limited, however. Nonetheless, economic processes to achieve high hydrocarbon conversions are desired.

SUMMARY

[0005] In one aspect, embodiments disclosed herein relate to a process for upgrading residuum hydrocarbons and heavy distillate feedstocks. The process includes contacting residuum hydrocarbons and hydrogen with a non-zeolitic base metal hydroconversion catalyst in a first ebullated bed hydroconversion reactor system to produce a first effluent. The first effluent from the first ebullated bed hydroconversion reactor system is fractionated to recover a liquid product and a vapor product, wherein fractionating the first effluent from the first ebullated bed hydroconversion reactor system to recover a liquid product and a vapor product further comprises: contacting the vapor product with a hydrocarbon stream to form a second vapor product and a second liquid product, and feeding the second vapor product as the vapor product to the second ebullated bed hydrocracking reactor system. The vapor product and a heavy distillate feedstock are contacted with a zeolitic selective hydrocracking catalyst in a second ebullated bed hydrocracking reactor system to produce a second effluent. The second effluent from the second ebullated bed hydrocracking reactor system is recovered and fractionated to recover one or more hydrocarbon fractions.

[0006] In another aspect, embodiments disclosed herein relate to a process for upgrading heavy distillate feedstocks by contacting hydrogen and the heavy distillate feedstocks with a zeolitic selective hydrocracking catalyst in an ebullated bed hydrocracking reactor system to produce an effluent. The effluent from the ebullated bed hydrocracking reactor system is recovered and fractionated to recover one or more hydrocarbon fractions. The process further comprises contacting a residuum hydrocarbon feedstock and hydrogen with a non-zeolitic base metal hydroconversion catalyst in a first ebullated bed hydroconversion reactor system to produce a first effluent; fractionating the first effluent from the first ebullated bed hydroconversion reactor system to recover a first liquid fraction and a first vapor fraction; contacting the first vapor fraction with a hydrocarbon stream to form a second vapor fraction and a second liquid fraction; feeding the second vapor fraction to the ebullated bed hydrocracking reactor system.

[0007] In another aspect, embodiments disclosed herein relate to a system for upgrading residuum hydrocarbons and heavy distillate feedstocks. The system includes a first ebullated bed hydrocracking reactor system containing a zeolitic selective hydrocracking catalyst for reacting the heavy distillate feedstock and hydrogen to produce a first effluent and a first fractionation unit to fractionate the first effluent to recover one or more hydrocarbon fractions. The system further comprises a second ebullated bed hydroconversion reactor system containing a non-zeolitic base metal hydroconversion catalyst for reacting the residuum hydrocarbons and hydrogen to produce a second effluent; a first separator to separate the second effluent and recover a liquid fraction and a vapor fraction, wherein the vapor fraction is sent to the first ebullated bed hydrocracking reactor system. The system also comprises an absorption tower using a gas oil range hydrocarbon stream to recover a second vapor fraction and a second liquid fraction from the vapor fraction, and wherein the second vapor fraction is sent to the first ebullated bed hydrocracking reactor system, and wherein the hydrocarbon system is a hydrocarbon stream derived from one or more of the hydrocarbon fractions recovered in the first fractionation system.

In still another aspect, there is provided a system for upgrading residuum hydrocarbons and heavy distillate feedstocks. The system includes a first ebullated bed hydroconversion reactor system containing a non-zeolitic base metal hydroconversion catalyst for reacting the residuum feedstock and hydrogen to produce a first effluent; a first separator to separate the first effluent and recover a liquid fraction and a vapor fraction; an absorption tower using a gas oil range hydrocarbon stream to recover a second vapor fraction and a second liquid fraction from the vapor fraction; a second ebullated bed hydrocracking reactor system containing a zeolitic selective hydrocracking catalyst for reacting the heavy distillate feedstock, the second vapor fraction and hydrogen to produce a second effluent; and a first fractionation unit to fractionate the second effluent to recover one or more hydrocarbon fractions.

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

CLAIMS

What is claimed:

1. A process for upgrading residuum hydrocarbons and heavy distillate feedstocks, the process comprising:

   contacting residuum hydrocarbons and hydrogen with a non-zeolitic base metal hydroconversion catalyst in a first ebullated bed hydroconversion reactor system to produce a first effluent;

   fractionating the first effluent from the first ebullated bed hydroconversion reactor system to recover a liquid product and a vapor product;

   contacting the vapor product and a heavy distillate feedstock with a zeolitic selective hydrocracking catalyst in a second ebullated bed hydrocracking reactor system to produce a second effluent;

   recovering the second effluent from the second ebullated bed hydrocracking reactor system; and

   fractionating the second effluent from the second ebullated bed hydrocracking reactor system to recover one or more hydrocarbon fractions,

   wherein fractionating the first effluent from the first ebullated bed hydroconversion reactor system to recover a liquid product and a vapor product further comprises: contacting the vapor product with a hydrocarbon stream to form a second vapor product and a second liquid product, and feeding the second vapor product as the vapor product to the second ebullated bed hydrocracking reactor system.

2. The process of claim 1, further comprising heating the residuum hydrocarbons and hydrogen prior to contact with the non-zeolitic base metal hydroconversion catalyst.

3. The process of claim 1, wherein the residuum hydrocarbons are selected from one or more of petroleum crudes, shale oils, tar sands bitumen, coal-derived oils, tall oils, black oils, organic wastes, biomass-derived liquids or any heavy oil residuum stream.

4. The process of claim 1, wherein the heavy distillate feedstock is selected from one or more of atmospheric gas oil; light vacuum gas oil; heavy vacuum gas oil, heavy coker gas oil; FCC cycle oil, and deasphalted oil derivable from petroleum, bitumen, kerogen, biomass or organic waste sources.

5. The process of claim 4, wherein the heavy distillate feedstock is a virgin vacuum gas oil topped off of the crude from which the residuum hydrocarbons were derived.

6. 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, fluid catalytically cracked (FCC) slurry oils, residuum derived from shale-derived oils, coal-derived oils, bio-derived crude oils, tar sands bitumen, tall oils, black oils.

contacting hydrogen and the heavy distillate feedstocks with a zeolitic selective hydrocracking catalyst in an ebullated bed hydrocracking reactor system to produce an effluent;

recovering the effluent from the ebullated bed hydrocracking reactor system; and

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

contacting a residuum hydrocarbon feedstock and hydrogen with a non-zeolitic base metal hydroconversion catalyst in a first ebullated bed hydroconversion reactor system to produce a first effluent;

fractionating the first effluent from the first ebullated bed hydroconversion reactor system to recover a first liquid fraction and a first vapor fraction;

contacting the first vapor fraction with a hydrocarbon stream to form a second vapor fraction and a second liquid fraction;

feeding the second vapor fraction to the ebullated bed hydrocracking reactor system.

15. The process of claim 14, further comprising contacting a residuum hydrocarbon feedstock and hydrogen in the first ebullated hydroconversion reactor system.

16. The process of claim 14, wherein the zeolitic selective hydrocracking catalyst is manufactured to be fluidizable and have high attrition resistance under the reaction conditions in the ebullated-bed hydrocracking reactor system.

17. The process of Claim 16, wherein the zeolitic selective hydrocracking catalyst is comprised of a noble metal incorporated onto a zeolitic support.

18. A system for upgrading residuum hydrocarbons and heavy distillate feedstocks, the system comprising:

a first ebullated bed hydrocracking reactor system containing a zeolitic selective hydrocracking catalyst for reacting the heavy distillate feedstock and hydrogen to produce a first effluent;

a first fractionation unit to fractionate the first effluent to recover one or more hydrocarbon fractions;

a second ebullated bed hydroconversion reactor system containing a non-zeolitic base metal hydroconversion catalyst for reacting the residuum hydrocarbons and hydrogen to produce a second effluent;

a first separator to separate the second effluent and recover a liquid fraction and a vapor fraction, wherein the vapor fraction is sent to the first ebullated bed hydrocracking reactor system,

an absorption tower using a gas oil range hydrocarbon stream to recover a second vapor fraction and a second liquid fraction from the vapor fraction, and

wherein the second vapor fraction is sent to the first ebullated bed hydrocracking reactor system,

wherein the hydrocarbon stream is a hydrocarbon stream derived from one or more of the hydrocarbon fractions recovered in the first fractionation system.

19. A system for upgrading residuum hydrocarbons and heavy distillate feedstocks, the system comprising:

a first ebullated bed hydroconversion reactor system containing a non-zeolitic base metal hydroconversion catalyst for reacting the residuum feedstock and hydrogen to produce a first effluent;

a first separator to separate the first effluent and recover a liquid fraction and a vapor fraction;

an absorption tower using a gas oil range hydrocarbon stream to recover a second vapor fraction and a second liquid fraction from the vapor fraction;

a second ebullated bed hydrocracking reactor system containing a zeolitic selective hydrocracking catalyst for reacting the heavy distillate feedstock, the second vapor fraction and hydrogen to produce a second effluent;

a first fractionation unit to fractionate the second effluent to recover one or more hydrocarbon fractions.