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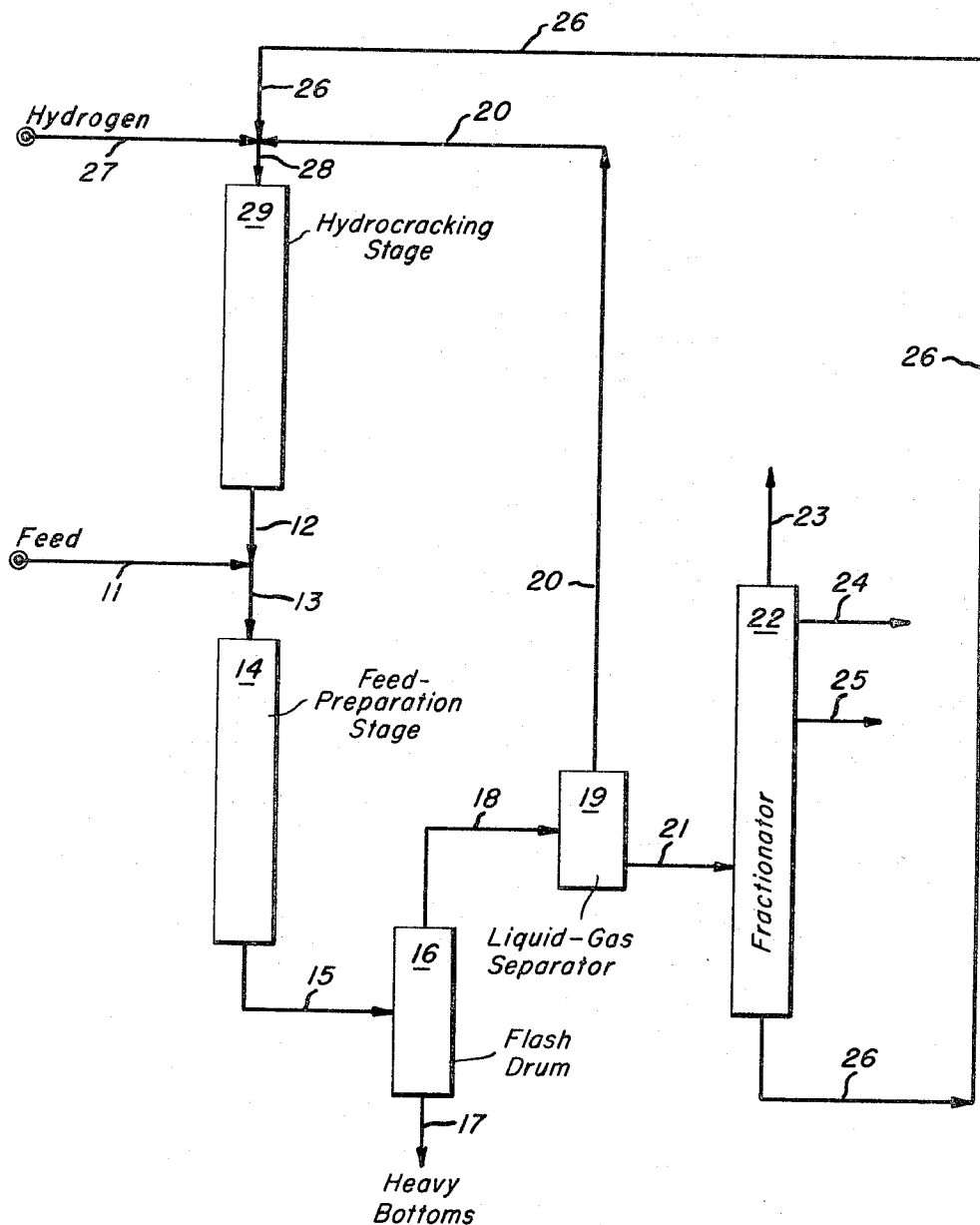
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TWO-STAGE PROCESS FOR THE HYDROCRACKING OF
HYDROCARBON OILS IN WHICH THE FEED OIL
IS PRETREATED IN THE FIRST STAGE

3,328,290

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2 Sheets-Sheet 1

Fig. 1



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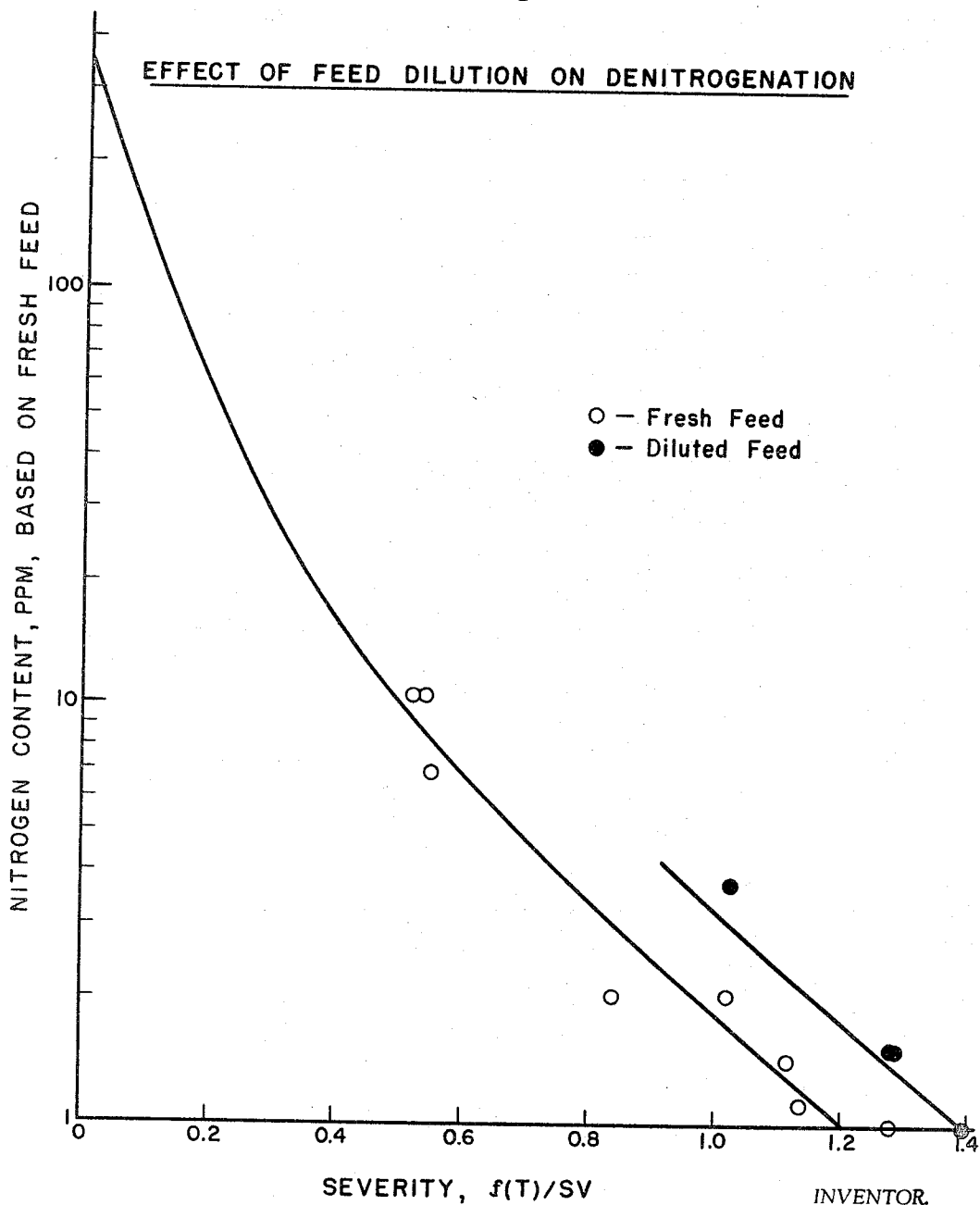
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Fig. 2



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TWO-STAGE PROCESS FOR THE HYDROCRACKING OF HYDROCARBON OILS IN WHICH THE FEED OIL IS PRETREATED IN THE FIRST STAGE

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This invention relates to the catalytic conversion of hydrocarbon feed stocks. More particularly, it relates to a novel processing scheme for the hydrocracking of relatively high-boiling hydrocarbon feed stocks to produce lower boiling hydrocarbons which boil predominantly in the gasoline boiling range.

Hydrocracking is a general term which is applied to petroleum refining processes wherein hydrocarbon feed stocks which have relatively high molecular weights are converted to lower-molecular-weight hydrocarbons at elevated temperature and pressure in the presence of a hydrocracking catalyst and a hydrogen-containing gas. Hydrogen is consumed in the conversion of organic nitrogen and sulfur to ammonia and hydrogen sulfide, respectively, in the splitting of high-molecular-weight compounds into lower-molecular-weight compounds, and in the saturation of olefins and other unsaturated compounds. In hydrocracking processes, hydrocarbon feed stocks, such as gas oils that boil in the range of about 350° F. to about 1000° F., typically, catalytic cycle oils boiling between about 350° F. and 850° F., are converted to lower-molecular-weight products, such as gasoline-boiling-range products and light distillates.

Generally, low-temperature hydrocracking processes for maximizing gasoline-boiling-range products employ two processing stages. In the first stage, the feed stock is hydrotreated to remove the basic nitrogen and sulfur that are typically found in the usual refinery feed stocks. In the second stage, the pretreated hydrocarbon stream is converted to lower-boiling products. Consequently, the first stage is a feed-preparation stage and the second stage is a hydrocracking stage.

A considerable investment in compressors, heat exchange and flashing equipment for suitably handling the hydrotreater effluent prior to hydrocracking is required in a conventional two-stage hydrocracking process. I have provided a novel hydrocracking process of simplified design which permits lower investment in equipment and, consequently, a more economical operation.

Briefly, in accordance with the present invention, there is provided a two-stage hydrocracking process wherein fresh feed is combined with effluent from the hydrocracking stage and the combined streams then are introduced into the hydrotreating stage. As described in more detail hereinafter, a hydrogen-rich gas is then separated from the effluent of the hydrotreater and transferred to the hydrocracking stage, and a small high-boiling fraction is preferably separated from the hydrotreater effluent. The remainder of the hydrotreater effluent is distilled to separate a light-product stream and a heavier-bottoms stream, which is passed to the hydrocracking stage in admixture with hydrogen-containing gas. In such an operation only one make-up hydrogen-containing gas stream is required and only one hydrogen-containing gas stream need be reused, that is, separated from the effluent from the feed-preparation zone and transferred to the hydrocracking zone. Consequently, compressor duty, as well as heat-exchanger duty, is minimized.

In a preferred embodiment of my improved process, a gas oil boiling within the range between 350° F. and 1000° F. is combined with the total hydrocrackate from a hydrocracking zone and the combined hydrocarbons are

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introduced into the top of the feed-preparation zone. Conditions for this feed-preparation zone include a pressure of 200 to 2500 p.s.i.g., a temperature between about 500° F. and 800° F. and a liquid hourly space velocity between about 0.2 to about 10.0. A suitable hydrogenation and denitrogenation catalyst, for example, cobalt and molybdenum oxides on a silica-alumina-cracking-catalyst support, is employed herein. The effluent from the feed-preparation zone is flashed to remove the heavy ends, the lighter material is condensed and a hydrogenation-containing gas is separated from the liquid product. This hydrogen-containing gas is transferred to a point in the system where it is combined with the hydrocarbon stream being introduced into the hydrocracking zone. The resulting liquid stream from the separation step is sent to a fractionation column where distillates and/or those products which boil in the gasoline boiling range are separated from the higher-boiling liquids and subsequently recovered. The remaining higher-boiling liquid stream is then sent to the hydrocracking zone. Prior to the introduction of this liquid stream into the hydrocracking zone, the hydrogen-containing gas from the feed-preparation zone and make-up hydrogen-containing gas are combined with it. Operating conditions in the hydrocracking zone include a temperature between about 450° F. and 750° F., a pressure between about 200 and 2500 p.s.i.g. and a liquid hourly space velocity between about 0.2 and 5.0 volumes of hydrocarbon per hour per volume of catalyst. A suitable hydrocracking catalyst, for example, arsenided nickel on a silica-alumina-cracking-catalyst support, is used in the hydrocracking zone. The effluent from the hydrocracking zone, i.e., the total hydrocrackate, is combined with fresh feed stock, and this combined hydrocarbon stream is introduced into the feed-preparation zone. In this improved process, only one make-up hydrogen-containing gas stream is used and this stream is introduced into the hydrocarbon stream which is to be fed into the hydrocracking zone. The hydrogen-containing gas stream which normally would be commingled with the hydrocarbon stream being fed into the feed-preparation zone has been eliminated. Furthermore, only one hydrogen-containing gas stream is reused. The reduced requirement for the addition and reuse of hydrogen and the associated compressor and heat-exchanger duty significantly increases the economic attractiveness of my two-stage hydrocracking process.

My invention will be more fully understood by reference to the following description of a preferred embodiment of the invention given in connection with the accompanying drawings. FIGURE 1 is a simplified flow diagram of my improved hydrocracking process. Since this figure represents a simplified flow diagram of a process, it does not include various pieces of auxiliary equipment such as heat exchangers, condensers, pumps, and compressors, which, of course, would be necessary for a complete processing scheme and which would be known and used by those skilled in the art. FIGURE 2 presents data obtained from a test to show the effect of feed dilution upon denitrogenation.

In the operation of my process, a selected feed stock would be commingled with the total hydrocrackate exiting from the hydrocracking zone, and this combined hydrocarbon stream would be introduced into the feed-preparation zone. This feed-preparation treatment may be operated in the liquid phase, the vapor phase or mixed vapor-liquid phase. The catalyst may be of a fixed-bed type, a fluidized-bed type or some other appropriate type of catalyst system. Feed stocks, which may be used, may be derived from petroleum, shale, gilsonite, and other sources.

Those feed stocks which may be satisfactorily hydro-

cracked in my improved process may have a wide range of compositions. Such hydrocarbon feed stocks may consist essentially of all saturates, or they may consist of practically all aromatics, or they may be mixtures of the two types of hydrocarbons. The saturates are hydrocracked to gasoline-boiling-range paraffins containing isoparaffins in the product in a concentration that is greater than that found for equilibrium. The polynuclear aromatics are partially hydrogenated and the hydrogenated ring portion is hydrocracked to produce an alkyl substituted benzene and an isoparaffin. Suitable feed stocks may contain the high-boiling fractions of crude oil, which may boil at a temperature as high as 1200° F. However, generally the feed stock will range from naphtha and kerosene to and through the heavy gas oils. Normally, the feed stocks will boil between 350° F. and about 850° F. Therefore, the light catalytic cycle oil, which boils in the range of from 350° F. to 650° F., a heavy catalytic cycle oil which boils in the range of from about 500° F. to about 800° F., and a virgin gas oil which boils in the range of 400° F. to 1000° F. are suitable feed stocks.

Amounts of sulfur which are found in such feed stocks do not generally affect adversely the catalyst employed in the hydrocracking stage. However, combined nitrogen and oxygen in such feed stocks deleteriously affect the hydrocracking catalyst; therefore, their concentration in the feed stock should be maintained as low as possible in order to minimize hydrocracking-catalyst contamination and deactivation. Although the above-mentioned feed stocks may contain as much as 0.1 weight percent nitrogen, such nitrogen concentration is readily reduced in the feed-pretreatment stage to a value which is conducive to a more satisfactory catalyst life.

In my improved two-stage hydrocracking process, as is done in many of the conventional two-stage hydrocracking processes, the feed is contacted with a suitable hydrofining catalyst in the presence of hydrogen in the feed-preparation zone. Elevated temperatures and pressures are employed. Suitable hydrofining catalysts include those which comprise the oxides and/or sulfides of the Group VI-B and/or Group VIII metals supported on a suitable carrier. Examples of satisfactory carriers are alumina, titania, and silica-alumina. A cobalt-molybdenum catalyst, supported on a silica-alumina carrier, would be a satisfactory catalyst for use in the feed-preparation zone. Preferably, a nickel-tungsten-sulfide-on-silica-alumina catalyst is used.

Suitable operating conditions that may be used in the feed-preparation zone include a reactor temperature in the range of from about 500° F. to about 800° F., a pressure in the range of from about 200 to about 2500 p.s.i.g., a hydrogen-to-oil ratio in the range of from about 500 standard cubic feet of hydrogen per barrel of hydrocarbon to about 10,000 standard cubic feet of hydrogen per barrel of hydrocarbon, and a liquid hourly space velocity in the range from about 0.2 to about 10. Preferably, the temperature may range from about 600° F. to 725° F.; the pressure, from about 1200 to 1800 p.s.i.g.; the hydrogen-to-oil ratio, from about 1000 to about 7500 standard cubic feet of hydrogen per barrel of hydrocarbon; and the liquid hourly space velocity, from about 0.5 to about 5.0 volumes of hydrocarbon per hour per volume of catalyst.

In the hydrocracking zone, the hydrocarbons are contacted with a suitable hydrocracking catalyst in the presence of hydrogen at elevated temperatures and pressures. Such catalysts may be selected from various well-known hydrocracking catalysts, which typically comprise a hydrogenation component and a solid acidic cracking component.

The hydrogenation component possesses hydrogenation-dehydrogenation activity and may exist in the metallic form or as a compound such as the oxides or sulfides thereof. A large number of well-known metallic hydrogenation catalysts may be used in the hydrocracking catalyst. Preferably, this metallic hydrogenation catalyst

is selected from the metals of Group VIII of the Periodic Table, for example, cobalt, nickel, and platinum, or from the metals of Group VI-B, for example, molybdenum and tungsten. These hydrogenation components can be introduced into the catalyst by impregnating the acidic cracking component with a heat-decomposable compound of the hydrogenation metal, and then calcining the resulting composite.

The acidic cracking component of the hydrocracking catalyst may be made up of one or more of the following solid acidic components: silica-alumina, silica-alumina-zirconia, silica-magnesia, acid-treated-aluminas, with or without halogens, such as fluorided alumina, boria alumina, and the various heteropoly acid-treated-aluminas, and other similar solid acidic components. Each acidic component must possess substantial cracking activity in the finished catalyst composite. The preparation and the properties of such acidic cracking components are well known to those skilled in the art and need not be considered further. A discussion of these components may be found in Emmett's *Catalysis*, volume 7, Reinhold Publishing Corporation, pages 1-91.

The preferred hydrocracking catalyst also comprises an activity-control-affording material. Such a material balances the activities of the various catalytic elements so that a low rate for hydrogenation relative to that for isomerization results. Such balanced activities in the catalyst provide more branched paraffins and a better product distribution. The normally solid elements of the Group VI-A of the Periodic Table, particularly sulfur, and the normally solid elements of Group V-A of the Periodic Table, particularly arsenic and antimony, and metals such as lead, mercury, copper, zinc, and cadmium can provide an advantageous balance in activities between the metallic hydrogenation component and the solid acidic component. Such activity-control-affording elements may be introduced into the catalyst during the catalyst manufacture by impregnating a composite of a hydrogenation component on a solid acidic component with a solution of an organic or inorganic compound, for example, triphenyl arsine, mercuric nitrate, and arsenic trioxide. Of course, the composite of hydrogenation component on acidic cracking component could be treated with a sulfur compound, such as hydrogen sulfide or carbon disulfide. Only small amounts of these activity-control-affording elements are required in the catalyst. Therefore, in the case of arsenic or antimony, only about 0.1 to 5 moles of arsenic or antimony, preferably about 0.1 to 1 mole, and optimally about 0.25 to 0.75 mole, of these elements are used per mole of the hydrogenation metal. Not only will the use of these activity-affording-control elements result in an increase of branched-chain paraffins, but also catalyst regeneration is facilitated.

Suitable operating conditions that are employed in the hydrocracking zone include a temperature of from about 450° F. to about 750° F., a pressure of from about 200 to 2500 p.s.i.g., a liquid hourly space velocity of from about 0.2 to about 5 volumes of hydrocarbon per hour per volume of catalyst, and a hydrogen-to-oil ratio of from about 2,000 to about 15,000 standard cubic feet of hydrogen per barrel of hydrocarbon. Preferably, the temperature is from 500° F. to 700° F.; the pressure, from about 1200 to about 1800 p.s.i.g.; the liquid hourly space velocity, from about 1 to about 2 volumes of hydrocarbon per hour per volume of catalyst; and the hydrogen-to-oil ratio, from about 5,000 to about 10,000 standard cubic feet of hydrogen per barrel of hydrocarbon.

The following specific example is presented for the purpose of illustration only and is not intended to limit my invention.

Referring to FIGURE 1, which represents a simplified flow diagram of my improved two-stage hydrocracking process, fresh hydrocarbon feed is introduced into the processing system by way of line 11. This hydrocarbon feed is commingled with total hydrocrackate in line 12.

The mixed feed-hydrocrackate stream is passed through line 13 into the top of reactor 14, which contains the feed-pretreatment zone of my process. A bed of nickel-tungsten-sulfide-on-silica-alumina catalyst is contained in reactor 14. The mixed feed-hydrocrackate stream is passed down through this catalyst bed under operating conditions which include a temperature between 680° F. and 700° F., a pressure of about 1200 p.s.i.g., a liquid hourly space velocity of 2.6 volumes of hydrocarbon per hour per volume of catalyst, and a hydrogen-to-oil ratio of approximately 5,700 standard cubic feet of hydrogen per barrel of hydrocarbon.

The effluent from reactor 14 is passed through line 15 into flash drum 16, where a small amount of heavy bottoms is separated therefrom and removed from the system via line 17. Water may be injected into the effluent from reactor 14 to wash ammonia from the system. The water, containing dissolved ammonia, will be removed along with the heavy bottoms via line 17. The rest of the effluent is passed by way of line 18 into liquid-gas separator 19, where the light gases containing hydrogen are separated therefrom and transferred by way of line 20 for introduction into the hydrocracking zone of my process. The liquid from liquid-gas separator 19 is passed through line 21 into fractionator 22, where material boiling in the gasoline boiling range and/or distillates are separated therefrom and removed from the system by way of lines 23, 24 and 25. The heavier material, hereinafter called hydrocracking feed, is passed through line 26, to be introduced into the hydrocracking zone.

Make-up hydrogen-containing gas and reused hydrogen are commingled with this hydrocracking feed in line 26. The make-up hydrogen is introduced into the system by way of line 27; the reused hydrogen, by way of line 28.

The mixed hydrogen-hydrocarbon stream is then passed by way of line 28 into the top of reactor 29, which contains the hydrocracking zone of my process. A nickel-arsenide-on-fluorided-silica-alumina catalyst is contained in reactor 29. The mixed hydrogen-hydrocarbon stream is passed down through this catalyst bed under hydrocracking conditions, which include a temperature within the range of 625° F. to 700° F., a pressure of about 1200 p.s.i.g., a liquid hourly space velocity of 1 volume of hydrocarbon per hour per volume of catalyst, and a hydrogen-to-oil ratio of about 10,000 standard cubic feet of hydrogen per barrel of hydrocarbon. Approximately 60% conversion to material boiling in the gasoline boiling range results. The effluent from reactor 29 is passed through line 12, where it is commingled with the fresh hydrocarbon feed being introduced into the system by way of line 11. This mixed hydrocarbon stream is then passed through line 13 into the feed-preparation zone of my process, as discussed above.

As can be readily seen, only one stream of make-up hydrogen-containing gas and only one stream of reused hydrogen-containing gas is required in the process of the present invention. However, two streams of make-up hydrogen-containing gas and two streams of recycled hydrogen-containing gas are required in the conventional two-stage hydrocracking process. Such a reduction in gas streams offers process advantages and the possibility of lower investment costs. Such advantages could be offset by a detrimental effect upon the pretreatment of the feed by the dilution of the feed stock.

To show the effect of feed dilution on the pretreatment of the feed, tests were performed in a bench-scale hydrogenation unit using a nickel-tungsten-sulfide-on-silica-alumina catalyst which had seen service for 203 days of operation on a light virgin gas oil. Two feed stocks were employed in this study. The fresh feed was a mixture of 75 volume percent light virgin gas oil and 25 volume percent of heavy catalytic cycle oil. The diluted feed was prepared by mixing 40 volume percent of this fresh feed with 60 volume percent of its hydrocracked product, which had been obtained from a prior hydrocracking test. This

hydrocrackate contained approximately 60% material boiling in the gasoline boiling range. The properties of these stocks are presented in Table I.

TABLE I

	Fresh Feed	Hydrocrackate	Diluted Feed
Gravity, °API.....	27.8	-----	42.0
Refractive Index.....	1.4980	-----	1.4573
Total Nitrogen, p.p.m.....	357	*1.5	144
Basic Nitrogen, p.p.m.....	86.1	*0.7	34.5

*Sample was not purged of hydrogen sulfide and ammonia.

Data were obtained over an 18-day period of operation in which the fresh and diluted feeds were alternately processed. Two-hour test samples were taken once each day and analyzed for total and basic nitrogen after the dissolved hydrogen sulfide and ammonia had been removed by purging the material with hydrogen. Results from representative test periods using the fresh feed and the diluted feed are presented in Table II.

TABLE II

Feed.....	Fresh (357 p.p.m. N)	Diluted (144 p.p.m. N)
Days on Stream.....	205	212
Pressure, p.s.i.g.....	1,200	1,200
Temperature, °F.....	692	691
Space Velocity, Vo./hr./Vo.....	2.0	2.0
H ₂ /HC ratio, M s.c.f.b.....	9.2	9.5
Total Nitrogen, p.p.m.....	10.6	0.6
Percent Denitrogenation.....	97.03	99.53

These results show that the diluted feed is easier to denitrogenate. However, an evaluation of the effect of diluting fresh feed to the pretreatment zone with hydrocrackate should be made on a fresh-feed basis.

In FIGURE 2, product nitrogen content, which is based on fresh feed, is plotted against a severity factor which consists of the product of a temperature function, involving an activation energy of 26 kcal., and the reciprocal of fresh feed space velocity. It is assumed that the nitrogen in the hydrocrackate, approximately 1.5 p.p.m., is readily removed and has no effect on the product content. This figure indicates that the addition of hydrocrackate to the feed-pretreatment zone increases the catalyst requirement in that zone for bringing about a specified level of denitrogenation. In this case, the increase in the amount of catalyst needed is approximately 20%. However, this increased catalyst requirement could be offset through an increase in temperature of approximately 10° F.

This relatively minor adjustment in catalyst requirement or reaction temperature that would be required to accommodate the dilution of the fresh feed with hydrocrackate prior to its introduction into the feed-pretreatment zone does not appreciably offset the advantages of my improved two-stage process.

What I claim is:

1. In a two-stage hydrocracking process wherein a hydrocarbon feed stock is pretreated in the presence of a hydrofining catalyst under hydrofining conditions in a feed-preparation zone to remove contaminants, hydrogen-containing gas is separated from the effluent from said feed-preparation zone, the liquid effluent from said feed-preparation zone is fractionated in a fractionation zone to separate light overhead products and a heavier liquid effluent, the overhead products from said fractionation zone are collected, heavier liquid effluent obtained from said fractionation zone is introduced into a hydrocracking zone to contact a hydrocracking catalyst therein in the presence of hydrogen-containing gas under hydrocracking conditions, the improvement which comprises combining effluent from said hydrocracking zone with said hydrocarbon feed stock and passing the resulting combined stream through said feed-preparation zone, commingling separated hydrogen-containing gas obtained from

said feed-preparation zone with said heavier liquid effluent, and introducing the resulting commingled stream into said hydrocracking zone to contact said hydrocracking catalyst therein under hydrocracking conditions.

2. The process of claim 1 wherein make-up hydrogen-containing gas is commingled with said separated hydrogen-containing gas and said heavier liquid effluent and the resulting commingled stream is subsequently introduced into said hydrocracking zone.

3. The process of claim 1 wherein the total effluent from said feed-preparation zone is flashed to remove a heavy-bottoms fraction.

4. The process of claim 1 wherein said light overhead products comprise hydrocarbons boiling in the gasoline boiling range.

5. The process of claim 1 wherein said light overhead products comprise hydrocarbon distillates.

6. The process of claim 1 wherein said light overhead products comprise hydrocarbon distillates and hydrocarbons boiling in the gasoline boiling range.

7. The process of claim 1 wherein said hydrocarbon feed stock is a light catalytic cycle oil which boils within the range from about 350° F. to about 650° F.

8. The process of claim 1 wherein said hydrocarbon feed stock is a heavy catalytic cycle oil which boils within the range from about 500° F. to about 800° F.

9. The process of claim 1 wherein said hydrocarbon feed stock is a virgin gas oil which boils within the range from about 400° F. to about 1000° F.

10. The process of claim 1 wherein said hydrocracking catalyst comprises a Group VIII metal hydrogenation component, a solid acidic support and from 0.1 to 1 mole of activity-control-affording element selected from the group consisting of sulfur and the normally solid elements of Group V-A of the Periodic Table per mole of said Group VIII metal to provide a hydrogenation-component activity low in relation to the activity of said acidic component and to provide a gasoline-boiling-range product rich in isoparaffins.

11. The process of claim 1 wherein said hydrocracking catalyst comprises sulfided nickel on a silica-alumina cracking support.

12. The process of claim 1 wherein said hydrocracking catalyst comprises arsenided nickel on a silica-alumina cracking support.

13. The process of claim 1 wherein said hydrocracking catalyst comprises arsenided nickel on a fluorided silica-alumina cracking support.

14. The process of claim 1 wherein said hydrofining catalyst comprises more than one hydrogenation component, each of which is selected from the group which consists of the elements in Group VI-B and Group VIII of the Periodic Table, and the oxides and sulfides thereof, supported on an adsorbent oxide carrier.

15. The process of claim 1 wherein said hydrofining catalyst comprises nickel-tungsten-sulfide on a silica-alumina cracking support.

16. The process of claim 1 wherein said hydrocracking conditions include a temperature within the range from about 450° F. to about 750° F., a pressure within the range from about 200 to about 2500 p.s.i.g., a liquid hourly space velocity within the range from about 0.2 to about 5 volumes of hydrocarbon per hour per volume of catalyst, and a hydrogen-to-oil ratio within the range from about 2,000 to about 15,000 standard cubic feet of hydrogen per barrel of hydrocarbon.

17. A hydrocracking process which comprises introducing a hydrocarbon feed stock into a feed-preparation zone, treating said feed stock in said feed-preparation zone in the presence of a hydrofining catalyst under hydrofining conditions, flashing the effluent from said feed-preparation zone to remove a heavy-bottoms fraction, separating hydrogen-containing light gases from the flashed material, passing the separated hydrogen-containing light gases to a hydrocracking zone, fractionating in

a fractionation zone the remainder of said flashed material to separate light overhead products and a heavier liquid effluent, passing said heavier liquid effluent to said hydrocracking zone, commingling said heavier liquid effluent with said hydrogen-containing light gases and make-up hydrogen-containing gas to obtain a mixed hydrogen-hydrocarbon stream, introducing said mixed hydrogen-hydrocarbon stream into said hydrocracking zone, hydrocracking said mixed hydrogen-hydrocarbon stream in said hydrocracking zone in the presence of a hydrocracking catalyst under hydrocracking conditions, and commingling the effluent from said hydrocracking zone with said feed stock prior to introducing said feed stock into said feed-preparation zone.

18. The process of claim 17 wherein said hydrocarbon feed stock is a light catalytic cycle oil which boils within the range from about 350° F. to about 650° F.

19. The process of claim 17 wherein said hydrocarbon feed stock is a heavy catalytic cycle oil which boils within the range of from about 500° F. to about 800° F.

20. The process of claim 17 wherein said hydrocarbon feed stock is a virgin gas oil which boils within the range from about 400° F. to about 1000° F.

21. The process of claim 17 wherein said hydrocracking catalyst comprises a Group VIII metal hydrogenation component, a solid acidic support and from 0.1 to 1 mole of activity-control-affording element selected from the group consisting of sulfur and the normally solid elements of Group V-A of the Periodic Table per mole of said Group VIII metal to provide a hydrogenation-component activity low in relation to the activity of said acidic component and to provide a gasoline-boiling-range product rich in isoparaffins.

22. The process of claim 17 wherein said hydrocracking catalyst comprises sulfided nickel on a silica-alumina cracking support.

23. The process of claim 17 wherein said hydrocracking catalyst comprises arsenided nickel on a silica-alumina cracking support.

24. The process of claim 17 wherein said catalyst comprises an arsenided nickel on a fluorided silica-alumina cracking support.

25. The process of claim 17 wherein said hydrofining catalyst comprises more than one hydrogenation component, each of which is selected from the group which consists of the elements of Group VI-B and Group VIII of the Periodic Table, and the oxides and sulfides thereof, supported on an adsorbent oxide carrier.

26. The process of claim 17 wherein said hydrofining catalyst comprises nickel-tungsten-sulfide on a silica-alumina cracking support.

27. The process of claim 17 wherein said light overhead products comprise hydrocarbons boiling in the gasoline boiling range.

28. The process of claim 17 wherein said light overhead products comprise hydrocarbon distillates.

29. The process of claim 17 wherein said light overhead products comprise hydrocarbon distillates and hydrocarbons boiling in the gasoline boiling range.

30. A hydrocracking process which comprises introducing a hydrocarbon feed stock into a feed-preparation zone, treating said feed stock in said feed-preparation zone in the presence of a hydrofining catalyst under hydrofining conditions, separating hydrogen-containing light gases from the effluent from said feed-preparation zone, passing separated hydrogen-containing light gases to a hydrocracking zone, fractionating in a fractionation zone the remainder of said effluent from said feed-preparation zone to separate light overhead products and a heavier liquid effluent, collecting said light overhead products, passing said heavier liquid effluent to said hydrocracking zone, introducing said heavier liquid effluent and hydrogen-containing gas into said hydrocracking zone, hydrocracking said heavier liquid effluent in said hydrocracking zone in the presence of a hydrocracking catalyst under

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hydrocracking conditions, and introducing effluent from said hydrocracking zone into said feed-preparation zone.

31. The process of claim 30 wherein said hydrogen-containing gas comprises said separated hydrogen-containing light gases.

32. The process of claim 30 wherein said hydrogen-containing gas comprises make-up hydrogen-containing gas.

33. The process of claim 30 wherein said hydrogen-containing gas comprises make-up hydrogen-containing gas and said separated hydrogen-containing light gases.

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34. The process of claim 30 wherein the effluent from said feed-preparation zone is flashed to remove a heavy-bottoms fraction.

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