a coker feed mixture, comprising a coker recycle fraction and at least a portion of the mixed heavy hydrocarbon fraction, to a coker, wherein the coker recycle fraction is less than 30 weight percent of the coker feed mixture; operating the coker at conditions to produce anode grade green coke and distillate hydrocarbons; recovering the distillate hydrocarbons from the coker; fractionating the distillate hydrocarbons recovered from the coker to recover three or more hydrocarbon fractions including a light distillates fraction, a heavy coker gas oil fraction, and ~~a~~ the coker recycle fraction.

[0007] In another aspect, there is provided a system for upgrading residuum hydrocarbon feedstocks. The system includes: a residuum hydroconversion reactor system for contacting a residuum hydrocarbon and hydrogen with a hydroconversion catalyst; a fractionation system for separating an effluent recovered from the residuum hydroconversion reactor system into two or more hydrocarbon fractions including at least a vacuum residuum fraction and a heavy vacuum gas oil fraction; a mixing device for combining at least a portion of the heavy vacuum gas oil fraction and at least a portion of the vacuum residuum fraction to form a mixed heavy hydrocarbon fraction; a coker for converting a coker feed mixture, comprising the mixed heavy hydrocarbon fraction and a coker recycle fraction, to produce anode grade green coke and distillate hydrocarbons; a fractionation system for fractionating the distillate hydrocarbons recovered from the coker into three or more hydrocarbon fractions including a light distillates fraction, a heavy coker gas oil fraction, and ~~a~~ the coker recycle fraction; and a flow measurement and control system for controlling the coker recycle fraction to be less than 30 weight percent of the coker feed mixture.

[0008] Other disclosures and advantages will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0009] Figure 1 is a simplified process flow diagram of a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.

[0010] Figure 2 is a simplified process flow diagram of a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.

[0011] Figure 3 is a simplified process flow diagram of a portion of a process for upgrading residuum hydrocarbon feedstocks according to embodiments herein.

[0012] Like numerals represent like parts throughout the figures.

DETAILED DESCRIPTION

[0013] In one aspect, embodiments herein relate generally to processes for upgrading vacuum residuum streams derived from petroleum, tar sands, shale oils, coal liquids,

CLAIMS

What is claimed:

1. A process for upgrading residuum hydrocarbon feedstocks, comprising:

contacting a residuum hydrocarbon and hydrogen with a hydroconversion catalyst in an residuum hydroconversion reactor system;

recovering an effluent from the residuum hydroconversion reactor system;

separating the effluent from the residuum hydroconversion reactor system to recover two or more hydrocarbon fractions including at least a vacuum residuum fraction and a heavy vacuum gas oil fraction;

combining at least a portion of the heavy vacuum gas oil fraction and at least a portion of the vacuum residuum fraction to form a mixed heavy hydrocarbon fraction;

feeding a coker feed mixture, comprising a coker recycle fraction and at least a portion of the mixed heavy hydrocarbon fraction, to a coker, wherein the coker recycle fraction is less than 30 weight percent of the coker feed mixture;

operating the coker at conditions to produce anode grade green coke and distillate hydrocarbons;

recovering the distillate hydrocarbons from the coker;

fractionating the distillate hydrocarbons recovered from the coker to recover three or more hydrocarbon fractions including a light distillates fraction, a heavy coker gas oil fraction, and ~~a~~ the coker recycle fraction.

~~2. The process of claim 1, further comprising admixing the mixed heavy hydrocarbon fraction with the coker recycle fraction to form a coker feed mixture.~~

~~3. The process of claim 2, wherein the coker recycle fraction is less than 30 weight percent of the coker feed mixture.~~

~~4.~~2. The process of claim ~~2~~1, wherein the coker recycle fraction is from ~~about~~ 15 weight percent to ~~about~~ 25 weight percent of the coker feed mixture.

~~5.~~3. The process of claim 1, further comprising:

contacting the heavy coker gas oil fraction and hydrogen with a hydroconversion catalyst in a hydroconversion reactor to convert at least a portion of the heavy coker gas oil fraction to distillate fuel range hydrocarbons;

recovering an effluent from the hydroconversion reactor; and

fractionating the effluent to form two or more hydrocarbon fractions.

~~6.~~4. The process of claim 1, wherein the heavy coker gas oil fraction has a Polycyclic Index based on Ultra Violet Absorption Spectrophotometry of less than 10,000.

~~7.~~5. The process of claim 1, wherein the residuum hydrocarbon has a metals content of less than ~~about~~ 100 ppmw nickel and less than ~~about~~ 200 ppm vanadium, a sulfur content of less than ~~about~~ 2.5 weight percent, and an asphaltenes content of less than ~~about~~ 12 weight percent.

~~8.~~6. The process of claim 1, wherein the mixed heavy hydrocarbon fraction has a nickel content of less than ~~about~~ 70 ppmw, a vanadium content of less than ~~about~~ 70 ppmw, an asphaltenes/Conradson Carbon Residue (CCR) ratio of less than 0.7 to 1, and a total sulfur content of less than ~~about~~ 24,000 ppmw.

~~9.~~7. The process of claim 1, wherein the residuum hydrocarbon comprises at least one of petroleum atmospheric or vacuum residua, deasphalted oils, deasphalter pitch, hydrocracked atmospheric tower or vacuum tower bottom, straight run vacuum gas oil, hydrocracked vacuum gas oil, fluid catalytically cracked (FCC) slurry oils, vacuum gas oil from an ebullated bed process, shale-derived oils, coal-derived oils, bioderived crude oils, tar sands bitumen, tall oils, black oils.

~~10.~~8. The process of claim 1, wherein the coker is a delayed coker.

~~11.~~9. The process of claim 1, wherein the residuum hydroconversion reactor system comprises an ebullated bed hydroconversion reactor system.

~~12.~~10. The process of claim 1, wherein the residuum hydroconversion reactor system comprises a slurry-phase hydrocracking process.

~~13.~~11. The process of claim 1, wherein the residuum hydroconversion reactor system comprises at least one of a fixed-bed vacuum gas oil (VGO) hydrocracking reactor system, a fluidized bed VGO hydrocracking reactor system.

~~14.~~12. The processes of claim 1, wherein the conversion rate in the residuum hydroconversion reactor system is at least 50%.

~~15.~~13. The processes of claim 1, wherein the residuum hydroconversion reactor system is operated at:

a pressure in the range from ~~about~~ 1000 psig to ~~about~~ 4000 psig;

LHSV in the range from ~~about~~ 0.1 to ~~about~~ 4.0 L/h/L;

a reactor temperature in the range from ~~about~~ 400°C to ~~about~~ 500°C;

a hydrogen/vacuum residuum feedstock ratio of ~~about~~ between 2000-6000 SCF/Bbl;

a fresh catalyst makeup rate in the range from ~~about~~ 0.1 to 0.6 lb/Bbl vacuum resid feedstock; and

using a catalyst comprised of one or more of nickel, cobalt, tungsten, molybdenum and combinations thereof, either unsupported or supported on a porous substrate such as silica, alumina, titania, or combinations thereof.

~~16.~~14. The processes of claim 1, wherein the coker is operated at:

a heater coil outlet temperature of at least 500°C;

a pressure in the range from ~~about~~ 20 psig to ~~about~~ 35 psig; and

with a drying time after the coking cycle of at least 2 hours.

~~17.~~15. The processes of claim 1, wherein the coke drum vapor outlet temperature in said coking unit is operated at:

at least 470°C for a drying time of at least 5 hours, or

at least 450°C for a drying time of at least 6 hrs

by passage of a superheated vapor stream through the filled coke drum.

~~18.~~16. The processes of claim 1, wherein said anode grade green coke has the following properties: nickel less than ~~about~~ 175 ppm; vanadium less than ~~about~~ 250 ppm; sulfur less than ~~about~~ 35,000 ppmw; Hardgrove Grindability Index of less than ~~about~~ 100 and Volatile Combustible Matter of less than ~~about~~ 12 wt%.

~~19.~~17. The processes of claim 1, wherein the coker is operated at a Coker Throughput Ratio, defined as the sum of the fresh coker feed rate plus the coker liquid recycle rate divided by the fresh coker feed rate on a liquid volumetric basis, of less than ~~about~~ 1.25/1.

~~20.~~18. The processes of claim 1, wherein the said vacuum residuum feedstock is derived from one or more of Arab Heavy, Arab Light, Banoco Arab Medium, Kuwait Export, Basrah Light, Rubble, Bahrain, Oman, Upper Zakam, REBCO, Kumkol, Azeri Light, Siberian Light, Siberian Heavy, and Tengiz petroleum crude oils.

~~21.~~19. A system for upgrading residuum hydrocarbon feedstocks, comprising:

a residuum hydroconversion reactor system for contacting a residuum hydrocarbon and hydrogen with a hydroconversion catalyst;

a fractionation system for separating an effluent recovered from the residuum hydroconversion reactor system into two or more hydrocarbon fractions including at least a vacuum residuum fraction and a heavy vacuum gas oil fraction;

a mixing device for combining at least a portion of the heavy vacuum gas oil fraction and at least a portion of the vacuum residuum fraction to form a mixed heavy hydrocarbon fraction;

a coker for converting a coker feed mixture, comprising the mixed heavy hydrocarbon fraction and a coker recycle fraction, to produce anode grade green coke and distillate hydrocarbons;

a fractionation system for fractionating the distillate hydrocarbons recovered from the coker into three or more hydrocarbon fractions including a light distillates fraction, a heavy coker gas oil fraction, and ~~a~~ the coker recycle fraction; and

a flow measurement and control system for controlling the coker recycle fraction to be less than 30 weight percent of the coker feed mixture.

~~22. The system of claim 21, further comprising a mixing device for admixing the mixed heavy hydrocarbon fraction with the coker recycle fraction to form a coker feed mixture.~~

~~23. The system of claim 21, further comprising a flow measurement and control system for controlling the coker recycle fraction to be less than 30 weight percent of the coker feed mixture.~~

~~24.~~ 20. The system of claim ~~21~~19, wherein the ~~further comprising a~~ flow measurement and control system is configured for controlling the coker recycle fraction to be from ~~about~~ 15 weight percent to ~~about~~ 25 weight percent of the coker feed mixture.

~~25.~~ 21. The system of claim ~~21~~19, further comprising:

a hydroconversion reactor for contacting the heavy coker gas oil fraction and hydrogen with a hydroconversion catalyst to convert at least a portion of the heavy coker gas oil fraction to distillate fuel range hydrocarbons; and

a separation system for fractionating an effluent from the hydroconversion reactor to form two or more hydrocarbon fractions.

~~26.~~ 22. The system of claim ~~21~~19, further comprising an operating system configured to control the residuum hydroconversion reactor system to produce the mixed heavy hydrocarbon fraction having a nickel content of less than ~~about~~ 70 ppmw, a vanadium content of less than ~~about~~ 70 ppmw, an asphaltenes/Conradson Carbon Residue (CCR) ratio of less than 0.7 to 1, and a total sulfur content of less than ~~about~~ 24,000 ppmw.

~~27.~~ 23. The system of claim ~~21~~19, wherein the coker is a delayed coker.

~~28.~~ 24. The system of claim ~~21~~19, wherein the residuum hydroconversion reactor system comprises an ebullated bed hydroconversion reactor system.

~~29.~~25. The system of claim ~~21~~19, wherein the residuum hydroconversion reactor system comprises a slurry-phase hydrocracking process.

~~30.~~26. The system of claim ~~21~~19, wherein the residuum hydroconversion reactor system comprises a fixed-bed VGO hydrocracking reactor system, a fluidized bed VGO hydrocracking reactor system.