

to process the SDA pitch directly in a RHU. Nonetheless, economic processes to achieve high hydrocarbon conversions and sulfur removal are desired.

SUMMARY

[0005] In one aspect, ~~embodiments disclosed herein relate to~~ there is provided a process for upgrading residuum hydrocarbons. The process ~~may include~~ includes the following steps: contacting a residuum hydrocarbon fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering a first effluent from the first ebullated bed hydroconversion reactor system; contacting the first effluent and hydrogen with a second hydroconversion catalyst in a second hydroconversion reactor system; recovering a second effluent from the second hydroconversion reactor system; contacting the second effluent and hydrogen with a third hydroconversion catalyst in a second ebullated bed hydroconversion reactor system; recovering a third effluent from the second ebullated bed hydroconversion reactor system; and fractionating the third effluent from the second ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions.

[0006] In another aspect, ~~embodiments disclosed herein relate to~~ there is provided a system for upgrading residuum hydrocarbons. The system ~~may include~~ includes the following: a first ebullated bed hydroconversion reactor system for contacting a residuum hydrocarbon fraction and hydrogen with a first hydroconversion catalyst to produce a first effluent; a second hydroconversion reactor system for contacting the first effluent and hydrogen with a second hydroconversion catalyst to produce a second effluent; a second ebullated bed hydroconversion reactor system for contacting the second effluent and hydrogen with a third hydroconversion catalyst to produce a third effluent and a fractionation unit to fractionate the third effluent to recover one or more hydrocarbon fractions and the vacuum residuum fraction.

[0007] In another aspect, ~~embodiments disclosed herein relate to~~ there is provided a process for upgrading residuum hydrocarbons. The process ~~may include~~ includes the following steps: contacting a residuum hydrocarbon fraction and hydrogen with a first hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering a first effluent from the first ebullated bed hydroconversion reactor system; contacting the first effluent and hydrogen with a second hydroconversion catalyst in a second hydroconversion reactor system; recovering a second effluent

from the second hydroconversion reactor system; contacting the second effluent and hydrogen with a third hydroconversion catalyst in a third hydroconversion reactor system; recovering a third effluent from the third hydroconversion reactor system; combining the second effluent and the third effluent to form a combined feed; feeding the combined feed to a separator to produce a vapor fraction and a liquid fraction; fractionating the liquid fraction to recover the vacuum residuum fraction in a first fractionation system; contacting the vapor fraction with a fourth hydroconversion catalyst in a fourth hydroconversion reactor system; recovering a fourth effluent from the third hydroconversion reactor system; fractionating the fourth effluent to recover one or more hydrocarbon fractions in a second fractionation system.

[0008]

In another aspect, ~~embodiments disclosed herein relate to~~ there is provided a system for upgrading residuum hydrocarbons. The system ~~may include~~ includes the following: a first ebullated bed hydroconversion reactor system for contacting a residuum hydrocarbon fraction and hydrogen with a first hydroconversion catalyst to produce a first effluent; a second hydroconversion reactor system for contacting the first effluent and hydrogen with a second hydroconversion catalyst to produce a second effluent; a second ebullated bed hydroconversion reactor system for contacting the second effluent and hydrogen with a third hydroconversion catalyst to produce a third effluent; and a separator for separating a combined fraction of the second effluent and the third effluent to recover a liquid fraction and a vapor fraction; a fractionation unit to fractionate the liquid to recover the vacuum residuum fraction; a fourth hydroconversion reactor system for contacting the vapor fraction with a fourth hydroconversion catalyst to produce a fourth effluent; and a fractionation unit to fractionate the fourth effluent to recover one or more hydrocarbon fractions.

In another aspect, there is provided a process for upgrading residuum hydrocarbons, the process comprising: contacting a residuum hydrocarbon fraction and hydrogen with a first hydroconversion catalyst in a first hydroconversion reactor system; recovering a first effluent from the first hydroconversion reactor system; contacting the first effluent and hydrogen with a second hydroconversion catalyst in a first ebullated bed hydroconversion reactor system; recovering a second effluent from the

first ebullated bed hydroconversion reactor system; contacting the second effluent and hydrogen with a third hydroconversion catalyst in a second ebullated bed hydroconversion reactor system; recovering a third effluent from the second ebullated bed hydroconversion reactor system; and fractionating the third effluent from the second ebullated bed hydroconversion reactor system to recover one or more hydrocarbon fractions.

[0009] Other ~~aspects—embodiments~~ and advantages will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0010] Figure 1 is a simplified process flow diagram of a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.

[0011] Figure 2 is a simplified process flow diagram of a process for upgrading residuum hydrocarbon feedstocks according to embodiments disclosed herein.