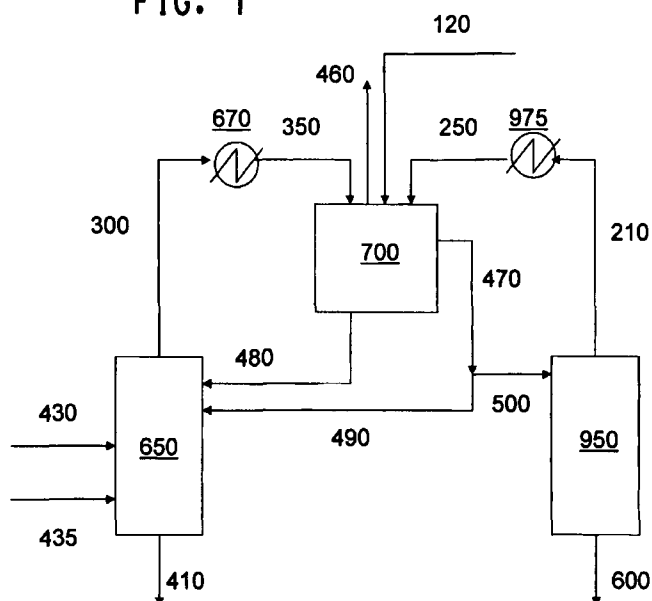


RECOVERY OF BUTANOL FROM A MIXTURE OF BUTANOL, WATER, AND AN ORGANIC EXTRACTANT

Abstract of the Invention

A process for recovering butanol from a mixture comprising a water-immiscible organic extractant, water, butanol, and optionally a non-condensable gas, is provided. The butanol is selected from 1-butanol, 2-butanol, isobutanol, and mixtures thereof. The extractant comprises at least one solvent selected from the group consisting of C_7 to C_{22} fatty alcohols, C_7 to C_{22} fatty acids, esters of C_7 to C_{22} fatty acids, C_7 to C_{22} fatty aldehydes, and mixtures thereof.

FIG. 1



WE CLAIM :

- I. A process comprising:
 - a) introducing a feed comprising:
 - (i) a water-immiscible organic extractant;
 - (ii) water;
 - (v) at least one isomer of butanol; and
 - (vi) optionally a non-condensable gasinto a first distillation column,
wherein the first distillation column comprises a stripping section and optionally a rectifying section at an introduction point above the stripping section, the first distillation column having an operating temperature T_1 and an operating pressure P_1 in the stripping section;
wherein T_1 and P_1 are selected to produce a first bottoms stream and a first vaporous overhead stream, the first bottoms stream comprising the water-immiscible organic extractant and water and being substantially free of butanol, and the first vaporous overhead stream comprising water, butanol, optionally the extractant, and optionally the non-condensable gas;
 - b) introducing a water-immiscible organic entrainer to at least one process stream or vessel;
 - c) condensing the first vaporous overhead stream to produce a gas phase and recover a first mixed condensate;
wherein the first mixed condensate comprises:
 - (i) an organic phase comprising butanol, entrainer, and water; and
 - (ii) an aqueous phase comprising water and butanol; and

wherein the first mixed condensate comprises sufficient entrainer to provide phase separation of the organic and the aqueous phases;
d) introducing at least a portion of the aqueous phase to the first distillation column;
e) introducing a first portion of the organic phase into a second distillation column having at least a stripping section; and
f) operating the second distillation column to produce a second bottoms stream comprising butanol and wherein said bottoms stream is substantially free of water and entrainer, and a second vaporous overhead stream comprising butanol, entrainer, and water.

2. The process of claim 1, wherein the extractant is selected such that it (A) preferentially extracts butanol over water and (B) is separable from butanol by distillation; and the entrainer is selected such that it (C) has a higher vapor pressure than butanol and (D) is separable from butanol by distillation.

3. The process of claim 1, further comprising any one of steps:
g) introducing a second portion of the organic phase into the first distillation column; or
h) condensing the vaporous overhead stream from the second distillation column to recover a second condensate stream, and introducing at least a portion of the second condensate stream into the first mixed condensate; or
j) both steps g) and step h).

4. The process of claim 1, wherein the process stream or vessel of step (b) is selected from the feed stream, the first vaporous overhead stream, the first mixed condensate stream, the second condensate stream, the portion of the organic phase which is introduced into the

second column, the vaporous overhead stream from the second distillation column, the first distillation column, the decanter, the upper section of the second distillation column, and combinations thereof.

5. The process of claim 1, further comprising the step of introducing water, steam, or a mixture thereof into the first distillation column.

6. The process of claim 1, further comprising the step of introducing at least a portion of the aqueous phase into a fermentation vessel.

7. The process of claim 1, wherein the process further comprises the step of introducing the bottoms stream from the first distillation column into a fermentation vessel.

8. The process of claim 1, wherein the process further comprises separating the bottoms stream from the first distillation column to obtain a bottoms aqueous phase comprising water and a bottoms organic phase comprising the extractant, introducing at least a portion of the bottoms organic phase into a fermentation vessel, and optionally introducing at least a portion of the bottoms aqueous phase into a fermentation vessel.

9. The process of claim 1, wherein the gas phase comprises entrainer, and the process further comprises condensing the gas phase to recover at least a portion of the entrainer and optionally introducing the recovered entrainer to the first mixed condensate.

10. The process of claim 9, wherein a non-condensable gas is present in the feed, the gas phase further comprises the non-condensable gas, and the process further comprises purging at least a portion of the gas phase comprising the non-condensable gas from the process.

11. The process of claim 1, wherein the non-condensable gas comprises carbon dioxide.

12. The process of claim 1, wherein the feed comprises an organic phase obtained from an extractive fermentation.

13. The process of claim 1, wherein the butanol concentration in the feed is from about 0.1 weight percent to about 40 weight percent, based on the weight of the feed.

14. The process of claim 1, wherein the entrainer comprises at least one hydrocarbon.

15. The process of claim 14, wherein said at least one hydrocarbon selected from the group consisting of pentane, hexane, hexene, cyclohexane, benzene, toluene, and xylene.

16. The process of claim 1, wherein the extractant comprises at least one solvent selected from the group consisting of C₇ to C₂₂ fatty alcohols, C₇ to C₂₂ fatty acids, esters of C₇ to C₂₂ fatty acids, C₇ to C₂₂ fatty aldehydes, C₇ to C₂₂ fatty amides, and mixtures thereof.

17. The process of claim 16, wherein the extractant comprises at least one solvent selected from the group consisting of C₁₂ to C₂₂ fatty alcohols, C₁₂ to C₂₂ fatty acids, esters of C₁₂ to C₂₂ fatty acids, C₁₂ to C₂₂ fatty aldehydes, C₁₂ to C₂₂ fatty amides, and mixtures thereof.

18. The process of claim 1, wherein the isomer of butanol is 1-butanol, 2-butanol, isobutanol, or mixtures thereof.

19. The process of claim 1, wherein the isomer of butanol is isobutanol.
20. The process of claim 1 wherein the butanol in the feed introduced into a first distillation column is produced by fermentation of corn or sugar cane.
21. The process of claim 1, wherein the feed further comprises ethanol and the second bottoms stream further comprises ethanol.
22. The process of claim 1 wherein there is a process to process heat exchange between the feed introduced to the first distillation column and the first bottoms stream.

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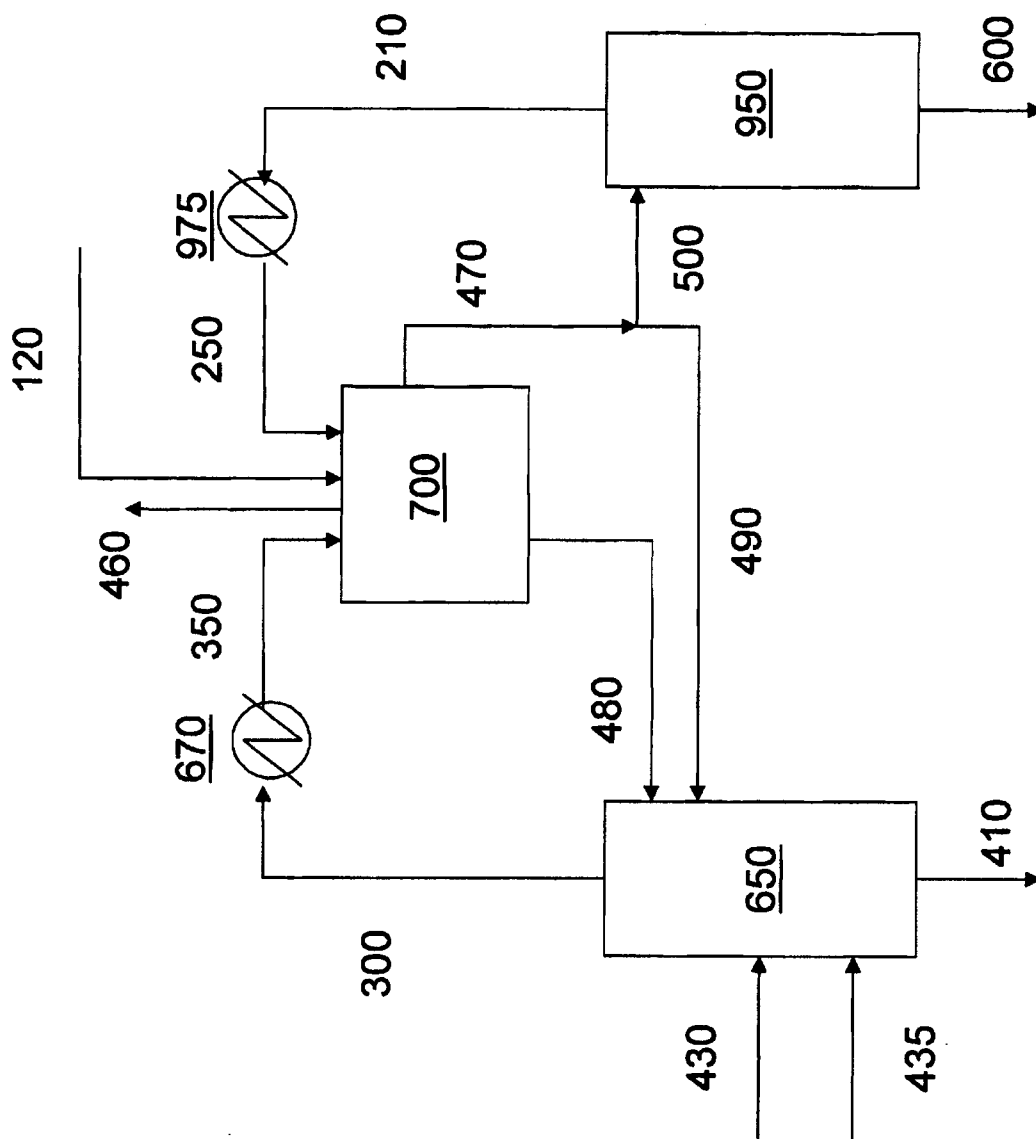


FIG. 1

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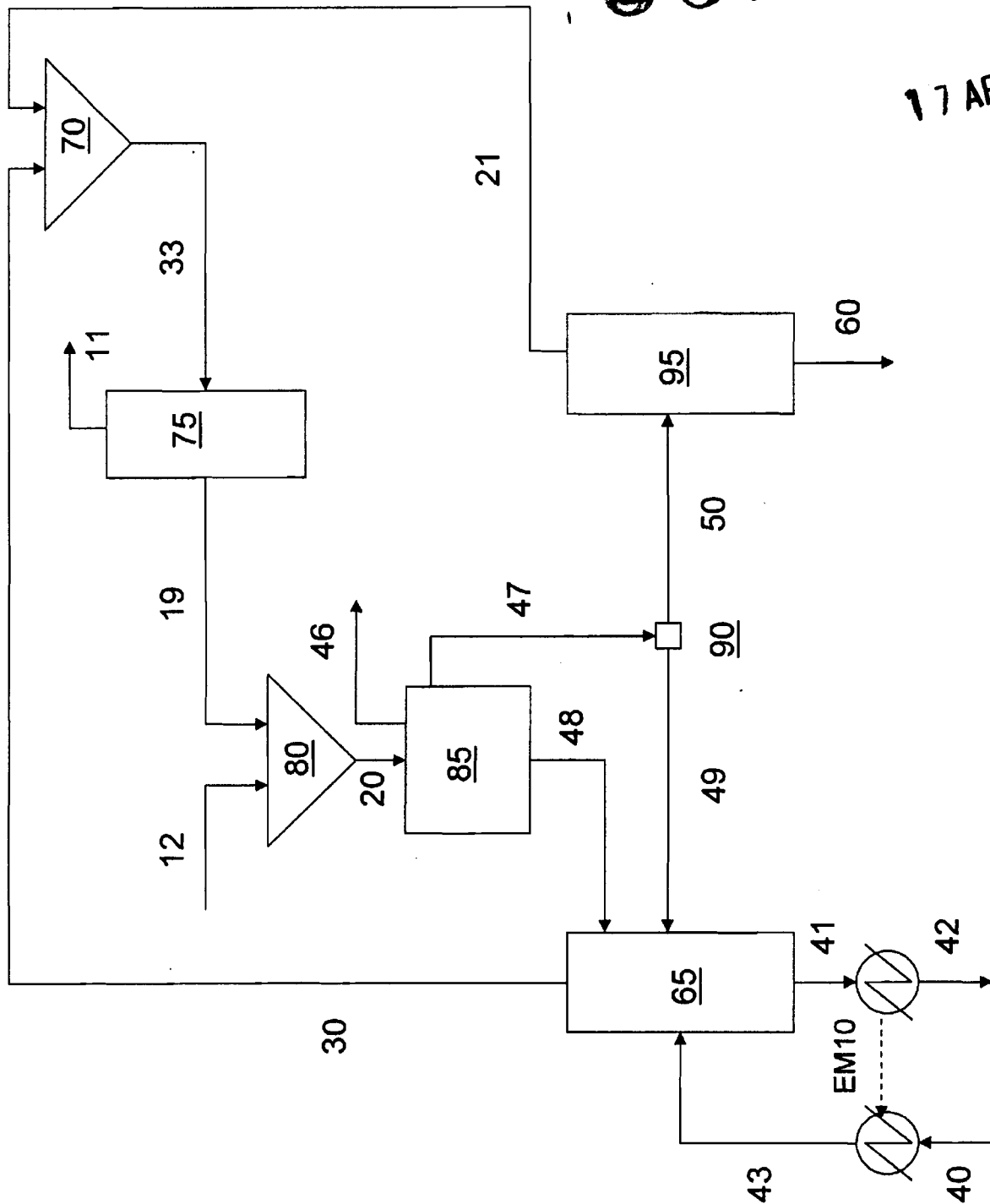


FIG. 2

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