CLAIMS:

What is claimed is:

1. A hydrocarbon upgrading process, comprising:

indirectly heating a hydrocarbon feed in a steam cracking furnace and combining the hydrocarbon feed with an aqueous fluid to produce a heated mixture comprising hydrocarbon and steam, wherein the heating is carried out before, during, and/or after the hydrocarbon feed is combined with the aqueous fluid;

separating from the heated mixture a vapor phase product and a liquid phase product, wherein the separation is carried out in at least one vapor-liquid separator that is integrated with the steam cracking furnace;

catalytically cracking the liquid phase product in the presence of a fluidized catalyst to produce a catalytically cracked effluent;

separating a bottoms product from the catalytically cracked effluent;

steam cracking the vapor phase product to produce a steam cracker effluent;

separating from the steam cracker effluent a tar product and an upgraded steam cracker effluent comprising ethylene and propylene;

hydroprocessing the bottoms product and the tar product to produce a hydroprocessed product~~, wherein the hydroprocessing is carried out under pre-treater hydroprocessing conditions~~; and

separating a hydroprocessor heavy product from the hydroprocessed product.

2. The process of claim 1, wherein: (i) the hydroprocessing is carried out under the pre-treater hydroprocessing conditions to produce a pretreated bottoms product; (ii) the pre-treater hydroprocessing conditions include hydroprocessing the bottoms product at a temperature (T_{PT}) of 400°C or less, a weight hour space velocity ($WHSV_{PT}$) of ≥ 0.3 hr^{-1} based on a weight of the bottoms product~~ that is subjected to the pre-treater hydroprocessing conditions~~, a total pressure (P_{PT}) of ≥ 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_{PT}) of less than 534 standard cubic meters per cubic meter of the bottoms product~~ that is subjected to the pre-treater hydroprocessing conditions~~, (iii) the pre-treated bottoms product comprises a vapor potion and a liquid portion; (iv) the hydroprocessed product is obtained by hydroprocessing the pre-treated bottoms product under bottoms product hydroprocessing conditions which include hydroprocessing the pre-treated bottoms product at a temperature (T_{BP}) of ≥ 200°C, a weight hour space velocity ($WHSV_{BP}$) of ≥ 0.3 hr^{-1} based on a weight of

the pre-treated bottoms product, a total pressure (P_{BP}) of ≥ 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_{BP}) of ≥ 534 standard cubic meters per cubic meter of the pre-treated bottoms product, and (v) $WHSV_{BP}$ is less than $WHSV_{PT}$.

3. The process of claim 2, wherein:

T_{PT} is 220°C to 300°C,

$WHSV_{PT}$ is 1.5 hr^{-1} to 3.5 hr^{-1},

SR_{PT} is 53 standard cubic meters per cubic meter of the bottoms product ~~that is subjected to the pre-treater hydroprocessing conditions~~ to 178 standard cubic meters per cubic meter of the bottoms product ~~that is subjected to the pre-treater hydroprocessing conditions~~,

P_{PT} is at least 6 MPa to 13.1 MPa,

in the ~~pre-treater hydroprocessing conditions~~ hydroprocessing the molecular hydrogen is consumed at a rate of 18 standard cubic meters per cubic meter of the bottoms product to 107 standard cubic meters per cubic meter of the bottoms product,

T_{BP} is 360°C to 410°C,

$WHSV_{BP}$ is 0.5 hr^{-1} to 1.2 hr^{-1},

SR_{BP} is 534 standard cubic meters per cubic meter of the pre-treated bottoms product to 890 standard cubic meters per cubic meter of the pre-treated bottoms product,

P_{BP} is at least 6 MPa to 13.1 MPa, and

in the bottoms product hydroprocessing conditions the molecular hydrogen is consumed at a rate of 285 standard cubic meters per cubic meter of the bottoms product in the pre-treated bottoms product to 570 standard cubic meters per cubic meter of the bottoms product in the pre-treated bottoms product.

4. The process of any of claims 1-3, further comprising:

separating a cycle oil from the catalytically cracked effluent; and

combining the cycle oil with the bottoms product before and/or during the hydroprocessing, wherein hydroprocessing the cycle oil with the fluxed bottoms produces additional hydroprocessor heavy product.

5. The process of any of claims 1-3, wherein the hydrocarbon feed comprises medium hydrocarbon and/or heavy hydrocarbon.

6. The process of any of claims 1-3, further comprising:

separating a cycle oil from the catalytically cracked effluent;

separating a utility fluid product from the hydroprocessed product; and

combining the tar product, the bottoms product, the cycle oil, and the utility fluid product before and/or during the hydroprocessing.

7. The process of any of claims 1-3, further comprising:

separating a utility fluid product from the hydroprocessed product; and

combining the tar product, the bottoms product, and the utility fluid product to produce a mixture, wherein the mixture is hydroprocessed to produce the hydroprocessed product.

8. The process of claim 7, wherein the utility fluid product comprises: (a) at least 1 wt. % of 1.0 ring class compounds, (b) at least 5 wt. % of 1.5 ring class compounds, and (c) at least 5 wt. % of 2.0 ring class compounds, wherein the weight percent values of (a), (b), and (c) are based on a weight of the utility fluid product.

9. The process of any of claims 1-3, further comprising:

separating a utility fluid product from the hydroprocessed product; and

contacting the steam cracker effluent with a portion of the utility fluid product to produce a cooled steam cracker effluent, wherein the tar product and the upgraded steam cracker effluent are separated from the cooled steam cracker effluent.

10. The process of claim 1, wherein the liquid phase product has a minimum boiling point of 340°C to 400°C.

11. A process for upgrading a hydrocarbon, comprising:

separating a heated mixture comprising steam and a hydrocarbon into a vapor phase product and a liquid phase product;

catalytically cracking the liquid phase product in the presence of a fluidized catalyst to produce a catalytically cracked effluent;

separating from the catalytically cracked effluent a bottoms product, a cycle oil, and at least one of a C_4 overhead, naphtha, and a distillate;

combining the bottoms product and the cycle oil to produce a fluxed bottoms;

steam cracking the vapor phase product to produce a steam cracker effluent;

separating from the steam cracker effluent a tar product and an upgraded steam cracker effluent comprising ethylene and propylene;

hydroprocessing the fluxed bottoms and the tar product to produce a hydroprocessed product;

separating a hydroprocessor heavy product and a utility fluid product from the hydroprocessed product;

12. The process of claim 11, wherein the fluxed bottoms is hydroprocessed ~~under pre-treater hydroprocessing conditions~~ to produce a pre-treated fluxed bottoms, and wherein the pre-treated fluxed bottoms is hydroprocessed ~~under bottoms product hydroprocessing conditions~~ to produce the hydroprocessed product.

13. The process of claim 12, wherein:

~~the pre-treater hydroprocessing conditions comprises hydroprocessing~~ the fluxed bottoms is hydroprocessed at a temperature (T_{PT}) of 400°C or less, a weight hour space velocity ($WHSV_{PT}$) of ≥ 0.3 hr^{-1} based on a weight of the fluxed bottoms ~~that is subjected to the pre-treater hydroprocessing conditions~~, a total pressure (P_{PT}) of ≥ 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_{PT}) of less than 534 standard cubic meters per cubic meter of the fluxed bottoms ~~that is subjected to the pre-treater hydroprocessing conditions~~,

the pre-treated bottoms product comprises a vapor potion and a liquid portion,

the bottoms product ~~hydroprocessing conditions comprise hydroprocessing the pre-treated fluxed bottoms~~ is hydroprocessed at a temperature (T_{BP}) of ≥ 200°C, a weight hour space velocity ($WHSV_{BP}$) of ≥ 0.3 hr^{-1} based on a weight of the pre-treated fluxed bottoms, a total pressure (P_{BP}) of ≥ 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_{BP}) of ≥ 534 standard cubic meters per cubic meter of the bottoms product in the pre-treated fluxed bottoms, and

$WHSV_{BP}$ is less than $WHSV_{PT}$.

14. The process of claim 11, further comprising mixing the tar product with the bottoms product and the cycle oil before the hydroprocessing, wherein hydroprocessing the tar product in the mixture produces additional hydroprocessor heavy product and additional utility fluid product.

15. The process of any of claims 11-14, further comprising contacting the steam cracker effluent with a quench fluid comprising a first portion of the utility fluid to produce a cooled steam cracker effluent, wherein the steam cracker effluent is at a temperature of at least 300°C when initially contacted with the quench fluid.

16. The process of claim 15, further comprising contacting the cooled steam cracker effluent with a second portion of the utility fluid product during separation of the tar product and the upgraded steam cracker effluent from the cooled steam cracker effluent, wherein the cooled steam cracker effluent is at a temperature of at least 300°C when initially contacted with the second portion of the utility fluid product.

17. The process of any of claims 11-14, wherein the bottoms product has an API gravity in the range of from -6° to +8°, a sulfur content in the range of 0.3 wt. % to 5.0 wt. %, a nitrogen content in the range of from 0.1 wt. % to 0.5 wt. %, and a solids content of 1000 – 6000 ppmw, the weight percents being based on the weight of the bottoms product.

18. The process of any of claims 11-14, wherein the tar comprises greater than or equal to 10 wt. % of molecules that are not asphaltenes having an atmospheric boiling point of greater than or equal to 565°C and less than or equal to 1,000 ppmw metals, wherein all weight percent values are based on a weight of the tar.

19. The process of any of claims 11-14, wherein the liquid phase product has a minimum boiling point of 340°C to 400°C.

20. The process of any of claims 11-14, wherein the utility fluid product comprises: (a) at least 1 wt. % of 1.0 ring class compounds, (b) at least 5 wt. % of 1.5 ring class compounds, and (c) at least 5 wt. % of 2.0 ring class compounds, wherein the weight percent values of (a), (b), and (c) are based on a weight of the utility fluid product.

21. A system for upgrading a hydrocarbon, comprising:

a steam cracker configured to indirectly heat a mixture comprising steam and a hydrocarbon to produce a heated mixture and to steam crack a first vapor phase product separated from the heated mixture to produce a steam cracker effluent;

a first separator configured to separate the first vapor phase product and a first liquid phase product from the heated mixture;

a fluidized catalytic cracker configured to crack the liquid phase product in the presence of a fluidized catalyst to produce a catalytically cracked effluent;

a second separator configured to separate a bottoms product from the catalytically cracked effluent;

a pre-treater hydroprocessor configured to hydroprocess the bottoms product ~~under pre-treater hydroprocessing conditions~~ to produce a pre-treated bottoms product;

a bottoms product hydroprocessor configured to hydroprocess the pre-treated bottoms product ~~under bottoms product hydroprocessing conditions~~ to produce a hydroprocessed product;

a third separator configured to separate a second vapor phase product and a second liquid phase product from the hydroprocessed product;

a fourth separator configured to separate a hydroprocessor heavy product from the hydroprocessed product; and

a fifth separator configured to separate from the steam cracker effluent a tar product and an upgraded steam cracker effluent comprising ethylene and propylene.

22. The system of claim 21, wherein the second separator is further configured to separate a cycle oil from the catalytically cracked effluent, the system further comprising a first transfer line configured to introduce at least portion of the cycle fluid to the bottoms product to produce a fluxed bottoms, wherein the fluxed bottoms is hydroprocessed in the first hydroprocessing unit to produce the pre-treated product.

23. The system of claims 21 or 22, wherein the fourth separator is further configured to separate a utility fluid from the hydroprocessed product, the system further comprising a second transfer line configured to introduce a first portion of the utility fluid to the steam cracker effluent at a location where the steam cracker effluent is at a temperature of ≥ 300°C to produce a cooled steam cracker effluent.

24. The system of claims 21 or 22, wherein the fourth separator is further configured to separate a utility fluid from the hydroprocessed product, the system further comprising a third transfer line configured to introduce a second portion of the utility fluid into the fifth separator

such that the second portion of the utility fluid product contacts the steam cracker effluent during separation of the tar product and the upgraded steam cracker effluent at a location where the steam cracker effluent is at a temperature of ≥ 300°C.

25. A process for upgrading a hydrocarbon, comprising:

producing a heated mixture comprising steam and hydrocarbon by indirectly heating a hydrocarbon feed in a furnace, and combining the hydrocarbon feed with an aqueous stream comprising water, steam, or a mixture thereof, wherein (i) the heating is carried out before, during, and/or after the hydrocarbon feed is combined with the aqueous stream, and (ii) the hydrocarbon includes one or more of naphtha, gas oil, vacuum gas oil, waxy residues, atmospheric residues, residue admixtures, and crude oil;

separating a vapor phase product and a liquid phase product from the heated mixture, wherein the separation does not include steam stripping of the liquid phase and/or the heated mixture;

catalytically cracking the liquid phase product in the presence of a fluidized catalyst to produce a catalytically cracked effluent;

separating a bottoms product and a cycle oil from the catalytically cracked effluent;

steam cracking the vapor phase product to produce a steam cracker effluent;

contacting the steam cracker effluent with a quench fluid to produce a cooled steam cracker effluent;

separating from the cooled steam cracker effluent a tar product and an upgraded steam cracker effluent comprising ethylene and propylene;

combining the tar product, a diluent, the bottoms product, and at least a portion of the cycle oil to produce a fluxed mixture;

hydroprocessing the fluxed mixture ~~under pre-treater hydroprocessing conditions~~ to produce a pre-treated fluxed mixture;

hydroprocessing the pre-treated fluxed mixture ~~under bottoms product hydroprocessing conditions~~ to produce a hydroprocessed product;

separating a hydroprocessor heavy product and a utility fluid product from the hydroprocessed product, wherein the quench fluid comprises a first portion of the utility fluid product, and wherein the diluent comprises a second portion of the utility fluid product.