We claim:

1. A process for producing a water stream, the process comprising:

hydrogenating an acetic acid feed stream to form a crude ethanol product; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream is essentially free of organic impurities other than acetic acid and ethanol.

2. The process of claim 1, wherein the hydrogenating is conducted over a catalyst comprising a combination of metals selected from the group consisting of platinum/tin, platinum/ruthenium, platinum/rhenium, palladium/ruthenium, palladium/rhenium, cobalt/palladium, cobalt/platinum, cobalt/chromium, cobalt/ruthenium, silver/palladium, copper/palladium, nickel/palladium, gold/palladium, ruthenium/rhenium, and ruthenium/iron.

3. A process for producing a water stream, the process comprising:

providing a crude ethanol product comprising ethanol, water, ethyl acetate, and acetic acid; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream is essentially free of organic impurities other than acetic acid and ethanol.

4. The process as in one of claims 1-3, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt.%, water in an amount of from 5 to 35 wt.%, acetic acid in an amount of from 0 to 90 wt.%, and ethyl acetate in an amount of from 0 to 20 wt.%.

5. The process as in one of claims 1-4, wherein the water stream comprises:

at least 97 wt.% water;

less than 0.5 wt.% acetic acid;

less than 0.005 wt.% ethanol; and

less than 0.001 wt.% ethyl acetate.

6. The process as in one of claims 1-5, wherein the water stream has a pH ranging from 2.99 to 3.35.

7. The process as in one of claims 1-6, wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

8. The process as in one of claims 1-7, wherein the at least one column has a base temperature of from 70 to 110°C.

9. The process as in one of claims 1-8, wherein the at least one column has a base temperature of at least 102°C.

10. The process as in one of claims 1-9, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water; and

separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

11. The process of claim 10, wherein the second column is an extractive distillation column, which uses an extraction agent.

12. The process as in one of claims 1-11, wherein at least a portion of the water stream is directed to the second column.

13. The process as in one of claims 1-12, wherein one of the plurality of columns is a scrubber.

14. The process of claim 13, wherein the water stream is directed to the scrubber.

15. A process for producing a water stream, the process comprising:

hydrogenating acetic acid to form a crude ethanol product; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream comprises:

at least 97 wt.% water;

less than 0.5 wt.% acetic acid;

less than 0.005 wt.% ethanol; and

less than 0.001 wt.% ethyl acetate.

16. A process for producing a water stream, the process comprising:

providing a crude ethanol product comprising ethanol, water, ethyl acetate, and acetic acid; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream comprises:

at least 97 wt.% water;

less than 0.5 wt.% acetic acid;

less than 0.005 wt.% ethanol; and

less than 0.001 wt.% ethyl acetate.

17. The process as in any one of claims 15 and 16, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt.%, water in an amount of from 5 to 35 wt.%, acetic acid in an amount of from 0 to 90 wt.%, and ethyl acetate in an amount of from 0 to 20 wt.%.

18. The process as in one of claims 15-17, wherein the water stream has a pH ranging from 2.99 to 3.35.

19. The process as in one of claims 15-18, wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

20. The process as in one of claims 15-19, wherein the at least one column has a base temperature of from 70 to 110°C.

21. The process as in one of claims 15-20, wherein the at least one column has a base temperature of at least 102°C.

22. The process as in one of claims 15-21, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water; and

separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

23. The process of claim 22, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt.%, water in an amount of from 5 to 35 wt.%, acetic acid in an amount of from 0 to 90 wt.%, and ethyl acetate in an amount of from 0 to 20 wt.%.

24. The process as in any one of claims 22 and 23, wherein the water stream has a pH ranging from 2.99 to 3.35.

25. The process as in one of claims 22-24, wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

26. The process as in one of claims 22-25, wherein the at least one column has a base temperature of from 70 to 110°C.

27. The process as in one of claims 22-26, wherein the at least one column has a base temperature of at least 102°C.

28. The process as in one of claims 22-27, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water; and

separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

We Claim:

1. A process for producing a water stream, the process comprising:

hydrogenating an acetic acid feed stream to form a crude ethanol product; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream is essentially free of organic impurities other than acetic acid and ethanol.

2. The process of claim 1, wherein the hydrogenating is conducted over a catalyst comprising a combination of metals selected from the group consisting of platinum/tin, platinum/ruthenium, platinum/rhenium, palladium/ruthenium, palladium/rhenium, cobalt/palladium, cobalt/platinum, cobalt/chromium, cobalt/ruthenium, silver/palladium, copper/palladium, nickel/palladium, gold/palladium, ruthenium/rhenium, and ruthenium/iron.

3. A process for producing a water stream, the process comprising:

providing a crude ethanol product comprising ethanol, water, ethyl acetate, and acetic acid; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream is essentially free of organic impurities other than acetic acid and ethanol.

4. (Amended) The process as in one of claims 1-3, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt.%, water in an amount of from 5 to 35 wt.%, acetic acid in an amount of from 0.001 to 90 wt.%, and ethyl acetate in an amount of from 0.001 to 20 wt.%.

5. The process as in one of claims 1-4, wherein the water stream comprises:

at least 97 wt.% water;

less than 0.5 wt.% acetic acid;

less than 0.005 wt.% ethanol; and

less than 0.001 wt.% ethyl acetate.

6. The process as in one of claims 1-5, wherein the water stream has a pH ranging from 2.99 to 3.35.

7. The process as in one of claims 1-6, wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

8. The process as in one of claims 1-7, wherein the at least one column has a base temperature of from 70 to 110°C.

9. The process as in one of claims 1 -8, wherein the at least one column has a base temperature of at least 102°C.

10. The process as in one of claims 1-9, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water; and

separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

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11. The process of claim 10, wherein the second column is an extractive distillation column, which uses an extraction agent.

12. The process as in one of claims 1-11, wherein at least a portion of the water stream is directed to the second column.

13. The process as in one of claims 1-12, wherein one of the plurality of columns is a scrubber.

14. The process of claim 13, wherein the water stream is directed to the scrubber.

15. A process for producing a water stream, the process comprising:

hydrogenating acetic acid to form a crude ethanol product; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream comprises:

at least 97 wt.% water;

less than 0.5 wt.% acetic acid;

less than 0.005 wt.% ethanol; and

less than 0.001 wt.% ethyl acetate.

16. A process for producing a water stream, the process comprising:

providing a crude ethanol product comprising ethanol, water, ethyl acetate, and acetic acid; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream comprises:

at least 97 wt.% water;

less than 0.5 wt.% acetic acid;

less than 0.005 wt.% ethanol; and

less than 0.001 wt.% ethyl acetate.

17. (Amended) The process as in any one of claims 15 and 16, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt.%, water in an amount of from 5 to 35 wt.%, acetic acid in an amount of from 0.001 to 90 wt.%, and ethyl acetate in an amount of from 0.001 to 20 wt.%.

18. The process as in one of claims 15-17, wherein the water stream has a pH ranging from 2.99 to 3.35.

19. The process as in one of claims 15-18, wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

20. The process as in one of claims 15-19, wherein the at least one column has a base temperature of from 70 to 110°C.

21. The process as in one of claims 15-20, wherein the at least one column has a base temperature of at least 102°C.

22. The process as in one of claims 15-21, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water; and

separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

23. (Amended) The process of claim 22, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt.%, water in an amount of from 5 to 35 wt.%, acetic acid in an amount of from 0.001 to 90 wt.%, and ethyl acetate in an amount of from 0.001 to 20 wt.%.

24. The process as in any one of claims 22 and 23, wherein the water stream has a pH ranging from 2.99 to 3.35.

25. The process as in one of claims 22-24, wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

26. The process as in one of claims 22-25, wherein the at least one column has a base temperature of from 70 to 110°C.

27. The process as in one of claims 22-26, wherein the at least one column has a base temperature of at least 102°C.

28. The process as in one of claims 22-27, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water; and

separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

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We claim:

1. A process for producing a water stream, the process comprising:

hydrogenating acetic acid to form a crude ethanol product; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream comprises:

at least 97 wt. % water;

less than 0.5 wt. % acetic acid;

less than 0.005 wt. % ethanol; and

less than 0.001 wt. % ethyl acetate.

2. The process of claim 1, wherein the crude ethanol product comprises ethanol, water, ethyl acetate, and acetic acid.

3. The process of claim 2, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt. %, water in an amount of from 5 to 35 wt. %, acetic acid in an amount of from 0 to 90 wt. %, and ethyl acetate in an amount of from 0 to 20 wt. %.

4. The process of claim 1, wherein the water stream has a pH ranging from 2.99 to 3.35.

5. The process of claim 1, wherein the water stream is essentially free of organic impurities other than acetic acid and ethanol, and wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

6. The process of claim 1, wherein the at least one column has a base temperature of from 70 to 110.degree. C.

7. The process of claim 1, wherein the at least one column has a base temperature of at least 102.degree. C.

8. The process of claim 1, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water; and

separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

9. A process for producing a water stream, the process comprising:

providing a crude ethanol product comprising ethanol, water, ethyl acetate, and acetic acid; and

separating at least a portion of the crude ethanol product in at least one column of a plurality of columns into a distillate comprising ethanol and a residue comprising the water stream;

wherein the water stream comprises:

at least 97 wt. % water;

less than 0.5 wt. % acetic acid;

less than 0.005 wt. % ethanol; and

less than 0.001 wt. % ethyl acetate.

10. The process of claim 9, wherein the crude ethanol product comprises ethanol in an amount of from 5 to 70 wt. %, water in an amount of from 5 to 35 wt. %, acetic acid in an amount of from 0 to 90 wt. %, and ethyl acetate in an amount of from 0 to 20 wt. %.

11. The process of claim 9, wherein the water stream has a pH ranging from 2.99 to 3.35.

12. The process of claim 9, wherein the water stream is essentially free of organic impurities other than acetic acid and ethanol, and wherein the organic impurities are selected from the group consisting of ethyl acetate, acetaldehyde, acetone, acetal and mixtures thereof.

13. The process of claim 9, wherein the at least one column has a base temperature of from 70 to 110.degree. C.

14. The process of claim 9, wherein the at least one column has a base temperature of at least 102.degree. C.

15. The process of claim 9, wherein the separating further comprises:

separating at least a portion of the crude ethanol product in a first column of the plurality of columns into a first distillate comprising ethanol, water and ethyl acetate, and a first residue comprising acetic acid;

separating at least a portion of the first distillate in a second column of the plurality of columns into a second distillate comprising ethyl acetate and a second residue comprising ethanol and water;

and separating at least a portion of the second residue in a third column of the plurality of columns into a third distillate comprising ethanol and a third residue comprising the water stream.

16. The process of claim 15, wherein the second column is an extractive distillation column, which utilizes an extraction agent.

17. The process of claim 16, wherein at least a portion of the water stream is directed to the second column.

18. The process of claim 9, wherein one of the plurality of columns is a scrubber.

19. The process of claim 18, wherein the water stream is directed to the scrubber.

20. The process of claim 9, wherein the hydrogenating is conducted over a catalyst comprising a combination of metals selected from the group consisting of platinum/tin, platinum/ruthenium,

platinum/rhenium, palladium/ruthenium, palladium/rhenium, cobalt/palladium, cobalt/platinum, cobalt/chromium, cobalt/ruthenium, silver/palladium, copper/palladium, nickel/palladium, gold/palladium, ruthenium/rhenium, and ruthenium/iron.

21. The process of claim 8, wherein the second column is an extractive distillation column, which utilizes an extraction agent.

22. The process of claim 21, wherein at least a portion of the water stream is directed to the second column.

23. The process of claim 1, wherein one of the plurality of columns is a scrubber.

24. The process of claim 23, wherein the water stream is directed to the scrubber.

25. The process of claim 1, wherein the hydrogenating is conducted over a catalyst comprising a combination of metals selected from the group consisting of platinum/tin, platinum/ruthenium, platinum/rhenium, palladium/ruthenium, palladium/rhenium, cobalt/palladium, cobalt/platinum, cobalt/chromium, cobalt/ruthenium, silver/palladium, copper/palladium, nickel/palladium, gold/palladium, ruthenium/rhenium, and ruthenium/iron.