CLAIMS

1. A process for conversion of crude oil comprising sulfur and metals characterized in that this process separates such feed into streams based on sulfur content, treats one or more liquid portions of such separate streams for sulfur removal while leaving other portions untreated, and then recombines a majority of the volumes of all treated and untreated liquid streams to form a liquid fuel (600) having an actual sulfur content at or below a target sulfur content, said process comprising

(a) separating said crude oil (2) by one or more distillation (100, 200) and solvent separation (300) steps, into light overhead still gases (4), metals enriched residue (90) insoluble in one or more solvents used for said solvent separation, gases comprising sulfur (420), and liquid fractions above sulfur breakpoint (20, 40) and liquid fractions at or below breakpoint (10),

(b) treating, by one or more hydrotreating steps, liquid fractions of over sulfur breakpoint (20, 40), but not liquid fractions at or below sulfur breakpoint (10) or insoluble residue (90), to form one or more hydrotreated streams (60, 70) having reduced sulfur content, and

(c) combining said hydrotreated streams (60, 70) with liquid fractions at or below sulfur breakpoint (10) to form said fuel (600).

2. A process in accordance with Claim 1, 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 the sulfur breakpoint as target sulfur content.

3. A process in accordance with Claim 1 having only four principle unit operations of one or more of atmospheric distillation and vacuum distillation, solvent separation, and hydrotreating, and not having hydrocarbon treating operations downstream of hydrotreating except required ancillary apparatus for firing of residue, for generation of hydrogen and process utilities, for capture of metals and sulfur, and all gases comprising sulfur are directed to one or more common sulfur recovery units.

4. A process in accordance with Claim 1 wherein said crude oil feed is separated into fractions but such fractions are subsequently recombined, either as treated or untreated, to form said fuel which is one liquid fuel product, not multiple hydrocarbon products, except hydrocarbon compositions comprising those within (a) light overhead still gases of distillation, (b) portion of said residue insoluble in solvents used for solvent

separation steps and (c) streams for sulfur or metals recovery, said fuel comprising a combination of hydrocarbons ranging from lowest boiling portion of said untreated liquid fraction to highest boiling portion of hydrotreated solubles from said solvent separation.

5. A process in accordance with Claim 1 wherein said residue 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.

6. A process in accordance with Claim 1 wherein said residue is fired in one or more boilers having flue gas sulfur and metals capture, for generation of electricity and an ancillary hydrogen generation unit operations for supply of hydrogen for said hydrotreating.

7. A process in accordance with Claim 1 wherein said crude oil feed is converted to substantially one liquid fuel product, not multiple hydrocarbon products, 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 breakpoint and 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.

8. A process in accordance with Claim 1 wherein said crude oil feed is converted to substantially one liquid fuel product, not multiple hydrocarbon products, 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, at or below, 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.

9. A process in accordance with Claim 1 wherein at least 70% by volume of each barrel of said crude oil feed is converted to liquid fractions, when subsequently treated or untreated but combined, to form one liquid fuel product, not multiple hydrocarbon products.

10. A process in accordance with Claim 1 wherein actual sulfur content of said fuel is adjusted to meet an IMO specification for marine fuel as the target sulfur content.

11. A process in accordance with Claim 1 wherein a high sulfur fuel oil is added to one or more of the feeds, or is separately fed, to one or more of said distillation steps, solvent separation step or hydrotreating step.

12. A process in accordance with Claim 1 for producing a fuel by combining or other co-processing a crude having the quality of untreated light tight oil or condensate, or a combination of untreated light tight oil or condensate, with one or more untreated fractions, hydrotreated streams, or fuels produced by Claim 1 wherein when flashpoint of fuel is not a consideration said light tight oil has a sulfur content in the ranges of 0.1 wt.% to 0.2 wt.% and a density, API (Deg) in the range of 38 to 57 and distillation cut fraction ranges, in weight percent of mass, of (a) 5 to 20 wt. % liquefied petroleum gas range, (b) 10 to 35 wt. % naphtha, (c) 15 to 30 wt.% kerosene, (d) 15 to 25% diesel, (e) vacuum gas oils and (f) no (0%) to 10% heavy residuals.

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

14. 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.

15. A fuel derived from processing crude oil characterized in that said fuel has an actual sulfur content of 0.50% m/m (wt.%) or less and comprises a range of crude oil derived hydrocarbons from C3 or C5 to greater than C20, said hydrocarbons 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 point of a hydrotreated stream combined in said fuel.

16. A process for integration of atmospheric and vacuum distillation, solvent separation, and hydrotreating to produce components of a fuel characterized in that the integration of this process separates feeds into streams, treats one or more portions of such 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 point of effluent from solvent separation which is subsequently treated and forms a portion of said fuel, said fuel having an actual sulfur content at or below a target sulfur content limit level, which process comprises

(a) feeding crude (2) comprising sulfur and metal contaminants to an atmospheric distillation column (100) and separating the feed into light

overhead gases 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), and

(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), and

(iv) vacuum residual (50)

(c) feeding (b)(iv) vacuum residual (50) to solvent separation (300) to produce

(i) deasphalted oil (80), and

(ii) metals rich pitch (90),

(d) feeding (a)(iii) light distillate (24), (a)(iv) medium distillate (26), (a)(v) first heavy distillate (28) and (b)(i) second heavy distillate (32) to a distillate hydrotreater
(430) with addition of hydrogen in presence of catalyst at hydrotreating conditions to form a stream (60) comprising

(i) wild naphtha

(ii) ultra low sulfur diesel being a reduced sulfur stream formed from combination of treated distillate stream (60) comprising (a)(iii) light distillate (24), (a)(iv) medium distillate (26), (a)(v) first heavy distillate (28) and (b)(i) second heavy distillate (32),
with associated byproducts (420) 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 (502) to either distillate hydrotreater of (d)(430) or heavy oil hydrotreater of (e) (460)

(e) feeding (b)(ii) light vacuum gas oil (36), (b)(iii) heavy vacuum gas oil (38) and (c)(i) deasphalted oil (80) to a heavy oil hydrotreater (460) with addition of hydrogen in presence of catalyst at hydrotreating conditions to form a stream (70) 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 streams comprising (b)(ii) light vacuum gas oil (36), (b)(iii) heavy vacuum gas oil (38) and (c)(i) deasphalted oil (80)

(iii) a second reduced sulfur stream (70) formed from a second portion of the combination of treated distillate steams (40) comprising (b)(ii) light vacuum gas oil (36), (b)(iii) heavy vacuum gas oil (38) and (c)(i) deasphalted oil (80)

with associated byproducts (420) comprising

(iv) sulfur containing gas stream comprising hydrogen sulfide

(v) hydrogen rich off gas, at least a portion of which is treated for sulfur removal and is recycled as hydrogen addition (502) to either distillate hydrotreater of (d)(430) or heavy oil hydrotreater of (e)(460), and

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

(i) streams without added treatment (10) of (a)(i) unstabilized wild straight run naphtha (16) and (a)(i) sulfur breakpoint cut (18) with

(ii) streams from distillate hydrotreater (60) comprising (d)(i) wild naphtha and (d)(ii) all or a portion of ultra low sulfur diesel, with

(iii) streams from heavy oil hydrotreater (70) comprising (e) (i) wild naphtha, (e)(ii) ultra low sulfur diesel and (e)(iii) a second reduced sulfur stream in a manner whereby actual sulfur content of said fuel does not exceed target sulfur content limit.

17. A process in accordance with Claim 16 comprising integration of a gasification system by

(a) feeding 16.(c)(ii) pitch which is a metals rich heavy residual to one or more gasification units comprising a gasifier for partial oxidation of said 16.(c)(ii) pitch in presence of steam and oxygen, to form

(iv) syngas, at least a portion of which is converted to hydrogen for use in distillate hydrotreater of 16.(d) and heavy oil hydrotreater of 16.(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

(v) solids soot comprising a portion of metal contaminants derived from the crude feed, which solids 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 16 to one or more gas recovery units for sulfur removal.

18. A process in accordance with Claim 16 wherein 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 of (a)(i) unstabilized wild straight run naphtha or (a)(ii) sulfur breakpoint cut, which streams have not been hydrotreated,

(b) streams to or from distillate hydrotreater, or

(c) streams to or from heavy oil hydrotreater,

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.

19. A process in accordance with Claim 16 achieved by

(a) feeding to the combination 16(a)(i) unstabilized wild straight run naphtha and 16.(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

(vi) streams to distillate hydrotreater,

(vii) streams to heavy oil hydrotreater, and

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

(viii) streams from distillate hydrotreater,

(ix) 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

(x) streams from distillate hydrotreater,

(xi) streams from heavy oil hydrotreater

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.

20. A process in accordance with Claim 16 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 16.(a)(i) unstabilized wild straight run naphtha and 16.(a)(ii) sulfur breakpoint cut which should available be without treatment and reduce the amount of streams which should be

directed to hydrotreating for treatment to form a fuel product having an actual sulfur content at or below a target sulfur content limit level.

21. A process in accordance with Claim 16 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 to form a fuel having an actual sulfur content at or below a target sulfur content limit level.

22. A process in accordance with Claim 16 wherein apparatus for said atmospheric distillation, vacuum distillation, solvent separation, and hydrotreating operations are sized to have added or spare capability to process additional feeds comprising high sulfur oil or other heavy residue sourced from a different source outside the battery limits of said operations to form a fuel having an actual sulfur content at or below a target sulfur content limit level and capture at least a portion of the sulfur and metals from said additional heavy residue.

23. A process in accordance with Claim 16 wherein a high sulfur fuel oil having a sulfur content greater than the target sulfur content limit level is fed to one or more of

(a) atmospheric or vacuum distillation,

(b) solvent separation,

(c) distillate hydrotreater, either separately or combined with one or more of 16.(a)(iii) light distillate, 16.(a)(iv) medium distillate, 16.(a)(v) first heavy distillate and 16 (b)(i) second heavy distillate feeds to said distillate hydrotreater, or

(d) heavy oil hydrotreater, either separately or combined with one or more of 16.(b)(i) light vacuum gas oil, 16.(b)(iii) heavy vacuum gas oil and 16.(c)(i) deasphalted oil, to form a fuel having an actual sulfur content at or below a target sulfur content limit level.

24. A process in accordance with Claim 16 wherein a high sulfur fuel oil or other heavy residue from a different source of supply from than from vacuum distillation, or solvent separation apparatus of Claim 16, said oil or residue having a sulfur content greater than the target sulfur content limit level is fed to one or more of

(a) 16.(b) vacuum distillation tower separately or combined with 16.(a)(vi) atmospheric residual to produce at least a portion of any or all of said 16.(b)(i) a second heavy distillate, 16.(b)(ii) light vacuum gas oil, 16.(b)(iii) heavy vacuum gas oil, 16.(b)(iv) vacuum residual, or

(b) 16.(c) solvent separation separately or combined with 16.(b)(iv) vacuum residual to produce 16.(c)(i) deasphalted oil and 16.(c)(ii) metals rich pitch, to form a fuel having an actual sulfur content at or below a target sulfur content limit level.

25. A process in accordance with Claim 16 wherein a high sulfur fuel oil having a sulfur content less than or greater than the target sulfur content limit level is combined with one or more of

(a) streams formed from 16 (a)(i) unstabilized wild straight run naphtha and 16 (a)(ii) sulfur breakpoint cut without added treatment or

(b) streams formed from distillate hydrotreater comprising 16(d)(i) wild naphtha and 16(d)(ii) ultra low sulfur diesel, or

(c) streams formed from heavy oil hydrotreater comprising 16(e)(i) wild naphtha, 16(e)(ii) ultra low sulfur diesel and 16 (e)(iii) a second reduced sulfur stream, to form a portion of a fuel having an actual sulfur content at or below a target sulfur content limit level.

26. A process in accordance with Claim 16 wherein light tight oil or condensate, or a combination of light tight oil or condensate, having low metals content and a sulfur content less than or greater the target sulfur content limit level is combined with one or more of

(a) feeds to atmospheric or vacuum distillation, solvent separation, distillate hydrotreater or heavy oil hydrotreater,

(b) streams formed from 16.(a)(i) unstabilized wild straight run naphtha and 16.(a)(ii) sulfur breakpoint cut without added treatment or

(c) streams formed from distillate hydrotreater comprising 16.(d)(i) wild naphtha and 16.(d)(ii) ultra low sulfur diesel, or

(d) streams formed from heavy oil hydrotreater comprising 16.(e)(i) wild naphtha, 16.(e)(ii) ultra low sulfur diesel and 16.(e)(iii) a second reduced sulfur stream, or

(e) a single effluent stream formed from a combination of all hydrotreated effluents of19.(c) from distillate hydrotreater and all hydrotreated effluents of 19.(d) from heavy oil hydrotreater to form a fuel having an actual sulfur content at or below a target sulfur content limit level.

27. A process in accordance with Claim 16 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.

28. A process in accordance with Claim 16 wherein segregated steams from said distillate hydrotreater and heavy oil hydrotreater are separately directed to a shared wall separator to form common overhead gas but are separately withdrawn for subsequent combination in fuel product, trim control as part of such combination or other use.

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

30. 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.

31. A fuel meeting or exceeding all ISO RMA 10 (ISO 2817-10) specifications except flashpoint, characterized in that such fuel comprises a range of hydrocarbons having an initial boiling point of naphtha and highest boiling point being that of the highest boiling point component thereof soluble in a solvent suitable for solvent separation, said fuel having:

(a) sulfur at 0.50% m/m (wt.%) or below,
(b) metals at 5.0 mg/Kg (ppmwt) or below, and
(c) flashpoint less than 60ºC without flashpoint treatment.

32. A fuel in accordance with Claim 31 having one or more of these additional distinguishing characteristics:

(a) viscosity of less than 10 cSt,

(b) a pour point of 0 (zero) ºC or less,

(c) density at 15 ºC in range of 820 to 880 Kg/M^3,

(d) CCAI less than 800, and

(e) sodium at 20 mg/Kg or below.

33. A fuel in accordance with Claim 31 which falls within a SOLAS exception for flashpoint requirements for cargo ships or which comprises flashpoint treatment to have flashpoint at 60 ºC or above.

34. A fuel in accordance with Claim 31 which comprises substantially the entire range of crude oil derived hydrocarbons from C3 or C5 to greater than C20, said hydrocarbons having an initial boiling point being the lowest boiling point of any fraction of said crude oil at atmospheric distillation

conditions and highest boiling point being the initial boiling point of the residual portion of said crude oil which is not soluble in a solvent suitable for solvent separation.

35. Use of a fuel of Claim 31 in marine or land based engines, combustion gas turbines, or fired heaters.

36. Use of a low viscosity, low pour point fuel of Claim 31 in marine engines to avoid or reduce energy consumption required in connection with heating conventional residual oils to enable pumping and handling, either in port at fueling stations or at sea.

37. A process for reducing emissions over IMO specifications by ships at sea by use of a fuel produced in accordance with Claim 1 having a sulfur content adjusted to less than the maximum applicable IMO specification at use location of said ship.

38. A process for reducing emissions over IMO specifications by a ship at sea by use of a fuel produced in accordance with Claim 16 having a sulfur content adjusted to less than maximum applicable IMO specification at use location of said ship.

39. A process for reducing emissions over IMO specifications by a ship at sea by use of a fuel of Claim 31.

40. A process for offsetting or reducing fuel costs incurred at sea by a ship tendering to grid on shore while in port all or portion of on-board electricity generated by use of a fuel produced in accordance with Claim 1.

41. A process for offsetting or reducing fuel costs incurred at sea by a ship tendering to grid on shore while in port all or portion of on-board electricity generated by use of a fuel produced in accordance with Claim 16.

42. A process for offsetting or reducing fuel costs incurred at sea by a ship tendering to grid on shore while in port all or portion of on-board electricity generated by use of a fuel of Claim 31.