Separation of Azeotropic Mixtures in Closed Batch Distillation Arrangements

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SCOPE OF THE PROJECT

• How can we separate ternary mixtures in closed batch distillation arrangements?
• What are the batch time (energy) requirements for separating each mixture?

SYSTEMS STUDIED

i) Zeotropic system: Methanol/Ethanol/Propanol

ii) Heteroazeotropic systems: Methanol/Water/Butanol (Serafimov’s class 1.0-2)

iii) Heteroazeotropic system: Ethyl Acetate/Water/Acetic Acid (Serafimov’s class 1.0-1a)

COLUMNS ARRANGEMENTS

a) Conventional multivessel column: The multivessel column combines a batch rectifier and a batch stripper. It has two sections and three vessels. The vapor stream from the stripping section bypasses the middle vessel (Figure 1a).

b) Modified multivessel column: Same characteristics like the conventional multivessel but there is no vapor bypass. The vapor stream is bubbled through the middle vessel (Figure 1b).

c) Cyclic column: A common batch rectifier. The column has one section and two vessels (Figure 1c).

A) MULTIVESSEL COLUMN

Heteroazeotropic systems

• The conventional multivessel column with vapor bypass is proposed for the separation of heterogeneous azeotropic systems. A common batch rectifier. The column has one section and two vessels (Figure 1c).

B) CYCLIC COLUMN

Heteroazeotropic system: Ethyl Acetate/Water/Acetic Acid (Serafimov’s class 1.0-1a)

- The cyclic column requires more time than the multivessel column for all separations studied here.
- The time advantages of the conventional multivessel column, compared to the cyclic column, become smaller as the specification in the middle vessel becomes stricter. The reason is the slow composition dynamics in the middle vessel because of the vapor bypass.

- The modified multivessel, without vapor bypass, performs better than the conventional one, for all separations. This should be attributed to the improved dynamics in the middle vessel. The time advantages of the modified multivessel does not depend on the specifications.

- The time advantages of the modified multivessel are small for the third mixture. This is a heteroazeotropic mixture and a decanter is placed in the middle vessel. The process is governed by the dynamics in the decanter and therefore the improved middle vessel dynamics become less important.

- The modified multivessel is problematic from the practical point of view for heteroazeotropic mixtures. When the decanter is placed in the middle vessel, as for class 1.0-2, we need a vapor stream entering the decanter. When the decanter is placed in the top vessel, as for class 1.0-1a, the time savings become unimportant.

DISCUSSION

• Separation possibilities in closed batch distillation arrangements were studied for different mixtures. A conventional multivessel column with a vapor bypass, a modified multivessel (without a vapor bypass) and a cyclic column (rectifier) were studied for the separation of one zeotropic and two heteroazeotropic systems. Batch time (energy) requirements were also provided, based on simulations.

• All systems studied can be separated in the closed arrangements.

• The modified multivessel column is superior to the cyclic column (rectifier), in terms of batch time (energy) requirements.

• The modified multivesSEL column without vapor bypass is proposed for the separation of heteroazeotropic systems.

• The conventional multivesSEL column with vapor bypass is proposed for the separation of heteroazeotropic systems.

CONCLUSIONS

Separation possibilities in closed batch distillation arrangements were studied for different mixtures. A conventional multivessel column (with a vapor bypass), a modified multivessel (without a vapor bypass) and a cyclic column (rectifier) were studied for the separation of one zeotropic and two heteroazeotropic systems. Batch time (energy) requirements were also provided, based on simulations.

• All systems studied can be separated in the closed arrangements.

• The modified multivessel column is superior to the cyclic column (rectifier), in terms of batch time (energy) requirements.

• The modified multivesSEL column without vapor bypass is proposed for the separation of heteroazeotropic systems.

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REFERENCES