

METHOD FOR FRACTIONATING HYDROCARBON FEEDSTOCKS USING A DEVICE INCLUDING INTERCHANGEABLE BASE AREAS

Field of the invention

The invention relates to the field of fractionating hydrocarbon feeds, and more precisely
5 to the distillation of hydrocarbon feeds.

Attempts to reduce the problems linked to sediment, coke and also gum type deposits in
fractionation equipment, often located downstream of conversion units, are known to the person
skilled in the art. Such attempts usually take the form of using various chemical and mechanical
means. However, the deposition of sediments, coke and/or gum in this equipment remains a
10 major problem in the majority of refining processes. These phenomena are often linked to the
presence of chemical entities in feeds to be treated which are capable of giving rise to a deposit
which may be a deposit of sediments, coke and/or gums on the devices for fractionation of said
feeds. These feeds are generally feeds comprising olefinic fractions, asphaltenes and/or sulphur-
containing and metallic impurities or any other chemical entity which is capable of giving rise to a
15 deposit of sediments, or to the formation of coke and/or gum on the fractionation devices.

Equipment for distilling hydrocarbon feeds usually has a basic configuration which consists
of using a single distillation unit. However, it is known that certain hydrocarbon feeds such as, for
example, crude oil feeds or effluents from feeds obtained from conversion processes, are rich in
impurities, sediments and/or asphaltenes. As the cycle for separating fractions of interest in the
20 fractionation device progresses, deposits of sediments, coke and/or gum form on the internals of the
columns which may be plates and/or a structured or unstructured packing, the edges of the device
and/or heating devices such as column bottom reboilers, thereby modifying the column traffic as
well as the heat transfer from the heating system. This results in a loss of separation efficiency of
the column and necessitates an increase in the heat supplied which is necessary for separation of the
25 various fractions of interest until the bottom of the device finishes by being completely obstructed
and/or the loss of separation efficiency is too high. Furthermore, the increase in the temperature of

the reboiler causes more rapid formation of sediments, coke and/or gum. As a consequence, stopping the entire device, as well as completely stopping the industrial process upstream and downstream thereof is then necessary in order to clean it. These stoppages generally occur at a frequency of about 1.5 months or more every 3 to 6 months, and have a deleterious effect on the fractionation process or even on the operability of the industrial process as a whole.

Thus, there is still a need to improve the operability of devices for fractionating hydrocarbon feeds, i.e. to limit or in fact avoid stoppages in the fractionation equipment.

One aim of the present invention is to extend the operability of the process for fractionating hydrocarbon feeds.

To this end, the Applicant has developed a process for fractionating hydrocarbon feeds employing at least one fractionation zone provided with separator internals, and at least two switchable bottom zones which can be connected to the bottom of the fractionation zone in a manner such that at least a first of the bottom zones operates with said fractionation zone, in alternation, for a period at most equal to a plugging period, in a manner such that when at least the first of the bottom zones becomes plugged or before it becomes plugged, it is disconnected from the fractionation zone in order to be cleaned while the feed fractionation process continues with at least one other of the bottom zones.

A process of this type has the advantage of being capable of operating continuously without stopping to clean the bottom zones. This results in a substantial increase in productivity and separation efficiency compared with known fractionation processes of the prior art.

Brief description of the figures

Figures 1 and 2 describe an embodiment of the process carried out with a device comprising one fractionation zone and two bottom zones disposed in parallel and operating in a cyclic and successive manner.

Figures 3 to 6 describe an embodiment of the process carried out with a device comprising one fractionation zone and two bottom zones disposed in series and operating in a cyclic and successive manner.

Description of the invention

5 The invention concerns a process for fractionating hydrocarbon feeds employing at least one fractionation zone provided with separator internals, and at least two switchable bottom zones which can be connected to the bottom of the fractionation zone in a manner such that at least a first of the bottom zones operates with said fractionation zone, in alternation, for a period at most equal to a plugging period, in a manner such that when at least the first of the bottom zones becomes
10 plugged or before it becomes plugged, it is disconnected from the fractionation zone in order to be cleaned while the feed fractionation process continues with at least one other of the bottom zones.

In accordance with the invention, the term “fractionation zone” is intended to mean any separation means which is known to the person skilled in the art which exploits the differences in volatility and molecular weight of the fractions of the feed to be separated.

15 Advantageously, the fractionation zone in accordance with the invention comprises at least one distillation column of any type provided with separator internals such as plates and/or structured or unstructured packing or any other device which is known to the person skilled in the art.

Advantageously, the temperature of the theoretical plate at the bottom of the fractionation zone is lower than the temperature for the formation of sediments, coke and/or gum in the feed to be
20 treated. A limitation of this type prevents the formation of sediments, coke and/or gum at the bottom of the fractionation zone. This temperature may vary as a function of the feed to be treated and may be determined by the person skilled in the art using known methods, non-exhaustive examples of which are: the Carbon Conradson content for coking feeds (ASTM D189/D482), the Maleic Anhydride Value (UOP326 – 08) and the Bromine Index (ASTM D1159) for feeds with
25 gum-forming potential linked to olefins and/or diolefins, IP375 and IP390 for unstable feeds leading to the formation of sediments.

Preferably, the fractionation zone comprises at least one distillation column.

The fractionation zone can be used to separate, for example:

- a gaseous fraction which may contain compounds such as H₂, H₂S, NH₃, methane, ethane, ethylene as well as liquefied petroleum gas,
- a gasoline cut with a boiling point in the range 20°C to 150°C,
- a gas oil cut with a boiling point in the range 150°C to 375°C,
- a heavy gas oil cut with a boiling point in the range 220°C to 375°C.

The bottom zones in accordance with the invention advantageously correspond to a plurality of switchable bottom zones which are capable of receiving bottom fractions from the feed with a boiling point which is higher than the temperature of the theoretical plate at the bottom of the fractionation zone. The term “bottom fraction” means any fraction at the foot of the fractionation zone. Advantageously, the bottom fractions of the feed have a boiling point which is at least more than 40°C, preferably more than 150°C, more preferably more than 220°C and yet more preferably more than 300°C under pressure conditions corresponding to atmospheric pressure.

The switchable bottom zones in accordance with the invention are used in a cyclic manner and are connected to the bottom of the fractionation zone, advantageously by means of conduits provided with valves, in a manner such that a first of the bottom zones operates with said fractionation zone, in alternation, for a period at most equal to a plugging period, such that when at least the first of the bottom zones becomes plugged, it is disconnected from the fractionation zone for cleaning while the feed fractionation process continues with at least one other of the bottom zones. The bottom zones are preferably also connected together by means of conduits provided with valves.

The operator does not have to await complete plugging of a bottom zone before rendering it non-operational by disconnecting it from the fractionation zone and/or the other bottom zones. The plugging period may correspond to a time selected by the operator.

The bottom zones in accordance with the invention are advantageously provided with separator internals such as plates, or structured or unstructured packing which are known to the person skilled in the art, in order to ensure separation of the compounds by contact with liquid and vapour fractions.

5 In a first embodiment of the invention, which we shall term the “in-parallel embodiment”, the bottom zones are disposed in parallel with respect to each other. In this embodiment, at least a first of the bottom zones is connected to the bottom of the fractionation zone in a manner such as to be able to operate with said fractionation zone in a cyclic and successive manner for a period at most equal to their plugging period, in a manner such that before at least one of the bottom zones
10 becomes plugged, it is disconnected for cleaning while the feed fractionation process continues with at least one other bottom zone.

 In a second embodiment of the invention, which we shall term the “in-series embodiment”, the switchable bottom zones are disposed and connected in series. In this embodiment, the bottom zones are connected together in series, and at least one first bottom zone is
15 connected to the bottom of the fractionation zone in a manner such as to be able to operate in a cyclic and successive manner for a period at most equal to the plugging period of the bottom zone furthest from the fractionation zone in accordance with an operating protocol wherein, when the bottom zone furthest from the fractionation zone becomes plugged or before it becomes plugged, it is disconnected for cleaning, while the feed fractionation process continues with the other bottom
20 zone or zones preceding said bottom zone, and when cleaning of said bottom zone is finished, it is rendered operational and connected directly to the head of the series, the operating protocol being repeated each time the bottom zone furthest from the fractionation zone becomes plugged or before it becomes plugged. The bottom zones are connected (linked) together, preferably via conduits provided with valves and capable of conveying the bottom fractions from one bottom zone to
25 another.

 An embodiment of this type has the advantage that:

- either, for a constant number of theoretical separation stages compared with the embodiment termed the “in-parallel embodiment”, of being capable of reducing the size of the switchable bottom zones, thereby substantially reducing the investment costs,
- or, with respect to the embodiment termed the “in-parallel embodiment”, of increasing the number of theoretical separation stages in order to benefit from a higher separation efficiency provided that more theoretical separation stages are available. This brings about a saving in energy to be consumed in carrying out the separations of the various cuts and fractions of interest.

The in-series embodiment can be used to optimize the use of the bottom zones because, apart from the period for cleaning the bottom zone furthest from the fractionation zone, all of the bottom zones are used in series, thus meaning that all of the theoretical separation stages can be used and not those of a single bottom zone as in the “in-parallel” embodiment. This embodiment can also be employed to operate the bottom zones in accordance with the “in-parallel” embodiment, in alternation as required.

In this in-series embodiment, once cleaned, the bottom zone furthest from the fractionation zone is rendered operational and connected directly to the head of the series, advantageously to the bottom of the fractionation zone and to the head of the first bottom zone which was previously connected to the bottom of the fractionation zone. The mention of the “head of the series” assumes that a system of conduits and valves, known to the person skilled in the art, is present so that said furthest bottom zone can be connected to the fractionation zone and to the other bottom zones, in particular to the first bottom zone which was previously connected to the bottom of the fractionation zone.

As they pass through the bottom zones, the bottom fractions advantageously undergo stripping using a stream of gas. The gas stream is injected as a counter-current into the bottom zones in a manner such as to entrain the light fractions towards the fractionation zone. These gas

streams can in fact be used to recover the light fractions entrained in the bottom fraction which have not been separated in the fractionation zone and return them to the fractionation zone.

The gas stream may be any chemical cut which vaporizes under the temperature and pressure conditions at the point of injection into the bottom zone.

5 The gas stream in accordance with the invention is advantageously selected from steam, hydrogen, nitrogen or a gas stream obtained from reboiling the bottom of the fractionation zone.

Advantageously in accordance with the invention, when the bottom zones are disposed in series, i.e. when the process in accordance with the invention is carried out in accordance with the embodiment termed the “in-series embodiment”, the gas stream is injected as a counter-current into
10 the bottom zone furthest from the fractionation zone, then the resulting stream of gas is subsequently sent to the other bottom zones before being returned to the fractionation zone.

The feed

The feeds for the process in accordance with the invention may be obtained from what is known as conventional crude oil (API degree $> 20^\circ$), heavy crude oil (API degree in the range 10
15 to 20°) or extra heavy (API degree $< 10^\circ$). The density of the feed in accordance with the invention is advantageously greater than 0.6, preferably greater than 0.85, more preferably greater than 0.88.

The feeds for the process in accordance with the invention are advantageously selected from crude oil feeds, or from feed effluents obtained from the distillation of crude oil and/or from
20 refining processes, or from feeds obtained from the direct liquefaction of coal (H-CoalTM) or obtained from the direct liquefaction of lignocellulosic biomass, alone or as a mixture with coal. They may in particular be selected from effluents from feeds obtained from thermal or catalytic conversion processes with or without hydrogen, atmospheric residues, vacuum residues, deasphalted oils, pitches, asphalts mixed with an aromatic distillate, coal hydrogenates, heavy oils
25 of any origin and in particular obtained from bituminous sand or oil shale, or mixtures thereof.

The conversion processes may be ebullated bed hydroconversion processes, fluid catalytic cracking units, fixed bed hydrotreatment units, cokers, delayed cokers or visbreaking and hydrovisbreaking units.

The feeds in accordance with the invention preferably comprise asphaltenes and sulphur-containing and metallic impurities and may have a boiling point of more than 20°C, preferably more than 180°C, more preferably more than 200°C, yet more preferably more than 250°C.

The feed treated by the process in accordance with the invention may have a metals content of more than 10 ppm (parts per million, expressed as the mass of metals with respect to the mass of feed), which is preferably more than 20 ppm, more preferably more than 50 ppm.

Advantageously, the fractionation process in accordance with the invention is carried out with feeds which may have a C7 asphaltenes content of more than 0.5% m/m (percentage expressed as the mass of C7 asphaltenes with respect to the mass of feed, measured in accordance with the NF T60-115 method), preferably more than 2% m/m, more preferably more than 5% m/m;

- and/or a Conradson Carbon Residue (also known as CCR) of more than 2% m/m (percentage expressed as the mass of CCR with respect to the mass of feed), preferably more than 5% m/m, more preferably more than 10% m/m.

The feeds in accordance with the invention may be feed effluents obtained from thermal cracking processes, in particular gasolines obtained from catalytic cracking, fluid catalytic cracking (FCC), from a coking process, from a visbreaking process, or from a pyrolysis process.

These feeds comprise unsaturated species such as monoolefins and diolefins, which are gum precursors and which run a high risk of fouling the fractionation equipment.

Detailed description of the figures

Several embodiments of the process of the invention are illustrated in Figures 1 to 6 for better comprehension. These embodiments are given by way of example and are not limiting in nature. These illustrations of the process of the invention do not include details of all of the components necessary for carrying it out. Only the elements necessary to understanding the

invention are represented therein; the person skilled in the art will be able to complete the picture in order to make and implement the invention.

In-parallel embodiment

Figures 1 and 2 describe an embodiment of the process carried out with a device comprising a fractionation zone and two bottom zones. In this embodiment, the bottom zones are disposed in parallel and operate in a cyclic and successive manner.

Figure 1 describes operational mode 1 (2a + 2b) of this embodiment in which the fractionation zone and the two bottom zones operate in parallel.

The feed is sent to the fractionation zone 2a via the conduit 1 and fractionated therein into several fractions of interest as a function of their boiling point (represented by the arrows A, B, C and D). These fractions are generally fractions such as a gaseous fraction, a gasoline cut, a gas oil cut, or a heavy gas oil cut. The bottom fraction leaving from the bottom of the fractionation zone 2a via the conduit 2 is sent to the bottom zone 2b via the conduit 4 provided with the open valve 3. After passing through the bottom zone 2b, the bottom fraction obtained from the bottom zone 2b is sent directly via the conduit 5 provided with the open valve 9 then via the conduit 10 for evacuation via the conduit 15. In operational mode 1 (2a + 2b) of the embodiment of the process, the zone 2c is advantageously not connected to the bottom of the fractionation zone.

During passage through the bottom zone 2b, the bottom fractions advantageously undergo stripping by means of a gas stream injected into said bottom zone 2b as a counter-current to the bottom fraction. The gas stream injected as a counter-current into the bottom zone 2b produces a gas stream charged with light fractions which is returned to the fractionation zone via the conduit 11 and the conduit 14 provided with the open valve 12.

After a period which is at least equal to the plugging period for the bottom zone 2b, the bottom zone 2b is disconnected from the zone 2a. It is isolated from the remainder of the device by closing the valves 3, 9 and 12, for cleaning (Figure 2). During this period, the device of the process

continues to operate in accordance with operational mode 2 of the embodiment of the process (2a + 2c) (Figure 2).

Figure 2 has the same nomenclature as that for Figure 1. Because the bottom zone 2b has been disconnected, the bottom fraction leaving the bottom of the fractionation zone 2a via the conduit 2 is sent to the bottom zone 2c by means of the conduit 4' provided with the open valve 3'. After passing through the bottom zone 2c, the bottom fraction obtained from the bottom zone 2c is sent directly via the conduit 8 provided with the open valve 9' then via the conduit 10' for evacuation via the conduit 15. During cleaning of the bottom zone 2b, injection of the gas stream into said zone is advantageously stopped.

During passage into the bottom zone 2c, the bottom fractions advantageously undergo stripping by means of a gas stream injected into said bottom zone 2c as a counter-current to the bottom fraction. The gas stream injected into the bottom zone 2c as a counter-current produces a gas stream charged with light fractions which is returned to the fractionation zone via the conduit 11' and the conduit 14' provided with the open valve 12'.

When cleaning of the bottom zone 2b is finished, the bottom zone 2b is rendered operational and connected directly to the bottom of the fractionation zone 2a in order to once again operate in accordance with operational mode 1 of the embodiment of the process (2a + 2b) described above with reference to Figure 1 and the operating protocol is then repeated each time the bottom zone which is operating is plugged or before it becomes plugged. The zone 2c is advantageously disconnected from the bottom of the fractionation zone during operational mode 1 of the embodiment of the process (2a + 2b) and cleaned.

In this first operational embodiment described in Figures 1 and 2, two bottom zones are shown in parallel. However, the invention does not exclude operating a plurality of bottom zones disposed in parallel.

In-series embodiment

Figures 3 to 6 describe an embodiment of the process carried out with a device comprising a fractionation zone and two bottom zones. In this embodiment, the bottom zones are disposed and connected in series and operate in a cyclic and successive manner.

Figure 3 describes operational mode 1 of the embodiment of the process in which the fractionation zone and the two bottom zones operate in series in accordance with the operational mode: $2a + 2b + 2c$.

The feed is sent to the fractionation zone 2a via the conduit 1 in which it is fractionated into several light fractions of interest depending on their boiling point (represented by the arrows A, B, C and D). These fractions are generally fractions such as a gaseous fraction, a gasoline cut, a gas oil cut, or a heavy gas oil cut. The bottom fraction leaving from the bottom of the fractionation zone 2a via the conduit 2 is sent to the bottom zone 2b by means of the conduit 4 provided with the open valve 3. After passing through the bottom zone 2b, said bottom fraction passes into the bottom zone 2c by means of the conduit 7 provided with the open valve 6 and the conduit 4'. The bottom fraction obtained from the bottom zone 2c then passes via the conduit 8 provided with the open valve 9' then via the conduit 10' for evacuation via the conduit 15.

During passage in the bottom zones 2b and 2c, the bottom fractions advantageously undergo stripping by means of a gas stream injected into said bottom zones as a counter-current to the bottom fraction. Advantageously, said gas stream is only injected as a counter-current into the bottom zone 2c in a manner such as to produce a gas stream charged with light fractions which is sent towards the bottom zone 2b via the conduit 11' and the conduit 13' provided with the open valve 16'. In the bottom zone 2b, said gas stream entrains more light fractions and is then returned to the fractionation zone via the conduit 11 and the conduit 14 provided with the open valve 12.

After a period at most equal to the plugging period of the bottom zone 2c, the bottom zone 2c is disconnected. This latter is isolated from the remainder of the device by closing the valves 6, 9' and 16', for cleaning. During this period, the device of the process continues to operate in accordance with operational mode 2 of the embodiment of the process ($2a + 2b$) (Figure 4).

Figure 4 has the same nomenclature as that for Figure 3. Because the bottom zone 2c has been disconnected, the bottom fraction obtained from the bottom zone 2b is sent directly via the conduit 5 provided with the open valve 9 then via the conduit 10 for evacuation via the conduit 15. During cleaning of the bottom zone 2c, injection of the gas stream into said zone is advantageously stopped.

When cleaning of the bottom zone 2c has finished, the bottom zone 2c is rendered operational and connected directly to the bottom of the fractionation zone 2a in order to operate in accordance with operational mode 3 of the embodiment of the process (2a + 2c + 2b) (Figure 5).

In Figure 5, the bottom fraction leaving the bottom of the fractionation zone 2a via the conduit 2 is sent to the bottom zone 2c via the conduit 4' provided with the open valve 3'. After passing through the bottom zone 2c, said bottom fraction passes into the bottom zone 2b via the conduit 7' provided with the open valve 6' and the conduit 4. The bottom fraction obtained from the bottom zone 2b then passes via the conduit 5 provided with the open valve 9 and subsequently via the conduit 10 for evacuation via the conduit 15.

During passage through the bottom zones 2c and 2b, the bottom fractions advantageously undergo stripping by means of a gas stream injected into said bottom zones as a counter-current to the bottom fraction. Advantageously, said gas stream is injected only as a counter-current into the bottom zone 2b in a manner such as to produce a gas stream charged with light fractions which is sent to the bottom zone 2c via the conduit 11 and the conduit 13 provided with the open valve 16. In the bottom zone 2c, said gas stream entrains more of the light fractions and is sent to the fractionation zone via the conduit 11' and the conduit 14' provided with the open valve 12'.

After a period at most equal to the plugging period of the bottom zone 2b, this latter is disconnected. It is isolated from the remainder of the device by closing the valves 6', 9 and 16, for cleaning. During this period, the device of the process continues to operate in accordance with operational mode 4 of the embodiment (2a + 2c) of the process (Figure 6).

Figure 6 has the same nomenclature as that for Figure 5. Because the bottom zone 2b is disconnected, the bottom fraction obtained from the bottom zone 2c passes directly via the conduit 8 provided with the open valve 9' then via the conduit 10' for evacuation via the conduit 15. During cleaning of the bottom zone 2b, injection of the gas stream into said zone is advantageously stopped.

When cleaning of the bottom zone 2b is finished, the bottom zone 2b is rendered operational and connected directly to the bottom of the fractionation zone 2a in order to operate again in accordance with operational mode 1 of the embodiment (2a + 2b + 2c) of the process as described in Figure 3 above and the operating protocol is then repeated each time that the bottom zone furthest from the fractionation zone becomes plugged.

In this embodiment, it is also possible to operate a plurality of zone bottoms connected in series.

EXAMPLE

A feed obtained from a process for ebullated bed hydroconversion (RHCK EB) of a vacuum residue (RSV) was sent for fractionation to an atmospheric distillation column (ADU).

The principal characteristics of the treated feed are summarized in Table 1 below.

Table 1: Characteristics of the feed

	Feed
D15/4 ^a	0.9237
V100 ^b (mm ² /s)	8
S (% by weight)	0.47
N (ppm by weight)	4036
Ni + V (ppm by weight)	14

^a D15/4 refers to the density of the feed (density of feed at 15°C divided by the density of water at 4°C). ^b V100 designates the viscosity at 100°C. S, N, Ni and V respectively refer to sulphur, nitrogen, nickel and vanadium.

The atmospheric distillation column (ADU) clogged up after 12 months and had to be stopped for cleaning for a period of 1.5 months. Normally, a conventional unit operating with a conventional atmospheric distillation column (ADU) operates 89% of the time with the atmospheric distillation column (ADU) running, and 11% of the time with the atmospheric distillation column stopped (for cleaning).

Fractionation of the feed was carried out in accordance with two embodiments of the process in accordance with the invention (the “in-parallel” embodiment and the “in-series” embodiment) and a comparative conventional embodiment in accordance with the prior art.

“In-parallel” embodiment (in accordance with the invention)

5 The device employed comprised a distillation column connected to two switchable bottom zones. The device was operated continuously. The two switchable bottom zones were disposed in parallel. At least a first of the bottom zones was connected to the bottom of the distillation column so as to be able to operate with said distillation column in a cyclic and successive manner for a period at most equal to their plugging period, so that before the first bottom zone plugged, it was
10 disconnected for cleaning while the feed fractionation process continued with the second bottom zone.

 The number of plates for the separation device (distillation column + zone bottom) was equal to 20.

“In-series” embodiment (in accordance with the invention)

15 The device employed comprised a distillation column connected to two switchable bottom zones connected in series via conduits provided with valves. The device was operated continuously.

 At least one first bottom zone was connected to the bottom of the distillation column so as to be able to operate in a cyclic and successive manner for a period at most equal to the plugging period for the bottom zone furthest from the distillation column in accordance with an operating
20 protocol such that when the bottom zone furthest from the distillation column was plugged or before it became plugged, it was disconnected for cleaning, while the feed fractionation process continued with only the first bottom zone. When cleaning of said bottom zone was finished, it was rendered operational and connected directly as the head of the series to the bottom of the distillation column and as the head of said first bottom zone which as a consequence became the bottom zone furthest
25 from the distillation column; the operating protocol was repeated each time the bottom zone furthest from the distillation column became plugged or before it plugged.

The number of plates for the separation device (distillation column + zone bottom) was equal to 20.

Conventional embodiment (not in accordance with the invention)

The device employed comprised just one traditional atmospheric distillation column.

- 5 Periodically, the column was cleaned, involving stopping it and stopping the upstream hydroconversion unit. Table 2 provides the comparative elements between the three separations.

Table 2: Comparison of economic results between two embodiments in accordance with the invention and a conventional case

	“In-parallel” embodiment	“In-series” embodiment	Conventional embodiment
Overall column bottom temperature (°C)	360	360	360
Number of theoretical plates	20	20	20
Head pressure (bar absolute)	2.3	2.3	2.3
ADU in operation over one year (time) (%)	100	100	89
ADU stopped over one year (time) (%)	0	0	11
ISBL ^a investment (M\$)	Base0 + 1.4	Base0 + 1.1	Base0
Net Present Value ^b (M\$)	Base1 + 280	Base1 + 282	Base1
Internal Rate of Return ^c (%)	Base2 + 1.5	Base2 + 1.5	Base2
Pay Out Time ^d (years)	Base3 - 1	Base3 - 1	Base3

- 10 ^aThe ISBL (Inside Battery Limits) denotes the investment limits for the manufacturing units. ^bThe Net Present Value refers to the sum of the current values for the cash flow associated with a project. ^cThe Internal Rate of Return is the maximum rate of return from a project that is required to return the capital invested. ^dThe Pay Out Time is the amount of time for revenue from a project to generate cash flow to recover the initial investment costs.

- 15 The invention allows for an increase in operability by avoiding total stoppage of the unit and ensuring a substantial economic advantage.

CLAIMS

1. A process for fractionating hydrocarbon feeds employing at least one fractionation zone provided with separator internals, and at least two switchable bottom zones connected together in series and at least one first bottom zone is connected to the bottom of the fractionation zone in a manner such as to be able to operate in a cyclic and successive manner for a period at most equal to the plugging period of the bottom zone furthest from the fractionation zone in accordance with an operating protocol wherein, when the bottom zone furthest from the fractionation zone becomes plugged or before it becomes plugged, it is disconnected for cleaning, while the feed fractionation process continues with the other bottom zone or zones preceding said bottom zone, and when cleaning of said bottom zone is finished, it is rendered operational and connected directly to the head of the series, the operating protocol being repeated each time the bottom zone furthest from the fractionation zone becomes plugged or before it becomes plugged.
2. The process as claimed in claim 1, in which the bottom zones are capable of receiving bottom fractions of the feed with a boiling point greater than the temperature of the theoretical stage at the bottom of the fractionation zone.
3. The process as claimed in one of the preceding claims, in which the bottom zones are provided with separator internals such as plates, or structured or unstructured packing.
4. The process as claimed in one of the preceding claims, in which the bottom fractions of the feed have a boiling point greater than the temperature of the theoretical stage at the bottom of the fractionation zone.
5. The process as claimed in claim 4, in which the bottom fractions of the feed have a boiling point of at least more than 40°C under the pressure conditions corresponding to atmospheric pressure.

6. The process as claimed in one of the preceding claims in which, during passage through the bottom zones, the bottom fractions undergo stripping by means of a gas stream.
7. The process as claimed in claim 6, in which the gas stream is injected as a counter-
5 current into the bottom zones so as to entrain the light fractions towards the fractionation zone.
8. The process as claimed in claim 6, in which the gas stream is a chemical cut which vaporizes under the temperature and pressure conditions at the point of injection into the bottom zone.
- 10 9. The process as claimed in claim 6, in which the gas stream is selected from steam, hydrogen, nitrogen or a gas stream obtained from reboiling the bottom of the fractionation zone.
10. The process as claimed in claim 6 in which, when the bottom zones are disposed in series, the gas stream is injected as a counter-current into the bottom zone furthest from
15 the fractionation zone then the resulting gas stream is subsequently sent to the other bottom zones before being returned to the fractionation zone.
11. The process as claimed in one of the preceding claims, in which the feed is selected from crude oil feeds or from feed effluents obtained from the distillation of crude oil and/or from refining processes, or from feeds obtained from the direct liquefaction of
20 coal or obtained from the direct liquefaction of lignocellulosic biomass, alone or as a mixture with coal.
12. The process as claimed in one of the preceding claims, in which the feed is selected from feed effluents obtained from thermal cracking processes, in particular from gasolines obtained from catalytic cracking, from fluid catalytic cracking, from a coking
25 process, from a visbreaking process, or from a pyrolysis process.