We claim:

1. A process for purifying acetic acid, comprising:

a. distilling a process stream in a column, the process stream comprising acetic acid at a concentration of greater than 90 wt. %, water at a concentration from 1 to 3 wt. %, one or more C_1-C_{14} alkyl iodides in a total concentration of no more than 6 wt. %, and methyl acetate at a concentration of no more than 6 wt. %;

b. forming acetic anhydride in a lower portion of the column;

c. withdrawing a product stream from the lower portion of the column, the product stream comprising acetic acid, water at a concentration of no more than 0.2 wt. %, and acetic anhydride at a concentration of no more than 600 wppm; and

d. hydrating the acetic anhydride in the product stream to form a purified acetic acid product comprising acetic anhydride at a concentration of no more than 50 wppm.

2. The process of claim 1, wherein the hydrating step comprises contacting the product stream with a cation exchange resin.

3. The process of claim 2, wherein the cation exchange resin comprises sulfonic acid or partially metal impregnated sulfonic acid functional groups.

4. The process of claim 1, wherein the product stream is not contacted with an aqueous stream after withdrawal of the product stream from the lower portion of the column.

5. The process of claim 1, wherein the process stream is substantially free of acetic anhydride.

6. The process of claim 1, wherein the process stream comprises hydrogen iodide at a concentration of no more than 300 wppm.

7. The process of claim 1, wherein the product stream comprises acetic anhydride at a concentration from 5 to 600 wppm.

8. The process of claim 1, wherein the purified acetic acid product comprises water at a concentration of no more than 0.2 wt. %.

9. The process of claim 1, wherein the purified acetic acid product comprises acetic anhydride at a concentration from 0.5 to 50 wppm.

10. The process of claim 1, wherein the product stream is withdrawn at a point within 5 actual stages from the base of the column.

11. The process of claim 1, further comprising contacting the purified acetic acid product with a metal-exchanged ion exchange resin having acid cation exchange sites to reduce the iodide concentration of the purified acetic acid product to no more than 100 wppb.

12. A process for producing acetic acid comprising:

a. carbonylating, in a reactor, at least one member selected from the group consisting of methanol, dimethyl ether, and methyl acetate in a reaction medium comprising water at a concentration from 0.1 to 14 wt. %, a rhodium catalyst, methyl iodide, and an iodide salt;

b. separating the reaction medium to form a liquid recycle stream and a vapor product stream;

c. distilling at least a portion of the vapor product stream in a first column to obtain a side stream comprising acetic acid at a concentration greater than 90 wt. %, water at a concentration from 1 to 3 wt. %, one or more C_1-C_{14} alkyl iodides in a total concentration of no more than 6 wt. % and methyl acetate at a concentration of no more than 6 wt. %;

d. distilling the side stream in a second column to obtain a product stream comprising acetic acid, water at a concentration of no more than 0.2 wt. % and acetic anhydride at a concentration of no more than 600 wppm; and

e. contacting the product stream with a cation exchange resin to form a purified acetic acid product comprising no more than 50 wppm acetic anhydride.

13. The process of claim 12, wherein the production rate of acetic anhydride is greater in the second column than the reactor.

14. The process of claim 12, wherein the side stream is substantially free of acetic anhydride.

15. The process of claim 12, wherein the side stream comprises hydrogen iodide at a concentration of no more than 300 wppm.

16. The process of claim 12, wherein the product stream comprises acetic anhydride at a concentration from 10 to 600 wppm.

17. The process of claim 12, wherein the purified acetic acid product comprises water at a concentration of no more than 0.2 wt. %.

18. The process of claim 12, wherein the purified acetic acid product comprises acetic anhydride at a concentration of no more than 10 wppm.

19. The process of claim 12, wherein the acetic anhydride concentration of the purified acetic acid product is less than the acetic anhydride concentration of the product stream.

20. The process of claim 12, further comprising contacting the purified acetic acid product with a metal-exchanged ion exchange resin having acid cation exchange sites to reduce the iodide concentration of the purified acetic acid product to no more than 100 wppb.