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Description

The present invention relates to a process for converting a feed containing heavy hydrocarbons having a high boiling range into a stream containing hydrocarbons having a lower boiling range.

It is an object of the present invention to provide a process for converting in a first stage a substantially liquid feed and in a second stage a substantially gaseous stream.

To this end the process for converting a stream containing heavy hydrocarbons containing more than 70% by weight of hydrocarbons having a boiling range above 370 °C, into a stream containing hydrocarbons which are liquid at normal conditions and containing more than 40% by weight of hydrocarbons having a boiling range below 370 °C, according to the invention comprises the steps of

a) passing through a first conversion zone containing a conversion catalyst suitable for removal of asphaltenes, for producing hydrocarbons having a decreased amount of carbon residue left after evaporation and pyrolysis and/or for demetallization, in the presence of hydrogen the feed containing heavy hydrocarbons at a temperature between 325 and 600 °C, a pressure between 1 and 30 MPa and at an hourly space velocity between 0.05 and 5 kg/l/hour to produce a primary converted stream;

b) passing the primary converted stream to a first separation zone which is not a fractional distillation, and removing from the first separation zone a gaseous stream, substantially free of heavy metals and heavy aromatic molecules and containing hydrocarbons which are liquid at normal conditions of temperature and pressure, and a liquid stream;

c) passing at least a part of the gaseous stream to a second conversion zone; and

d) passing through the second conversion zone containing a conversion catalyst suitable for desulphurization, hydrogenation and/or denitrogenation, in the presence of hydrogen the gaseous stream at a temperature between 325 and 600 °C, a pressure between 1 and 30 MPa and at an hourly space velocity between 0.1 and 10.0 kg/l/hour to produce a stream containing more than 40% wt of hydrocarbons having a boiling range below 370 °C.

An advantage of the process according to the invention is that no fractional distillation is carried out between the first conversion zone and the second conversion zone. A further advantage is that the gaseous stream is maintained at a high pressure and at a high temperature.

From the Petroleum Handbook, 6th edition, Elsevier, p. 310, a process is known for hydrotreating pyrolysis gasoline, which is a hydrocarbon-containing stream having a boiling range between 180 and 205 °C, comprising treating the stream in a first reactor at a temperature between 80 and 130 °C and a pressure of about 6 MPa, separating the effluent from the first reactor into a gaseous stream and a liquid stream of which a part is returned to the first reactor, treating the gaseous stream and the remaining part of the liquid stream combined in a second reactor at a temperature between 230 and 280 °C and a pressure between 4.5 and 6.5 MPa, and separating the effluent from the second reactor into a gaseous stream which is recycled to the second reactor and a liquid product stream.

Further, a process for dewaxing heavy distillate and residual oil is known from EP-A-0,181,066, in which process feedstock is contacted in a first dewaxing step with a dewaxing catalyst, and from the effluent thus obtained a liquid stream is separated, which liquid stream is sent to a second dewaxing unit.

The heavy hydrocarbons containing more than 70% by weight of hydrocarbons having a boiling range above 370 °C may contain sulphur, for example between 0.05 and 8% by weight, and heavy metals such as vanadium, for example between 0.5 and 2 000 ppm (parts per million by weight).

In the specification and in the claims the hourly space velocity is expressed as kg hydrocarbon-containing stream per liter of catalyst per hour (kg/l/hour).

The first conversion zone contains a first conversion catalyst suitable for hydrocarbon conversion, for removal of asphaltenes, for producing hydrocarbons having a decreased amount of carbon residue left after evaporation and pyrolysis, and/or for demetallization. Examples of suitable catalysts are catalysts comprising an inorganic oxidic carrier, for example silica and/or alumina, containing one or more compounds of nickel, vanadium, molybdenum and tungsten.

The second conversion zone contains a second conversion catalyst suitable for desulphurization, hydrogenation and/or denitrogenation of a gaseous hydrocarbon stream. Examples of suitable catalysts are catalysts comprising an inorganic oxidic carrier, for example alumina and/or silica, containing either nickel and/or cobalt, or molybdenum and/or tungsten.

Heavy metals from the heavy hydrocarbons are deposited on the catalyst in the first conversion zone. Furthermore, in the separation zone heavy highly aromatic molecules, which are still present in the product from the first conversion zone, are separated from the gaseous stream. Therefore a stream substantially free of heavy metals and of heavy aromatic molecules is contacted with the catalyst in the second conversion zone. This has a

beneficial effect on the life of the catalyst in the second conversion zone.

The invention will now be described by way of example in more detail with reference to the drawings, wherein

Figure 1 shows schematically a first embodiment of the invention;

Figure 2 shows schematically a second embodiment of the invention;

Figure 3 shows schematically a third embodiment of the invention; and

Figure 4 shows schematically a fourth embodiment of the invention.

Reference is made to Figure 1 showing an apparatus for carrying out the process according to the invention. The apparatus comprises a first conversion zone in the form of first reactor 1, a first separation zone in the form of first gas/liquid separator 4 and a second conversion zone in the form of second reactor 7. To the first reactor 1 a hydrogen supply conduit 8 and a feed supply conduit 9 are connected. The first gas/liquid separator 4 is connected to the first reactor 1 by means of conduit 10. The upper zone of the first gas/liquid separator 4 is connected to the second reactor 7 by means of conduit 12, and a liquid conduit 15 is connected to the lower zone of the first gas/liquid separator 4. To the second reactor 7 a second hydrogen supply conduit 17 is connected, and to the upper end of the second reactor 7 an effluent removal conduit 18 is connected.

During normal operation, a preheated, substantially liquid feed containing heavy hydrocarbons is supplied to the first reactor 1 through the feed supply conduit 9, and hydrogen is supplied to the first reactor 1 through the hydrogen supply conduit 8. The temperature of the hydrocarbon-containing stream is between 325 and 600 °C and suitably between 350 and 500 °C, the pressure between 1 and 30 MPa and suitably between 2 and 25 MPa, and the rate at which the hydrocarbon-containing stream is supplied is selected such that in the first reactor 1 the hourly space velocity is between 0.05 and 5 kg/l/hour and suitably between 0.1 and 2.5 kg/l/hour. The amount of hydrogen is suitably between 250 and 2 000 Nm3 per 1 000 kg hydrocarbon-containing stream. A primary converted stream is removed from the first reactor 1 and is passed via conduit 10 to the first gas/liquid separator 4. From the first gas/liquid separator 4 a gaseous stream and a liquid stream are removed. Since the gas/liquid separation is carried out substantially at the same pressures and temperatures as the conversions in the first reactor and second reactor the gaseous stream, which contains hydrogen, is passed to the second reactor without substantially heating and/or pressurizing.

The gaseous stream is supplied via conduit 12 to the second reactor 7 at a temperature between 325 and 600 °C and suitably between 350 and 500 °C, a pressure between 1 and 30 MPa and suitably between 2 and 25 MPa. The amount of catalyst in the second reactor 7 is such that at the rate at which the hydrocarbon-containing stream is supplied the hourly space velocity is between 0.1 and 10.0 kg/l/hour and suitably between 0.25 and 5.0 kg/l/hour. In addition hydrogen can be supplied to the second reactor 7, the amount of hydrogen being suitably up to 2 000 Nm^3 per kg hydrocarbon-containing stream. A further converted stream containing hydrocarbons having a lower boiling range is withdrawn from the second reactor 7 through effluent removal conduit 18.

To control the pressure in the first gas/liquid separator 4 and in the second reactor 7, the conduits 10 and/or 12 may be provided with pressure control means (not shown).

EXAMPLE I

A liquid hydrocarbon-containing feed containing 93.5% by weight of hydrocarbons having a boiling range above 370 °C, 4.7% by weight sulphur, and 84 ppm vanadium is supplied to the first reactor 1 at an hourly space velocity of 1 kg/l/hour, a temperature of 440 °C and a pressure of 15 MPa. Hydrogen is supplied to the first reactor 1 at a rate of 1 000 Nm^3/1 000 kg of liquid hydrocarbon-containing feed. The first reactor 1 is filled with a catalyst comprising a silica-containing carrier and compounds of nickel and vanadium. The primary converted stream produced in the first reactor 1 is passed to the first gas/liquid separator 4 and from the first gas/liquid separator 4 a gaseous stream and a liquid stream are removed.

The liquid stream is removed from the first gas/liquid separator 4 through liquid conduit 15, and the amount of the liquid stream is 39% by weight of the liquid hydrocarbon-containing feed supplied to the first reactor. The liquid stream contains 53.47% by weight of hydrocarbons having a boiling range between 370 and 520 °C and 46.53% by weight of hydrocarbons having a boiling range above 520 °C, and contains further 3.2% by weight of sulphur and 4 ppm vanadium.

The gaseous stream removed from the first gas/liquid separator 4 through conduit 12 comprises hydrocarbons and hydrogen, the hydrocarbon content of this stream is 61% by weight of the liquid hydrocarbon-containing feed supplied to the first reactor 1. The hydrocarbon part of the gaseous stream comprises 83% by weight hydrocarbons having a boiling range below 370 °C and 0.8% by weight sulphur.

This gaseous stream is supplied to the second reactor 7 at a temperature of 410 °C and a pres-

sure of 13 MPa. No extra hydrogen is supplied to the second reactor 7. The second reactor 7 is filled with a catalyst comprising an alumina-containing carrier and compounds of nickel and molybdenum. The volume of the reactor filled with catalyst is such that at the rate at which the stream to be treated is supplied the hourly space velocity is 0.5 kg/l/hour.

The further converted stream produced in the second reactor 7 contains hydrocarbons, hydrogen and gaseous contaminants such as H_2S and NH_3. The hydrocarbon content of the further converted stream equals 61% by weight of the liquid hydrocarbon-containing feed supplied to the first reactor 1, and it comprises 9.64% by weight of hydrocarbons having 1 to 4 carbon atoms, 32.78% by weight of hydrocarbons having more than 5 carbon atoms and a boiling range below 250 °C, 49.61% by weight of hydrocarbons having a boiling range between 250 and 370 °C, 7.98% by weight of hydrocarbons having a boiling range between 370 and 520 °C, and 0.014% by weight of sulphur. It will be appreciated that hydrogen sulphide and hydrogen can be removed from the further converted stream in a conventional manner which is not described here, and that the separated hydrogen can be compressed and reused in the first or second conversion zone.

In the embodiment of the invention shown in Figure 2 liquid conduit 15 is connected by means of conduit 20 to the feed supply conduit 9. The parts of the apparatus shown in Figure 2 which are similar to the parts shown in Figure 1 have the same reference numerals. This embodiment allows passing to the first reactor 1 a part of or substantially all liquid separated from the primary converted stream to the first reactor 1, s o that the liquid stream can be further converted with the catalyst in the first reactor 1.

EXAMPLE 21

The hydrocarbon-containing feed of Example I is supplied under the same conditions to the first reactor 1 together with a recycle stream to be described hereinafter.

The amount of liquid stream removed from the first gas/liquid separator 4 is 106% by weight of the liquid hydrocarbon-containing feed supplied to the first reactor 1. The liquid stream contains 61.03% by weight of hydrocarbons having a boiling range between 370 and 520 °C and 38.97% by weight of hydrocarbons having a boiling range above 520 °C, and contains further 2% by weight of sulphur and 2 ppm vanadium. From the liquid removed from the first gas/liquid separator 4 an amount equal to 60% by weight of the liquid hydrocarbon-containing feed supplied to the first reactor 1 is passed as the recycle stream to the first reactor 1 through conduit 20.

The amount of liquid stream removed from liquid conduit 15 downstream to the point where conduit 20 is connected to conduit 15 is 46% by weight of the hydrocarbon-containing feed supplied to the first reactor 1, and this stream is removed as a bottom product.

The gaseous stream removed from the gas/liquid separator 4 through conduit 12 contains hydrocarbons and hydrogen, the hydrocarbon content of the gaseous stream is 54% by weight of the hydrocarbon-containing feed supplied to the first reactor 1. The hydrocarbon part of the gaseous stream comprises 73% by weight of hydrocarbons having a boiling range below 370 °C and 0.9% by weight sulphur. This gaseous stream is supplied to the second reactor 7 at a temperature of 410 °C and a pressure of 13 MPa. No extra hydrogen is supplied to the second reactor 7. The second reactor 7 is filled with the same catalyst as in Example 1. The volume of the reactor filled with catalyst is such that at the rate at which the stream to be treated is supplied the hourly space velocity is 0.5 kg/l/hour.

The further converted stream produced in the second reactor 7 contains hydrocarbons, hydrogen and contaminants such as H_2S and NH_3. The hydrocarbon part of the further converted stream comprises 7.33% by weight of hydrocarbons having 1 to 4 carbon atoms, 28.86% by weight of hydrocarbons having more than 5 carbon atoms and a boiling range below 250 °C, 50.73% by weight of hydrocarbons having a boiling range between 250 and 370 °C, and 13.08% by weight of hydrocarbons having a boiling range between 370 and 520 °C and 0.021% by weight of sulphur. The amount of hydrocarbons in the range C_1-C_4 in the further converted stream per unit of converted heavy hydrocarbon is less than in the further converted stream produced in Example 1.

For some kinds of heavy hydrocarbons to be converted it would be more profitable to increase the upper limit of the boiling range of the gaseous stream supplied to the second reactor in order to improve the overall conversion of the hydrocarbons having a boiling range above 370 °C.

To increase the upper limit of the boiling range of the gaseous stream liquid outlet 15 is connected to a second separation zone in the form of second gas/liquid separator 24 (see Figure 3). The gaseous hydrocarbons are removed from the second gas/liquid separator 24 and passed through conduit 25 to conduit 12 and into the second conversion reactor 7.

The liquid hydrocarbons are removed from the second gas/liquid separator 24 through conduit 26. If required a part of the liquid hydrocarbons may

be added through conduit 27 to the feed containing heavy hydrocarbons before this stream is passed through the first reactor 1.

EXAMPLE 3

A hydrocarbon-containing feed containing 90.5% by weight of hydrocarbons having a boiling range above 370 °C, 4.7% by weight sulphur, and 84 ppm vanadium is supplied to the first reactor 1 at an hourly space velocity of 1 kg/l/hour, a temperature of 440 °C and a pressure of 15 MPa, together with a recycle stream to be described hereinafter. Hydrogen is supplied to the first reactor 1 at a rate of 1 000 Nm^3/1 000 kg of hydrocarbon-containing stream. The first reactor 1 is filled with a catalyst comprising a silica-containing carrier and compounds of nickel and vanadium. The primary converted stream produced in the first reactor 1 is passed to the first gas/liquid separator 4 and from the first separation zone a gaseous stream and a liquid stream are removed.

The liquid stream is removed from the gas/liquid separator 4 through liquid conduit 15. The amount of this liquid stream is 77% by weight of the hydrocarbon-containing feed supplied to the first reactor 1, and the liquid stream does not contain hydrocarbons having a boiling range below 410 °C, and contains 1.9% by weight of sulphur and 4 ppm vanadium. The liquid stream is supplied to the second gas/liquid separator 24. In the second gas/liquid separator 24, operating at a pressure of 4 kPa (30 mm Hg), the stream is separated into a gaseous stream, corresponding to 28.4 % by weight of the hydrocarbon-containing feed supplied to the first reactor 1, and a liquid stream. The gaseous stream is supplied to the second reactor 7. The liquid stream contains 4.03% by weight of hydrocarbons having a boiling range between 370 and 520 °C and 95.97% by weight of hydrocarbons having a boiling range above 520 °C. A fraction of the liquid stream, corresponding to 30% by weight of the hydrocarbon-containing feed supplied, is supplied as the recycle stream to the first reactor 1 through conduit 27 to the first reactor 1, and the remaining part of the liquid stream, corresponding to 19 % by weight of the hydrocarbon-containing feed supplied to the first reactor 1, is removed through conduit 26 downstream conduit 27 as a bottom product.

The gaseous stream removed from the gas/liquid separator 4 through conduit 12 contains hydrocarbons and hydrogen, the hydrocarbon content of the gaseous stream is 54% by weight of the hydrocarbon-containing feed supplied to the first reactor 1. The hydrocarbon part of the gaseous stream comprises 73% by weight of hydrocarbons having a boiling range below 370 °C and 0.9% by weight of sulphur. This gaseous stream is supplied to the second reactor 7.

The gaseous streams from the separators 4 and 24 are supplied to the second reactor 7 at a temperature of 410 °C and a pressure of 13 MPa. The total amount of the gaseous streams is 81% by weight of the hydrocarbon-containing feed supplied to the first reactor 1. No extra hydrogen is supplied to the second reactor 7. The second reactor 7 is filled with a catalyst comprising an alumina-containing carrier and compounds of nickel and molybdenum. The volume of the reactor filled with catalyst is such that at the rate at which the streams to be treated are supplied the hourly space velocity is 0.5 kg/l/hour.

The hydrocarbon content of the further converted stream produced in the second reactor 7 is 81% by weight of the hydrocarbon-containing feed supplied to the first reactor 1, and the further converted stream comprises 5.75% by weight of hydrocarbons having 1 to 4 carbon atoms, 25.90% by weight of hydrocarbons having more than 5 carbon atoms and a boiling range below 250 °C, 42.34% by weight of hydrocarbons having a boiling range between 250 and 370 °C, 25.74% by weight of hydrocarbons having a boiling range between 370 and 520 °C, 0.26% by weight of hydrocarbons having a boiling range above 520 °C, and 0.032% by weight of sulphur.

Reference is now made to Figure 4, showing an embodiment of the invention wherein the liquid stream removed from the first gas/liquid separator 4 is passed through conduit 15 for further conversion to a further conversion zone in the form of reactor 30. In reactor 30 the liquid stream is contacted in the presence of hydrogen with a conversion catalyst of the kind which is present in the second reactor 7 to produce a secondary converted stream.

This conversion catalyst is suitable for desulphurization, hydrogenation and/or denitrogenation of a gaseous hydrocarbon stream. Examples of suitable catalysts are catalysts comprising a carrier containing alumina or silica and alumina, and either nickel and/or cobalt, or molybdenum and/or tungsten.

The temperature of the liquid stream is between 325 and 600 °C and suitably between 350 and 500 °C, the pressure in reactor 30 is between 1 and 30 MPa and suitably between 2 and 25 MPa, and the volume of catalyst in reactor 30 is such that at the rate at which the liquid stream is supplied the hourly space velocity in reactor 30 is between 0.05 and 10 kg/l/hour and suitably between 0.1 and 5 kg/l/hour. If required hydrogen can be supplied to reactor 30 through hydrogen supply conduit 31. The secondary converted stream is removed from reactor 30 through outlet conduit 32.

To remove the gaseous components from the secondary converted stream this stream can be passed directly to the first gas/liquid separator (not shown), or the secondary converted stream can be passed to a further separation zone in the form of gas/liquid separator 35.

From gas/liquid separator 35 a gaseous stream is passed through conduit 36 to the second reactor 7. A liquid stream is removed from gas/liquid separator 35 through conduit 37. If required a part or all of the liquid stream can be passed through conduit 38 to the first reactor 1.

EXAMPLE 4

The hydrocarbon-containing feed of Example 1 is supplied under the same conditions to the first reactor 1 together with a recycle stream as hereinafter described.

The gaseous stream removed from the gas/liquid separator 4 through conduit 12 contains hydrocarbons and hydrogen, and the hydrocarbon content of the gaseous stream is 54% by weight of the hydrocarbon-containing feed supplied to the first reactor 1. The hydrocarbon part of the gaseous stream comprises 73% by weight of hydrocarbons having a boiling range below 370 °C, 0.9% by weight of sulphur. This gaseous stream is supplied to the second reactor 7 at a temperature of 410 °C and a pressure of 13 MPa.

The liquid stream is removed from liquid conduit 15. The amount of the liquid stream is 76% by weight of the hydrocarbon-containing feed supplied to the first reactor 1, and comprises 63% by weight having a boiling range above 520 °C and does not contain hydrocarbons having a boiling range below 410 °C, and 1.9% by weight of sulphur.

The liquid stream is passed to reactor 30 which is filled with a catalyst comprising an alumina-containing carrier and compounds of nickel and molybdenum. The volume of the reactor filled with catalyst is such that at the rate at which the stream to be treated is supplied the hourly space velocity is 2.7 kg/l/hour. The secondary converted stream produced in reactor 30 comprises 97% by weight of hydrocarbons having a boiling range above 370 °C and 58% by weight of hydrocarbons having a boiling range above 520 °C, and 0.4% by weight of sulphur. This stream is passed through conduit 32 to gas/liquid separator 35, operating at 4 kPa (30 mm Hg).

The amount of liquid stream obtained in gas/liquid separator 35 is 45% by weight of the hydrocarbon-containing feed supplied to the first reactor 1. The liquid stream contains 3.97% by weight of hydrocarbons having a boiling range between 370 and 520 °C and 96.03% by weight of hydrocarbons having a boiling range above 520 °C. A part of the liquid stream, corresponding to 15% by weight of the hydrocarbon-containing feed as supplied to the first reactor 1, is removed through conduit 37 as a bottom product.

The remaining part of the liquid stream is passed through conduit 38 as the recycle stream to the first reactor 1, the amount of this stream is 30% by weight of the hydrocarbon-containing feed supplied to the first reactor 1.

The amount of the gaseous stream obtained in gas/liquid separator 35 equals 31% by weight of the hydrocarbon-containing feed supplied to the first reactor 1. The gaseous stream is passed through conduit 36 to the second reactor 7, where it is converted together with the gaseous stream from the first gas/liquid separator 4. No extra hydrogen is supplied to the second reactor. The second reactor 7 is filled with a catalyst comprising an alumina-containing carrier and compounds of nickel and molybdenum. The volume of the reactor filled with catalyst is such that at the rate at which the stream to be treated is supplied the hourly space velocity is 0.5 kg/l/hour.

The hydrocarbon content of the further converted stream produced in the second reactor 7 is 84.90% by weight of the hydrocarbon-containing feed supplied to the first reactor 1, the further converted stream comprises 6.15% by weight of hydrocarbons having 1 to 4 carbon atoms, 24.50% by weight of hydrocarbons having more than 5 carbon atoms and a boiling range below 250 °C, 41.41% by weight of hydrocarbons having a boiling range between 250 and 370 °C, 27.59% by weight of hydrocarbons having a boiling range between 370 and 520 °C, 0.33% by weight of hydrocarbons having a boiling range above 520 °C, and 0.020% by weight of sulphur.

A reactor as referred to in the Figures with reference numeral 1, 7 or 31 may be a packed bed reactor wherein the catalyst is arranged in a stationary bed, or a moving bed reactor wherein spent catalyst is continuously removed from the reactor at a predetermined rate and fresh catalyst is supplied to the reactor to replace spent catalyst, or a fluidized bed reactor wherein catalyst is fluidized by upwardly flowing fluid to be converted.

Each conversion zone may comprise a single reactor or more than one, for example three or four.

Hydrogen may be introduced as a separate stream into the reactor, or it may be mixed with the fluid to be converted before the fluid enters into the reactor.

Claims

1. Process for converting a feed containing more than 70% by weight of hydrocarbons having a boiling range above 370 °C, into a stream

containing hydrocarbons which are liquid at normal conditions and containing more than 40% by weight of hydrocarbons having a boiling range below 370 °C, comprising the steps of

a) passing through a first conversion zone containing a conversion catalyst suitable for removal of asphaltenes, for producing hydrocarbons having a decreased amount of carbon residue left after evaporation and pyrolysis and/or for demetallization, in the presence of hydrogen the feed containing heavy hydrocarbons at a temperature between 325 and 600 °C, a pressure between 1 and 30 MPa and at an hourly space velocity between 0.05 and 5 kg/l/hour to produce a primary converted stream;

b) passing the primary converted stream to a first separation zone which is not a fractional distillation, and removing from the first separation zone a gaseous stream, substantially free of heavy metals and heavy aromatic molecules and containing hydrocarbons which are liquid at normal conditions of temperature and pressure, and a liquid stream;

c) passing at least a part of the gaseous stream to a second conversion zone; and

d) passing through the second conversion zone containing a conversion catalyst suitable for desulphurization, hydrogenation and/or denitrogenation, in the presence of hydrogen the gaseous stream at a temperature between 325 and 600 °C, a pressure between 1 and 30 MPa and at an hourly space velocity between 0.1 and 10.0 kg/l/hour to produce a stream containing more than 40 %wt of hydrocarbons having a boiling range below 370 °C.

2. Process as claimed in claim 1, wherein a part of the liquid stream obtained in step b) is added to the feed containing heavy hydrocarbons before this stream is passed in step a) through the first conversion zone.

3. Process as claimed in claim 1, wherein the liquid stream obtained in step b) is added to the feed containing heavy hydrocarbons before this stream is passed in step a) through the first conversion zone.

4. Process as claimed in claim 1, further comprising passing the liquid stream obtained in step b) to a second separation zone, removing from the second separation zone a gaseous stream and a liquid stream, and adding the gaseous stream to the gaseous stream obtained in step b), before this gaseous stream is passed through the second conversion zone in step d).

5. Process as claimed in claim 4, wherein a part of the liquid stream removed from the second separation zone is added to the feed containing heavy hydrocarbons before this stream is passed in step a) through the first conversion zone.

6. Process as claimed in claim 1, further comprising passing through a third conversion zone containing a conversion catalyst in the presence of hydrogen the liquid stream obtained in step b) at a temperature between 325 and 600 °C, a pressure between 1 and 30 MPa and at an hourly space velocity between 0.05 and 10 kg/l/hour to produce a secondary converted stream.

7. Process as claimed in claim 6, further comprising passing a part of the secondary converted stream to the first separation zone.

8. Process as claimed in claim 6, further comprising passing the secondary converted stream to a further separation zone and removing from the third separation zone a gaseous stream and a liquid stream, and adding the gaseous stream to the gaseous stream obtained in step b), before this gaseous stream is passed through the second conversion zone in step d).

9. Process as claimed in claim 8, further comprising adding a part of the liquid stream removed from the further separation zone to the stream containing heavy hydrocarbons before this stream is passed in step a) through the first conversion zone.

Revendications

1. Procédé de conversion d'une charge contenant plus de 70 % en poids d'hydrocarbures ayant un domaine d'ébullition au-dessus de 370 °C en un courant contenant des hydrocarbures qui sont liquides dans les conditions normales et contenant plus de 40 % en poids d'hydrocarbures ayant un domaine d'ébullition au-dessous de 370 °C, comprenant les étapes selon lesquelles

a) on fait passer à travers une première zone de conversion contenant un catalyseur de conversion convenable pour l'élimination des asphaltènes, pour la production d'hydrocarbures ayant une teneur réduite en résidu de carbone laissé après évaporation et pyrolyse et/ou pour la démétallisation, en

présence d'hydrogène, la charge contenant des hydrocarbures lourds à une température comprise entre 325 et 600 °C, une pression comprise entre 1 et 30 MPa et une vitesse spatiale horaire comprise entre 0,05 et 5 kg/1/h afin de produire un courant transformé primaire ;

b) on fait passer le courant transformé primaire à une première zone de séparation qui n'est pas une distillation fractionnée, et on évacue de la première zone de séparation un courant gazeux, substantiellement exempt de métaux lourds et de molécules aromatiques lourdes et contenant des hydrocarbures qui sont liquides dans les conditions normales de température et de pression, et un courant liquide ;

c) on fait passer au moins une partie du courant gazeux à une deuxième zone de conversion ; et

d) on fait passer à travers la deuxième zone de conversion contenant un catalyseur de conversion convenable pour désulfuration, hydrogénation et/ou dénitrification, en présence d'hydrogène, le courant gazeux à une température comprise entre 325 et 600 °C, une pression comprise entre 1 et 30 MPa et une vitesse spatiale horaire comprise entre 0,1 et 10,0 kg/1/h afin de produire un courant contenant plus de 40 % en poids d'hydrocarbures ayant un domaine d'ébullition au-dessous de 370 °C.

2. Procédé selon la revendication 1, dans lequel une partie du courant liquide obtenu dans l'étape b) est ajoutée à la charge contenant des hydrocarbures lourds avant que cette charge ne soit passée dans l'étape a) à travers la première zone de conversion.

3. Procédé selon la revendication 1, dans lequel le courant liquide obtenu dans l'étape b) est ajouté à la charge contenant des hydrocarbures lourds avant que cette charge ne soit passée dans l'étape a) à travers la première zone de conversion.

4. Procédé selon la revendication 1, dans lequel en outre on fait passer le courant liquide obtenu dans l'étape b) à une deuxième zone de séparation, on évacue de la deuxième zone de séparation un courant gazeux et un courant liquide et on ajoute le courant gazeux au courant gazeux obtenu dans l'étape b), avant que ce courant gazeux ne soit passé à travers la deuxième zone de conversion dans l'étape d).

5. Procédé selon la revendication 4, dans lequel une partie du courant liquide évacué de la deuxième zone de séparation est ajoutée à la charge contenant des hydrocarbures lourds avant que cette charge ne soit passée dans l'étape a) à travers la première zone de conversion.

6. Procédé selon la revendication 1, dans lequel en outre on fait passer à travers une troisième zone de conversion contenant un catalyseur de conversion en présence d'hydrogène le courant liquide obtenu dans l'étape b) à une température comprise entre 325 et 600 °C, une pression comprise entre 1 et 30 MPa et une vitesse spatiale horaire comprise entre 0,05 et 10 kg/1/h afin de produire un courant transformé secondaire.

7. Procédé selon la revendication 6, dans lequel en outre on fait passer une partie du courant transformé secondaire à la première zone de séparation.

8. Procédé selon la revendication 6, dans lequel en outre on fait passer le courant transformé secondaire à une zone de séparation supplémentaire et on évacue de cette zone de séparation un courant gazeux et un courant liquide, et on ajoute le courant gazeux au courant gazeux obtenu dans l'étape b), avant que ce courant gazeux ne soit passé à travers la deuxième zone de conversion dans l'étape d).

9. Procédé selon la revendication 8, dans lequel en outre ou ajoute une partie du courant liquide évacué de la zone de séparation supplémentaire à la charge contenant des hydrocarbures lourds avant que cette charge ne soit passée dans l'étape a) à travers la première zone de conversion.

Patentansprüche

1. Verfahren zur Umwandlung eines mehr als 70 Gew.-% an Kohlenwasserstoffen mit einem Siedebereich über 370 °C enthaltenden Einsatzmaterials in einen Strom, der bei Normalbedingungen flüssige Kohlenwasserstoffe enthält und mehr als 40 Gew.-% Kohlenwasserstoffe mit einem Siedebereich unter 370 °C aufweist, umfassend die folgenden Stufen:

a) Führen des schwere Kohlenwasserstoffe enthaltenden Einsatzmaterials bei einer Temperatur von 325 bis 600 °C und bei einem Druck von 1 bis 30 MPa und bei einer Raumgeschwindigkeit von 0,05 bis 5 kg/1/h in Gegenwart von Wasserstoff durch eine erste Umwandlungszone, die einen

Umwandlungskatalysator enthält, der sich für die Abtrennung von Asphaltenen, für die Ausbildung von Kohlenwasserstoffen mit einer verringerten Menge an Kohlenstoffrückstand nach einem Verdampfen und einer Pyrolyse und/oder für eine Demetallisierung eignet, um einen Primärumwandlungsstrom auszubilden;

b) Führen des Primärumwandlungsstromes zu einer ersten Trennzone, bei der es sich nicht um eine fraktionierte Destillation handelt, und Abziehen eines im wesentlichen von Schwermetallen und schweren aromatischen Molekülen freien gasförmigen Stroms, der Kohlenwasserstoffe enthält, die bei Normalbedingungen von Temperatur und Druck flüssig sind, sowie eines flüssigen Stromes aus der ersten Trennzone;

c) Überleiten wenigstens eines Teiles des gasförmigen Stromes in eine zweite Umwandlungszone; und

d) Führen des gasförmigen Stromes bei einer Temperatur von 325 bis 600 °C, einem Druck von 1 bis 30 MPa und einer Raumgeschwindigkeit von 0,1 bis 10,0 kg/1/h in Gegenwart von Wasserstoff durch die zweite Umwandlungszone, die einen Umwandlungskatalysator enthält, der sich zur Desulfurierung, Hydrierung und/oder Entstickung eignet, um einen Strom auszubilden, der mehr als 40 Gew.-% an Kohlenwasserstoffen mit einem Siedebereich unter 370 °C enthält.

2. Verfahren nach Anspruch 1, worin ein Teil des in Stufe b) erhaltenen flüssigen Stroms dem schwere Kohlenwasserstoffe enthaltenden Einsatzmaterial zugesetzt wird, bevor dieser Strom in Stufe a) durch die erste Umwandlungszone geführt wird.

3. Verfahren nach Anspruch 1, worin der in Stufe b) erhaltene flüssige Strom dem schwere Kohlenwasserstoffe enthaltenden Einsatzmaterial zugesetzt wird, bevor dieser Strom in Stufe a) durch die erste Umwandlungszone geführt wird.

4. Verfahren nach Anspruch 1, umfassend weiterhin das Zuführen des in Stufe b) erhaltenen flüssigen Stroms zu einer zweiten Trennzone, ein Abziehen eines gasförmigen Stromes und eines flüssigen Stromes aus der zweiten Trennzone und ein Zusetzen des gasförmigen Stromes zu dem in Stufe b) erhaltenen gasförmigen Strom, bevor dieser gasförmige Strom durch die zweite Umwandlungszone in Stufe d) geführt wird.

5. Verfahren nach Anspruch 4, worin ein Teil des aus der zweiten Trennzone abgenommenen flüssigen Stroms dem schwere Kohlenwasserstoffe enthaltenden Einsatzmaterial zugesetzt wird, bevor dieser Strom in Stufe a) durch die erste Umwandlungszone geführt wird.

6. Verfahren nach Anspruch 1, umfassend weiterhin ein Führen des in Stufe b) erhaltenen flüssigen Stromes in Gegenwart von Wasserstoff durch eine einen Umwandlungskatalysator enthaltende Umwandlungszone bei einer Temperatur von 325 bis 600 °C, einem Druck von 1 bis 30 MPa und einer Raumgeschwindigkeit von 0,05 bis 10 kg/1/h zur Ausbildung eines Sekundärumwandlungsstromes.

7. Verfahren nach Anspruch 6, weiterhin umfassend ein Führen eines Teiles des Sekundärumwandlungsstromes zur ersten Trennzone.

8. Verfahren nach Anspruch 6, weiterhin umfassend ein Führen des Sekundärumwandlungsstromes zu einer weiteren Trennzone und ein Abnehmen eines gasförmigen Stromes und eines flüssigen Stromes aus der dritten Trennzone, und ein Zusetzen des gasförmigen Stromes zu dem in Stufe b) erhaltenen gasförmigen Strom, bevor dieser gasförmige Strom durch die zweite Umwandlungszone in Stufe d) geführt wird.

9. Verfahren nach Anspruch 8, weiterhin umfassend ein Zusetzen eines Teiles des aus der weiteren Trennzone abgenommenen flüssigen Stromes zu dem schwere Kohlenwasserstoffe enthaltenden Strom, bevor dieser Strom in Stufe a) durch die erste Umwandlungszone geführt wird.

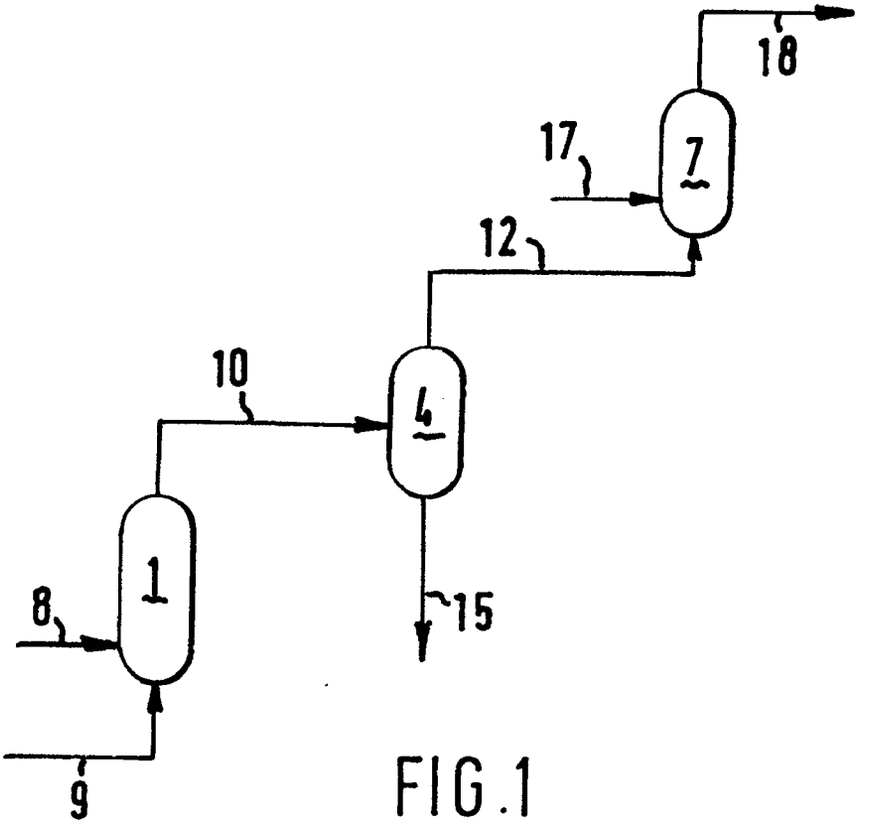


FIG.1

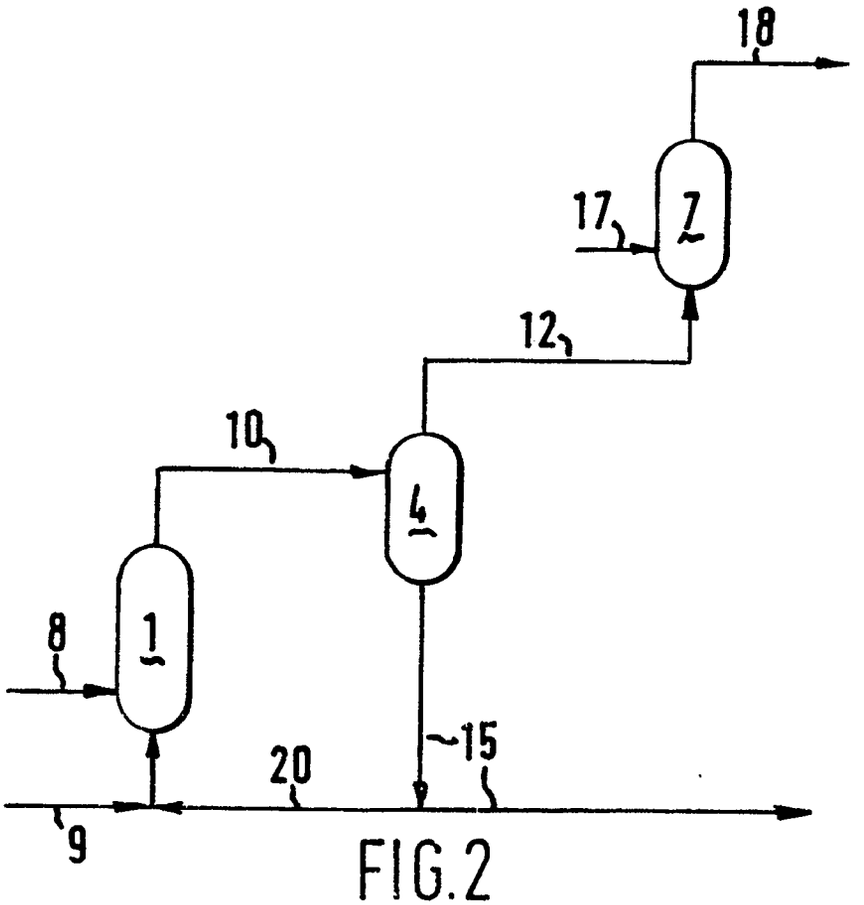


FIG.2

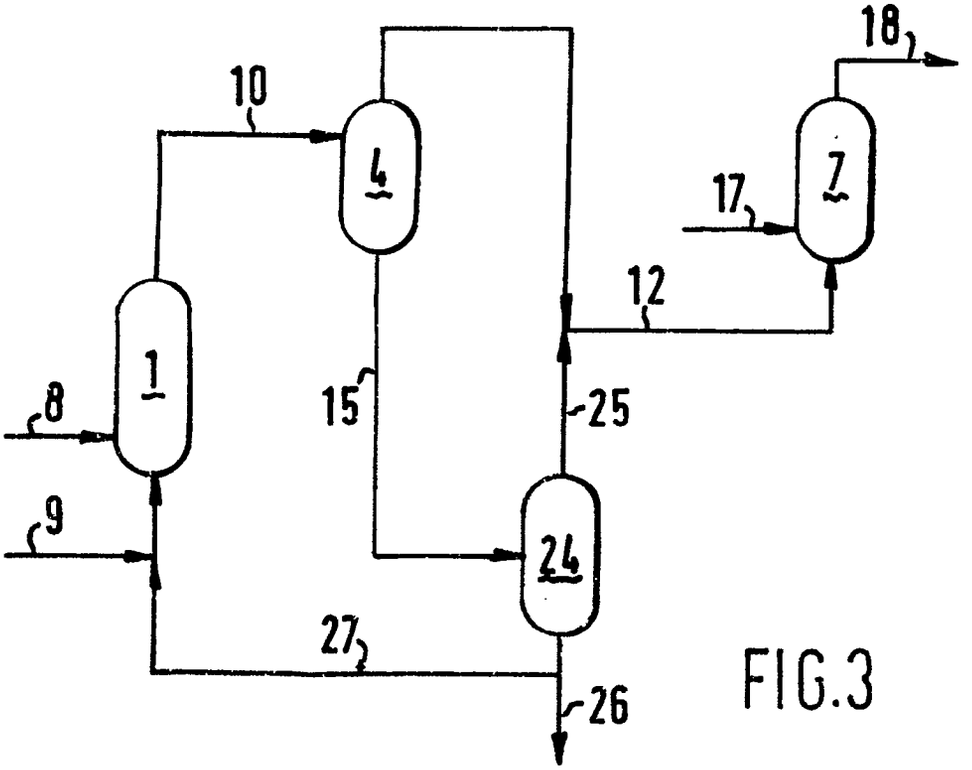

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FIG.3

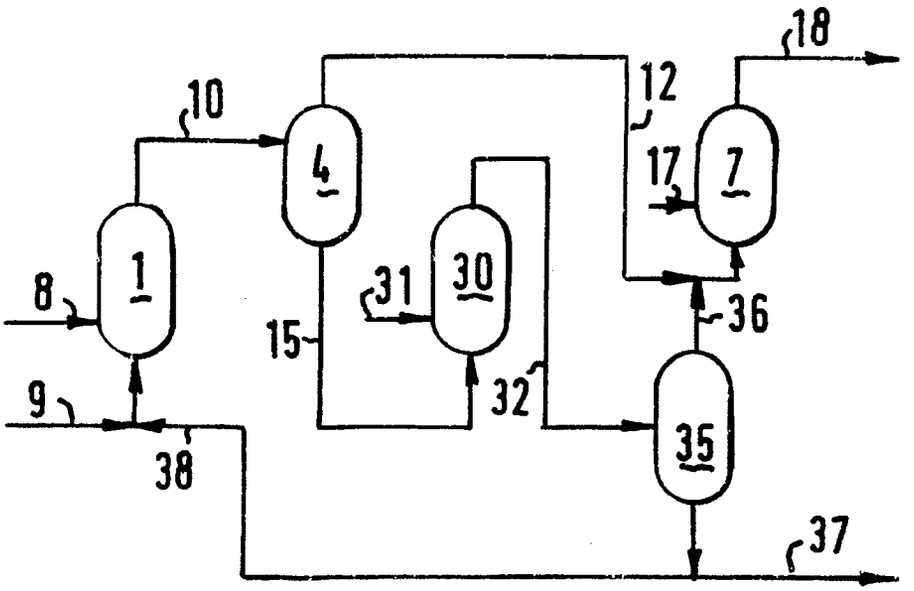

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FIG.4