A process for improving a recovery from a bottoms stream from a vacuum tower. The bottom stream is passed to a first cracking zone and unconverted material from the first cracking zone is passed to a second cracking zone. The first cracking zone may include a visbreaking reactor. The second cracking zone may include a slurry hydrocracking reactor.
FIELD OF THE INVENTION

This invention relates generally to a process for converting a stream from the bottom of a vacuum tower, and more particular to a process using two cracking zones to increase the recovery from the stream and improve the handling of same.

BACKGROUND OF THE INVENTION

Thermal cracking of hydrocarbons can achieve a high conversion of heavy feed stocks, such as vacuum residues, to lower boiling, more valuable distillate products. However, a portion of the product can remain after vacuum distillation. The remaining portion typically comprises unconverted pitch that may have a boiling point greater than about 500° C. The pitch can be sent to a slurry hydrocracking unit to recover some of the hydrocarbons therefrom.

Due to the cost of the slurry hydrocracking reactors, refiners seek to achieve the maximum conversion of the vacuum residues. To meet the desired conversion levels, as well as to provide mesophase (or coke and coke precursor) free conditions, refiners often utilize a large reactor, or integrate the slurry hydrocracker with an existing fluid catalytic cracking unit (for clarified slurry oil).

The variety of the physical properties of feed stocks to the slurry hydrocracking unit can also create issues. For example, a vacuum column bottoms stream from a Light Arabian crude oil may have a viscosity of about 0.0019 m²/s (1900 cSt) at 100° C, while a vacuum column bottom stream from a Heavy Arabian crude oil may have a viscosity of about 0.0470 m²/s (47000 cSt) at 100° C. If the feed to the hydrocracking reactor becomes more viscous, handling issues can arise. In order to produce a flow for such a highly viscous material, a large pressure differential is required in the feed delivery system as well as use of elevated temperature to overcome viscosity limitations. The high temperature can create storage problems for the effluent.

Therefore, it would be desirable to have one or more processes for processing a vacuum tower bottoms stream that provides a high level of conversion without requiring a large slurry hydrocracking reactor or a fluid catalyst cracking reactor.

It would also be desirable for one or more processes to efficiently and effectively accommodate the variety of physical properties among the varying feed stocks.

SUMMARY OF THE INVENTION

One or more processes for processing a vacuum tower bottom stream have been invented.

In a first aspect, the present invention may be characterized as a process for processing a bottom stream from a vacuum tower, the process comprising: passing a bottoms stream from a vacuum tower to a first cracking zone to produce a converted stream and an unconverted stream; and, passing the unconverted stream of the first cracking zone to a second cracking zone to produce a second converted stream and a pitch stream, wherein the second cracking zone is operated with a pressure that is higher than the first cracking zone.

In one method, conversion can be monitored as the net disappearance of 524° C.+ (975° F.+) normal boiling range materials as measured in a standard gas chromatograph method, such as ASTM 2887 and ASTM D7169.

In various embodiments of the present invention, the first cracking zone comprises a visbreaking reactor. It is further contemplated that the second cracking zone comprises a slurry hydrocracking reactor.

In some of the embodiments of the present invention, the first cracking zone is free from hydrocracking catalyst. It is also contemplated that the second cracking zone includes a hydrocracking catalyst.

In at least one embodiment of the present invention, the converted stream from the first cracking zone includes gas oil. The process further includes passing at least a portion of the gas oil to the second cracking zone. It is contemplated that the second cracking zone has a combined feed ratio of at least approximately 1.2. The “combined feed ratio” is the ratio of the mass flow rate of the feed stream and any recycle streams passed to a particular zone to the mass flow rate of the feed stream passed to that particular zone.

In at least one embodiment of the present invention, between 90 to 95% of the bottom stream from the vacuum tower is recovered in the first converted stream and the second converted stream.

In a second aspect, the present invention may be characterized as a process for reducing a viscosity of a bottoms stream from a vacuum tower in which the process includes: passing a bottom stream from a vacuum tower to a cracking zone including a visbreaking reactor, the cracking zone providing a converted stream and an unconverted stream; and, passing the unconverted stream from the cracking zone to a hydrocracking zone, wherein the unconverted stream from the cracking zone has a lower viscosity than the bottoms stream from the vacuum tower. The hydrocracking zone may include a slurry hydrocracking reactor.

In at least one embodiment, the hydrocracking zone includes a catalyst.

It some embodiments of the present invention, the invention further includes separating the converted stream from the cracking zone into at least a gas oil stream. It is also contemplated that the process further includes passing the gas oil stream to the hydrocracking zone. The hydrocracking zone may provide a second converted product stream. The process may further include separating the second converted product stream into at least a second gas oil stream and, recycling at least a portion of the second gas oil stream to the hydrocracking zone. The hydrocracking zone may have a combined feed ratio of at least approximately 1.2. It is contemplated that the cracking zone is a thermal cracking zone operated to convert approximately 10 to 40% of 349° C.+ (660° F.+) material from the bottoms stream of the vacuum tower. It is further contemplated that the hydrocracking zone is operated to convert between approximately 90 to 95% of the unconverted stream from the cracking zone.

In another aspect of the present invention, the invention may be characterized as a process for increasing a conversion of a bottoms stream from a vacuum tower in which the process includes:

passing a bottoms stream from a vacuum tower to a visbreaking reactor, the visbreaking reactor recovering approximately 25 to 55% of the 521° C.+ (975° F.+) material from the bottoms stream in a converted stream and the remaining portion comprising an unconverted stream; and, passing the unconverted stream from the visbreaking reactor to a slurry hydrocracking reactor, wherein the unconverted
stream from the visbreaking reactor has a lower viscosity than the bottoms stream from the vacuum tower. It is contemplated that the process further includes converting approximately 10 to 20% of the bottoms stream from the vacuum tower into a gas oil stream. It is also contemplated that the process includes passing a portion of the gas oil stream to the slurry hydrocracking reactor.

[0019] Additional objects, embodiments, aspects, and details of the invention are set forth in the following detailed description of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0020] The drawing is a simplified process diagram in which the FIGURE shows a process according to one or more embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] As mentioned above, one or more processes have been invented for processing a vacuum tower bottom stream. In the processes two different cracking zones are used, preferably a first zone includes a visbreaking reactor and a second zone includes a slurry hydrocracker reactor downstream from the visbreaking reactor. Unlike slurry hydrocracking reactors, visbreaking reactors are relatively inexpensive. Thus, it would be less costly for a refiner to include a visbreaking reactor. Additionally, such process may provide for higher overall conversion of the feedstock without increasing the severity of the slurry hydrocracker operation. For example, to achieve a desired 95% conversion of the 524°C (975°F) material in the vacuum column bottoms (or vacuum residue), a slurry hydrocracker unit downstream of a visbreaking reactor (operating at 25% conversion, as discussed below) would have to operate at 90% conversion. Such process may also enable the design of a smaller slurry hydrocracking reactor. With a typical visbreaking reactor operating at 25% conversion, the feed rate to the hydrocracking unit would be less. Upstream visbreaking would also reduce the vapor production within the hydrocracking reactor, since it would remove molecules which were easier to crack under milder visbreaking conditions. Furthermore, such process would make the feed to the slurry hydrocracker easier to handle and would lead to potential operating cost reductions, due to reduced pump duties and heat tracing because of the reduced viscosity in slurry hydrocracking feed after visbreaking. Finally, such process would also allow gas oil from the visbreaking reactor to be integrated with the slurry hydrocracking unit. This could be added to the reactor feed to increase CFR which is desired because high combined feed ratios have been shown to reduce the formation of coke or any coke precursors (which is to be avoided).

[0022] Referring to the FIGURE, an exemplary process will be described with the understanding that it is merely exemplary and not intended to be limiting.

[0023] As shown in the FIGURE, a feed 10, such as a crude oil is first passed to an atmospheric fractionation zone 12. The atmospheric fractionation zone 12 can produce one or more overhead streams 14 and an atmospheric bottom stream 16. The one or more overhead streams 14 can include a variety of products, such as light gases, gasoline, diesel, and kerosene. These one or more overhead streams 14 can exit the atmospheric fractionation zone 12 separately or in combination. The atmospheric bottom stream 16 can typically include a heavy hydrocarbon boiling at or above about 340°C.

[0024] The atmospheric bottom stream 16 can be provided to a vacuum fractionation zone 18 having at least one vacuum column 19. The vacuum column 19 separates the atmospheric bottom stream 16 into an overhead stream 20 and a vacuum column bottom stream 22.

[0025] Typically, the overhead stream 20 can include one or more compounds boiling above about 300°C. The vacuum column bottom stream 22 can include material boiling above about 500°C.

[0026] As is known, a vacuum column may comprise a distillation column with a three-stage eductor at the overhead to provide the vacuum in the column. Each stage of the eductor is co-fed with a gas stream such as steam to pull a vacuum upstream of the eductor in the vacuum column. Pressure is greater on the downstream side of each eductor stage, causing the overhead stream to condense in an accumulator to liquid products that can be recovered. Typically, a vacuum column may be maintained at a pressure between about 1 and 10 kPa.

[0027] In accordance with the various embodiments of the present invention, the vacuum column bottom stream 22 is passed to a first cracking zone 24 where a first portion 26 will be the converted and the remaining portion 28 will comprise the unconverted hydrocarbons which can be passed to a second cracking zone 30. The two cracking zones 24, 30 are preferably operated at different pressures. Additionally, it is preferred that the first cracking zone 24 is catalyst free, while the second cracking zone 30 includes a catalyst. In a most preferred embodiment, the first cracking zone 24 comprises a thermal cracking zone such as with no or low hydrogen gas pressure, with, for example, a visbreaking reactor 25 and the second cracking zone 30 comprises a hydrocracking zone such as with a desired addition of hydrogen gas pressure, with, for example, a slurry hydrocracking reactor 31.

[0028] Visbreaking is a mild thermal cracking type of hydrocarbon conversion process which is normally employed to reduce the viscosity and/or pour point of various heavy petroleum-derived hydrocarbonaceous liquids. The visbreaking operation may be employed to decrease the amount of low value residual material produced in a petroleum refinery by upgrading a portion of the charge stock to a salable fuel oil product. It is also normal to recover some lighter hydrocarbons such as naphtha which are produced by the thermal cracking operation. The visbreaking process may employ a single fractionation column as the initial separation zone or may be integrated with a vacuum fractionation column to recover additional amounts of light and heavy gas oils.

[0029] The visbreaking operation typically comprises the basic steps of heating the feed stream to the relatively high temperature required for the mild thermal cracking operation and maintaining the feed stream at this temperature for a predetermined time, which is inversely proportional to the temperature employed. The material treated in this manner may then be quenched to a temperature low enough to terminate the thermal cracking reactions and passed into the separation facilities. As with all such processes in which a feed stream must be heated to an elevated temperature, the inherent inefficiency of heat recovery requires an input of heat.

[0030] Although not depicted as such, the vacuum column bottom stream 22 passed to the visbreaking reactor 25 may be first heated by indirect heat exchange in various heat recovery steps. After being heated, the vacuum column bottom stream 22 is then passed into a visbreaking zone which comprises the visbreaking reactor 25. Steam may be admitted with the feed
stream to minimize coking within the heater tubes of the visbreaking reactor 25. The visbreaking reactor 25 is maintained at visbreaking conditions. Visbreaking conditions in general include a temperature within the general range of about 426°C to 525°C (800°F to 975°F). Normal visbreaking conditions also comprise a pressure between about 172 and about 2785 kPag (25 to 400 psig) although higher pressures to about 689 kPag (1000 psig) have been described in the literature. The vacuum column bottom stream 22 is preferably subjected to these visbreaking conditions for a period of about 20 to 65 equivalent seconds at a temperature above 480°C (900°F) while within the visbreaking reactor 25. The effluent of the visbreaking reactor 25 may be quenched, as with a gas oil, to reduce its temperature by about 21°C to about 60°C (70°F to 140°F).

[0031] A common variation in visbreaking is the use of a soaker drum in which the still-hot effluent of the visbreaking reactor 25 is retained for a preselected time prior to quenching. In these soaker-type visbreaking reactors, the thermal conversion reactions continue within the drum thereby allowing a reduction in the temperature required for the same degree of conversion. The exact conditions of temperature and pressure which are preferred will vary with such factors as the characteristics of the feed material and the degree of thermal cracking desired.

[0032] As mentioned, the visbreaking reactor 25 will crack hydrocarbons into the first stream 26 comprising converted hydrocarbons and the second stream 28 which comprises unconverted hydrocarbons, or the remaining portion of the vacuum column bottom stream 22.

[0033] The first stream 26 can be separated into various components (or cuts) such as naphtha, distillate, gas oil, etc. which may be passed to downstream processing. As will be discussed below, a gas oil stream 32, can be used with the second stream 28 from the first cracking zone 24 to provide a combined feed ratio of at least 1.2 for the feed stream to the second cracking zone 30.

[0034] As mentioned above, it is preferred that the second cracking zone 30 comprises a slurry hydrocracking reactor 31. As is known, a slurry hydrocracking reactor 31 utilizes a catalyst and is operated under hydrocracking conditions to hydrocrack the longer hydrocarbons in the second stream 28 from the first cracking zone 24.

[0035] As an example, exemplary catalyst compounds can include a catalytically effective amount of one or more compounds having iron. Particularly, the one or more compounds can include at least one of an iron oxide, an iron sulfate, and an iron carbonate. Other forms of iron can include at least one of an iron sulfide, a pyrrhotite, and a pyrite. The catalyst can contain materials other than an iron, such as at least one of molybdenum, nickel, and manganese, and/or a salt, an oxide, and/or a mineral thereof. The one or more compounds may include an iron sulfate, and, more specifically, at least one of an iron sulfate monohydrate and an iron sulfate dihydrate. Oxidic iron-containing compounds obtained from sources such as a limonite, a laterite, a wrought iron, a clay, a magnetite, a hematite, a gibbsite, or a Kish carb can also be used. One particularly such material is ferrous sulfate. The ferrous sulfate can either be a monohydrate or a dehydrated.

[0036] One or more catalyst particles can include about 2 to about 45 wt % iron oxide and about 20 to about 90 wt % alumina. Iron-containing bauxite is such material having these proportions. Bauxite can have about 10 to about 40 wt % iron oxide (Fe₂O₃), and about 50 to about 84 wt % alumina and may have about 10 to about 35 wt % iron oxide and about 55 to about 80 wt % alumina. Bauxite also may include silica (SiO₂) and titania (TiO₂) in amounts of usually no more than about 10 wt % and typically in amounts of no more than about 6 wt %. Volatiles such as water and carbon dioxide may also be present, but the foregoing weight proportions exclude such volatiles. Iron oxide is also present in bauxite in a hydrated form, but again the foregoing proportions exclude water in the hydrated composition.

[0037] It may be desirable for the catalyst to be supported. Such a supported catalyst can be relatively resilient and maintain its particle size after being processed through the slurry hydrocracking reactor. As a consequence, such a catalyst can include a support of alumina, silica, titania, one or more aluminosilicates, magnesia, bauxite, coal and/or petroleum coke. Such a supported catalyst can include a catalytically active metal, such as at least one of iron, molybdenum, nickel, and vanadium, as well as sulfides of one or more of these metals. Generally, the catalyst can have about 0.01 to about 30 wt % of the catalytic active metal based on the total weight of the catalyst.

[0038] Generally, it is desirable to have a catalyst of sufficient size to allow it to be readily filtered, centrifuged, settled, or otherwise separated from the products. If the catalyst is too small, separation may be difficult. As a consequence, it is desirable for the catalyst to have a particle size of about 1 to 300 micrometers in size, or preferably between about 1 to 100 micrometers, or more preferably between 1 to 50 micrometers.

[0039] The slurry hydrocracking reactor 31 can receive the second stream 28 from the first cracking zone 24, the gas oil stream 32 and a recycle stream 34 (also preferably gas oil, discussed below). Since the process allows for two gas oil streams 32, 34 to be combined with the feed stream 28, the combined feed ratio can be at least 1.2. As mentioned above, this should reduce the formation of coke or any coke precursors in the slurry hydrocracking reactor 31 and allow for easier transportation of the second stream 38 from the first cracking zone 24 as explained below. Hydrogen may be provided (not shown) to the second stream 28 from the first cracking zone 24 to before being passed into the second cracking zone 30. Generally, the hydrogen can include recycled and/or make-up hydrogen, and as such can include other light hydrocarbon molecules, such as methane and ethane.

[0040] Generally, the hydrocracking reactor 31 can operate either in up-flow or down-flow manner. One exemplary hydrocracking reactor 31 can be a tubular reactor through which the feed, catalyst, and gas pass upwardly. Generally, the temperature can be about 400°C to about 500°C (752°F to 932°F), preferably about 440°C to about 465°C (824°F to 860°F), and a pressure between about 3 to about 28 MPa (435 to 4000 psig), preferably between about 10 to about 18 MPa (1450 to 2610 psig). The liquid hourly space velocity is typically below about 4 hr⁻¹.

[0041] As known, the second cracking zone 30 may also include or more separators to separate lighter hydrocarbons from a stream 38 of unconverted hydrocarbons, catalyst, coke, and some trace amounts of converted hydrocarbons. Additionally, due to the higher combined feed ratio, the viscosity of the stream 38 of the unconverted portion is improved as well. In some instances it is believed that stream 38 can comprise approximately 5 to 20% of the original feed stock. The improved viscosity will allow for a lower grading of pipeline tracing and tankage heating to be installed.
In order to demonstrate the principles of the present invention a theoretical modeling of a slurry hydrocracking unit processing a vacuum column bottoms stream from a Light Arabian crude oil distillation was performed. The slurry hydrocracking unit was operated at a 90% conversion of the vacuum column bottoms stream (521°C C+ (970°F) material (materials with a boiling point of 521°C or greater)) is expected to produce about 5.0 wt % C4− hydrocarbon stream, about 22.0 wt % naphtha, and about 35.0 wt % distillate. The slurry hydrocracking unit will also produce about 28.0 wt % gas oil, some of which can be recycled to provide a combined feed ratio of about 1:1 for the slurry hydrocracking unit. Finally, about 10.0 wt % of the slurry hydrocracking product vacuum column bottoms stream will comprise unconverted material.

In another theoretical modeling, a vacuum column bottoms stream from a Light Arabian crude oil distillation was first passed to a visbreaking unit operating with 25% conversion (typical for visbreaking units) of the 349°C C+ (660°F) material (materials with a boiling point of 349°C or greater) and with 40% conversion of 521°C C+ (970°F) material. The visbreaking unit is expected to produce about 6.0 wt % naphtha and about 15.5 wt % distillate, both of which can be sent to downstream hydrotreating. There will also be about 16.0 wt % gas oil yield. Approximately, 11.0 wt % of the gas oil can be sent to a downstream hydrocracking reactor, and about 5 wt % can be used to increase the combined feed ratio of the stream passed to the slurry hydrocracking unit. The unconverted 60 wt % of the 521°C C+ (970°F) material from the visbreaking unit can be passed to the slurry hydrocracking unit.

Applying the production levels for a 90% operation mode of the slurry hydrocracking unit discussed above, a slurry hydrocracking unit downstream of the visbreaking unit is believed to produce about 3.0 wt % of a C4− hydrocarbon stream, about 13.2 wt % naphtha, about 21.0 wt distillate, about 16.8 wt % gas oil, and about 6.0 wt % unconverted material. A combined feed ratio of 1:2 can be utilized. As shown below in Table 1, by combining the visbreaking unit and the slurry hydrocracking unit, the amount of diesel produced is increased.

<table>
<thead>
<tr>
<th></th>
<th>Both Visbreaking &amp;</th>
<th>Slurry Hydrocracking</th>
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<tbody>
<tr>
<td>C4− hydrocarbons</td>
<td>5.8 wt %</td>
<td>7.0 wt %</td>
</tr>
<tr>
<td>Naphtha</td>
<td>19.2 wt %</td>
<td>22.0 wt %</td>
</tr>
<tr>
<td>Distillate</td>
<td>41.0 wt %</td>
<td>35.0 wt %</td>
</tr>
<tr>
<td>Gas Oil</td>
<td>28.0 wt %</td>
<td>28.0 wt %</td>
</tr>
<tr>
<td>521°C C+</td>
<td>6.0 wt %</td>
<td>8.0 wt %</td>
</tr>
<tr>
<td>100.0 wt %</td>
<td>100.0 wt %</td>
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</table>

*The distillate yield assumes heavy gas oil from visbreaking is 100% converted to distillate range material.

As shown in Table 1, the recovery of distillate is improved by utilizing both the visbreaking reactor and the slurry hydrocracking reactor. Thus, the recovery from the vacuum column bottoms stream can be improved. Additionally, the amount of unconverted hydrocarbons boiling over 521°C is reduced, lowering the amount of pitch that needs to be disposed of. It is believed that by adjusting the cut point to 524°C, the recovery will reach 95% (shown in Table 1 as 94% with a 521°C cut point).

It is also believed that by utilizing such a process, a feed stream with an initial viscosity of 0.00093 m/s² would have an improved viscosity of around 0.00011 m/s², James G. Speight, The Chemistry and Technology of Petroleum (4th Edition ed.)(CRC Press)(2006), as a feed stream to the slurry hydrocracking zone if a visbreaking was performed upstream of the slurry hydrocracking. Thus, not only will the processes improve the recovery, and minimize waste, but the feed to the slurry hydrocracker will be less viscous, allowing for easier handling and transportation. As mentioned above, since the visbreaking reactor is much less costly compared to a large slurry hydrocracking unit, the processes of the present invention provides a more economical and more efficient process for processing a vacuum column bottoms stream.

It should be appreciated and understood by those of ordinary skill in the art that various other components such as valves, pumps, filters, coolers, etc. were not shown in the drawings as it is believed that the specifics of same are well within the knowledge of those of ordinary skill in the art and a description of same is not necessary for practicing or understanding the embodiments of the present invention.

While at least one exemplary embodiment has been presented in the foregoing detailed description of the invention, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration of the invention in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the invention, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope of the invention as set forth in the appended claims and their legal equivalents.

What is claimed is:

1. A process for increasing a recovery from a bottom stream from a vacuum tower, the process comprising:
   passing a bottoms stream from a vacuum tower to a first cracking zone to produce a converted stream and an unconverted stream; and,
   passing the unconverted stream of the first cracking zone to a second cracking zone to produce a second converted stream and a pitch stream, wherein the second cracking zone is operated with a pressure that is higher than the first cracking zone.

2. The process of claim 1 wherein the first cracking zone includes a visbreaking reactor.

3. The process of claim 2 wherein the second cracking zone includes a slurry hydrocracking reactor.

4. The process of claim 1 wherein the first cracking zone is free from hydrocracking catalyst.

5. The process of claim 4 wherein the second cracking zone includes a hydrocracking catalyst.

6. The process of claim 1 wherein the converted stream from the first cracking zone includes gas oil, and the process further comprising:
   passing at least a portion of the gas oil to the second cracking zone.

7. The process of claim 6 wherein the second cracking zone has a combined feed ratio of at least 1.2.

8. The process of claim 1 wherein at least approximately 87% of the bottom stream from the vacuum tower is recovered converted product.
9. A process for reducing a viscosity of a bottoms stream from a vacuum tower, the process comprising:
   passing a bottoms stream from a vacuum tower to a cracking zone including a visbreaking reactor, the cracking zone providing a converted stream and an unconverted stream; and,
   passing the unconverted stream from the cracking zone to a hydrocracking zone, wherein the unconverted stream from the cracking zone has a lower viscosity than the bottoms stream from the vacuum tower.
10. The process of claim 9 wherein the hydrocracking zone includes a slurry hydrocracking reactor.
11. The process of claim 9 wherein the hydrocracking zone includes a catalyst.
12. The process of claim 9 further comprising:
   separating the converted stream from the cracking zone into at least a gas oil stream.
13. The process of claim 12 further comprising:
   passing the gas oil stream to the hydrocracking zone.
14. The process of claim 13 wherein the hydrocracking zone provides a second converted product stream, and the process further comprising:
   separating the second converted product stream into at least a second gas oil stream; and,
   recycling the second gas oil stream to the hydrocracking zone.
15. The process of claim 14 wherein the hydrocracking zone has a combined feed ratio of at least 1.2.
16. The process of claim 15 wherein the cracking zone is operated to convert approximately 10 to 40% of material with a boiling point of 349°C (660°F) of higher from the bottoms stream of the vacuum tower.
17. The process of claim 15 wherein the hydrocracking zone is operated to convert at least approximately 87% of the unconverted stream from the cracking zone.
18. A process for increasing a conversion of a bottoms stream from a vacuum tower, the process comprising:
   passing a bottoms stream from a vacuum tower to a visbreaking reactor, the visbreaking reactor converting approximately 25 to 55% of material with a boiling point of 521°C (970°F.) of higher from the bottoms stream into a converted stream and the remaining portion of the bottoms stream comprising an unconverted stream; and,
   passing the unconverted stream from the visbreaking reactor to a slurry hydrocracking reactor, wherein the unconverted stream from the visbreaking reactor has a lower viscosity than the bottoms stream from the vacuum tower.
19. The process of claim 18 further comprising:
   converting approximately 10 to 20% of the bottoms stream from the vacuum tower into a gas oil stream.
20. The process of claim 19 further comprising:
   passing a portion of the gas oil stream to the slurry hydrocracking reactor.

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