SUMMARY

In an embodiment of the present ~~invention~~ disclosure there is provided a method for converting an HF 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 HF alkylation unit.

In another embodiment, there is provided a method for converting an HF alkylation unit to an ionic liquid alkylation system, the HF alkylation unit including a fractionation unit, and the method comprises providing an ionic liquid alkylation reactor and an ionic liquid coalescer, connecting the ionic liquid alkylation reactor to at least one hydrocarbon feed line for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor, and connecting the ionic liquid coalescer to the fractionation unit.

According to a further embodiment, there is provided a method for converting an HF alkylation unit to an ionic liquid alkylation system, the HF alkylation unit including a fractionation unit, and the method comprising providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions, the ionic liquid alkylation reactor having an ionic liquid/hydrocarbon injection unit in fluid communication therewith; connecting at least one hydrocarbon feed line to the ionic liquid/hydrocarbon injection unit for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor; providing an ionic liquid/hydrocarbon separation unit; connecting the ionic liquid/hydrocarbon separation unit to the ionic liquid alkylation reactor, wherein the ionic liquid/hydrocarbon separation unit is configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase comprising an ionic liquid catalyst and a hydrocarbon phase comprising alkylate; and connecting the ionic liquid/hydrocarbon separation unit to the fractionation unit for feeding at least a portion of the hydrocarbon phase to the fractionation unit.

In one embodiment, there is provided a method for converting an HF alkylation unit which includes an HF settler 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 coalescer;

b) connecting the ionic liquid alkylation reactor to the HF settler for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the HF settler, wherein the HF settler is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase; and

c) connecting the HF settler to the ionic liquid coalescer for feeding the hydrocarbon phase from the HF settler to the ionic liquid coalescer, wherein the alkylation reactor effluent is a homogeneous emulsion.

In one embodiment, there is provided a method for converting an HF alkylation unit to an ionic liquid alkylation system, the HF alkylation unit including a fractionation unit, an HF reactor, and an HF settler disposed downstream from the HF reactor and upstream from the fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor and an ionic liquid coalescer;

b) connecting the ionic liquid alkylation reactor to at least one hydrocarbon feed line for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor;

c) connecting the ionic liquid coalescer to the fractionation unit;

d) 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 and 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;

e) disconnecting the HF settler from the HF reactor;

f) connecting the HF settler to the ionic liquid alkylation reactor, wherein the HF settler is in fluid communication with the ionic liquid alkylation reactor for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the HF settler, and the HF settler is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase; and

g) connecting the HF settler to the ionic liquid coalescer, wherein the alkylation reactor effluent is a homogeneous emulsion.

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

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions, the ionic liquid alkylation reactor having an ionic liquid/hydrocarbon injection unit in fluid communication therewith;

b) connecting at least one hydrocarbon feed line to the ionic liquid/hydrocarbon injection unit for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor;

c) providing an ionic liquid/hydrocarbon separation unit;

d) connecting the ionic liquid/hydrocarbon separation unit to the ionic liquid alkylation reactor, wherein the ionic liquid/hydrocarbon separation unit is configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase comprising an ionic liquid catalyst and a hydrocarbon phase comprising alkylate;

e) connecting the ionic liquid/hydrocarbon separation unit to the fractionation unit for feeding at least a portion of the hydrocarbon phase to the fractionation unit; and

f) modifying the fractionation unit to provide a modified fractionation unit such that the modified fractionation unit is configured for separating an HCl-rich C3-fraction from the hydrocarbon phase, and the ionic liquid alkylation system is configured for recycling the HCl-rich C3-fraction to the ionic liquid alkylation reactor, wherein the alkylation reactor effluent is a homogeneous emulsion.

In still a further embodiment, there is provided an ionic liquid alkylation system derived from an existing HF unit having a fractionation unit, the ionic liquid alkylation system comprising

WHAT IS CLAIMED IS:

1. A method for converting an HF 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 HF alkylation unit.

2. 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:

c) 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.

3. The method according to claim 1, wherein the HF alkylation unit includes an HF settler and a fractionation unit disposed downstream from the HF settler, the ionic liquid specific sub-system further comprises a primary separator vessel, and the method further comprising:

d) disconnecting the HF settler from the fractionation unit;

e) connecting the ionic liquid alkylation reactor to the primary separator vessel 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.

4. The method according to claim 3, wherein the ionic liquid specific sub-system further comprises 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.

5. The method according to claim 1, wherein the HF alkylation unit includes an HF settler, and the ionic liquid specific sub-system further comprises an ionic liquid coalescer, and the method further comprising:

h) connecting the ionic liquid alkylation reactor to the HF settler for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the HF settler, wherein the HF settler is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase; and

i) connecting the HF settler to the ionic liquid coalescer for feeding the hydrocarbon phase from the HF settler to the ionic liquid coalescer.

6. The method according to claim 1, wherein the HF alkylation unit includes a fractionation unit, and the method further comprising:

j) 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.

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

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

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

a) providing an ionic liquid alkylation reactor and an ionic liquid coalescer;

b) connecting the ionic liquid alkylation reactor to at least one hydrocarbon feed line for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor; and

c) connecting the ionic liquid coalescer to the fractionation unit.

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

d) 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:

e) 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, further comprising:

f) providing a primary separator vessel; and

g) connecting the primary separator vessel to the ionic liquid coalescer.

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

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

14. The method according to claim 13, wherein:

the HF alkylation unit further includes an HF reactor, and an HF settler disposed downstream from the HF reactor and upstream from the fractionation unit, and the method further comprising:

i) disconnecting the HF reactor from at least one hydrocarbon feed line; and

j) disconnecting the HF settler from the fractionation unit.

15. The method according to claim 8, wherein:

the HF alkylation unit includes an HF reactor, and an HF settler disposed downstream from the HF reactor and upstream from the fractionation unit, and the method further comprising:

k) disconnecting the HF settler from the HF reactor;

l) connecting the HF settler to the ionic liquid alkylation reactor, wherein the HF settler is in fluid communication with the ionic liquid alkylation reactor for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the HF settler, and the HF settler is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase; and

m) connecting the HF settler to the ionic liquid coalescer.

16. The method according to claim 8, wherein an alkylation reactor effluent from the ionic liquid alkylation reactor comprises a hydrocarbon phase, and the method further comprising:

n) 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.

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

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions, the ionic liquid alkylation reactor having an ionic liquid/hydrocarbon injection unit in fluid communication therewith;

b) connecting at least one hydrocarbon feed line to the ionic liquid/hydrocarbon injection unit for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor;

c) providing an ionic liquid/hydrocarbon separation unit;

d) connecting the ionic liquid/hydrocarbon separation unit to the ionic liquid alkylation reactor, wherein the ionic liquid/hydrocarbon separation unit is configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase comprising an ionic liquid catalyst and a hydrocarbon phase comprising alkylate; and

e) connecting the ionic liquid/hydrocarbon separation unit to the fractionation unit for feeding at least a portion of the hydrocarbon phase to the fractionation unit.

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

f) 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.

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

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

20. The method according to claim 17, 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, and wherein:

step d) comprises connecting the primary separator vessel to the ionic liquid alkylation reactor, and

step e) comprises connecting the ionic liquid coalescer to the fractionation unit.

21. The method according to claim 20, wherein:

the HF alkylation unit further includes an HF settler, and

the primary separator vessel comprises the HF settler.

22. An ionic liquid alkylation system derived from an existing HF unit having a 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, wherein the ionic liquid/hydrocarbon separation unit is configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into a hydrocarbon phase and an ionic liquid phase; and

the fractionation unit, wherein the fractionation unit is in fluid communication with the ionic liquid/hydrocarbon separation unit.

23. The ionic liquid alkylation system according to claim 22, further comprising:

an ionic liquid/hydrocarbon injection unit, in fluid communication with the ionic liquid alkylation reactor, for injecting an ionic liquid/hydrocarbon mixture into the ionic liquid alkylation reactor.

24. The ionic liquid alkylation system according to claim 23, wherein:

the ionic liquid/hydrocarbon injection unit is at least partially disposed within the ionic liquid alkylation reactor, and

the ionic liquid alkylation reactor and the ionic liquid/hydrocarbon injection unit are co-configured for forming, in the ionic liquid alkylation reactor, a homogeneous mixture comprising an ionic liquid dispersed phase and a continuous hydrocarbon phase.

25. The ionic liquid alkylation system according to claim 22, 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, for receiving at least a portion of the hydrocarbon phase from the primary separator vessel; and

the ionic liquid coalescer is configured for separating entrained ionic liquid from the hydrocarbon phase.

26. The ionic liquid alkylation system according to claim 25, wherein:

the fractionation unit is in fluid communication with the ionic liquid coalescer for receiving the hydrocarbon phase from the ionic liquid coalescer, and

the fractionation unit is configured for separating at least one hydrocarbon product from the hydrocarbon phase.

27. The ionic liquid alkylation system according to claim 22, wherein:

the fractionation unit is modified 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, and

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

What is claimed is:

1. A method for converting an HF alkylation unit which includes an HF settler 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 coalescer;

b) connecting the ionic liquid alkylation reactor to the HF settler for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the HF settler, wherein the HF settler is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase; and

c) connecting the HF settler to the ionic liquid coalescer for feeding the hydrocarbon phase from the HF settler to the ionic liquid coalescer, wherein the alkylation reactor effluent is a homogeneous emulsion.

2. 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 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.

3. The method according to claim 1, wherein the HF alkylation unit includes an HF settler and a fractionation unit disposed downstream from the HF settler, the ionic liquid specific sub-system further comprises a primary separator vessel, and the method further comprising:

e) disconnecting the HF settler from the fractionation unit;

f) connecting the ionic liquid alkylation reactor to the primary separator vessel 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.

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

g) 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

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

5. The method according to claim 1, wherein the HF alkylation unit includes a fractionation unit, and the method further comprising:

i) 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.

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

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

7. A method for converting an HF alkylation unit to an ionic liquid alkylation system, the HF alkylation unit including a fractionation unit, an HF reactor, and an HF settler disposed downstream from the HF reactor and upstream from the fractionation unit, and the method comprising:

a) providing an ionic liquid alkylation reactor and an ionic liquid coalescer;

b) connecting the ionic liquid alkylation reactor to at least one hydrocarbon feed line for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor;

c) connecting the ionic liquid coalescer to the fractionation unit;

d) 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 and 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;

e) disconnecting the HF settler from the HF reactor;

f) connecting the HF settler to the ionic liquid alkylation reactor, wherein the HF settler is in fluid communication with the ionic liquid alkylation reactor for feeding an alkylation reactor effluent from the ionic liquid alkylation reactor to the HF settler, and the HF settler is configured for separating the alkylation reactor effluent into a hydrocarbon phase and an ionic liquid phase; and

g) connecting the HF settler to the ionic liquid coalescer, wherein the alkylation reactor effluent is a homogeneous emulsion.

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

h) 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.

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

i) providing a primary separator vessel; and

j) connecting the primary separator vessel to the ionic liquid coalescer.

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

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

11. The method according to claim 10, wherein the HF alkylation unit further includes an HF reactor, and an HF settler disposed downstream from the HF reactor and upstream from the fractionation unit, and the method further comprising:

l) providing the HF reactor from at least one hydrocarbon feed line; and

m) connecting the HF settler from the fractionation unit.

12. The method according to claim 7, wherein an alkylation reactor effluent from the ionic liquid alkylation reactor comprises a hydrocarbon phase, and the method further comprising:

n) 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.

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

a) providing an ionic liquid alkylation reactor configured for ionic liquid catalyzed alkylation reactions, the ionic liquid alkylation reactor having an ionic liquid/hydrocarbon injection unit in fluid communication therewith;

b) connecting at least one hydrocarbon feed line to the ionic liquid/hydrocarbon injection unit for feeding at least one hydrocarbon feed to the ionic liquid alkylation reactor;

c) providing an ionic liquid/hydrocarbon separation unit;

d) connecting the ionic liquid/hydrocarbon separation unit to the ionic liquid alkylation reactor, wherein the ionic liquid/hydrocarbon separation unit is configured for separating an alkylation reactor effluent of the ionic liquid alkylation reactor into an ionic liquid phase comprising an ionic liquid catalyst and a hydrocarbon phase comprising alkylate;

e) connecting the ionic liquid/hydrocarbon separation unit to the fractionation unit for feeding at least a portion of the hydrocarbon phase to the fractionation unit; and

f) 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, and the ionic liquid alkylation system is configured for recycling the HCl-rich C_3-fraction to the ionic liquid alkylation reactor, wherein the alkylation reactor effluent is a homogeneous emulsion.

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

g) 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.

15. The method according to claim 13, 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, and wherein:

step d) comprises connecting the primary separator vessel to the ionic liquid alkylation reactor, and

step e) comprises connecting the ionic liquid coalescer to the fractionation unit.

16. The method according to claim 15, wherein the HF alkylation unit further includes an HF settler, and the primary separator vessel comprises the HF settler.