CLAIMS:

What is claimed is:

1. A hydrocarbon upgrading process, comprising:

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

hydroprocessing the liquid phase product to produce a first hydroprocessed product;

separating a pitch and one or more hydrocarbon products from the first hydroprocessed product;

contacting the pitch with a diluent to produce a pitch-diluent mixture;

hydroprocessing the pitch-diluent mixture to produce a second hydroprocessed product;

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

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

separating a tar product and a process gas comprising ethylene and propylene from the steam cracker effluent.

2. The process of claim 1, wherein the pitch is at a temperature of at least 300°C when contacted with the diluent, and wherein the pitch has a Conradson carbon residue of 20 wt. % to 30 wt. %, an °API gravity measured at a temperature of 15.8°C of less than 5, a sulfur content of 1 wt. % to 3 wt. %, and a nitrogen content of 0.3 wt. % to 0.6 wt. %.

3. The process of claims 1 or 2, further comprising contacting the steam cracker effluent with a quench fluid comprising a second portion of the utility fluid product to produce a cooled steam cracker effluent, wherein the tar product and the process gas are separated from the cooled steam cracker effluent.

4. The process of any of claims 1-3, further comprising contacting the steam cracker effluent with a third portion of the utility fluid product during separation of the tar product and the process gas from the steam cracker effluent.

5. The process of claims 1 or 2, further comprising:

contacting the steam cracker effluent with a quench fluid comprising a second portion of the utility fluid product 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 second portion of the utility fluid, and wherein the tar product and the process gas are separated from the cooled steam cracker effluent; and

contacting the cooled steam cracker effluent with a third portion of the utility fluid product during separation of the tar product and the process gas 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 third portion of the utility fluid.

6. The process of any of claims 1-4, further comprising combining the tar product with the pitch-diluent mixture to produce a pitch-diluent-tar mixture, wherein the pitch-diluent-tar mixture is hydroprocessed to produce the second hydroprocessed product.

7. The process of any of claims 1-4, wherein hydroprocessing the pitch-diluent mixture comprises hydroprocessing the pitch-diluent mixture under pre-treater hydroprocessing conditions to produce a pre-treated pitch-diluent mixture comprising a vapor portion and a liquid portion and hydroprocessing the pre-treated pitch-diluent mixture under pitch hydroprocessing conditions to produce the second hydroprocessed product.

8. The process of claim 7, wherein:

the pre-treater hydroprocessing conditions comprises hydroprocessing the pitch-diluent mixture at a temperature (T_{PT}) of 400°C or less, a weight hour space velocity ($WHSV_{PT}$) of at least 0.3 hr^{-1} based on a weight of the pitch-diluent mixture that is subjected to the pre-treater hydroprocessing conditions, a total pressure (P_{PT}) of at least 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 pitch-diluent mixture,

the pitch hydroprocessing conditions comprises hydroprocessing the pre-treated pitch-diluent mixture at a temperature (T_P) of at least to 200°C, a weight hour space velocity ($WHSV_P$) of at least 0.3 hr^{-1} based on a weight of the pre-treated pitch-diluent mixture, a total pressure (P_2) of at least 6 MPa, and in the presence of molecular hydrogen supplied at a rate

(SR_P) of ≥ 534 standard cubic meters per cubic meter of the pre-treated pitch-diluent mixture, and

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

9. The process of any of claims 1-4, 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.

10. The process of any of claims 1-4, wherein the liquid phase product comprises hydrocarbons having a minimum boiling point of 500°C to 570°C, and wherein the pitch has a Conradson carbon residue of 20 wt. % to 30 wt. %, an °API gravity measured at a temperature of 15.8°C of less than 5, a sulfur content of 1 wt. % to 3 wt. %, and a nitrogen content of 0.3 wt. % to 0.6 wt. %.

11. A hydrocarbon upgrading process, comprising:

heating in a furnace a mixture comprising an aqueous diluent and hydrocarbon feed to produce a heated mixture, wherein the hydrocarbon feed comprises primarily liquid phase hydrocarbon;

separating a vapor phase product and a liquid phase product from the heated mixture;

hydroprocessing the liquid phase product to produce a first hydroprocessed product;

separating a pitch and one or more hydrocarbon products from the first hydroprocessed product, wherein the pitch has a Conradson carbon residue of 20 wt. % to 30 wt. %, an °API gravity measured at a temperature of 15.8°C of less than 5, a sulfur content of 1 wt. % to 3 wt. %, and a nitrogen content of 0.3 wt. % to 0.6 wt. %;

combining the pitch with a diluent to produce a pitch-diluent mixture comprising 5 wt. % to 95 wt. % of the diluent, based on a combined weight of the pitch and the diluent;

hydroprocessing the pitch-diluent mixture to produce a second hydroprocessed product;

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

introducing the vapor phase product into the furnace and steam cracking the vapor phase product in the furnace to produce a steam cracker effluent; and

separating a tar product and a process gas comprising ethylene and propylene from the steam cracker effluent.

12. The process of claim 11, further comprising contacting the steam cracker effluent with a quench fluid comprising a second portion of the utility fluid product 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 second portion of the utility fluid, and wherein the tar product and the process gas are separated from the cooled steam cracker effluent.

13. The process of claim 12, further comprising contacting the cooled steam cracker effluent with a third portion of the utility fluid product during separation of the tar product and the process gas 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 third portion of the utility fluid.

14. The process of claims 11 or 12, wherein hydroprocessing the pitch-diluent mixture comprises hydroprocessing the pitch-diluent mixture under pre-treater hydroprocessing conditions to produce a pre-treated pitch-diluent mixture comprising a vapor portion and a liquid portion and hydroprocessing the pre-treated pitch-diluent mixture under pitch hydroprocessing conditions to produce the second hydroprocessed product.

15. The process of claim 14, wherein:

the pre-treater hydroprocessing conditions comprises hydroprocessing the pitch-diluent mixture at a temperature (T_{PT}) of 400°C or less, a weight hour space velocity ($WHSV_{PT}$) of at least 0.3 hr^{-1} based on a weight of the pitch-diluent mixture that is subjected to the pre-treater hydroprocessing conditions, a total pressure (P_{PT}) of at least 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 pitch-diluent mixture

the pitch hydroprocessing conditions comprises hydroprocessing the pre-treated pitch-diluent mixture at a temperature (T_P) of at least to 200°C, a weight hour space velocity ($WHSV_P$) of at least 0.3 hr^{-1} based on a weight of the pre-treated pitch-diluent mixture, a total pressure (P_2) of at least 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_P) of ≥ 534 standard cubic meters per cubic meter of the pre-treated pitch-diluent mixture, and

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

16. The process of claim 15, 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 pitch-diluent mixture to 178 standard cubic meters per cubic meter of the pitch-diluent mixture,

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

in the first set of hydroprocessing conditions the molecular hydrogen is consumed at a rate of 18 standard cubic meters per cubic meter of the pitch in the pitch-diluent mixture to 107 standard cubic meters per cubic meter of the pitch in the pitch-diluent mixture,

T_P is 360°C to 410°C,

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

SR_P is 534 standard cubic meters per cubic meter of the pre-treated pitch-diluent mixture to 890 standard cubic meters per cubic meter of the pre-treated pitch-diluent mixture,

P_P is at least 6 MPa to 13.1 MPa, and

in the second set of hydroprocessing conditions the molecular hydrogen is consumed at a rate of 285 standard cubic meters per cubic meter of the pitch in the pre-treated pitch-diluent mixture to 570 standard cubic meters per cubic meter of the pitch in the pre-treated pitch-diluent mixture.

17. The process of claims 11 or 12, wherein the liquid phase product comprises hydrocarbons having a minimum boiling point of 500°C to 570°C, and wherein the primarily liquid phase hydrocarbon includes one or more of raw feed, crude oil, heavy hydrocarbon, and medium hydrocarbon.

18. The process of claims 11 or 12, wherein hydroprocessing the liquid phase product to produce the first hydroprocessed product comprises hydroprocessing the liquid phase product at a temperature ("T_{FLP}") ≥ 200°C, a total pressure (P_{FLP}) ≥ 3.5 MPa, a weight hour space velocity ($WHSV_{FLP}$) ≥ 0.3 hr^{-1} based on a weight of the first liquid phase product that is subjected to the hydroprocessing, and in the presence of a total amount of molecular hydrogen supplied at a rate that is ≥ 178 standard cubic meters per cubic meter of the first liquid phase product subjected to the hydroprocessing.

19. The process of claims 11 or 12, wherein hydroprocessing the pitch-diluent mixture to produce the first hydroprocessed product comprises hydrocracking the pitch in the pitch-diluent mixture.

20. The process of claims 11 or 12, wherein the pitch-diluent mixture comprises 5 wt. % to 95 wt. % of the utility fluid product, based on a weight of the pitch.

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 vapor phase product separated from the heated mixture to produce a steam cracker effluent;

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

a first hydroprocessing unit configured to hydroprocess the liquid phase product to produce a first hydroprocessed product;

a second separator configured to separate a pitch and one or more hydrocarbon products form the first hydroprocessed product;

a first transfer line configured to introduce a diluent to the pitch to produce a pitch-diluent mixture;

a second hydroprocessing unit configured to hydroprocess the pitch-diluent mixture to produce a second hydroprocessed product;

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

a fourth separator configured to separate a hydroprocessor heavy product and a utility fluid product from the second liquid phase product, wherein the diluent comprises a first portion of the utility fluid product; and

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

22. The system of claim 21, further comprising a second transfer line configured to introduce a second portion of the utility fluid product to the steam cracker effluent to produce a cooled steam cracker effluent, wherein the fourth separator is configured to separate the tar product and the process gas from the cooled steam cracker effluent.

23. The system of claims 21 or 22, further comprising a third transfer line configured to introduce a third portion of the utility fluid product into the fifth separator such that the third portion of the utility fluid product contacts the steam cracker effluent during separation of the tar product and the process gas from the steam cracker effluent.

24. The system of any of claims 21-23, wherein the second hydroprocessing unit is configured to hydroprocess the pitch-diluent mixture under a first set of hydroprocessing conditions to produce a pre-treated pitch-diluent mixture and is configured to hydroprocess the pre-treated pitch-diluent mixture under a second set of hydroprocessing conditions to produce the second hydroprocessed product.

25. A hydrocarbon upgrading process, 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;

hydroprocessing the liquid phase product to produce a first hydroprocessed product;

separating a pitch and one or more hydrocarbon products from the first hydroprocessed product, wherein the pitch has a Conradson carbon residue of 20 wt. % to 30 wt. %, an °API gravity measured at a temperature of 15.8°C of less than 5, a sulfur content of 1 wt. % to 3 wt. %, and a nitrogen content of 0.3 wt. % to 0.6 wt. %;

combining the pitch with a diluent to produce a pitch-diluent mixture;

hydroprocessing the pitch-diluent mixture under pre-treater hydroprocessing conditions to produce a pre-treated pitch-diluent mixture comprising a vapor portion and a liquid portion, wherein the pre-treater hydroprocessing conditions comprises hydroprocessing the pitch-diluent mixture at a temperature (T_{PT}) of 400°C or less, a weight hour space velocity ($WHSV_{PT}$) of at least 0.3 hr^{-1} based on a weight of the pitch-diluent mixture that is subjected to the pre-treater hydroprocessing conditions, a total pressure (P_{PT}) of at least 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 pitch-diluent mixture;

hydroprocessing the pre-treated pitch-diluent mixture under pitch hydroprocessing conditions to produce a second hydroprocessed product, wherein the pitch hydroprocessing conditions comprises hydroprocessing the pre-treated pitch-diluent mixture at a temperature (T_P) of at least to 200°C, a weight hour space velocity ($WHSV_P$) of at least 0.3 hr^{-1} based on a weight of the pre-treated pitch-diluent mixture, a total pressure (P_2) of at least 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_P) of $\geq$ 534 standard cubic meters per cubic meter of the pre-treated pitch-diluent mixture, and wherein $WHSV_P$ is less than $WHSV_{PT}$;

separating a hydroprocessor heavy product and a utility fluid product from the second hydroprocessed product, wherein the diluent comprises a first portion of the utility fluid product, wherein the pitch-diluent mixture comprises 5 wt. % to 95 wt. % of the utility fluid product, based on a weight of the pitch, and 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;

exposing the vapor phase product to a temperature of at least 400°C under steam cracking conditions to produce a steam cracker effluent;

contacting the steam cracker effluent with a quench fluid comprising a second portion of the utility fluid product 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 second portion of the utility fluid; and

separating a tar product and a process gas comprising ethylene and propylene from the cooled steam cracker effluent, wherein the cooled steam cracker effluent is contacted with a third portion of the utility fluid product during separation of the tar product and the process gas from the cooled steam cracker effluent, and wherein the cooled steam cracker effluent is at a temperature of at least 300°C when initially contacted with the third portion of the utility fluid.