(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 264 158 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 87201992.2

(22) Date of filing: 16.10.87

(51) Int. Cl.⁴: C10G 65/12

(30) Priority: 17.10.86 GB 8624952

(43) Date of publication of application: 20.04.88 Bulletin 88/16

(84) Designated Contracting States: AT BE CH DE ES FR GB GR IT LI NL SE

(71) Applicant: SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.
Carel van Bylandtlaan 30
NL-2596 HR Den Haag(NL)

(72) Inventor: Blauwhoff, Petrus Matthias Marie
Badhuisweg 3
NL-1031 CM Amsterdam(NL)
Inventor: Van Dongen, Robert Hendrik
Badhuisweg 3
NL-1031 CM Amsterdam(NL)
Inventor: Kieffer, Eduard Philip
Badhuisweg 3
NL-1031 CM Amsterdam(NL)

(74) Representative: Aalbers, Onno et al
P.O. Box 302
NL-2501 CH The Hague(NL)

(54) Converting a stream containing heavy hydrocarbons into a stream containing hydrocarbons having a lower boiling range.

(57) Process for converting a stream containing heavy hydrocarbons comprising the steps of

a) passing through a first conversion reactor (1) containing a conversion catalyst in the presence of hydrogen the stream 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/1/hour to produce a primary converted stream;

b) passing the primary converted stream to a first gas/liquid separator (4) and removing from the first gas/liquid separator (4) a gaseous stream and a liquid stream;

c) passing the gaseous stream to a second conversion reactor (7); and d) passing through the second conversion reactor (7) containing a conversion catalyst 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 kg/l/hour to produce a further converted stream having a lower boiling range.

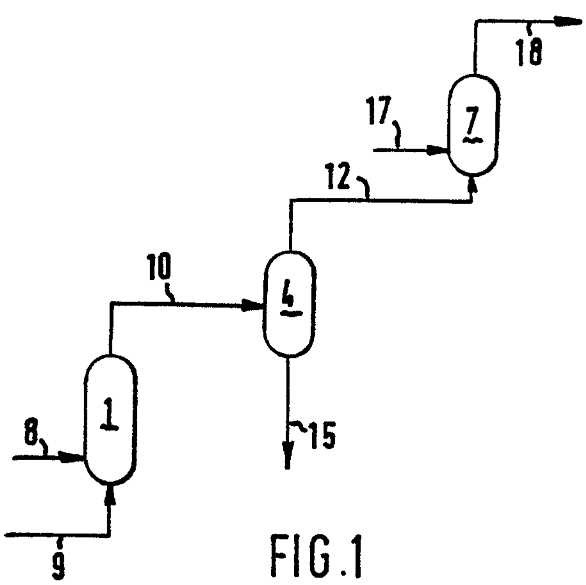


FIG.1

EP 0 264 158 A1

CONVERTING A STREAM CONTAINING HEAVY HYDROCARBONS INTO A STREAM CONTAINING HYDROCARBONS HAVING A LOWER BOILING RANGE

The present invention relates to a process for converting a stream 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 stream and in a second stage a substantially gaseous stream.

To this end the process for converting a stream containing heavy hydrocarbons having a high boiling range into a stream containing hydrocarbons having a lower boiling range according to the invention comprises the steps of

a) passing through a first conversion zone containing a conversion catalyst in the presence of hydrogen the stream containing heavy hydrocarbons having a high boiling range 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 and removing from the first separation zone a gaseous stream 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 in the presence of hydrogen the gaseous stream at a temperature between 325 and 600 °C, a pressure between l and 30 MPa and at an hourly space velocity between 0.1 and 10.0 kg/l/hour to produce a further converted stream having a lower boiling range.

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.

Known is a process 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.

In the specification and in the claims the expression "heavy hydrocarbons having a high boiling range" is used to refer to hydrocarbons containing more than 70% by weight of hydrocarbons having a boiling range above 370 °C. These hydrocarbons further 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). The expression "hydrocarbons having a lower boiling range" is used to refer to hydrocarbons which are liquid at normal conditions containing more than 40% by weight hydrocarbons having a boiling range below 370 °C.

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 hydrocarbons having a high boiling range 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 stream containing heavy hydrocarbons having a high boiling range 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 stream 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 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 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 stream 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 stream 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 pressure 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 stream 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, so that the liquid stream can be further converted with the catalyst in the first reactor 1.

EXAMPLE 21

The hydrocarbon-containing stream 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 stream 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 stream 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 stream 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 stream 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 stream containing heavy hydrocarbons having a high boiling range before this stream is passed through the first reactor 1.

EXAMPLE 3

A hydrocarbon-containing stream 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 stream 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 30 mm Hg, the stream is separated into a gaseous stream, corresponding to 28.4 % by weight of the hydrocarbon-containing stream 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 stream 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 stream 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 stream 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 stream 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 stream 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 third conversion zone in the form of third reactor 30. In the third 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 the third reactor 30 is between 1 and 30 MPa and suitably between 2 and

25 MPa, and the volume of catalyst in the third reactor 30 is such that at the rate at which the liquid stream is supplied the hourly space velocity in the third 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 the third reactor through hydrogen supply conduit 31. The secondary converted stream is removed from the third 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 third separation zone in the form of a third gas/liquid separator 35.

From the third gas/liquid separator 35 a gaseous stream is passed through conduit 36 to the second reactor 7. A liquid stream is removed from the third 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 stream 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 stream 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 stream 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 the third 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 the third 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 the third gas/liquid separator 35, operating at 30 mm Hg.

The amount of liquid stream obtained in the third gas/liquid separator 35 is 45% by weight of the hydrocarbon-containing stream 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 stream 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 stream supplied to the first reactor 1.

The amount of the gaseous stream obtained in the third gas/liquid separator 35 equals 31% by weight of the hydrocarbon-containing stream 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 stream 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 stream containing heavy hydrocarbons having a high boiling range into a stream containing hydrocarbons having a lower boiling range comprising the steps of

a) passing through a first conversion zone containing a conversion catalyst in the presence of hydrogen the stream containing heavy hydrocarbons having a high boiling range 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 and removing from the first separation zone a gaseous stream 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 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 further converted stream having a lower boiling range.

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

3. Process as claimed in claim 2, wherein the liquid stream obtained in step b) is added to the stream containing heavy hydrocarbons having a high boiling range 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 stream containing heavy hydrocarbons having a high boiling range 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 third 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 third separation zone to the stream containing heavy hydrocarbons having a high boiling range before this stream is passed in step a) through the first conversion zone.

10. Process for converting a stream containing heavy hydrocarbons having a high boiling range into a stream containing hydrocarbons having a lower boiling range substantially as described with reference to the drawings.

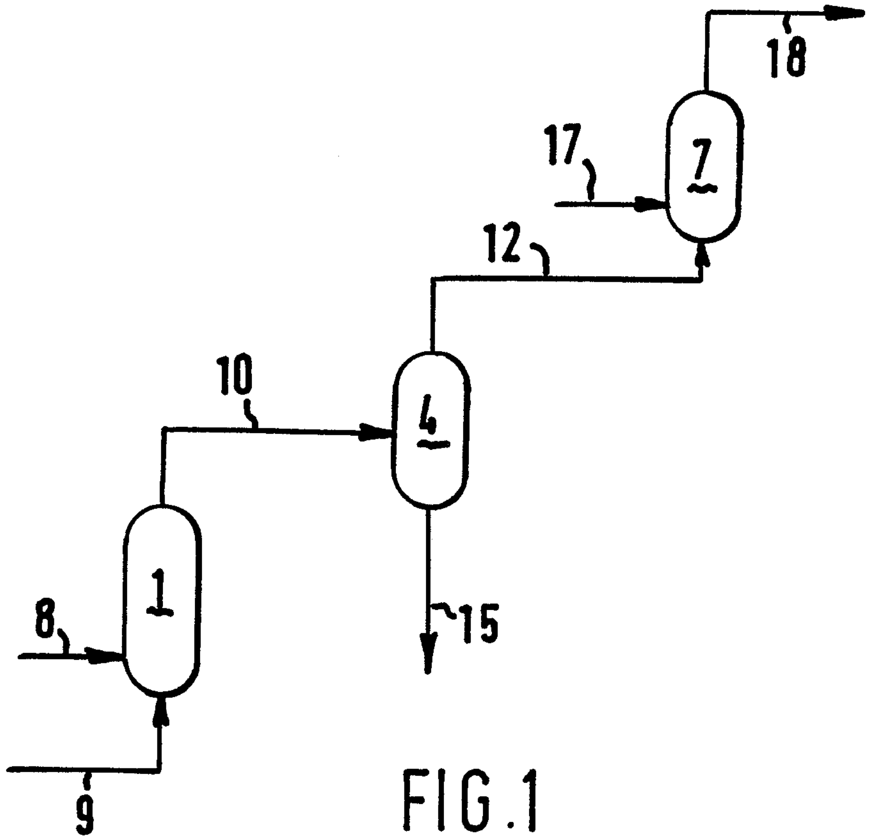


FIG.1

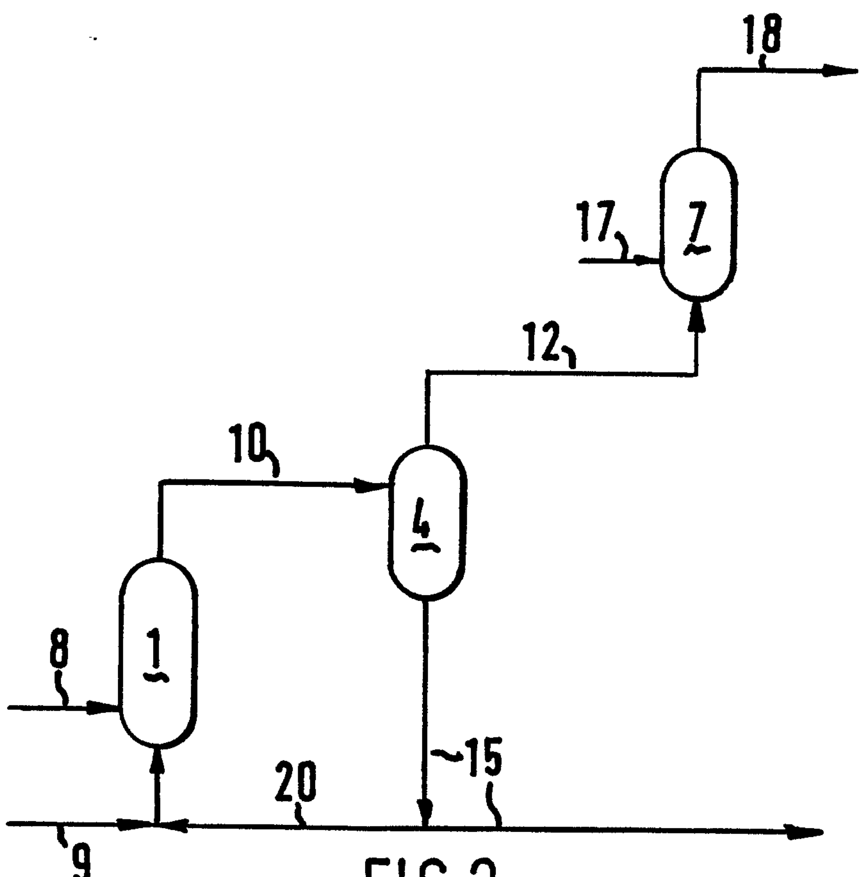
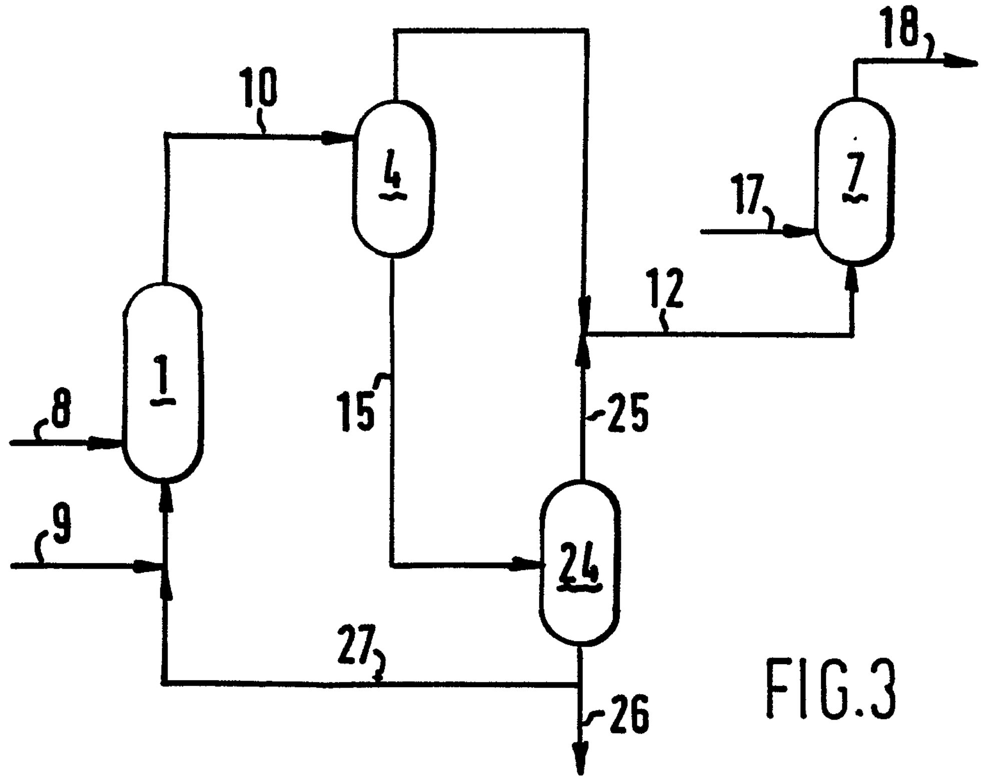
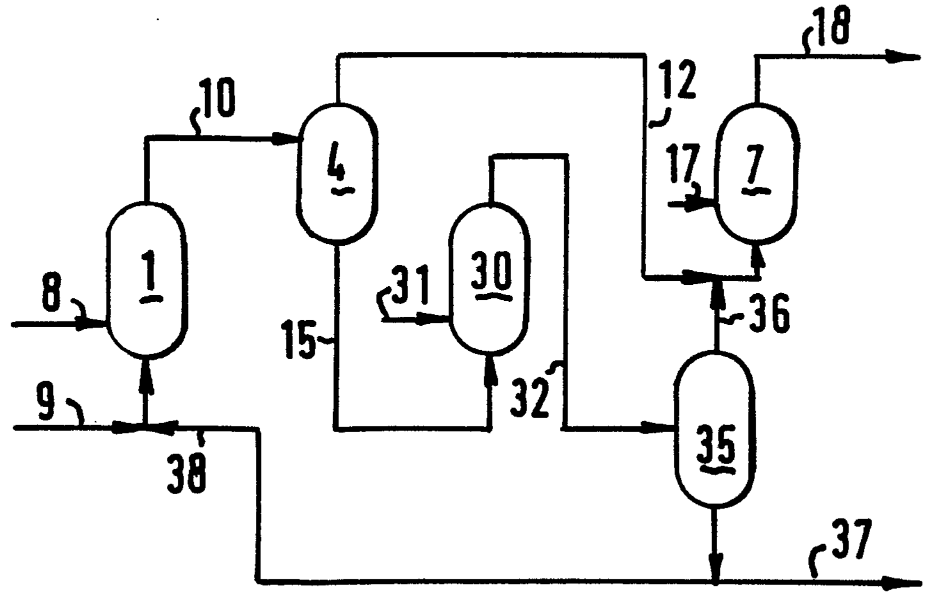


FIG.2



18
10
4
7
17
12
1
15
25
8
9
24
27
26

FIG.3



18
12
10
4
17
7
30
1
31
8
15
36
32
9
35
38
37

FIG.4

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 87201992.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	GB - A - 1 378 829 (TEXACO DEVELOPMENT CORPORATION) * Claim 1; fig. * --	1	C 10 G 65/12
A	US - A - 3 506 566 (HANEY) * Abstract; example * --	1	
A	US - A - 3 992 283 (HUTCHINGS) * Claim 1 * ----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 10 G 65/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	23-11-1987	MARCHART

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document