

CLAIMS

1. A pyrolysis tar conversion process, comprising:
 - (a) providing a pyrolysis tar, wherein, at least 70 wt. % of the pyrolysis tar's components have a normal boiling point of at least 290°C, based upon the total weight of the pyrolysis tar;
 - (b) maintaining the pyrolysis tar within a temperature range of from T_1 to T_2 for time t_{HS} to produce a pyrolysis tar composition having an Insolubles Content (IC) ≤ 6 wt. %, wherein T_1 is $\geq 150^\circ\text{C}$, T_2 is $\leq 320^\circ\text{C}$, and t_{HS} is ≥ 1 minute;
 - (c) combining the pyrolysis tar composition with a sufficient amount of a utility fluid to produce a tar-fluid mixture having a 50°C kinematic viscosity that is ≤ 500 cSt;
 - (d) determining a reactivity R_M of the tar-fluid mixture and comparing R_M to a predetermined reference activity R_{Ref} of a hydroprocessing stage; and
 - (e) when:
 - (i) R_M is $\leq R_{Ref}$, producing a hydroprocessed tar by hydroprocessing at least a portion of the tar-fluid mixture in the hydroprocessing stage under Standard Hydroprocessing Conditions; and
 - (ii) R_M is both $> R_{Ref}$ and ≤ 18 Bromine Number ("BN"), producing the hydroprocessed tar by hydroprocessing at least a portion of the tar-fluid mixture in the hydroprocessing stage under Mild Hydroprocessing Conditions.
2. The process of claim 1, wherein the pyrolysis tar has an R_T is in the range of from 29 BN to 45 BN, and the R_M of the tar-fluid mixture is ≤ 17 BN.
3. The process of claim 1, wherein ≥ 90 wt. % of the pyrolysis tar components have a normal boiling point $\geq 290^\circ\text{C}$, and the pyrolysis tar has a 50°C kinematic viscosity $\geq 1 \times 10^4$ cSt and/or a density ≥ 1.1 g/cm³.
4. The process of claim 1, wherein in the pyrolysis tar is a steam cracker tar having an insolubility number (I_N) > 80 .

5. The process of claim 1, wherein R_{Ref} is ≤ 11 BN.
6. The process of claim 1, wherein the IC of the pyrolysis tar composition is ≤ 5 wt. %.
- 5 7. The process of claim 1, wherein (i) hydroprocessed tar has a 15°C density that is at least 0.10 g/cm^3 less than that of the pyrolysis tar, and (ii) the hydroprocessed tar has a 50°C kinematic viscosity < 200 cSt.
- 10 8. The process of claim 1, further comprising blending the hydroprocessed tar to produce a fuel oil composition comprising < 0.5 wt. % sulfur.
9. The process of claim 1, wherein T_1 is $\geq 160^\circ\text{C}$ and T_2 is $\leq 310^\circ\text{C}$, and t_{HS} is in the range of from 1 minute to 400 minutes.
- 15 10. The process of claim 1, wherein T_1 is $\geq 180^\circ\text{C}$ and T_2 is $\leq 300^\circ\text{C}$, and t_{HS} is in the range of from 5 minutes to 100 minutes.
11. The process of claim 1, wherein T_1 is $\geq 200^\circ\text{C}$ and T_2 is $\leq 290^\circ\text{C}$, and t_{HS} is in the range of from 5 minutes to 30 minutes.
- 20 12. The process of claim 1, wherein R_{Ref} is ≤ 12 BN, and wherein the temperature at which the pyrolysis tar is maintained is (i) constant at a temperature T_{HS} during t_{HS} and (ii) T_{HS} is at least 10°C greater than T_1 .
- 25 13. The process of claim 1, wherein step (e) further comprises:
(iii) when R_M is > 18 , increasing T_{HS} and/or t_{HS} and repeating steps (c)-(e).
14. The process of claim 1, wherein the utility fluid comprises ≥ 15 wt. % of combined two-ring and three-ring aromatic hydrocarbon compounds, and wherein the utility fluid has an A.S.T.M. D86 10% distillation point $\geq 60^\circ\text{C}$ and a 90% distillation point $\leq 425^\circ\text{C}$.
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15. The process of claim 1, wherein the hydroprocessing of step (e)(i) exhibits a 566°C+ conversion of at least 20 wt. % continuously for at least ten days.
16. The process of claim 1, wherein the hydroprocessed pyrolysis tar of step (e)(i)
5 has a density measured at 15°C that is at least 0.10 g/cm³ less than that of the pyrolysis tar.
17. The process of claim 1, wherein (i) the hydroprocessing of step (e)(i) and/or the hydroprocessing of step (e)(ii) is carried out in the presence of a catalytically effective
10 amount of at least one catalyst, (ii) the catalyst comprises at least one metal from any of Groups 5 to 10 of the Periodic Table, and (iii) the catalyst comprises the metal in an amount in the range of from 0.005 grams to 0.3 grams per gram of catalyst.
18. The process of claim 1, wherein the Standard Hydroprocessing Conditions
15 include a temperature $T_S \geq 200^\circ\text{C}$, a pressure $P_S \geq 8 \text{ MPa}$, a weight hourly space velocity ("WHSV_S", pyrolysis tar basis) $\geq 0.3 \text{ hr}^{-1}$, and a molecular hydrogen consumption rate C_S in the range of 270 S m³/m³ of molecular hydrogen per cubic meter of the pyrolysis tar (S m³/m³) to 534 S m³/m³.
- 20 19. The process of claim 1, wherein the Mild Hydroprocessing Conditions include a temperature T_M that is $\geq 200^\circ\text{C}$ but less than T_S , a pressure P_M that is $\geq 8 \text{ MPa}$ but less than P_S , a WHSV_M of the pyrolysis tar that is $\geq 0.3 \text{ hr}^{-1}$ and greater than WHSV_S, and a molecular hydrogen consumption rate (C_M) that is in the range of from 150 standard cubic meters of molecular hydrogen per cubic meter of the pyrolysis tar (S m³/m³) to
25 about 400 S m³/m³ (845 SCF/B to 2250 SCF/B), but less than C_S .