Claims

1. A process for conversion of hydrocarbonaeous feeds comprising sulfur and metals to form a fuel characterized in that feed comprises light tight oil and high sulfur fuel oil, said process comprising:

(a) feeding one or more high sulfur fuel oils (41) to a residue hydroconversion zone (401) and contacting such oil with hydrogen in presence of catalyst at residue hydroconversion conditions in an ebullated-bed reactor to form

(1) reactor zone effluent which is separated into hydroconverted liquids (411) and purge gases (420) comprising hydrogen and sulfur,

(2) unconverted oils (409) which are directed to solvent separation (301) to form (A) soluble deasphalted oil (311) which is recycled as feed to said hydroconversion zone (401), either separately or combined with added high sulfur fuel oil feed to said reactor and (B) insoluble pitch (351) which is directed to pitch treatment (501), and

(b) combining all or one or more portions of a light tight oil (1) with said hydroconverted liquids (411) to form a fuel (600).

2. A process in accordance with Claim 1 wherein a light tight oil is fractionated to remove overhead still gases to leave fractionator bottoms which are combined with said hydroconverted liquids to form a fuel.

3. A process in accordance with Claim 1 wherein high sulfur fuel oil is fed to said solvent separation directly or is combined with said reactor unconverted oil for feed to solvent separation.

4. A process in accordance with Claim 1 wherein high sulfur fuel oil is combined with said soluble deasphalted oil for a portion of the feed to said reactor.

5. A process in accordance with Claim 1 wherein said fuel has a wide range of hydrocarbons comprising those from the lowest boiling point within said light

tight oil forming said fuel up to the maximum boiling point of effluent from solvent separation which is subsequently treated, either by hydrotreating or hydroconversion, and forms a portion of said fuel.

6. A process in accordance with Claim 1 wherein a light tight oil is fractionated to remove overhead still gases to form an upper zone lighter fraction comprising naphtha range hydrocarbons and higher boiling bottoms fraction, and at least a portion of such lighter fraction is subject to contact with hydrogen under reforming conditions to form a light treated stream and said higher boiling bottoms fraction forms a portion of said fuel.

7. A process in accordance with Claim 1 wherein said reactor zone effluent is separated by vacuum fractionation into two or more treated liquid fractions, at least one of such fractions having a sulfur content above the target sulfur content is directed as part of the feed to said residue hydroconversion zone reactor or as part of the feed to solvent separation.

8. A process in accordance with Claim 1 wherein said reactor zone effluent is separated by vacuum fractionation into more than one hydroconverted liquid fractions, and at least one of such fractions having a sulfur content above the target sulfur content is directed to a hydrotreating zone for contact with hydrogen in presence of catalyst at hydrotreating conditions to form a reduced sulfur hydrotreated stream having a sulfur content less than the target sulfur content, and said hydrotreated stream is combined with an untreated stream derived from light tight oil and other hydroconverted liquids in quantities needed to adjust fuel sulfur content to make a fuel having an actual sulfur content at or below a target sulfur content.

9. A process in accordance with Claim 1 where said residue hydroconversion zone integrates a residue hydroconversion reactor with a heavy oil range hydrotreater and a distillate range hydrotreater, integrating one or more gas and liquid separators, streams of hydrogen, purge gases, sulfur recovery steps and common treated liquids recovery.

10. A process in accordance with Claim 1 where said residue hydroconversion zone integrates a residue hydroconversion reactor with a heavy oil range hydrotreater and a distillate range hydrotreater, integrating one or more gas and liquid separators, streams of hydrogen, purge gases, and sulfur recovery steps but with separate treated liquids recovery to enable measurement of sulfur content of each separate stream and adjustment of amount of flow to combination zone so as to form a fuel having an actual sulfur content at or below a target sulfur content.

11. A process in accordance with Claim 1 wherein said light tight oil feed has a density API in the range of 45 to 55 degrees and said high sulfur fuel oil has a density API in the range of 14 to 21 degrees, said hydroconverted liquids have a density API in the range of 26 to 30 degrees, and said combination fuel product has a density API in the range of 37 to 43 degrees and a sulfur content of less than 0.5 wt.% sulfur.

12. A process in accordance with Claim 1 wherein a single product fuel is formed.

13. A process in accordance with Claim 1 wherein actual sulfur content of said fuel is adjusted to meet a target sulfur content within an IMO specification for marine fuel or a turbine manufacturer’s specification for a combustion gas turbine.

14. A fuel produced in accordance with the process of Claim 1.

15. Use of a fuel produced in accordance with the process of Claim 1 in marine or land based engines, combustion gas turbines, or fired heaters.

16. A process for conversion of one or more hydrocarbonaeous feeds comprising sulfur and metals characterized in that said conversion is directed to a single liquid fuel product, said process comprising

(a) separating said feed (2, 3) by atmospheric (100) and vacuum distillation (200), into

(i) light overhead still gases (6),

(ii) liquid fractions at or below sulfur breakpoint (16), and

(iii) fractions above sulfur breakpoint comprising

(A) distillate range fractions comprising sulfur (24,26,28, 32)

(B) vacuum gas oil range fractions comprising sulfur (36, 38) and

(C) vacuum residue comprising sulfur (50), and

associated purge gases comprising sulfur

(b) directing the liquid fractions at or below the sulfur breakpoint (10), as untreated liquids, to a combination zone (600)

(c) directing 16.(a)(iii)(A) distillate range fractions (20) to distillate hydrotreater (430) and 16.(a)(iii)(B) vacuum gas oil range fractions (39) to vacuum gas oil hydrotreater (460) for contact with addition of hydrogen in presence of catalyst at hydrotreating conditions to form

(1) one or more treated liquids (65, 75) which are directed to a combination zone (600), and

(2) purge gases comprising sulfur (428)

(d) directing the 16.(a)(iii)(C) vacuum residue (50, 57) to ebullated residue hydroconversion (490) for contact with addition of hydrogen in presence of catalyst at ebullated hydroconversion conditions to form

(1) one more treated liquids (85) which are directed to said combination zone (600)

(2) purge gases comprising sulfur (428)

(3) unconverted oils (409) which are directed to solvent separation (301) to form

(A) soluble deasphalted oil (311) which is directed to said residue hydroconversion (490), either alone or combined with vacuum residue (50), and

(B) insoluble pitch (351) which is directed to pitch treatment (501)

(e) combining said untreated liquids (10) with said treated liquids (65, 75, 85) to form a fuel (600) having an actual sulfur content at or below a target sulfur content.

17. A process in accordance with Claim 16 wherein said pitch is fired in one or more gasifiers for generation of electricity and at least a portion of hydrogen for said hydrotreating and for capture at least a portion of said metals in gasifier solids which are removed.

18. A process in accordance with Claim 16 wherein said pitch is fired, either

alone with a diluent, in one or more boilers, for generation of electricity and steam, said boiler having ancillary facilities to reduce or remove sulfur and metal from flue gases and other process gases and a hydrogen generation unit which may use at least of portion of such boiler steam in a hydrogen source comprising a natural gas steam cracker with a pressure swing absorption unit.

19. A process in accordance with Claim 16 wherein said pitch is used for asphalt production or as coker feed.

20. A process in accordance with Claim 16 wherein at least one of said hydrotreated streams is an ultralow sulfur stream having 10 ppmwt or less of sulfur which is used to adjust, by reduction or addition of the amount of such stream to said combination, formation of said fuel to control actual sulfur content at or below a target sulfur content.

21. A process in accordance with Claim 16 having only five principle unit operations of one or more of atmospheric distillation and vacuum distillation, hydrotreating, residue hydroconversion, and solvent separation, and not having hydrocarbon treating operations downstream of hydrotreating or residue hydroconversion except required ancillary apparatus for firing of residue, for generation of hydrogen and process utilities, for capture of metals and sulfur, whereby all gases comprising sulfur are directed to one or more common sulfur recovery units.

22. A process in accordance with Claim 16 wherein substantial all hydrocarbon compositions of said crude oil feed are separated into fractions but are subsequently recombined to form said fuel which is one liquid fuel product, not multiple hydrocarbon products, except hydrocarbon compositions comprising those within (i) light overhead still gases of distillation, (ii) said pitch and (iii) streams for sulfur or metals recovery, said fuel comprising a combination of hydrocarbons ranging from lowest boiling portion of said untreated liquid fraction from said atmospheric distillation to highest boiling portion of effluent from solvent separation which is subsequently treated, either by hydrotreating or hydroconversion, and forms a

portion said fuel.

23. A process in accordance with Claim 16 wherein at least one of the hydrotreated streams is an ultralow sulfur stream having less than 10 ppmwt of sulfur, and the untreated fraction has a sulfur content in excess of the target sulfur content and said untreated fraction is used as trim control, by reduction or addition of the amount of such untreated fraction to said combination, to form a fuel having an actual sulfur content at or below a target sulfur content.

24. A process in accordance with Claim 16 wherein a first hydrotreated stream is a reduced sulfur stream having a sulfur content less than 10 ppmwt of sulfur, and a second hydrotreated fuel fractions is a reduced sulfur stream having a sulfur content in the range of 0.12 to 0.18 wt% sulfur, and the untreated fraction has a sulfur content in excess of the target sulfur content and either said first hydrotreated stream or second hydrotreated stream, or both, are used as trim control, by reduction or addition of the amount of such streams to said combination, to form a fuel having an actual sulfur content at or below a target sulfur content.

25. A process in accordance with Claim 16 wherein said residue hydroconversion and hydrotreating zone comprises a separate distillate hydrotreating reactor, heavy oil hydrotreating reactor and residue hydroconversion reactor, with each reactor forming a separate treated effluent, and each treated effluent is separately directed to a shared wall separator to form a common overhead gas comprising sulfur and one or more separate reduced gas liquid treated effluents associated with each reactor treated effluent which is separately withdrawn from said separator at a rate based upon its respective sulfur content and directed either (a) to said combination with said untreated liquid stream to form a fuel having an actual sulfur content at or below a target sulfur content or (b) to reserve storage for subsequent trim control of fuel sulfur content.

26. A process in accordance with Claim 16 where by reasons of volume gain caused, at least in part by hydrogen addition, the volume of output product fuel may exceed the total volume of input feeds.

27. A process in accordance with Claim 16 wherein actual sulfur content of said fuel is adjusted to meet a target sulfur content within an IMO specification for marine fuel or a turbine manufacturer's specification for a combustion gas turbine.

28. A fuel produced in accordance with the process of Claim 16.

29. Use of a fuel produced in accordance with the process of Claim 16 in marine or land based engines, combustion gas turbines, or fired heaters.

30. A process for integration of atmospheric and vacuum distillation, solvent separation, hydrotreating, and hydroconversion to produce components of a fuel characterized in that the integration of this process separates feeds into streams, treats one or more portions of separate streams, and then recombines treated and untreated streams to form a fuel having an initial boiling point being the lowest boiling point of any fraction within untreated streams combined in said fuel and highest boiling point being the highest boiling portion of effluent from solvent separation which is subsequently treated and forms a portion said fuel, where said process comprises

(a) feeding light tight oil (3) and crude oil (2) comprising sulfur and metal contaminants to an atmospheric distillation column (100) and separating the feed into light overhead gases (6) and multiple cuts comprising:

(i) unstabilized wild straight run naphtha (16)

(ii) sulfur breakpoint cut (18)

(iii) light distillate over breakpoint (24)

(iv) medium distillate (26)

(v) a first heavy distillate (28)

(vi) atmospheric residual (30),

(b) feeding (a)(vi) atmospheric residual (30) to a vacuum distillation tower (200) to produce

(i) a second heavy distillate (32)

(ii) light vacuum gas oil (36)

(iii) heavy vacuum gas oil (38)

(iv) vacuum residual (50),

(c) feeding (b)(iv) vacuum residual (50) to a residue hydroconversion zone (490) with addition of hydrogen in presence of catalyst at residue hydroconversion conditions in an ebullated-bed reactor system having liquids recovery comprising vacuum distillation within integrated zone (401) to form

(i) hydroconverted liquids (85) comprising (A) naphtha (B) all or a portion of middle distillates product of hydroconversion and (C) all or a portion of vacuum gas oils product of hydroconversion within integrated zone (401), and associated purge gases comprising hydrogen and sulfur

(ii) unconverted oils (409) which are directed to solvent separation (301) to form (A) soluble deasphalted oil (311) which is recycled as feed to said hydroconversion reactor (490), either separately or combined with added high sulfur fuel oil feed to said hydroconversion reactor and (B) substantially insoluble metals rich pitch (351) which is directed to pitch treatment (501), and

(d) feeding to distillate hydrotreater (430) stream (20) comprising (a)(iii) light distillate, (a)(iv) medium distillate, (a)(v) first heavy distillate, and (b)(i) second heavy distillate stream and directing to distillate hydrotreater (430), as needed for sulfur content control, a portion of distillate range products of hydroconversion formed within integrated zone (401), for contact with addition of hydrogen in presence of catalyst at hydrotreating conditions to form a stream (65) comprising

(i) wild naphtha

(ii) ultra low sulfur diesel being a reduced sulfur stream formed from combination of treated distillate streams comprising (a)(iii) light distillate, (a)(iv) medium distillate, (a)(v) first heavy distillate and (b)(i) second heavy distillate and a portion of distillate range treated (c)(i)(B) middle distillate product of hydroconversion within integrated zone (401)

and associated byproducts comprising

(iii) sulfur containing gas stream comprising hydrogen sulfide

(iv) hydrogen rich off gas, at least a portion of which is treated for sulfur removal and is recycled as hydrogen addition,

(e) feeding to heavy oil hydrotreater (460) stream (39) comprising (b)(ii) light vacuum gas oil, (b)(iii) heavy vacuum gas oil, and directing to heavy oil hydrotreater (460) a portion of (c)(i)(C) vacuum gas oils product of hydroconversion within integrated zone (401) for contact with addition of hydrogen in presence of catalyst at

hydrotreating conditions to form a stream (75) comprising

(i) wild naphtha

(ii) ultra low sulfur diesel being a first reduced sulfur stream formed from a first portion of the combination of treated distillate steams comprising (b)(ii) light vacuum gas oil (36), (b)(iii) heavy vacuum gas oil (38), and a hydrotreated portion (c)(i)(C) derived from vacuum gas oils products of hydroconversion within integrated zone (401) and

(iii) a second reduced sulfur stream formed from a second portion of the combination of treated distillate steams comprising (b)(ii) light vacuum gas oil (36), (b)(iii) heavy vacuum gas oil (38), and a hydrotreated portion derived from (c)(i)(C) vacuum gas oils product of hydro-conversion within integrated zone (401), and associated byproducts comprising

(iv) sulfur containing gas stream comprising hydrogen sulfide

(v) hydrogen rich off gas (428), at least a portion of which is treated for sulfur removal and is recycled as hydrogen addition, and

(f) forming said fuel product (600) having an actual sulfur content at or below a target sulfur content limit level by combining

(i) streams (a)(i) unstabilized wild straight run naphtha and (a)(ii) sulfur breakpoint cut without added treatment (10) with

(ii) streams from distillate hydrotreater (65) comprising (d)(i) wild naphtha and (d)(ii) all or a portion of ultra low sulfur diesel, with

(iii) streams from heavy oil hydrotreater (75) comprising (e)(i) wild naphtha, (e)(ii) ultra low sulfur diesel and (e)(iii) a second reduced sulfur stream, with

(iv) streams from hydroconversion (85) comprising (c)(i) hydroconverted liquids,

in a manner whereby actual sulfur content of said fuel (600) does not exceed target sulfur content limit.

31. A process in accordance with Claim 30 comprising integration of a gasification system by

(a) feeding 30.(c)(ii)(B) pitch which is a metals rich heavy residual to one or more gasification units comprising a gasifier for partial oxidation of said stream 30.(c)(ii) in presence of steam and oxygen, to form

(1) syngas, at least a portion of which is converted to hydrogen for

use in distillate hydrotreater of 30.(d) and heavy oil hydrotreater of 30.(e) and syngas for firing combustion gas turbine of a combined cycle power plant, also comprising a heat recovery generator to recover heat from gas turbine gas to produce steam which drives steam turbine, for electricity generation and

(2) solids soot comprising a portion of metal contaminants derived from the crude feed, which solids soot are directed from each gasifier for metals removal, and

(b) directing all sulfur containing gas streams from said gasification and all unit operations of Claim 30 to one or more gas recovery units for sulfur removal.

32. A process in accordance with Claim 30 where in actual product sulfur level is achieved by adjustment by increasing or decreasing amounts to a combination of one or more of any of

(a) streams to or from hydroconversion reactor,

(b) streams to or from distillate hydrotreater,

(c) streams to or from heavy oil hydrotreater, or

(d) streams comprising one or more of light tight oil, (a)(i) unstabilized wild straight run naphtha or (a)(ii) sulfur breakpoint cut, which streams have not been subject to hydroconversion or hydrotreating

where adjustment is based upon measurement of relative sulfur content of each stream to the combination to form a fuel product having an actual sulfur content at or below a target sulfur content limit level.

33. A process in accordance with Claim 30 achieved by

(a) feeding to the combination light tight oil, 30(a)(i) unstabilized wild straight run naphtha and 30.(a)(ii) sulfur breakpoint cut, each without added treatment,

(b) adjusting actual product sulfur level by increasing or decreasing amounts to the combination of one or more of any of

(i) streams to distillate hydrotreater,

(ii) streams to heavy oil hydrotreater,

(iii) streams to hydroconversion, and

(c) then decreasing amounts, or the desulfurization severity, to the combination of one or more of any of

(i) streams from distillate hydrotreater,

(ii) streams from heavy oil hydrotreater

if needed for any reason to increase the actual product sulfur level to the target sulfur level, or

(d) increasing amounts to the combination of one or more of any of

(i) streams from distillate hydrotreater,

(ii) streams from heavy oil hydrotreater,

(iii) streams from hydroconversion

if needed for any reason to decrease the actual product sulfur content at or below the target sulfur content limit level to form a fuel product having an actual sulfur content at or below a target sulfur content limit level.

34. A process in accordance with Claim 30 wherein sulfur content of feed is measured by an assay which indicates end of the sulfur breakpoint cut or start of exponential rate of rise of sulfur content over run of unit volume and use such assay to control adjustments to atmospheric distillation to maximize the available amount of 30.(a)(i) unstabilized wild straight run naphtha and 30.(a)(ii) sulfur breakpoint cut which should available be without treatment and reduce the amount of streams which should to be directed to hydrotreating or hydroconversion for treatment to form a fuel product having an actual sulfur content at or below a target sulfur content limit level.

35. A process in accordance with Claim 30 wherein sulfur content of feed is measured by an assay which indicates the end of the sulfur breakpoint cut or start of exponential rate of rise of sulfur content over run of unit volume and use such assay to determine and control the amount of streams to be directed to hydrotreating or hydroconversion to form a fuel having an actual sulfur content at or below a target sulfur content limit level.

36. A process in accordance with Claim 30 wherein treatment for sulfur removal from sulfur containing gas streams from all unit operations, where crude feed sulfur content distribution comprises (a) only relatively small portions of sulfur in basic H2S or RSH thiol type of basic forms of sulfur and (b) relatively high portions of sulfur in

more complex organic structure forms, treats basic less complex forms and more complex forms differently by removal by solvent and reactive chemical based treatment by more than one amine or other removal agents and solvents in one or more removal units where each ratio of removal agents in each unit is adjusted based on sulfur distribution to each unit to selectively remove less or more complex sulfur containing molecules.

37. A fuel produced in accordance with the process of Claim 30 wherein target sulfur content limit level is sulfur of 0.25 wt.% or less, and metals of said fuel are 100 ppmwt or less, and low nitrogen.

38. Use of a fuel produced in accordance with the process of Claim 30 in marine or land based engines, combustion gas turbines, or fired heaters.

39. A formulated fuel comprising light tight oil and hydroconversion reaction effluent boiling at or below highest boiling component of treated soluble deasphalted oil derived from high sulfur fuel oil or other residuals processed by said hydroconversion, said fuel having a range of hydrocarbons from an initial boiling being that of lowest boiling component of light tight oil or lighter materials from said hydroconversion so combined, and highest boiling point being that of highest boiling component of treated soluble deasphalted oil derived from high sulfur fuel oil or other residuals so combined and said fuel having, a density within 820 to 880 Kg/M3 at 15°C, sulfur of 0.5 wt.% or less, and metals of 25 ppmwt or less.