

## **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  $\geq 150^\circ\text{C}$ ,  $T_2$  is  $\leq 320^\circ\text{C}$ , and  $t_{HS}$  is  $\geq 1$  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; and
  - (d) hydroprocessing at least a portion of the tar-fluid mixture in the presence of molecular hydrogen 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 ( $R_F$ )  $\leq 12$  BN, and
    - (iii) the hydroprocessing is carried out under Pretreatment Hydroprocessing Conditions which include a temperature  $T_{PT} \leq 400^\circ\text{C}$ , a space velocity ( $WHSV_{PT}$ )  $\geq 0.3 \text{ hr}^{-1}$  based on the weight of the hydroprocessed portion of the tar-fluid mixture, a total pressure ( $P_{PT}$ )  $\geq 8\text{MPa}$ , 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).
2. 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  $\geq 290^\circ\text{C}$ , and wherein the pyrolysis tar has an Insolubles Content ( $IC_T$ )  $\leq 6$  wt. %, an  $I_N \geq 80$ , a  $15^\circ\text{C}$  kinematic viscosity  $\geq 600 \text{ cSt}$ , and a  $15^\circ\text{C}$  density ( $\rho_T$ )  $\geq 1.1 \text{ g/cm}^3$ .
3. The process of claim 1, wherein  $IC_C$  is  $\leq 5$  wt. %.

4. 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  $\leq 8.5^\circ\text{API}$ ; (iii) a 50°C viscosity in the range of  $1 \times 10^3$  cSt to  $1.0 \times 10^7$  cSt; and (iv) a sulfur content that is  $> 0.5$  wt. %.
5. The process of claim 1, wherein  $t_{\text{HS}}$  is in the range of from 10 minutes to 400 minutes,  $R_C \leq 28$  BN, and  $R_C$  is  $\leq R_T - 4$  BN.
6. The process of claim 1, wherein the tar-fluid mixture has 50°C kinematic viscosity that is  $\leq 500$  cSt, and  $12 \text{ BN} < R_M \leq 18 \text{ BN}$ .
7. The process of claim 1, wherein  $t_{\text{HS}}$  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.
8. The process of claim 1, wherein  $T_1 \geq 180^\circ\text{C}$ ,  $T_2 \leq 300^\circ\text{C}$ ,  $t_{\text{HS}}$  is in the range of from 5 minutes to 100 minutes, and  $R_C$  is  $\leq R_T - 0.5$  BN.
9. The process of claim 1, wherein the utility fluid comprises aromatic hydrocarbon and has a 10% distillation point  $\geq 60^\circ\text{C}$  and a 90% distillation point  $\leq 425^\circ\text{C}$ .
10. 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.
11. The process of claim 1, wherein (i)  $T_{\text{PT}}$  is in the range of from  $220^\circ\text{C}$  to  $300^\circ\text{C}$ ,  $\text{WHSV}_{\text{PT}}$  is in the range of from  $1.5 \text{ hr}^{-1}$  to  $3.5 \text{ hr}^{-1}$ , and the molecular hydrogen supply rate is in a range of about 300 (SCF/B) to 1000 SCF/B, and  $P_{\text{PT}}$  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 .

12. The process of claim 1, wherein the hydroprocessing of step (d) is carried out in a first reactor, and the first reactor has a pressure drop of  $\leq 15$  psi during substantially continuous operation for at least fifteen days.

13. The process of claim 1, further comprising (e) 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 ( $T_I$ )  $\geq 200^\circ\text{C}$ , total pressure (" $P_I$ ")  $\geq 8\text{MPa}$ , a space velocity ( $\text{WHSV}_I$ )  $\geq 0.3\text{ hr}^{-1}$  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)  $\text{WHSV}_I < \text{WHSV}_{PT}$ .

14. The process of claim 13, wherein (i)  $T_I$  in the range of from  $360^\circ\text{C}$  to  $410^\circ\text{C}$ ,  $T_I > T_{PT}$ ,  $\text{WHSV}_I$  is in the range of from  $0.5\text{ hr}^{-1}$  to  $1.2\text{ hr}^{-1}$ , 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 .

15. The process of claims 13 wherein the hydroprocessing of step (e) is carried out in a second reactor, and the second reactor exhibits a  $566^\circ\text{C}+$  conversion of at least 20 wt. % substantially continuously for at least thirty days.

16. The process of claim 13, further comprising: separating from the hydroprocessor 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  
5 third stream to step (c).

17. The process of claim 2, further comprising  
(e) hydroprocessing in the presence of molecular hydrogen at least a portion of the  
pretreater effluent under Intermediate Hydroprocessing Conditions to produce a  
10 hydroprocessor effluent comprising hydroprocessed pyrolysis tar, wherein:

(i) the Intermediate Hydroprocessing Conditions include a temperature  
( $T_I$ )  $\geq 200^\circ\text{C}$ , total pressure (“ $P_I$ ”)  $\geq 8\text{MPa}$ , a space velocity ( $\text{WHSV}_I$ )  $\geq 0.3\text{ hr}^{-1}$  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  
15 hydroprocessed in (e) ( $\text{SCF/B}$ ), and

(ii)  $\text{WHSV}_I < \text{WHSV}_{PT}$ .

(f) separating from the hydroprocessor 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  
20 pyrolysis tar, and (iii) a primarily liquid-phase third stream comprising at least a  
portion of any unreacted utility fluid;

(g) recycling to the hydroprocessing of steps (d) and/or (e) at least a portion of the  
first stream, and

(h) recycling at least a portion of the third stream to step (c), wherein the second  
25 stream has a  $15^\circ\text{C}$  density ( $\rho_2$ )  $\leq \rho_T - 0.12\text{ g/cm}^3$ .

18. The process of claim 16, wherein the second stream comprises  $\geq 1\text{ wt. \%}$  of  
sulfur and  $\leq 10\text{ wt. \%}$  of hydrocarbon having a 10% distillation point  $\geq 60^\circ\text{C}$  and a  
90% distillation point  $\leq 425^\circ\text{C}$ , and wherein the process further comprises  
30 hydroprocessing the second stream under Retreatment Hydroprocessing Conditions in  
the presence of molecular hydrogen to produce an upgraded tar comprising  
 $\leq 0.5\text{ wt. \%}$  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<sup>-1</sup> to 0.5 hr<sup>-1</sup>, 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  $WHSV_R < WHSV_I$ .

5

19. The process of claim 18, wherein the upgraded tar has an  $S_{BN} \geq 190$  and an  $I_N \leq 100$ .

10 20. The process of claim 19, further comprising combining the upgraded tar with a second hydrocarbon to produce a blend having a 50°C kinematic viscosity < 380 cSt, a 15°C density < 991 kg/m<sup>3</sup>, a sulfur content < 0.10 wt. %, a flash point  $\geq 60^\circ\text{C}$ , and a pour point < 30°C.