CLAIMS:

What is claimed is:

1. A process for upgrading a hydrocarbon, comprising:

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

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, wherein the steam cracker effluent is at a temperature of ≥ 300°C when initially contacted with the quench fluid;

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

hydroprocessing the tar product to produce a first hydroprocessed product;

separating from the upgraded steam cracker effluent at least a process gas, a steam cracker naphtha, and a bottoms product; and

separating a hydroprocessor heavy product and a utility fluid product from the first hydroprocessed product, wherein (i) the quench fluid comprises a first portion of the utility fluid product and (ii) the quench fluid is substantially free of the bottoms product.

2. The process of claim 1, 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 process gas from the cooled steam cracker effluent, wherein the cooled steam cracker effluent is at a temperature of ≥ 300°C when initially contacted with the second portion of the utility fluid product.

3. The process of claim 1, further comprising:

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

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

reacting the pitch and an oxidant at conditions sufficient to produce a synthesis gas comprising a mixture of molecular hydrogen and carbon monoxide.

4. The process of claim 3, wherein reacting the pitch and the oxidant comprises:

partially oxidizing the pitch in the presence of the oxidant and a catalyst at conditions sufficient to combust a portion of the pitch to produce a mixture comprising carbon dioxide and non-combusted pitch and heat; and

reforming at least a portion of the non-combusted pitch in the presence of the heat and the catalyst to produce the synthesis gas.

5. The process of claim 3, wherein the tar product is hydroprocessed in the presence of molecular hydrogen separated from the synthesis gas.

6. The process of claim 3, wherein the pitch has a Conradson carbon residue of about 20 wt. % to about 30 wt. %, an °API gravity measured at a temperature of 15.8°C of less than 5, a sulfur content of about 1 wt. % to about 3 wt. %, and a nitrogen content of about 0.3 wt. % to about 0.6 wt. %.

7. The process of claim 1, further comprising combing a third portion of the utility fluid product with the tar product to produce a tar-utility fluid mixture, wherein the tar-utility fluid mixture is hydroprocessed to produce the first hydroprocessed product.

8. The process of claim 1, wherein the utility fluid product comprises: (a) ≥ 1 wt. % of 1.0 ring class compounds; (b) ≥ 5 wt. % of 1.5 ring class compounds; (c) ≥ 5 wt. % of 2.0 ring class compounds; and (d) ≥ 0.1 wt. % of 5.0 ring class compounds, wherein the weight percent values of (a), (b), (c), and (d) are based on a weight of the utility fluid product.

9. The process of claim 1, wherein the liquid phase product comprises hydrocarbons having a minimum boiling point of about 500°C to about 570°C, and wherein the liquid phase product is conducted away from the process and used as a fuel or a fuel blending component.

10. The process of claim 1, wherein hydroprocessing the tar product comprises hydroprocessing the tar product under pre-treater hydroprocessing conditions to produce a pre-treated tar product comprising a vapor portion and a liquid portion and hydroprocessing the pre-treated tar product under tar hydroprocessing conditions to produce the first hydroprocessed product.

11. The process of claim 10, wherein:

the pre-treater hydroprocessing conditions comprise hydroprocessing the tar 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 tar 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 tar product,

the tar hydroprocessing conditions comprise hydroprocessing the pre-treated tar product at a temperature (T_T) of ≥ 200°C, a weight hour space velocity ($WHSV_T$) of ≥ 0.3 hr^{-1} based on a weight of the pre-treated tar product subjected to the tar hydroprocessing, a total pressure (P_T) of ≥ 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_T) of ≥ 534 standard cubic meters per cubic meter of the pre-treated tar product subjected to the tar hydroprocessing, and

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

12. A process for upgrading a hydrocarbon, comprising:

separating a vapor phase product and a liquid phase product from a heated mixture comprising steam and a hydrocarbon, wherein the hydrocarbon comprises naphtha, gas oil, vacuum gas oil, waxy residues, atmospheric residues, residue admixtures, crude oil, or a mixture thereof;

exposing the vapor phase product to a temperature of ≥ 400°C under steam cracking conditions to produce a steam cracker effluent that is at least partially in a gas phase;

contacting the steam cracker effluent with a quench fluid to produce a cooled steam cracker effluent, wherein the steam cracker effluent is at a temperature of ≥ 300°C when initially contacted with the quench fluid, and wherein at least a portion of the gas phase condenses into a liquid;

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

separating from the upgraded steam cracker effluent at least a process gas, a steam cracker naphtha, and a bottoms product; wherein the bottoms product is conducted away from the process;

hydroprocessing the tar product to produce a first hydroprocessed product; and

separating a hydroprocessor heavy product and a utility fluid product from the first hydroprocessed product, wherein the quench fluid comprises a first portion of the utility fluid product, wherein the utility fluid product comprises: (a) ≥ 1 wt. % of 1.0 ring class compounds; (b) ≥ 5 wt. % of 1.5 ring class compounds; (c) ≥ 5 wt. % of 2.0 ring class compounds; and (d) ≥ 0.1 wt. of 5.0 ring class compounds, wherein the weight percent values of (a), (b), (c), and (d) are based on a weight of the utility fluid product, and wherein the cooled steam cracker effluent comprises about 5 wt. % to about 80 wt. % of the utility fluid, based on a combined weight of the quench fluid and the steam cracker effluent.

13. The process of claim 12, 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 process gas from the cooled steam cracker effluent, wherein the cooled steam cracker effluent is at a temperature of ≥ 325°C when initially contacted with the second portion of the utility fluid.

14. The process of claim 12, further comprising:

separating a second vapor phase product comprising molecular hydrogen from the first hydroprocessed product; and

contacting the steam cracker naphtha with the molecular hydrogen in the second vapor phase product and a catalyst under hydroprocessing conditions sufficient to produce a stabilized steam cracker naphtha.

15. The process of claim 12, further comprising:

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

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

reacting the pitch and oxygen at conditions sufficient to produce a synthesis gas comprising a mixture of molecular hydrogen and carbon monoxide.

16. The process of claim 12, wherein at least one of the tar product and the liquid phase product is hydroprocessed in the presence of molecular hydrogen separated from the synthesis gas.

17. The process of claim 12, further comprising combing a third portion of the utility fluid product with the tar product to produce a tar-utility fluid mixture, wherein the tar-utility fluid mixture is hydroprocessed to produce the first hydroprocessed product.

18. The process of claim 12, wherein hydroprocessing the tar product comprises hydroprocessing the tar product under pre-treater hydroprocessing conditions to produce a pre-treated tar product comprising a vapor portion and a liquid portion and hydroprocessing the pre-treated tar product under tar hydroprocessing conditions to produce the first hydroprocessed product, and wherein:

the pre-treater hydroprocessing conditions comprise hydroprocessing the tar 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 tar product that is subjected to the pre-treater hydroprocessing conditions, a total pressure (P_{PT}) of $\geq$ 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 tar product,

the tar hydroprocessing conditions comprise hydroprocessing the pre-treated tar product at a temperature (T_T) of $\geq$ 200°C, a weight hour space velocity ($WHSV_T$) of ≥ 0.3 hr^{-1} based on a weight of the pre-treated tar product subjected to the tar hydroprocessing, a total pressure (P_T) of $\geq$ 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_T) of $\geq$ 534 standard cubic meters per cubic meter of the pre-treated tar product subjected to the tar hydroprocessing, and

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

19. The process of claim 18, wherein:

T_{PT} is about 220°C to about 300°C,

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

SR_{PT} is about 53 standard cubic meters per cubic meter of the hydroprocessed portion of the tar product to about 178 standard cubic meters per cubic meter of the tar product,

P_{PT} is $\geq$ 6 MPa to about 13.1 MPa,

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

T_T is about 360°C to about 410°C,

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

SR_T is about 534 standard cubic meters per cubic meter of the pre-treated tar product subjected to the tar hydroprocessing to about 890 standard cubic meters per cubic meter of the pre-treated tar product subjected to the tar hydroprocessing,

P_T is ≥ 6 MPa to about 13.1 MPa, and

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

20. The process of claim 12, wherein the liquid phase product comprises hydrocarbons having a minimum boiling point of about 500°C to about 570°C.

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 transfer line configured to introduce a first portion of a utility fluid product 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;

a second separator configured to separate a tar product and a process gas comprising ethylene and propylene from the cooled steam cracker effluent;

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

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

a fourth separator configured to separate a hydroprocessor heavy product and the utility fluid product from the second liquid phase product.

22. The system of claim 21, further comprising:

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

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

a reactor configured to react the pitch and an oxidant at conditions sufficient to produce a synthesis gas comprising a mixture of molecular hydrogen and carbon monoxide.

23. The system of claim 21, wherein:

the second separator is configured to separate a steam cracker naphtha from the cooled steam cracker effluent,

the second vapor phase product comprises molecular hydrogen, and

a third hydroprocessing unit is configured to hydroprocess the steam cracker naphtha in the presence of the molecular hydrogen in the second vapor phase product to produce a stabilized steam cracker naphtha.

24. The system of claim 21, further comprising a second transfer line configured to introduce a second portion of the utility fluid product into the second separator such that the second portion of the utility fluid product contacts the cooled steam cracker effluent during separation of the tar product and the process gas at a location where the steam cracker effluent is at a temperature of $\geq 300°C$.

25. A hydrocarbon upgrading process, comprising:

separating a vapor phase product and a liquid phase product from a heated mixture comprising steam and a hydrocarbon, wherein the hydrocarbon comprises naphtha, gas oil, vacuum gas oil, waxy residues, atmospheric residues, residue admixtures, crude oil, or a mixture thereof;

exposing the vapor phase product to a temperature of $\geq 400°C$ under steam cracking conditions to produce a steam cracker effluent that is at least partially in a gas phase;

contacting the steam cracker effluent with a quench fluid to produce a cooled steam cracker effluent, wherein at least a portion of the gas phase condenses into a liquid phase;

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

separating from the upgraded steam cracker effluent at least a process gas, a steam cracker naphtha, and a bottoms product; wherein the bottoms product is conducted away from the process;

hydroprocessing the tar product under pre-treater hydroprocessing conditions to produce a pre-treated tar product comprising a vapor portion and a liquid portion and hydroprocessing the pre-treated tar product under tar hydroprocessing conditions to produce a first hydroprocessed product, wherein:

the pre-treater hydroprocessing conditions comprise hydroprocessing the tar product at a temperature (T_{PT}) of 400°C or less, a weight hour space velocity ($WHSV_{PT}$) of $\geq$ 0.3 hr^{-1} based on a weight of the tar product subjected to the pre-treater hydroprocessing conditions, a total pressure (P_{PT}) of $\geq$ 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 tar product,

the tar hydroprocessing conditions comprise hydroprocessing the pre-treated tar product at a temperature (T_T) of $\geq$ 200°C, a weight hour space velocity ($WHSV_T$) of $\geq$ 0.3 hr^{-1} based on a weight of the pre-treated tar product that is subjected to the tar hydroprocessing, a total pressure (P_T) of $\geq$ 6 MPa, and in the presence of molecular hydrogen supplied at a rate (SR_T) of $\geq$ 534 standard cubic meters per cubic meter of the pre-treated tar product subjected to the tar hydroprocessing, and

$WHSV_T$ is less than $WHSV_{PT}$;

separating a hydroprocessor heavy product and a utility fluid product from the first hydroprocessed product, wherein the quench fluid comprises a first portion of the utility fluid product, wherein the utility fluid product comprises: (a) $\geq$ 1 wt. % of 1.0 ring class compounds; (b) $\geq$ 5 wt. % of 1.5 ring class compounds; (c) $\geq$ 5 wt. % of 2.0 ring class compounds; and (d) $\geq$ 0.1 wt. % of 5.0 ring class compounds, wherein the weight percent values of (a), (b), (c), and (d) are based on a weight of the utility fluid product, and wherein the cooled steam cracker effluent comprises about 5 wt. % to about 80 wt. % of the utility fluid, based on a combined weight of the quench fluid and the steam cracker effluent;

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

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

reacting the pitch and oxygen at conditions sufficient to produce a synthesis gas comprising a mixture of molecular hydrogen and carbon monoxide, wherein at least one of the tar product and the liquid phase product is hydroprocessed in the presence of molecular hydrogen separated from the synthesis gas.