B is produced as the bottom product of the second distillation column and as the top product of distillation column 3.

As a torrent with same composition is formed from a reboiler as well as a condenser, Petlyuk et al.[7] eliminated the associated exchangers and combined column 2 with column 3 of the configuration in Figure 3a into a single shell.

Thus, they got the basic configuration with concurrent heat and mass integration shown in Figure 3b. Like concurrent heat and mass integration between distillation columns creating final product stream of same composition (Figure 3), distillation columns making sub-mixtures of same components have also been heat and mass integrated.

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