

SUMMARY

[0004] In one aspect, embodiments disclosed herein relate to a process for upgrading residuum hydrocarbons. The process ~~may~~includes the following steps: solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction; contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering an effluent from the first ebullated bed hydroconversion reactor system; fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions; contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit; recovering an effluent from the residue hydrodesulfurization unit; contacting the residue hydrodesulfurization unit effluent or a portion thereof with a third hydroconversion catalyst in a hydrocracking reactor system; recovering an effluent from the hydrocracking reactor system; and fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

[0005] In another aspect, embodiments disclosed herein relate to a process for upgrading residuum hydrocarbons which ~~may~~includes the following steps: solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction; contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering an effluent from the first ebullated bed hydroconversion reactor system; fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions; contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit; recovering an effluent from the residue hydrodesulfurization unit; contacting the residue hydrodesulfurization unit effluent with a third hydroconversion catalyst in a hydrocracking reactor system; recovering an effluent from the hydrocracking reactor system; and fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

[0006] In another aspect, embodiments disclosed herein relate to a process for upgrading residuum hydrocarbons which ~~may~~includes the following steps: solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction; contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering an effluent from the first ebullated bed hydroconversion reactor system; fractionating the effluent

from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions; contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit; recovering an effluent from the residue hydrodesulfurization unit; fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions including a vacuum residua hydrocarbon fraction; contacting the vacuum residua hydrocarbon fraction with a third hydroconversion catalyst in a hydrocracking reactor system; ~~and~~ recovering an effluent from the hydrocracking reactor system; and fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

In another aspect, embodiments disclosed herein relate to a process for upgrading residuum hydrocarbons which includes the following steps: solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction; contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering an effluent from the first ebullated bed hydroconversion reactor system; contacting the effluent from the first ebullated bed hydroconversion reactor with a second hydroconversion catalyst prior to fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions; contacting the deasphalted oil fraction and hydrogen with a third hydroconversion catalyst in a residue hydrodesulfurization unit; recovering an effluent from the residue hydrodesulfurization unit; contacting the residue hydrodesulfurization unit effluent with a fourth hydroconversion catalyst in a hydrocracking reactor system; recovering an effluent from the hydrocracking reactor system; and fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

In another aspect, embodiments disclosed herein relate to a process for upgrading residuum hydrocarbons which includes the following steps: solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction; contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering an effluent

from the first ebullated bed hydroconversion reactor system; fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions; contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit; recovering an effluent from the residue hydrodesulfurization unit; contacting the residue hydrodesulfurization unit effluent or a portion thereof with a third hydroconversion catalyst in a hydrocracking reactor system; recovering an effluent from the hydrocracking reactor system; and contacting the effluent from the hydrocracking reactor system with a fourth hydroconversion catalyst prior to fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

[0007] Other aspects and advantages will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0008] Figure 1 is a simplified process flow diagram of a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.

[0009] Figure 2 is a simplified process flow diagram of a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.

[0010] Figure 3 is a simplified process flow diagram of a process for an integrated hydroprocessing reactor system to be used with a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.

[0011] Figure 4 is a simplified alternate process flow diagram of a process for an integrated hydroprocessing reactor system to be used with a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.

DETAILED DESCRIPTION

[0012] In one aspect, embodiments herein relate generally to hydroconversion processes, including processes for hydrocracking residue and other heavy hydrocarbon fractions. More specifically, embodiments disclosed herein relate to solvent deasphalting of a residuum hydrocarbon feedstock, processing the resulting deasphalted oil in a residue desulfurization unit and a residue hydrocracking unit, and processing the pitch from the solvent deasphalting in a separate residue hydrocracking unit.

CLAIMS

What is claimed:

1. A process for upgrading residuum hydrocarbons, the process comprising:
 - solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction;
 - contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system;
 - recovering an effluent from the first ebullated bed hydroconversion reactor system;
 - fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions;
 - contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit;
 - recovering an effluent from the residue hydrodesulfurization unit;
 - contacting the residue hydrodesulfurization unit effluent or a portion thereof with a third hydroconversion catalyst in a hydrocracking reactor system;
 - recovering an effluent from the hydrocracking reactor system; and
 - fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.
2. The process of claim 1, further comprising mixing the asphalt fraction with a diluent to form a diluted asphalt fraction prior to the contacting.
3. The process of claim 2, wherein the diluent comprises at least one of FCC cycle oils, slurry oils, aromatics extracts, and straight run vacuum gas oils.
4. ~~The process of claim 1, further comprising:~~
 - ~~contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit;~~
 - ~~recovering an effluent from the residue hydrodesulfurization unit;~~
 - ~~contacting the residue hydrodesulfurization unit effluent or a portion thereof with a third hydroconversion catalyst in a hydrocracking reactor system;~~
 - ~~recovering an effluent from the hydrocracking reactor system;~~
 - ~~fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.~~
- ~~5.4.~~ The process of claim 4~~1~~, wherein the hydrocracking reactor system includes a second ebullated bed hydroconversion reactor system comprising one or more ebullated bed reactors.
- ~~6.5.~~ The process of claim 5~~4~~, wherein the deasphalted oil fraction has a metals content of greater than about 80 wppm and a Conradson Carbon Residue (CCR) content of greater than about 10 wt%.

- ~~7.6.~~ The process of claim ~~41~~, wherein the effluent from the first ebullated bed hydroconversion reactor system and the hydrocracking reactor system are fractionated in a common fractionation system.
- ~~8.7.~~ The process of claim ~~41~~, wherein the one or more hydrocarbon fractions produced in fractionating the effluents from one or both the first ebullated bed hydroconversion reactor systems and the hydrocracking reactor system includes a vacuum residua hydrocarbon fraction.
- ~~9.8.~~ The process of claim ~~76~~, further comprising recycling the vacuum residua hydrocarbon fraction to at least one of the solvent deasphalting, the first ebullated bed hydroconversion reactor system, and the hydrocracking reactor system.
- ~~10.9.~~ The process of claim 1, wherein the residuum hydrocarbon fraction comprises at least one of petroleum atmospheric or vacuum residua, deasphalted oils, deasphalter pitch, hydrocracked atmospheric tower or vacuum tower bottoms, straight run vacuum gas oils, hydrocracked vacuum gas oils, fluid catalytically cracked (FCC) slurry oils, vacuum gas oils from an ebullated bed process, shale-derived oils, coal-derived oils, bio-derived crude oils, tar sands bitumen, tall oils, black oils.
- ~~11.10.~~ The process of claim 1, wherein contacting in the first ebullated bed hydroconversion reactor system results in a hydrocarbon conversion in the range from about 40 wt% to about 75 wt%, sulfur removal is in the range from about 40 wt% to about 80 wt%, metals removal is in the range from about 60 wt% to about 85 wt% and Conradson Carbon Residue (CCR) removal is in the range from about 30 wt% to about 65 wt%.
- ~~12.11.~~ The process of claim ~~41~~, wherein an overall conversion of the deasphalted oil fraction through both the residue desulfurization unit and the hydrocracking reactor system is in the range from about 75 wt% to about 95 wt%.
- ~~13.12.~~ The process of claim ~~41~~, wherein a fuel oil produced via the fractionation of the hydrocracking reaction system effluent has a sulfur content of 1 wt% or less.
- ~~14.13.~~ The process of claim 1, wherein a fuel oil produced via the fractionation of the ebullated bed reaction system effluent has a sulfur content of less than 2 wt% or less.
- ~~15.14.~~ The process of claim ~~41~~, wherein an overall conversion of the residuum hydrocarbon fraction is in the range from about 60 wt% to about 95 wt%.

~~16.~~15. The process of claim 1, wherein a solvent used in the solvent deasphalting unit is a light hydrocarbon containing from 3 to 7 carbon atoms.

~~17.~~16. The process of claim 1, further comprising contacting the effluent from the first ebullated bed hydroconversion reactor with a second hydroconversion catalyst prior to fractionating the effluent from the first ebullated bed hydroconversion reactor system.

~~18.~~17. The process of claim ~~4~~1, further comprising contacting the effluent from the hydrocracking reactor system with a second hydroconversion catalyst prior to fractionating the effluent from the hydrocracking reactor system.

~~19.~~18. A process for upgrading residuum hydrocarbons, the process comprising:
solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction;
contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system;
recovering an effluent from the first ebullated bed hydroconversion reactor system;
fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions;
contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit;
recovering an effluent from the residue hydrodesulfurization unit;
contacting the residue hydrodesulfurization unit effluent with a third hydroconversion catalyst in a hydrocracking reactor system;
recovering an effluent from the hydrocracking reactor system; and
fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

~~20.~~19. A process for upgrading residuum hydrocarbons, the process comprising:
solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction;
contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system;

recovering an effluent from the first ebullated bed hydroconversion reactor system;

fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions;

contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit;

recovering an effluent from the residue hydrodesulfurization unit;

fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions including a vacuum residua hydrocarbon fraction;

contacting the vacuum residua hydrocarbon fraction with a third hydroconversion catalyst in a hydrocracking reactor system;

recovering an effluent from the hydrocracking reactor system; and

fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

24.20. A process for upgrading residuum hydrocarbons, the process comprising:

solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction;

contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system;

recovering an effluent from the first ebullated bed hydroconversion reactor system;

contacting the effluent from the first ebullated bed hydroconversion reactor with a second hydroconversion catalyst prior to fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions;

contacting the deasphalted oil fraction and hydrogen with a third hydroconversion catalyst in a residue hydrodesulfurization unit;

recovering an effluent from the residue hydrodesulfurization unit;

contacting the residue hydrodesulfurization unit effluent with a fourth hydroconversion catalyst in a hydrocracking reactor system;

recovering an effluent from the hydrocracking reactor system; and
fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.

22.21. A process for upgrading residuum hydrocarbons, the process comprising:
solvent deasphalting a residuum hydrocarbon fraction to produce a deasphalted oil fraction and an asphalt fraction;
contacting the asphalt fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system;
recovering an effluent from the first ebullated bed hydroconversion reactor system;
fractionating the effluent from the first ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions;
contacting the deasphalted oil fraction and hydrogen with a second hydroconversion catalyst in a residue hydrodesulfurization unit;
recovering an effluent from the residue hydrodesulfurization unit;
contacting the residue hydrodesulfurization unit effluent or a portion thereof with a third hydroconversion catalyst in a hydrocracking reactor system;
recovering an effluent from the hydrocracking reactor system; and
contacting the effluent from the hydrocracking reactor system with a fourth hydroconversion catalyst prior to fractionating the effluent from the hydrocracking reactor system to recover one or more hydrocarbon fractions.