We claim:

1. A process for producing acetic acid, comprising

reacting a first reaction mixture comprising carbon monoxide and at least one of methanol and a methanol derivative in a first reactor under conditions effective to produce a crude acetic acid product;

separating the crude acetic acid product into at least one derivative stream comprising residual carbon monoxide;

reacting a second reaction mixture comprising at least a portion of the residual carbon monoxide in the at least one derivative stream and at least one of methanol and a methanol derivative in a second reactor to produce additional acetic acid,

wherein the second reactor is a homogeneous reactor and a second reactor carbon monoxide partial pressure is less than 1.05 MPa, preferably ranging from 0.005 MPa to 1.05 MPa.

2. The process of claim 1, further comprising the step of:

compressing the at least one derivative stream to form a compressed derivative stream, wherein the compressed derivative stream has a feed carbon monoxide partial pressure of at least 0.03 MPa, preferably ranging from 0.03 MPa to 1.75 MPa.

3. The process of claim 1, wherein the second reactor contains a liquid catalyst.

4. The process of claim 3, wherein, in the second reactor, the at least one of methanol and a methanol derivative and the catalyst are liquids.

5. The process of claim 1, wherein the first reaction mixture further comprises a first amount of rhodium and the second reaction mixture further comprises a second amount of rhodium and wherein the first amount of rhodium is less than the second amount of rhodium..

6. The process of claim 1, wherein the first reactor contains catalyst and wherein the crude acetic acid product comprises catalyst.

7. The process of claim 6, further comprising the step of:

separating the crude acetic acid product to form a catalyst recycle stream comprising catalyst.

8. The process of claim 7, further comprising the step of:

directing at least a portion of the catalyst recycle stream to the second reactor.

9. The process of claim 1, wherein the second reactor yields a product stream comprising less than 40 mol% carbon monoxide.

10. The process of claim 1, wherein a pressure in the second reactor is less than the pressure in the first reactor.

11. The process of claim 1, wherein the at least one derivative stream comprising residual carbon monoxide, comprises:

from 10 mol% to 95 mol% carbon monoxide; and

from 0.1 mol% to 40 mol% at least one of methanol and a methanol derivative.

12. The process of claim 1, wherein the reaction temperature in the second reactor ranges from 100°C to 250°C.

13. The process of claim 1, wherein the at least one of methanol and a methanol derivative, in the second reactor is provided by a supplemental feed stream or another of the derivative streams.

14. The process of claim 1, wherein the at least one of methanol and a methanol derivative comprise methyl acetate and/or dimethyl ether.

15. The process of claim 1, wherein the first reactor comprises a catalyst; and

wherein the separating comprises:

flashing the crude acetic acid product into a first vapor stream comprising acetic acid, residual carbon monoxide and catalyst and a first liquid residue stream comprising catalyst; and

separating the flashed vapor stream into a second vapor stream comprising carbon monoxide, a purified acetic acid product, and a second liquid residue stream comprising catalyst.

16. The process of claim 15, wherein at least a portion of the second liquid residue stream is directed to the second reactor.

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

decanting the second vapor stream to form a third vapor stream comprising residual carbon monoxide and a third liquid residue stream comprising methyl iodide, methyl acetate, acetaldehyde; and

compressing the third vapor stream to form the compressed derivative stream.

18. A process for producing acetic acid, the process comprising:

reacting in a reactor a carbon monoxide feed and at least one of methanol and a methanol derivative under conditions effective to produce a reaction product comprising a crude acetic acid product and a vent stream comprising less than 60 mol % carbon monoxide;

wherein the reaction in the reactor is a homogeneous reaction and the reaction is conducted at a carbon monoxide partial pressure less than 1.05 MPa.

19. The process of claim 18, wherein the vent stream comprises less than 50 mol% carbon monoxide.

20. The process of claim 18, wherein the carbon monoxide feed comprises a carbon monoxide partial pressure of less than 60% of the total pressure of the carbon monoxide feed.

We claim:

1. A process for producing acetic acid, comprising

reacting a first reaction mixture comprising carbon monoxide and at least one of methanol and a methanol derivative in a first reactor under conditions effective to produce a crude acetic acid product;

separating the crude acetic acid product into at least one derivative stream comprising residual carbon monoxide;

reacting a second reaction mixture comprising at least a portion of the residual carbon monoxide in the at least one derivative stream and at least one of methanol and a methanol derivative, preferably comprising comprise methyl acetate and/or dimethyl ether, in a second reactor, preferably comprising a liquid catalyst, to produce a product stream comprising additional acetic acid and, optionally less than 40 mol% carbon monoxide,

wherein the second reactor is a homogeneous reactor and a second reactor carbon monoxide partial pressure is less than 1.05 MPa, preferably ranging from 0.005 MPa to 1.05 MPa.

2. The process of claim 1, further comprising the step of:

compressing the at least one derivative stream to form a compressed derivative stream, wherein the compressed derivative stream has a feed carbon monoxide partial pressure of at least 0.03 MPa, preferably ranging from 0.03 MPa to 1.75 MPa.

3. The process of claim 1, wherein, in the second reactor, the at least one of methanol and a methanol derivative and the catalyst are liquids.

4. The process of claim 1, wherein the first reaction mixture further comprises a first amount of rhodium and the second reaction mixture further comprises a second amount of rhodium and wherein the first amount of rhodium is less than the second amount of rhodium.

5. The process of claim 1, wherein the first reactor contains catalyst and wherein the crude acetic acid product comprises catalyst.

6. The process of claim 5, further comprising the step of:

separating the crude acetic acid product to form a catalyst recycle stream comprising catalyst; and/or

directing at least a portion of the catalyst recycle stream to the second reactor.

7. The process of claim 1, wherein a pressure in the second reactor is less than the pressure in the first reactor.

8. The process of claim 1, wherein the at least one derivative stream comprising residual carbon monoxide, comprises:

from 10 mol% to 95 mol% carbon monoxide; and

from 0.1 mol% to 40 mol% at least one of methanol and a methanol derivative.

9. The process of claim 1, wherein the reaction temperature in the second reactor ranges from 100°C to 250°C.

10. The process of claim 1, wherein the at least one of methanol and a methanol derivative, in the second reactor is provided by a supplemental feed stream or another of the derivative streams.

11. The process of claim 1, wherein the first reactor comprises a catalyst; and

wherein the separating comprises:

flashing the crude acetic acid product into a first vapor stream comprising acetic acid, residual carbon monoxide and catalyst and a first liquid residue stream comprising catalyst; and

separating the flashed vapor stream into a second vapor stream comprising carbon monoxide, a purified acetic acid product, and a second liquid residue stream comprising catalyst.

12. The process of claim 11, wherein at least a portion of the second liquid residue stream is directed to the second reactor.

13. The process of claim 11, wherein the separating comprises:

decanting the second vapor stream to form a third vapor stream comprising residual carbon monoxide and a third liquid residue stream comprising methyl iodide, methyl acetate, acetaldehyde; and

compressing the third vapor stream to form the compressed derivative stream.

14. A process for producing acetic acid, the process comprising:

reacting in a reactor a carbon monoxide feed and at least one of methanol and a methanol derivative under conditions effective to produce a reaction product comprising a crude acetic acid product and a vent stream comprising less than 60 mol % carbon monoxide; preferably less than 50 mol% carbon monoxide;

wherein the reaction in the reactor is a homogeneous reaction and the reaction is conducted at a carbon monoxide partial pressure less than 1.05 MPa.

15. The process of claim 14, wherein the carbon monoxide feed comprises a carbon monoxide partial pressure of less than 60% of the total pressure of the carbon monoxide feed.