SUMMARY

In an embodiment, there is provided a method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the method comprising providing an ionic liquid specific sub-system comprising an ionic liquid alkylation reactor, and connecting at least one component of the ionic liquid specific sub-system to at least one component of the sulfuric acid alkylation unit.

In one aspect, there is provided a method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the method comprising:

a) providing an ionic liquid specific sub-system comprising an ionic liquid alkylation reactor and an ionic liquid/hydrocarbon separation unit configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into a hydrocarbon phase and an ionic liquid phase, wherein the ionic liquid/hydrocarbon separation unit comprises a primary separator vessel and an ionic liquid coalescer;

b) connecting at least one component of the ionic liquid specific sub-system to at least one component of the sulfuric acid alkylation unit;

c) connecting the primary separator vessel to the ionic liquid coalescer for feeding the hydrocarbon phase from the primary separator vessel to the ionic liquid coalescer; and

d) connecting the ionic liquid coalescer to the fractionation unit for feeding the hydrocarbon phase from the ionic liquid coalescer to the fractionation unit.

In another embodiment, there is provided a method for converting a conventional alkylation unit to an ionic liquid alkylation system, the conventional alkylation unit including a fractionation unit, and the method comprising providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions, and connecting the ionic liquid alkylation reactor to at least one component of the conventional alkylation unit.

In one aspect, there is provided a method for converting a conventional alkylation unit to an ionic liquid alkylation system, the conventional alkylation unit including a fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions;

b) providing an ionic liquid/hydrocarbon separation unit comprising a primary separator vessel and an ionic liquid coalescer in fluid communication with the primary separator vessel;

c) connecting the ionic liquid alkylation reactor to at least one component of the conventional alkylation unit; and

d) connecting the primary separator vessel to the ionic liquid alkylation reactor for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the primary separator vessel, wherein the primary separator vessel is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase.

According to a further embodiment, there is provided a method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the sulfuric acid alkylation unit including a conventional fractionation unit, and the method comprising providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions, providing an ionic liquid/hydrocarbon separation unit configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase and a hydrocarbon phase, connecting the ionic liquid alkylation reactor to the ionic liquid/hydrocarbon separation unit for feeding the alkylation reactor effluent to the ionic liquid/hydrocarbon separation unit, and modifying the conventional fractionation unit to provide a modified fractionation unit, such that the modified fractionation unit is configured for separating an HCl-rich C_3- fraction from at least a portion of the hydrocarbon phase.

In one aspect, there is provided a method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the sulfuric acid alkylation unit including a conventional fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions;

b) providing an ionic liquid/hydrocarbon separation unit configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase and a hydrocarbon phase;

c) connecting the ionic liquid alkylation reactor to the ionic liquid/hydrocarbon separation unit for feeding the alkylation reactor effluent to the ionic liquid/hydrocarbon separation unit; and

d) modifying the conventional fractionation unit to provide a modified fractionation unit, such that the modified fractionation unit is configured for separating an HCl-rich C_3- fraction from at least a portion of the hydrocarbon phase for recycling to the alkylation unit.

WHAT IS CLAIMED IS:

1. A method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the method comprising:

a) providing an ionic liquid specific sub-system comprising an ionic liquid alkylation reactor; and

b) connecting at least one component of the ionic liquid specific sub-system to at least one component of the sulfuric acid alkylation unit.

2. The method according to claim 1, wherein:

the sulfuric acid alkylation unit comprises at least one hydrocarbon feed line, and

step b) comprises connecting the ionic liquid alkylation reactor to the at least one hydrocarbon feed line.

3. The method according to claim 1, wherein:

the ionic liquid specific sub-system further comprises an ionic liquid feed line, and the method further comprising:

c) connecting the ionic liquid alkylation reactor to the ionic liquid feed line.

4. The method according to claim 1, wherein the ionic liquid specific sub-system further comprises an ionic liquid/hydrocarbon injection unit in fluid communication with the ionic liquid alkylation reactor, and the method further comprising:

d) connecting the ionic liquid/hydrocarbon injection unit to an ionic liquid feed line, and

e) connecting the ionic liquid/hydrocarbon injection unit to at least one hydrocarbon feed line, wherein the ionic liquid alkylation reactor and the ionic liquid/hydrocarbon injection unit are co-configured for forming a mixture comprising an ionic liquid phase and a hydrocarbon phase.

5. The method according to claim 1, wherein the ionic liquid specific sub-system further comprises an ionic liquid/hydrocarbon separation unit configured for separating an alkylation

reactor effluent of the ionic liquid alkylation reactor into a hydrocarbon phase and an ionic liquid phase

6. The method according to claim 5, wherein the ionic liquid separation unit comprises a primary separator vessel and an ionic liquid coalescer, and the method further comprising:

f) connecting the primary separator vessel to the ionic liquid coalescer for feeding the hydrocarbon phase from the primary separator vessel to the ionic liquid coalescer; and

g) connecting the ionic liquid coalescer to the fractionation unit for feeding the hydrocarbon phase from the ionic liquid coalescer to the fractionation unit.

7. The method according to claim 5, wherein the sulfuric acid alkylation unit includes at least one of an acid settler, an acid wash vessel, and an alkaline water wash vessel, and the ionic liquid/hydrocarbon separation unit comprises at least one of the acid settler, the acid wash vessel, and the alkaline water wash vessel.

8. The method according to claim 5, wherein the sulfuric acid alkylation unit includes a fractionation unit, and the method further comprising:

h) modifying the fractionation unit to provide a modified fractionation unit such that the modified fractionation unit is configured for separating an HCl-rich C_3- fraction from the hydrocarbon phase.

9. The method according to claim 1, further comprising:

i) replacing at least one component of the sulfuric acid alkylation unit with a component comprising a Ni/Cr alloy or a Ni/Cu alloy.

10. A method for converting a conventional alkylation unit to an ionic liquid alkylation system, the conventional alkylation unit including a fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions; and

b) connecting the ionic liquid alkylation reactor to at least one component of the conventional alkylation unit.

11. The method according to claim 10, wherein the conventional alkylation unit comprises at least one hydrocarbon feed line, and the method further comprising:

c) providing an ionic liquid/hydrocarbon injection unit, wherein step b) comprises connecting the ionic liquid alkylation reactor to the at least one hydrocarbon feed line via the ionic liquid/hydrocarbon injection unit.

12. The method according to claim 11, further comprising:

d) connecting the ionic liquid/hydrocarbon injection unit to an ionic liquid feed line, wherein the ionic liquid/hydrocarbon injection unit is configured for injecting an ionic liquid catalyst and at least one hydrocarbon feed into the ionic liquid alkylation reactor.

13. The method according to claim 11, wherein the ionic liquid alkylation reactor and the ionic liquid/hydrocarbon injection unit are co-configured for forming a mixture comprising a dispersed ionic liquid phase and a continuous hydrocarbon phase.

14. The method according to claim 10, further comprising:

e) providing an ionic liquid/hydrocarbon separation unit comprising a primary separator vessel; and

f) connecting the primary separator vessel to the ionic liquid alkylation reactor for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the primary separator vessel, wherein the primary separator vessel is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase.

15. The method according to claim 14, wherein the ionic liquid/hydrocarbon separation unit further comprises an ionic liquid coalescer in fluid communication with the primary separator vessel.

16. The method according to claim 10, wherein the conventional alkylation unit is configured for sulfuric acid catalyzed alkylation.

17. The method according to claim 10, wherein:

the conventional alkylation unit comprises an external refrigeration unit,

the ionic liquid alkylation system further comprises a heat exchanger, and the method further comprising:

g) decommissioning the external refrigeration unit;

h) providing an effluent refrigeration unit; and

i) connecting the heat exchanger to the effluent refrigeration unit, wherein the heat exchanger is in thermal communication with the ionic liquid alkylation reactor for removing heat from the ionic liquid alkylation reactor.

18. The method according to claim 17, further comprising:

j) connecting the effluent refrigeration unit to the fractionation unit.

19. The method according to claim 14, further comprising:

k) modifying the fractionation unit to provide a modified fractionation unit such that the modified fractionation unit is configured for separating an HCl-rich C_3- fraction from the hydrocarbon phase, wherein the ionic liquid alkylation system is configured for recycling the HCl-rich C_3- fraction to the ionic liquid alkylation reactor.

20. A method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the sulfuric acid alkylation unit including a conventional fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions;

b) providing an ionic liquid/hydrocarbon separation unit configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase and a hydrocarbon phase;

c) connecting the ionic liquid alkylation reactor to the ionic liquid/hydrocarbon separation unit for feeding the alkylation reactor effluent to the ionic liquid/hydrocarbon separation unit; and

d) modifying the conventional fractionation unit to provide a modified fractionation unit, such that the modified fractionation unit is configured for separating an HCl-rich C_3- fraction from at least a portion of the hydrocarbon phase.

21. The method according to claim 20, wherein the sulfuric acid alkylation unit further comprises a sulfuric acid alkylation reactor, and the method further comprising:

e) decommissioning the sulfuric acid alkylation reactor;

f) connecting the ionic liquid alkylation reactor to an ionic liquid catalyst feed line; and

g) connecting the ionic liquid alkylation reactor to at least one hydrocarbon feed line.

22. The method according to claim 20, wherein:

the ionic liquid/hydrocarbon separation unit comprises a primary separator vessel and an ionic liquid coalescer in fluid communication with the primary separator vessel,

step c) comprises connecting the ionic liquid alkylation reactor to the primary separator vessel, and the method further comprising:

h) before or after step d), connecting the ionic liquid coalescer to the conventional fractionation unit or to the modified fractionation unit.

23. The method according to claim 20, further comprising:

i) providing an ionic liquid catalyst regeneration unit, wherein the ionic liquid alkylation system is configured for recycling regenerated ionic liquid catalyst from the ionic liquid catalyst regeneration unit to the ionic liquid alkylation reactor.

24. An ionic liquid alkylation system derived from an existing, conventional alkylation unit having a conventional fractionation unit, the ionic liquid alkylation system comprising:

an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions;

an ionic liquid/hydrocarbon separation unit, in fluid communication with the ionic liquid alkylation reactor, for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase and a hydrocarbon phase; and

a modified fractionation unit in fluid communication with the ionic liquid/hydrocarbon separation unit, wherein:

the modified fractionation unit is derived from the conventional fractionation unit, and the conventional fractionation unit is modified such that the modified fractionation unit is configured for separating an HCl-rich C_{3-} fraction from the hydrocarbon phase, and

the ionic liquid alkylation system is configured for recycling the HCl-rich C_{3-} fraction to the ionic liquid alkylation reactor.

25. The ionic liquid alkylation system according to claim 24, further comprising:

a heat exchanger in thermal communication with the ionic liquid alkylation reactor for cooling the ionic liquid alkylation reactor, the ionic liquid alkylation system configured for feeding at least a portion of the hydrocarbon phase through the heat exchanger; and

an effluent refrigeration unit in fluid communication with the heat exchanger for receiving the hydrocarbon phase from the heat exchanger.

26. An ionic liquid catalyzed alkylation process, comprising:

a) contacting at least one isoparaffin and at least one olefin with an ionic liquid catalyst in an ionic liquid alkylation zone under ionic liquid catalyzed alkylation conditions;

b) separating a hydrocarbon phase from a reactor effluent of the ionic liquid alkylation zone;

c) flashing at least a portion of the hydrocarbon phase;

d) exchanging heat between the flashed hydrocarbon phase and the ionic liquid alkylation zone such that heat is removed from the ionic liquid alkylation zone by the flashed hydrocarbon phase;

e) separating, via an effluent refrigeration unit, the flashed hydrocarbon phase into a plurality of hydrocarbon streams;

f) fractionating at least one of the hydrocarbon streams to provide an HCl-rich C_{3-} fraction; and

g) recycling the HCl-rich C_{3-} fraction to the ionic liquid alkylation zone.

What is claimed is:

1. A method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the method comprising:

a) providing an ionic liquid specific sub-system comprising an ionic liquid alkylation reactor and an ionic liquid/hydrocarbon separation unit configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into a hydrocarbon phase and an ionic liquid phase, wherein the ionic liquid/hydrocarbon separation unit comprises a primary separator vessel and an ionic liquid coalescer;

b) connecting at least one component of the ionic liquid specific sub-system to at least one component of the sulfuric acid alkylation unit;

c) connecting the primary separator vessel to the ionic liquid coalescer for feeding the hydrocarbon phase from the primary separator vessel to the ionic liquid coalescer; and

d) connecting the ionic liquid coalescer to the fractionation unit for feeding the hydrocarbon phase from the ionic liquid coalescer to the fractionation unit.

2. The method according to claim 1, wherein:

the sulfuric acid alkylation unit comprises at least one hydrocarbon feed line, and step b) comprises connecting the ionic liquid alkylation reactor to the at least one hydrocarbon feed line.

3. The method according to claim 1, wherein: the ionic liquid specific sub-system further comprises an ionic liquid feed line, and the method further comprising:

e) connecting the ionic liquid alkylation reactor to the ionic liquid feed line.

4. The method according to claim 1, wherein the ionic liquid specific sub-system further comprises an ionic liquid/hydrocarbon injection unit in fluid communication with the ionic liquid alkylation reactor, and the method further comprising:

f) connecting the ionic liquid/hydrocarbon injection unit to an ionic liquid feed line, and

g) connecting the ionic liquid/hydrocarbon injection unit to at least one hydrocarbon feed line, wherein the ionic liquid alkylation reactor and the ionic liquid/hydrocarbon injection unit are co-configured for forming a mixture comprising an ionic liquid phase and a hydrocarbon phase.

5. The method according to claim 1, wherein the sulfuric acid alkylation unit includes at least one of an acid settler, an acid wash vessel, and an alkaline water wash vessel, and the ionic liquid/hydrocarbon separation unit comprises at least one of the acid settler, the acid wash vessel, and the alkaline water wash vessel.

6. The method according to claim 1, wherein the sulfuric acid alkylation unit includes a fractionation unit, and the method further comprising: h) modifying the fractionation unit to provide a modified fractionation unit such that the modified fractionation unit is configured for separating an HCl-rich C_{3-} fraction from the hydrocarbon phase for recycling to the alkylation unit.

7. The method according to claim 1, further comprising:

i) replacing at least one component of the sulfuric acid alkylation unit with a component comprising a Ni/Cr alloy or a Ni/Cu alloy.

8. A method for converting a conventional alkylation unit to an ionic liquid alkylation system, the conventional alkylation unit including a fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions;

b) providing an ionic liquid/hydrocarbon separation unit comprising a primary separator vessel and an ionic liquid coalescer in fluid communication with the primary separator vessel;

c) connecting the ionic liquid alkylation reactor to at least one component of the conventional alkylation unit; and

d) connecting the primary separator vessel to the ionic liquid alkylation reactor for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the primary separator vessel, wherein the primary separator vessel is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase.

9. The method according to claim 8, wherein the conventional alkylation unit comprises at least one hydrocarbon feed line, and the method further comprising:

e) providing an ionic liquid/hydrocarbon injection unit, wherein step b) comprises connecting the ionic liquid alkylation reactor to the at least one hydrocarbon feed line via the ionic liquid/hydrocarbon injection unit.

10. The method according to claim 9, further comprising:

f) connecting the ionic liquid/hydrocarbon injection unit to an ionic liquid feed line, wherein the ionic liquid/hydrocarbon injection unit is configured for injecting an ionic liquid catalyst and at least one hydrocarbon feed into the ionic liquid alkylation reactor.

11. The method according to claim 9, wherein the ionic liquid alkylation reactor and the ionic liquid/hydrocarbon injection unit are co-configured for forming a mixture comprising a dispersed ionic liquid phase and a continuous hydrocarbon phase.

12. The method according to claim 8, wherein the conventional alkylation unit is configured for sulfuric acid catalyzed alkylation.

13. The method according to claim 8, wherein:

the conventional alkylation unit comprises an external refrigeration unit, the ionic liquid alkylation system further comprises a heat exchanger, and the method further comprising:

g) decommissioning the external refrigeration unit;

h) providing an effluent refrigeration unit; and

i) connecting the heat exchanger to the effluent refrigeration unit, wherein the heat exchanger is in thermal communication with the ionic liquid alkylation reactor for removing heat from the ionic liquid alkylation reactor.

14. The method according to claim 13, further comprising:

j) connecting the effluent refrigeration unit to the fractionation unit.

15. The method according to claim 8, further comprising:

k) modifying the fractionation unit to provide a modified fractionation unit such that the modified fractionation unit is configured for separating an HCl-rich C_{3-} fraction from the hydrocarbon phase, wherein the ionic liquid alkylation system is configured for recycling the HCl-rich C_{3-} fraction to the ionic liquid alkylation reactor.

16. A method for converting a sulfuric acid alkylation unit to an ionic liquid alkylation system, the sulfuric acid alkylation unit including a conventional fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions;

b) providing an ionic liquid/hydrocarbon separation unit configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase and a hydrocarbon phase;

c) connecting the ionic liquid alkylation reactor to the ionic liquid/hydrocarbon separation unit for feeding the alkylation reactor effluent to the ionic liquid/hydrocarbon separation unit; and

d) modifying the conventional fractionation unit to provide a modified fractionation unit, such that the modified fractionation unit is configured for separating an HCl-rich C_{3-} fraction from at least a portion of the hydrocarbon phase for recycling to the alkylation unit.

17. The method according to claim 16, wherein the sulfuric acid alkylation unit further comprises a sulfuric acid alkylation reactor, and the method further comprising:

e) decommissioning the sulfuric acid alkylation reactor;

f) connecting the ionic liquid alkylation reactor to an ionic liquid catalyst feed line; and g) connecting the ionic liquid alkylation reactor to at least one hydrocarbon feed line.

18. The method according to claim 16, wherein: the ionic liquid/hydrocarbon separation unit comprises a primary separator vessel and an ionic liquid coalescer in fluid communication with the primary separator vessel,

step c) comprises connecting the ionic liquid alkylation reactor to the primary separator vessel, and the method further comprising:

h) before or after step d), connecting the ionic liquid coalescer to the conventional fractionation unit or to the modified fractionation unit.

19. The method according to claim 16, further comprising:

i) providing an ionic liquid catalyst regeneration unit, wherein the ionic liquid alkylation system is configured for recycling regenerated ionic liquid catalyst from the ionic liquid catalyst regeneration unit to the ionic liquid alkylation reactor.