CLAIMS

1. A pyrolysis tar pretreatment process, comprising:

(a) providing a pyrolysis tar having a reactivity (R_T) > 28 BN, wherein, at least 70 wt. % of the pyrolysis tar's components have a normal boiling point of at least 290°C, based on the total weight of the pyrolysis tar;

(b) maintaining the pyrolysis tar within a temperature range of from T_1 to T_2 for a time (t_{HS}) sufficient to produce a pyrolysis tar composition having a reactivity $R_C < R_T$ and an insolubles content $IC_C \leq 6$ wt. %, wherein, T_1 is ≥ 150°C, T_2 is ≤ 320°C, and t_{HS} is ≥ 1 minute;

(c) combining the pyrolysis tar composition with a utility fluid comprising hydrocarbon to produce a tar-fluid mixture having a reactivity $R_M \leq 18$ BN;

(d) during a time period of from t_1 to t_2, hydroprocessing during a pretreatment mode at least a portion of the tar-fluid mixture in the presence of molecular hydrogen within a pretreatment reactor to produce a pretreater effluent comprising a vapor portion and a liquid portion, wherein:

(i) the liquid portion comprises a pretreated tar-fluid mixture which includes a pretreated pyrolysis tar,

(ii) the pretreated tar-fluid mixture has a reactivity (R_F) ≤ 12 BN, and

(iii) the hydroprocessing is carried out under Pretreatment Hydroprocessing Conditions which include a pressure drop $\Delta P = \Delta P_1$ at t_1, a temperature $T_{PT} \leq 400$°C, a space velocity ($WHSV_{PT}$) ≥ 0.3 hr^{-1} based on the weight of the hydroprocessed portion of the tar-fluid mixture, a total pressure (P_{PT}) ≥ 8 MPa, and supplying the molecular hydrogen at a rate < 3000 standard cubic feet per barrel of the hydroprocessed portion of the tar-fluid mixture (SCF/B) , and

(e) switching the pretreatment reactor from the pretreatment mode to a regeneration mode carried out after t_2 for a time period of from t_3 to t_4, and during regeneration mode regenerating the pretreatment reactor under regeneration conditions which include a pressure drop ΔP_3 at t_3, a temperature $T_{Reg} \geq T_{PT}$, a total pressure $P_{Reg} \geq 3.5$ MPa, and a molecular hydrogen $GHSV_{Reg}$ in the range of from 75 hr^{-1} to 750 hr^{-1}.

2. The process of claim 1, wherein

(i) t_2 corresponds to the time at which the pretreatment reactor achieves a pressure drop ΔP_2 that is the lesser of (I) F * ΔP_1, with F being in the range of from 1.5 to 20, or (II) a threshold $\Delta P \geq 2$ psi ; and

(ii) t_4 corresponds to the time at which the pretreatment reactor achieves a pressure drop $\Delta P_4 \leq 0.5 * \Delta P_3$.

3. The process of claim 1, wherein P_{Reg} is $\leq P_{PT}$ and $GHSV_{Reg}$ is in the range of from 211 hr^{-1} to 600 hr^{-1}.

4. The process of claim 1, wherein

(i) T_{Reg} is in the range of from 325°C to 425°C during at least part of the regeneration, and

(ii) during the part of the regeneration where T_{Reg} is in the range of from 325°C to 425°C, ΔP exhibits a decrease of ≥ 0.5 psi , during which decrease ABS[d(ΔP)/dt] is ≥ 1 psi/hr .

5. The process of claim 1, wherein R_T is in the range of from 29 BN to 45 BN, $\geq$ 90 wt. % of the pyrolysis tar has a normal boiling point $\geq$ 290°C, and wherein the pyrolysis tar has an Insolubles Content (IC_T) $\leq$ 6 wt. %, an $I_N \geq 80$, a 15°C kinematic viscosity $\geq$ 600 cSt, and a 15°C density (ρ_T) $\geq$ 1.1 g/cm^3.

6. The process of claim 1, wherein the pyrolysis tar is a steam cracker tar having one or more of (i) a TH content in the range of from 5.0 wt. % to 40.0 wt. %; (ii) an API gravity (measured at a temperature of 15.8°C) of $\leq$ 8.5°API; (iii) a 50°C viscosity in the range of 1 x 10^3 cSt to 1.0 x 10^7 cSt; and (iv) a sulfur content that is > 0.5 wt. %.

7. The process of claim 1, wherein t_{HS} is in the range from 10 minutes to 400 minutes, $R_C \leq 28$ BN, and R_C is $\leq R_T - 4$ BN.

8. The process of claim 1, wherein the tar-fluid mixture has 50°C kinematic viscosity that is $\leq$ 500 cSt, and 12 BN < $R_M \leq 18$ BN.

9. The process of claim 1, wherein t_{HS} is in the range of from 30 minutes to 400 minutes, R_C is $\leq R_T - 8$ BN, and $R_F \leq 11$ BN.

10. The process of claim 1, wherein $T_1 \geq 180°C$, $T_2 \leq 300°C$, t_{HS} is in the range of from 5 minutes to 100 minutes, and R_C is $\leq R_T - 0.5$ BN.

11. The process of claim 1, wherein the utility fluid comprises aromatic hydrocarbon and has a 10% distillation point $\geq$ 60°C and a 90% distillation point $\leq$ 425°C.

12. The process of claim 1, wherein the tar-fluid mixture comprises 50 wt. % to 70 wt. % of pyrolysis tar, with $\geq$ 90 wt. % of the balance of the tar-fluid mixture comprising the utility fluid.

13. The process of claim 1, wherein (i) T_{PT} is in the range of from 220ºC to 300ºC, $WHSV_{PT}$ is in the range of from 1.5 hr^{-1} to 3.5 hr^{-1}, and the molecular hydrogen supply rate is in a range of about 300 SCF/B to 1000 SCF/B , and P_{PT} is in the range of from 6 MPa to 13.1 MPa; and (ii) the Pretreatment Hydroprocessing Conditions further include a molecular hydrogen consumption rate in the range of from 100 standard cubic feet per barrel of the pyrolysis tar composition in the tar-fluid mixture (SCF/B) to 600 SCF/B.

14. The process of claim 1, further comprising:

(f) hydroprocessing in the presence of molecular hydrogen at least a portion of the pretreater effluent under Intermediate Hydroprocessing Conditions to produce a hydroprocessor effluent comprising hydroprocessed pyrolysis tar, wherein:

(i) the Intermediate Hydroprocessing Conditions include a temperature (T_I) $\geq$ 200ºC, total pressure (P_I) $\geq$ 8MPa, a space velocity ($WHSV_I$) $\geq$ 0.3 hr^{-1} based on the weight of the liquid portion of the pretreater effluent hydroprocessed in (e), and a molecular hydrogen supply rate $\geq$ 3000 standard cubic feet of the pretreated tar hydroprocessed in (e) (SCF/B) , and

(ii) $WHSV_I < WHSV_{PT}$.

15. The process of claim 14, wherein (i) T_I in the range of from 360°C to 410°C, $T_I > T_{PT}$, $WHSV_I$ is in the range of from 0.5 hr^{-1} to 1.2 hr^{-1}, the molecular hydrogen supply rate is in the range of from 3000 SCF/B to 5000 SCF/B, and P_I is in the range of from 6 MPa to 13.1 MPa; and (ii) the Intermediate Hydroprocessing Conditions further include a molecular hydrogen consumption rate in the range of from 1600 standard cubic feet per barrel of tar in the pretreater effluent (SCF/B) to 3200 SCF/B .

16. The process of claims 14, wherein the hydroprocessing of step (f) is carried out in a second reactor, and the second reactor exhibits a 566°C+ conversion of at least 20 wt. % substantially continuously for at least thirty days.

17. The process of claim 14, further comprising separating from the hydroprocessed effluent (i) a primarily vapor-phase first stream comprising at least a portion of any unreacted molecular hydrogen; (ii) a primarily liquid-phase second stream comprising at least a portion of the hydroprocessed pyrolysis tar, and (iii) a primarily liquid-phase third stream comprising at least a portion of any unreacted utility fluid; recycling to the hydroprocessing of steps (d) and/or (e) at least a portion of the first stream, and recycling at least a portion of the third stream to step (c).

18. The process of claim 17, wherein the second stream comprises ≥ 1 wt. % of sulfur and ≤ 10 wt. % of hydrocarbon having a 10% distillation point ≥ 60°C and a 90% distillation point ≤ 425°C, and wherein the process further comprises hydroprocessing the second stream under Retreatment Hydroprocessing Conditions in the presence of molecular hydrogen to produce an upgraded tar comprising ≤ 0.5 wt. % sulfur, and the Retreatment Hydroprocessing Conditions include a temperature (T_R) in the range of from 370°C to 415°C, a space velocity ($WHSV_R$) is in the range of from 0.2 hr^{-1} to 0.5 hr^{-1}, a molecular hydrogen supply rate in the range of from 3000 SCF/B to 5000 SCF/B , a total pressure in the range of from 6 MPa to 13.1 MPa, and $WHSV_R < WHSV_I$.

19. The process of claim 1, further comprising removing at least a portion of the insolubles at a temperature in the range of from 80°C to 100°C using a centrifuge.