

INTEGRATED TWO-STAGE DESULFURIZATION/DEWAXING
WITH STRIPPING HIGH-TEMPERATURE SEPARATOR

FIELD OF THE INVENTION

[0001] This invention relates to a two stage hydroprocessing process with interstage stripping. More particularly, the interstage stripping occurs at high pressure and temperature with recycle of high temperature gaseous effluent from the stripping stage.

BACKGROUND OF THE INVENTION

[0002] Current regulations on the specifications for diesel fuel in North America, and more generally around the world, present a patchwork of standards that must be met for properties such as cloud point and sulfur removal. Factors such as geography and local concerns about the environment mean that a single refinery must often consider a wide variety of standards in determining how to set the processing conditions for producing diesel fuel. This is further complicated by variations in crude feeds that are available.

[0003] A common method to remove contaminants such as nitrogen and sulfur from a hydrocarbon feedstock in diesel fuel production is to use a hydrotreating step to convert the nitrogen and sulfur contaminants to hydrogen sulfide and ammonia. The hydrotreating step may then be followed by a catalytic dewaxing step to improve the flow properties of the diesel fuel, such as cloud point. The catalyst for such a dewaxing step is typically sensitive to the presence of sulfur and nitrogen contaminants.

[0004] One conventional approach for producing a diesel fuel is to perform the hydrotreatment and dewaxing steps in a single reactor. In such a configuration, the output from the hydrotreatment step is cascaded to the dewaxing step. Due to the cascading of the product from the first treatment step, the processing temperatures for the hydrotreatment and dewaxing steps will be similar. In order to satisfy the specification for sulfur within the fuel, the temperature of the system will typically be selected based on the hydrotreatment step, with the result that the dewaxing step operates at a higher temperature than necessary. This leads to overprocessing of the diesel fuel, which produces a lower cloud point than necessary, and a correspondingly lower yield. Additionally, this type of configuration tends to reduce the operating lifetime of the dewaxing catalyst. Occasionally, this situation may be reversed and the dewaxing step may operate at a higher temperature than is needed for hydrotreatment, such as when a new hydrotreatment catalyst is loaded into a reactor, leading to similar reduction in operating lifetime for the hydrotreatment catalyst. The cascaded product can be passed through a high temperature separator prior to being introduced into the dewaxing stage, but sulfur and nitrogen containing gases are typically not fully removed, which results in faster aging of the dewaxing catalyst.

[0005] Another conventional approach is to have two separate reactors for the hydrotreatment and dewaxing steps. While this allows for stripping between the hydrotreatment and dewaxing stages, two reactor configurations are far more costly to build.

[0006] U.S. Patent 6,635,170 provides a general system for catalytic treatment of a hydrocarbon feed. In 6,635,170, a feedstock is hydroprocessed to remove contaminants, undergoes a first stripping step at a pressure similar to the operating pressure of the hydrotreatment step, and then is subjected to a second

hydroprocessing step. The product from the second hydroprocessing step is then stripped, and at least a portion of the gases from the second hydroprocessing step are recycled to serve as the stripping gas for the first stripping step.

[0007] U.S. Patent 6,623,628 provides a system for processing of middle distillates to make products such as diesel fuel. In 6,623,628, the middle distillate is subjected to hydroprocessing in two separate reactors with stripping in between. A portion of the product from the second hydroprocessing step is then refluxed back to the start of the hydroprocessing train.

[0008] U.S. Published Patent Application 2005/0269245 describes a method for producing diesel fuel from a gas oil feedstock. The method includes hydrotreatment, hydrofinishing, and catalytic dewaxing. The hydrofinishing and catalytic dewaxing treatments are performed using a counter-current flow of hydrogen.

[0009] US 6,676,828 describes another method for producing a diesel fuel from a gas oil. The method involves at least two hydrotreatment steps, with a stripping and washing step between the hydrotreatment steps. The washing step includes injecting an additional hydrocarbon stream into the liquid product from the first hydrotreatment step. The additional hydrocarbon stream can be diesel, gasoline, or a light vacuum gas oil.

[0010] What is needed is a flexible method for producing a diesel fuel product that allows a refiner to meet a variety of diesel specifications without incurring substantial additional capital costs.

SUMMARY OF THE INVENTION

[0011] In an embodiment, a method is provided for producing a diesel fuel product. The method includes passing a first hydrocarbon feedstock having a first initial cloud point to a hydrotreatment zone and hydrotreating the feedstock under effective hydrotreatment conditions to form a hydrotreated product having a sulfur content of 15 wppm or less, the hydrotreatment zone having a hydrotreatment temperature and pressure. The hydrotreated product is then passed to a stripping zone, where the hydrotreated product is stripped to form a gaseous effluent and a liquid effluent. The liquid effluent is then passed to a catalytic dewaxing zone and dewaxed under effective catalytic dewaxing conditions to form a dewaxed product having a cloud point at least 10°C lower than the first initial cloud point, the catalytic dewaxing conditions including a first average catalytic dewaxing temperature that is at least 15°C less than the hydrotreatment temperature. Next, the temperature of the catalytic dewaxing zone is lowered to a second catalytic dewaxing temperature that is at least 5°C less than the first catalytic dewaxing temperature. A second hydrocarbon feedstock having a second initial cloud point is then passed to the hydrotreatment zone and the feedstock is hydrotreated at the hydrotreatment temperature to form a second hydrotreated product having a sulfur content of 15 wppm or less. Once again, the second hydrotreated product is passed to the stripping zone and stripped to form a second gaseous effluent and a second liquid effluent. The second liquid effluent is then passed to the catalytic dewaxing zone and dewaxed at the second catalytic dewaxing temperature to form a second dewaxed product, the second dewaxed product having a cloud point at least 10°C lower than the second initial cloud point.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Figure 1 depicts a reaction system suitable for performing a process according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] In an embodiment, the invention provides a process that retains benefits of the two-stage configuration but at reduced capital cost. The process makes use of a stripping high-temperature separator between the hydrotreatment and catalytic dewaxing stages within a reactor. The desulfurization reactor effluent is sent to the stripping high-temperature separator and stripped with make-up hydrogen to remove and separate dissolved ammonia and hydrogen sulfide in the desulfurized liquid. In addition, only one common recycle compressor is required to serve both the desulfurization and dewaxing reactors. Both the hydrotreatment and dewaxing stages are operated in a co-current manner.

[0014] The various embodiments of the invention also provide further advantages. A high pressure stripper is not needed after the dewaxing stage, in part because make-up gas is used for the stripping stage between the hydrotreatment and dewaxing stages. Additionally, no reflux of product is needed from any of the process stages. More generally, an additional hydrocarbon stream does not need to be introduced into the effluent from the hydrotreatment stage prior to passing the effluent to the catalytic dewaxing stage.

[0015] Still another advantage of various embodiments of the invention is the ability to independently control the temperatures of the hydrotreatment and dewaxing stages. This flexibility provides many benefits with regard to diesel fuel production. For example, by adjusting only the temperature of the dewaxing stage while maintaining the temperature of the hydrotreatment stage,

diesel fuels matching various specifications can be produced from a single feedstock while maximizing the diesel fuel yield at each specification.

[0016] The present process involves a first hydroprocessing zone, a first separation zone following the first hydroprocessing zone, and a second hydroprocessing zone. Unlike the common practice in the art, the first separation zone is operated at the pressure of the preceding hydroprocessing zone. There is no disengagement, i.e., depressurization between first and second hydroprocessing zones. After the second hydroprocessing zone, the feedstock may be disengaged.

[0017] The various location-based requirements and specifications for U.S. diesel fuel are provided in ASTM D975. Other similar regulations exist for Europe, Canada, and other countries. These specifications typically include a requirement that sulfur be reduced in the diesel product to 15 wppm or less. Additionally, the cloud point specification is widely variable, but winter month specifications routinely require a cloud point well below 0°C.

[0018] Diesel boiling range feedstreams suitable for use in the present invention boil within the range of about 215°F to about 800°F. Preferably, the diesel boiling range feedstream has an initial boiling point of at least 250°F, or at least 300°F, or at least 350°F, or at least 400°F, or at least 451°F. Preferably, the diesel boiling range feedstream has a final boiling point of 800°F or less, or 775°F or less, or 750°F or less. In an embodiment, the diesel boiling range feedstream has a boiling range of from 451°F to about 800°F. In another embodiment, the diesel boiling range feedstream also includes kerosene range compounds to provide a feedstream with a boiling range of from about 250°F to about 800°F. These feedstreams can have a nitrogen content from about 50 to about 2000 wppm nitrogen, preferably about 50 to about 1500 wppm nitrogen,

and more preferably about 75 to about 1000 wppm nitrogen. In an embodiment, feedstreams suitable for use herein have a sulfur content from about 100 to about 40,000 wppm sulfur, preferably about 200 to about 30,000 wppm, and more preferably about 350 to about 25,000 wppm. The feedstreams suitable for use can include feedstreams derived from synthetic sources, such as Fischer-Tropsch hydrocarbons, or feedstreams derived from biocomponent sources, such as animal or vegetable oils, fats, or fatty acids.

[0019] The primary purpose of hydrotreating is typically to reduce the sulfur, nitrogen, and aromatic content of a feed, and is not primarily concerned with boiling point conversion of the feed. Catalysts usually contain at least one of Group VIA and Group VIII metal on a support such as alumina or silica. Examples include Ni/Mo, Co/Mo and Ni/W catalysts. Hydrotreating conditions typically include temperatures of 315-425°C, pressures of 300-3000 psig, Liquid Hourly Space Velocities (LHSV) of 0.2-10 h⁻¹ and hydrogen treat rates of 500-10000 scf/bbl.

[0020] In order to satisfy regulatory requirements, the sulfur present in the diesel product must be below 15 wppm. In order to satisfy this specification, it is desirable to have a lower target sulfur value, so that variations within a process will not result in exceeding the specification. This also provides a margin for error in case subsequent contamination of the diesel fuel occurs, such as during transport.

[0021] Catalytic dewaxing relates to the removal and/or isomerization of long chain, paraffinic molecules from feeds. Hydrodewaxing can be accomplished by selective hydrocracking or by hydroisomerizing these long chain molecules. Hydrodewaxing catalysts are suitably molecular sieves such as crystalline aluminosilicates (zeolites) or silico-aluminophosphates (SAPOs),

such as zeolite Beta. Preferably, the molecular sieve can be a 10-ring sieve such as ZSM-5, ZSM-22, ZSM-23, ZSM-35, ZSM-48, SAPO-11, SAPO-41 and the like. These catalysts may also carry a metal hydrogenation component, preferably Group VIII metals, especially Group VIII noble metals.

Hydrodewaxing conditions include temperatures of 280-380°C, pressures of 300-3000 psig, LHSV of 0.1-5.0 h⁻¹ and treat gas rates of from 500-5000 scf/bbl.

[0022] In a preferred embodiment, the dewaxing catalyst is selected to also provide additional desulfurization. In such an embodiment, the hydrotreating step can be used to reduce the sulfur in a feedstock to a first level, such as from about 12 wppm to about 25 wppm. Additional sulfur is then removed during the dewaxing step to guarantee that the sulfur level is below 15 wppm. By relaxing the sulfur requirement of the hydrotreatment step, the severity of conditions in the hydrotreatment step can be reduced, which allows for an improved yield. Suitable dewaxing catalysts can include bound molecular sieve catalysts containing ZSM-48, ZSM-23, zeolite Beta, and a Group VIII noble metal, such as Pt or Pd. Molecular sieves that are isostructural with ZSM-48, ZSM-23, or zeolite Beta, such as ZBM-30, EU-2, or EU-11, can also be used.

[0023] Typical distillate feeds suitable for conversion into a diesel fuel product can have initial cloud points ranging from about -20°C to about 5°C. In order to form a suitable diesel fuel product for winter conditions, the catalytic dewaxing conditions can be selected to reduce the cloud point by at least about 10°C, or at least about 20°C, or at least about 30°C, or at least about 40°C, or at least about 50°C. In order to satisfy this type of cloud point reduction, the dewaxing temperature can be 15°C lower than the hydrotreatment temperature, or 20°C lower, or 25°C lower, or 30°C lower.

[0024] The dewaxing temperature selected can also be influenced by the diesel fuel product specification that is being matched. Because the temperatures of the hydrotreatment and dewaxing steps can be separately controlled, it is feasible to adjust the dewaxing temperature to match a desired specification. For example, it may be desirable to make some diesel fuel at a first cloud point specification, and then a second batch of diesel fuel intended for different winter climate that has a corresponding change in the specified cloud point. Since the dewaxing temperature is not dictated by the hydrotreatment temperature, the dewaxing temperature for producing the diesel fuel at the first cloud point specification can be optimized. When sufficient diesel fuel at the first cloud point specification has been produced, the dewaxing temperature can be increased by at least about 5°C, or at least about 10°C, or at least about 15°C. Alternatively, the dewaxing temperature can be decreased by at least about 5°C, or at least about 10°C, or at least about 15°C. Note that in this alternative embodiment where the dewaxing temperature is decreased, some dewaxing of the diesel fuel is desirable, so the change in dewaxing temperature does not correspond to simply turning off the dewaxing stage. Thus, the decrease in the temperature of the dewaxing stage is less than 100°C. This modification of the dewaxing temperature allows for an improved yield at diesel product specifications with a less severe cloud point requirement, while still allowing for production of diesel fuels with lower cloud points when necessary.

[0025] A common practice in the art is to disengage, i.e., depressurize between hydroprocessing steps. The reason for such disengagement is to strip the effluent from the first hydroprocessing step (or zone) before passing the effluent to a second hydroprocessing step. An interstage stripping zone is employed to remove gaseous contaminants created in the first hydroprocessing step such as H₂S and NH₃ and may also be used to strip light (low boiling) products from the effluent. Such gaseous contaminants may adversely impact the

performance of catalysts in the second hydroprocessing step or zone. However, before passing the stripped effluent to the second hydroprocessing step, it is usually necessary to repressurize and reheat the effluent.

[0026] High pressure separators are known in the art. They may include flash drums, pressure strippers which include pressure separators for separating liquids and gases at high temperatures, or combinations thereof. These units are designed to operate at high temperatures such as the temperature of the preceding hydroprocessing zone. High pressure strippers may operate in either the co-current or countercurrent mode with regard to the stripping gas.

[0027] The process is further described with reference to a representative process shown in FIG. 1. Fresh feed is fed through line 15 to hydrotreater 20 to produce a hydrotreated product, hydrogen sulfide, ammonia and light hydrocarbon gases. The hydrogen for the first hydroprocessing zone is provided from recycle apparatus 70 via line 35. The products from the hydrotreater are passed through to a first separation zone 30 which is a stripping separator operated at a temperature and pressure similar to the output temperature and pressure of the hydrotreater.

[0028] The liquid hydrotreated product is stripped with make-up hydrogen gas that is passed to first separation zone 30 via line 25. Light hydrocarbons, hydrogen sulfide and ammonia are separated from the hydrotreated product and sent to a second separation zone 40. This separation zone can be a conventional separator at a cooler temperature. The gas phase products from second separation zone 40 are sent to recycle apparatus 70. The stripped hydrotreated product is sent to the second catalytic dewaxer 50. There is no disengagement (no depressurization) between hydrotreater 20 and catalytic dewaxer 50. For purposes of pressure balance, catalytic dewaxer 50 may be operated at a pressure

similar to hydrotreater 20, although slightly higher or lower pressures are also acceptable.

[0029] The catalytic dewaxer removes and/or modifies waxy paraffins from the hydrotreated product by selective hydrocracking, isomerization or some combination thereof. The hydrogen for catalytic dewaxer 50 is provided by the make-up hydrogen flow used in first separation zone 30 and additional hydrogen from the recycle apparatus. The resulting dewaxed product and any gases are then passed to separation zone 60. The separator that comprises separation zone 60 separates liquid product from gases. The liquid product (the dewaxed product) is passed through line 65 for use as a diesel fuel product. The gaseous product from separator 60 is passed to the same recycle loop used for the gas phase product from separator 40. Thus, a common recycle apparatus can be used for all hydrogen in the system.

[0030] In the process described for FIG. 1, most of the hydrogen sulfide and ammonia is removed in separation zone 30 except for the equilibrium concentration dictated by the partial pressures of these gases in the effluent from the first hydroprocessing zone. This equilibrium amount is further reduced by incorporating the needed make-up hydrogen for the system as a stripping gas in separator 30. The liquid product that enters catalytic dewaxer 50 thus contains almost no hydrogen sulfide or ammonia. This can be important if the catalyst used in catalytic dewaxer 50 is sensitive to these contaminants. The equilibrium is shifted in favor of desorption of any remaining hydrogen sulfide and ammonia in the liquid product from the first hydroprocessing zone. Not only is greater catalyst protection afforded for the second hydroprocessing zone, but higher reaction rates may also occur. By not depressurizing between or after hydroprocessing zones, a considerable expense savings occurs as the need for depressurizing and repressurizing gaseous streams is avoided.

[0031] Due to the configuration used for the hydrotreater and dewaxer, the temperatures of the hydrotreatment and dewaxing steps can be controlled independently. In particular, this allows the temperature of each reactor to be independently modified to achieve a desired specification. As a result, the reaction conditions can be readily modified in response to a change in product specification or a change in the type of available feedstock.

[0032] As an example, the process of the invention could be used for production of diesel fuels intended for a variety of locations. The cloud point requirement for a diesel fuel varies significantly by month and region, as shown in the specification maps provided in ASTM D975 and/or regulations in other countries. It is most economic for a user to be able to vary the dewaxing severity to meet a specific cloud point requirement. For a given feedstock, the hydrotreatment severity will not need to change, as the sulfur specification is uniform.

[0033] With a single stage reactor, there is limited ability to adjust the dewaxing temperature independently of the hydrotreating stage. There may be some hydrogen quench between the hydrotreating and dewaxing catalyst, but its ability to adjust temperature is very limited. So, for a constant feed, a user may have to over-hydrotreat to get to a higher cloud point target. Or a user may just settle for an average cloud point improvement that is not the most economic.

[0034] The process of the invention overcomes the above problem by allowing the hydrotreatment and dewaxing temperatures to be set separately. This allows a first, higher temperature to be selected for the hydrotreatment step. The temperature of the dewaxing step can then be set to be at least 10°C lower, or at least 15°C, or at least 20°C, or at least 25°C lower in order to match a

desired cloud point specification. Alternatively, the higher temperature may be in the dewaxing step, in which case the temperature of the dewaxing step can be at least 10°C higher, or at least 15°C, or at least 20°C, or at least 25°C higher in order to match a desired cloud point specification. By matching the desired cloud point specification, instead of simply operating at the temperature of the hydrotreatment stage, the yield of diesel fuel from the process can be increased.

[0035] Applicants note that when referring to the temperatures for hydrotreatment and catalytic dewaxing, the temperatures herein refer to average temperatures. Average temperatures are used as the catalyst beds (or reaction stages) will typically have some variation in temperature from the top to the bottom of a catalyst bed/reaction stage.

[0036] The process of the invention allows a further advantage in that multiple types of product specifications can be accommodated. For example, during the transition from summer to winter, it would be desirable to continue making summer type diesel for any locations which permit the fuel for as long as possible, as the yield is improved. However, other locations may switch earlier to a lower cloud point requirement. The process of the invention allows the dewaxing temperature to be varied in order to produce multiple diesel product types, thus maximizing yield while still meeting desired product specifications. The change in cloud point between locations can be at least 5°C, or at least 10°C, or at least 15°C, or at least 20°C.

[0037] Another example of the process flexibility provided by the invention relates to the types of initial feedstocks available for use. Depending on the original source of the feedstock, it may be desirable to perform hydrotreatment at more or less severe conditions. For example, a Fischer-Tropsch type feed might require little processing, while a feed including biocomponent might

require additional severity to meet the desired sulfur target. Alternatively, one mineral feed may be similar in overall profile to a second feed, except for a change in the sulfur or nitrogen content. The process according to the invention allows the hydrotreatment severity to be modified without harming the ability to meet a desired cloud point specification.

Example

[0038] Applicants have discovered that the impact of contaminants on a catalytic dewaxing process is more severe than previously expected. A pilot plant was used to investigate the cloud point performance of a dewaxing catalyst composed of alumina bound ZSM-48 with about 0.6 wt% Pt. The catalyst was used to dewax a middle distillate feed with a cloud point of about -5°C. This corresponds roughly to the type of feed that would be provided after the hydrotreatment and stripping stages of the invention. After dewaxing at 610°F, the catalyst reduced the cloud point of the hydrocarbon stream to about -65°C.

[0039] After several days, various contaminants were added to the feed to determine the impact on cloud point, and the process temperature needed to achieve a cloud point. First, 50 ppm of NH₃ was added to the feed. After about 5 days, the cloud point of the resulting product was increased to about -50°C. The level of NH₃ was then increased to about 250 ppm for 3 days. This resulted in a cloud point of just above -20°C. The ammonia was then removed from the feed for about a week, which caused the process to recover to a product cloud point of about -40°C.

[0040] Next, 25 ppm of aniline was added for 3 days. This once again raised the cloud point to above -20°C. The temperature was then increased to 630°F, and the aniline amount was increased to 50 ppm for about 7 days. The

cloud point of the resulting product stabilized around -25°C. The aniline was then removed while maintaining the 630°F temperature. After about 2 weeks, the cloud point recovered to the initial value of about -65°C.

[0041] The effect of sulfur content was then investigated. The same feed was spiked with 5000 wppm of sulfur and processed at 630°F for 5 days. The cloud point of the product quickly stabilized at a level just below -10°C. Increasing the temperature to 650°F reduced the cloud point to about -25°C, and further increasing the temperature to 680°F resulted in a cloud point of about -40°C.

CLAIMS

1. A method for producing a diesel fuel, comprising:

passing a first hydrocarbon feedstock having a first initial cloud point to a hydrotreatment zone and hydrotreating the feedstock under effective hydrotreatment conditions to form a hydrotreated product having a sulfur content of 15 wppm or less, the hydrotreatment zone having a hydrotreatment temperature and pressure;

passing the hydrotreated product to a stripping zone;

stripping the hydrotreated product to form a gaseous effluent and a liquid effluent;

passing the liquid effluent to a catalytic dewaxing zone and dewaxing the liquid effluent under effective catalytic dewaxing conditions to form a dewaxed product having a cloud point at least 10°C lower than the first initial cloud point, the catalytic dewaxing conditions including a first catalytic dewaxing temperature that is at least 10°C less than the hydrotreatment temperature;

lowering the temperature of the catalytic dewaxing zone to a second catalytic dewaxing temperature, the second catalytic dewaxing temperature being at least 5°C less than the first catalytic dewaxing temperature;

passing a second hydrocarbon feedstock having a second initial cloud point to the hydrotreatment zone and hydrotreating the second hydrocarbon feedstock at the hydrotreatment temperature to form a second hydrotreated product having a sulfur content of 15 wppm or less;

passing the second hydrotreated product to the stripping zone;

stripping the second hydrotreated product to form a second gaseous effluent and a second liquid effluent; and

passing the second liquid effluent to the catalytic dewaxing zone and dewaxing the second liquid effluent at the second catalytic dewaxing temperature to form a second

dewaxed product, the second dewaxed product having a cloud point at least 10°C lower than the second initial cloud point.

2. A method for producing a diesel fuel, comprising:

passing a first hydrocarbon feedstock having a first initial cloud point to a hydrotreatment zone and hydrotreating the feedstock under effective hydrotreatment conditions to form a hydrotreated product having a sulfur content of 15 wppm or less, the hydrotreatment zone having a hydrotreatment temperature and pressure;

passing the hydrotreated product to a stripping zone;

stripping the hydrotreated product to form a gaseous effluent and a liquid effluent;

passing the liquid effluent to a catalytic dewaxing zone and dewaxing the liquid effluent under effective catalytic dewaxing conditions to form a dewaxed product having a cloud point at least 10°C lower than the first initial cloud point, the catalytic dewaxing conditions including a first catalytic dewaxing temperature that is at least 10°C less than the hydrotreatment temperature;

increasing the temperature of the catalytic dewaxing zone to a second catalytic dewaxing temperature, the second catalytic dewaxing temperature being at least 5°C greater than the first catalytic dewaxing temperature;

passing a second hydrocarbon feedstock having a second initial cloud point to the hydrotreatment zone and hydrotreating the second hydrocarbon feedstock at the hydrotreatment temperature to form a second hydrotreated product having a sulfur content of 15 wppm or less;

passing the second hydrotreated product to the stripping zone;

stripping the second hydrotreated product to form a second gaseous effluent and a second liquid effluent; and

passing the second liquid effluent to the catalytic dewaxing zone and dewaxing the second liquid effluent at the second catalytic dewaxing temperature to form a second

dewaxed product, the second dewaxed product having a cloud point at least 10°C lower than the second initial cloud point.

3. A method for producing a diesel fuel, comprising:

passing a first hydrocarbon feedstock to a hydrotreatment zone and hydrotreating the feedstock under effective hydrotreatment conditions to form a hydrotreated product having a sulfur content of about 12 wppm to about 25 wppm of sulfur, the hydrotreatment zone having a hydrotreatment temperature and pressure;

passing the hydrotreated product to a stripping zone;

stripping the hydrotreated product to form a gaseous effluent and a liquid effluent;

passing the liquid effluent to a catalytic dewaxing zone and dewaxing the liquid effluent under effective catalytic dewaxing conditions to form a dewaxed product having a cloud point at least 10°C lower than the first initial cloud point, the catalytic dewaxing conditions including a first catalytic dewaxing temperature that is at least 10°C less than the hydrotreatment temperature,

wherein the sulfur content of the dewaxed product is lower than the sulfur content of the hydrotreated product and is less than 15 wppm.

4. The process of claims 1 or 2, wherein the hydrotreated product and second hydrotreated product are stripped with make-up hydrogen.

5. The process of any of claims 1 to 3, wherein the process is carried out without reflux of product from the catalytic dewaxing zone to the hydrotreatment zone or the stripping zone.

6. The process of claims 1 or 2, wherein stripping the first hydrotreated product comprises stripping at a temperature and pressure corresponding to an exit temperature and pressure of the hydrotreatment zone.
7. The process of claim 3, wherein stripping the hydrotreated product comprises stripping at a temperature and pressure corresponding to an exit temperature and pressure of the hydrotreatment zone.
8. The process of claims 1 or 2, wherein the first catalytic dewaxing temperature is at least 15°C less than the hydrotreatment temperature.
9. The process of claims 1 or 2, wherein the first catalytic dewaxing temperature is at least 25°C less than the hydrotreatment temperature.
10. The process of claim 3, wherein the catalytic dewaxing temperature is at least 15°C less than the hydrotreatment temperature.
11. The process of claim 3, wherein the catalytic dewaxing temperature is at least 25°C less than the hydrotreatment temperature.
12. The process of claim 1, wherein the second catalytic dewaxing temperature is at least 10°C greater than the first catalytic dewaxing temperature.
13. The process of claim 1, wherein the second catalytic dewaxing temperature is at least 15°C greater than the first catalytic dewaxing temperature.

14. The process of claim 2, wherein the second catalytic dewaxing temperature is at least 10°C less than the first catalytic dewaxing temperature.

15. The process of claim 2, wherein the second catalytic dewaxing temperature is at least 15°C less than the first catalytic dewaxing temperature.