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(54) **Title:** SYSTEM AND PROCESS FOR INCREASING HEAVY OILS CONVERSION CAPACITY

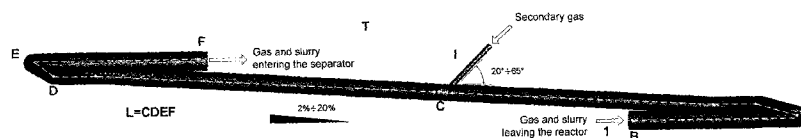


Fig. 1

(57) **Abstract:** System and corresponding process for the hydroconversion of heavy oils essentially comprising a reactor, a liquid-vapor separator and a section for stripping conversion products outside the reactor comprising an inlet conduit for the stripping gases located at a point on the conduit providing a connection between the head of the reactor and the liquid-vapor separator inclined, at least from the point of entry, upwards with a gradient of between 2% and 20%, preferably between 3% and 12%, with respect to a horizontal plane. The inlet conduit for the stripping gases is inclined with respect to the axis of the conduit providing a connection between the reactor head and the liquid-vapor separator through an angle of between 20° and 65°, more preferably between 30° and 60°, even more preferably between 40° and 50°. The stripping gas delivered to the connection conduit between the head of the reactor and the separator flows in a downward direction.



SYSTEM AND PROCESS FOR INCREASING HEAVY OILS CONVERSION CAPACITYDescription

This invention relates to a system and corresponding process for increasing heavy oils conversion capacity.

The hydroconversion of heavy petroleum products can be achieved using different process systems. The core of the technology is the hydroconversion reactor, which may be of the fixed bed, ebullated bed or slurry type. In the latter case the catalyst is dispersed in the reaction medium and is uniformly distributed within the reactor itself.

One EST system (ENI Slurry Technology) (IT-MI2007A1044; IT-MI2007A1045; IT-MI2007A1198; IT-MI2008A1061; IT-MI2010A1989) provides for delivering the effluent from the head of the reactor to an HP/HT high pressure / high temperature liquid-vapor separator. The gas leaving the HP/HT separator is passed to a gas treatment section from which a flow rich in hydrogen is recovered and recycled to the reactor, while the liquid passes through a series of vessels at decreasing pressure and temperature (medium pressure separator, atmospheric column and vacuum column) to separate the reaction products and give rise to recycling of the catalyst and the unconverted charge.

If the reaction products are obtained exclusively in the vapor phase (VPO) (Vapor Phase Outflow), the low pressure sections which might bring about the formation of coke outside the reactor can be avoided, even though this results in a decrease in the capacity of the plant.

When catalyst is present and hydrogen is absent, at pressures below the reactor pressure, it has been found by experiment that dehydrogenation reactions leading to the production of hydrogen and coke can take place. High temperature, low pressure and long

residence times in the liquid holdups in the vessels can render solids formation outside the reactor of the same order of magnitude as that within the reactor. In addition to this, if the vacuum unit is not sufficiently dimensioned at the design stage the formation of hydrogen at the base of the vacuum column may have a significant impact on the fractionation capacity of the column.

By adopting an EST system according to which the products are obtained only in the vapor phase (VPO), which we will call EST-VPO, the slurry is confined to the zone of high H_2 partial pressure, eliminating all the problems associated with dehydrogenation and the formation of solid outside the reactor. Against this advantage the capacity of an EST-VPO plant with direct recycling from the HP/HT separator is significantly lower, for the same reaction temperature, than that of an EST plant with recycling from the vacuum column. The loss of capacity may be compensated by increasing the reaction temperature, even though this results in an increase in the formation of solid within the reactor itself.

Feeding a gas with a high H_2 concentration (also referred to as “secondary” in order to distinguish it from the “primary” gas of the same composition fed to the reactor) to the connecting line between the reactor and high temperature / high pressure separator is one way of increasing the conversion capacity of an EST-VPO plant on account of the stripping effect of the gas itself.

An EST-VPO system which does not provide for the use of secondary gas has a smaller capacity for the same operating conditions because the liquid leaving the HP/HT separator and recycled to the reactor has the same composition as the liquid leaving the reactor. Using the secondary gas increases the throughput of reaction products leaving the top of the separator. At the same time the composition of the liquid phase recycled to the reactor changes and is again subjected to a hydroconversion reaction, but at this point

it is impoverished in lighter components which have passed into the gas phase. Because products only leave from the top of the separator in the EST-VPO system, the increase in their throughput coincides with an increase in the capacity of the plant. It can be demonstrated that the more the liquid recycled to the reactor is similar to that leaving the reactor in terms of composition, the greater the shift towards the formation of light products. In comparison with an EST-VPO system which does not make provision for it, through the effect of the stripping action of the secondary gas the liquid recycled to the reactor will be heavier than that leaving the reactor and as a consequence the quantity of products leaving with the vapor phase will increase, although with a different composition. Feeding gas with a high hydrogen content to the connecting line between the head of the reactor and the high pressure / high temperature HP/HT separator makes it possible to increase the conversion capacity of an EST-VPO system.

The length of line downstream from the secondary gas feed acts as a theoretical liquid/vapor equilibrium stage. The geometry and fluid dynamics of the connecting line are designed to achieve equilibrium between the liquid and vapor in the reactor effluent/secondary gas mixture before entering the separator. Where liquid/vapor equilibrium does not have to be achieved the effect of adding the secondary gas can in the worst of cases be reduced to a mere addition of gas.

While the use of stripping gas to assist release of the components in the gas phase which would normally be confined in the liquid phase and feeding a stripping gas to the connecting line between the head of the reactor and the separator is known (IT-MI2007A1044), no description has been provided as to how the stripping gas should be fed to that line.

The connecting line between the head of the reactor and the separator must be suitably

designed in order to achieve liquid/vapor equilibrium in the flow before it enters the separator.

We have now found that a suitable upward inclination of the connecting line between the head of the reactor and the separator is essential for achieving liquid/vapor equilibrium before entering the liquid-vapor separator.

Combining the inclination selected with a suitable insertion of the secondary gas feed line, at a suitable length and/or at a suitable cross-section of the connecting line may also be advisable.

The system for the hydroconversion of heavy oils constituting the subject matter of this invention essentially comprises a reactor, a liquid-vapor separator and a section for stripping conversion products outside the reactor comprising a conduit for feeding stripping gases located in such a way that the said gas feed takes place at a point in a connection conduit between the head of the reactor and the liquid-vapor separator in which the said connection conduit is upwardly inclined, at least from the feed point, with a gradient of between 2% and 20%, preferably between 3% and 12%.

With the line suitably upwardly inclined, within a specific range of gas/liquid throughputs leaving the reactor, a stratified wavy flow regime is set up, in which suitable remixing between the phases takes place from the point at which the secondary gas is fed in.

The establishment of a stratified wavy flow regime makes possible the continuous renewal of the surface of the liquid in contact with the gas, thus increasing the efficiency of material exchange.

It is recommended that the stripping gas feed conduit should be inclined with respect to the axis of the connection conduit between the head of the reactor and the liquid-vapor separator at an angle of between 20° and 65°, more preferably between 30° and 60°,

even more preferably between 40° and 50°. It is also advisable that the stripping gas flow should preferably occur in a downward direction.

It is also preferable that the said feed conduit, with the angles of inclination recommended above, should lie in the vertical plane passing through the axis of the connection conduit.

Preferably the cross-section (A) of the conduit providing the connection between the head of the reactor and the liquid-vapor separator and the length (L) of the portion of that conduit between the point of entry for the stripping gases and the point of entry to the separator satisfy the following relationships:

$$(A \times L)(Q_V + Q_{Vsec} + Q_L) > 10 \text{ s, more preferably } > 15 \text{ s,}$$

$$(Q_V + Q_L)/A > 0.5 \text{ m/s, more preferably } > 1 \text{ m/s,}$$

$$2 > Q_{Vsec}/Q_V > 0.25, \text{ more preferably } 1 > Q_{Vsec}/Q_V > 0.5$$

where Q_V and Q_L are the volumetric throughputs of vapor and slurry (liquid + solid) leaving the head of the reactor and Q_{Vsec} is the volumetric throughput of secondary gas.

One embodiment of conduit (T) connecting the head of the reactor to the liquid-vapor separator and conduit (I) for the entry of stripping gas is illustrated in Figure 1.

The flow of gas and slurry (1) leaving the reactor enters at point (B) on the conduit (T) and undergoes stripping in the portion between point (C) and point (F) by means of the gases entering through entry conduit (I) inclined at an angle of between 20° and 65° with respect to the axis of conduit (T). The section of conduit (T) to which the entry conduit is inserted is inclined upwards with a gradient of between 2% to 20% with respect to a horizontal plane. The flow of gas and slurry which has been stripped finally exits at point (F) to enter the separator.

The length (L) of section of conduit (T) extends from the point of entry for the stripping gas as far as the point of entry to the separator (from point (C) to point (F) in Figure 1, passing

through points (D) and (E)).

Obstacles of suitable geometry which assist intimate remixing of the liquid and vapor phase and allow liquid/vapor equilibrium to be achieved may be inserted within the conduit connecting the head of the reactor to the entry to the separator.

It is recommended that the said obstacles be inserted along the top wall within the said conduit providing a connection between the head of the reactor and the liquid-vapor separator in such a way as to cause the gas to thread its way beneath the liquid thus bringing about adequate remixing and at the same time avoiding any accumulation of solid behind the obstacle, which may occur all the more so because of the positive gradient of the conduit. This embodiment is illustrated in Figure 2, where with an obstacle (G) located:

- along the lower wall of conduit (T) problems may occur with the accumulation of solids (AS) (Figure 2a);
- along the upper wall of conduit (T) the solids remain dispersed (DS) (Figure 2b).

The system applies to all types of reactors in which the outflow comprises a two-phase L/V flow, also including a flow obtained from the merging of at least one liquid flow and at least one vapor flow leaving the reactor, including fixed bed reactors which might contain dispersed solids, slurry reactors, preferably a slurry bubble column, and ebullated bed reactors.

A further object of this invention is the process for the hydroconversion of heavy oils carried out using the system according to the invention.

The said process for the hydroconversion of heavy oils comprises sending the heavy oil to a hydrotreatment stage performed in a reactor with a suitable hydrogenation catalyst, into which reactor hydrogen or a mixture of hydrogen and light hydrocarbons are delivered,

performing a stripping stage with a suitable stripping gas on the liquid and vapor flow leaving the reactor, or on the flow obtained from the merging of at least one liquid flow and at least one vapor flow leaving the reactor, passing the said flow to a liquid-vapor separation in a suitable separator separating the liquid phase, which is recycled to the reactor, less purges, from the vapor phase containing the conversion products, the said stripping stage being performed by means of a conduit delivering stripping gas positioned at a point on the conduit connecting the head of the reactor and the liquid-vapor separator and characterized in that the said connection conduit is inclined upwards with a gradient of between 2% and 20%, preferably between 3% and 12%, at least from the point of entry. The process claimed is particularly recommended in the case of the stage of hydrotreatment performed in a reactor with a slurry phase hydrogenation catalyst, preferably selected from a bubble column or a ebullated bed reactor.

When carried out using a slurry phase reactor it is also recommended that it should be operated with a volumetric ratio at the outlet from the reactor of:

vapor flow rate (Q_v)

(vapor flow rate (Q_v) + slurry flow rate (Q_L))

of more than 0.75, preferably more than 0.85,

where the slurry comprises liquid plus solid.

The cross section (A) of the connection conduit between the head of the reactor and the liquid-vapor separator and the length (L) of the section of the said conduit from the point of entry for the stripping gases to the point of entry to the separator (from point (C) to point (F) in Figure 1) preferably satisfies the following relationships:

$(A \times L)(Q_v + Q_{vsec} + Q_L) > 10 \text{ s}$, more preferably $> 15 \text{ s}$,

$(Q_V + Q_L)/A > 0.5 \text{ m/s}$, more preferably $> 1 \text{ m/s}$,

$2 > Q_{V\text{sec}}/Q_V > 0.25$, more preferably $1 > Q_{V\text{sec}}/Q_V > 0.5$

where $Q_{V\text{sec}}$ is the volumetric throughput of the secondary gas.

The hydrotreatment stage is preferably performed at a temperature of between 400 and 450°C and a pressure of between 100 and 200 atm.

The hydrogenation catalyst is preferably based on Mo or W sulfide.

Further details may be found in the abovementioned application IT-MI2007A1198.

In order that the invention be better defined some examples demonstrating the effectiveness of using secondary gas in the process embodiment according to the invention leading to the acquisition of products in the gas phase (VPO) are described.

Examples

As already mentioned previously, a change from the EST system (with conversion products in the liquid phase and the presence of low pressure sections) to an EST-VPO system (in which the products leave only in the gas phase) results in a drastic reduction in the potential capacity of the plant. In order to overcome this the reaction temperature must be increased and secondary gas must be used because in the absence of the latter the potential capacity of the plant, other operating conditions being equal, is in any event reduced by approximately 20% in comparison with the EST reference case.

The embodiment of conduit (T) connecting the head of the reactor to the liquid-vapor separator and conduit (I) feeding the stripping gases is that already illustrated in Figure 1, in which:

- the section of conduit connecting the point of entry for the secondary gas to point (D) is inclined upwards with a gradient of 6%;
- the entry conduit for the stripping gases is inclined with respect to the axis of the

conduit connecting the head of the reactor to the liquid-vapor separator by an angle of 45°;

- the flow of stripping gas fed to the connection conduit between the head of the reactor and the separator takes place in a downward direction, in the vertical plane passing through the axis of the connection conduit.

Bearing in mind that the flow rate of secondary gas (W_{sec}) varies between 0 and 100, where 0 corresponds to the absence of secondary gas whereas 100 indicates that the flow of secondary gas is capable of ensuring the same potential capacity of a plant using an EST system ($W_{\text{sec}}^{\text{EST}}$), although operating at a higher reaction temperature, the increase in plant capacity and percentage terms as the secondary gas is varied is shown in Table 1.

Table 1

$(W_{\text{sec}}/W_{\text{sec}}^{\text{EST}}) \times 100$	Increase in fresh charge
0	-
10	3.4%
20	6.3%
30	8.9%
40	11.1%
50	13.1%
60	14.8%
70	16.3%
80	17.7%
90	18.9%

100	20.1%
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Thus, for example using 50% of the throughput of secondary gas required to achieve the potential capacity of an EST system plant (although operating at higher temperature) there is an increase of 13.1% in fresh charge.

The effect of secondary gas on the throughput of fresh charge in terms of percentage increase can be displayed by graphically illustrating what is set out in the table (Figure 3). Figure 4 also shows the effect of secondary gas on the increase in the capacity of an EST-VPO plant (W_{FF}^{VPO}) operated at higher temperature, in comparison with the potential capacity of an EST (W_{FF}^{EST}). In the latter case, using 50% of the flow rate of secondary gas the potential capacity of the plant achieves 94% of the maximum throughput which can be obtained in accordance with the above definition.

The stripping effect of the secondary gas has the result that products which are "heavier" in comparison with the situation in which it is not used leave the plant, but the benefit achieved in terms of productivity is appreciable. The different quality of the products obtained can be assessed by analysing the percentage increase in Diesel, Naphtha and VGO products as a function of the (W_{sec}/W_{sec}^{EST}) ratio expressed in percentage terms relative to the secondary gas as shown in Table 2.

Table 2 - Increase in products as the Secondary Gas varies

$(W_{sec}/W_{sec}^{EST}) \times$	Diesel	Naphtha	VGO
100			
0	-	-	-
10	2.9%	2.9%	6.8%
20	5.4%	5.3%	12.8%
30	7.6%	7.4%	18.1%

40	9.5%	9.1%	22.7%
<u>50</u>	<u>11.2%</u>	<u>10.5%</u>	<u>26.8%</u>
60	12.7%	11.6%	30.4%
70	14.0%	12.7%	33.8%
80	15.2%	13.5%	36.9%
90	16.3%	14.3%	39.8%
100	17.3%	15.0%	42.5%

Here again, if 50% of the throughput of secondary gas is considered, the effect achieved is increases of 11.2%, 10.5% and 26.8% in Diesel, Naphtha and VGO respectively. The effect of the overall increase on the three products of interest is also shown in Figure 5 which comprises the change in the throughput of products in relation to the $(W_{\text{sec}}/W_{\text{sec}}^{\text{EST}}) \times 100$ ratio of secondary gas in percentage terms.

Also, with 50% of secondary gas as defined above, 94%, 96% and 89% of the maximum throughput which can be achieved for Diesel, Naphtha and VGO respectively are achieved (Figure 6).

As may be seen, the secondary gas has a greater influence on the VGO leaving the plant in comparison with Diesel and Naphtha, an indication that the stripping effect is effective in displacing even rather heavy compounds towards the gas phase.

It has already been pointed out that in comparison with an EST-VPO system without the use of secondary gas the liquid recycled to the reactor is heavier than that leaving the reactor itself as a result of the stripping action of the gas. In fact, when the molecular weight of the liquid phase leaving the HP separator recycled to the reactor is monitored in comparison with the molecular weight of the liquid phase leaving the head of the reactor, as the secondary gas increases it is observed that the two flows have an increasingly

marked difference in terms of composition and therefore molecular weight. In the absence of secondary gas the molecular weights (MW) of the two liquid phases are identical, but as the throughput of secondary gas is increased the lighter compounds present in the liquid phase pass into the products which then leave the plant in the gas phase, while the liquid phase becomes increasingly heavier. With 50% of secondary gas, according to the definition given above, the molecular weights of the two flows differ by 11%. Figure 7 shows the change in MW of the two liquid flows as the secondary gas ($W_{\text{sec}}/W_{\text{sec}}^{\text{EST}}$), both expressed in percentage terms, is varied.

CLAIMS

1. System for heavy oils hydroconversion essentially comprising a reactor, a liquid-vapor separator, and a stripping section of conversion products, external to the reactor, comprising a supply conduit of the stripping gas in a point of the connection conduit between the reactor head and the liquid-vapor separator, the said connection conduit being upwardly inclined, at least from the point of entry, with a gradient of between 2% and 20% with respect to the horizontal plane.
2. System according to claim 1, wherein the supply conduit of the stripping gas is inclined to the axis of the connection conduit between the head of the reactor and the liquid-vapor separator at an angle of between 20° and 65°, preferably between 30° and 60°, more preferably between 40° and 50°.
3. System according to claim 1, wherein the stripping gas flow entering the connection conduit between the reactor head and the separator is in a downward direction.
4. System according to claim 2, wherein the supply conduit lies in the vertical plane passing through the axis of the connection conduit.
5. The system according to claim 1 wherein the reactor is a bubble column or ebullated bed reactor.
6. System according to claim 1, wherein the connection conduit between the reactor head and the liquid-vapor separator, at least from the point of entry, is inclined upward with a gradient of between 3% and 12%.
7. System according to claim 1, wherein obstacles of suitable geometry are inserted inside the connection conduit between the reactor head and the vapor-liquid separator, preferably along the upper wall inside the said conduit, which facilitates intimate mixing of the liquid and vapor phases and makes it possible for liquid /

vapor equilibrium to be achieved.

8. Process for heavy oils hydroconversion comprising passing the heavy oil to a hydrotreatment stage carried out in a reactor with a suitable hydrogenation catalyst, to which reactor hydrogen or a mixture of hydrogen and light hydrocarbons are fed, performing a step of stripping with suitable stripping gas on the flow of liquid and vapor phase leaving the reactor, or on the flow obtained merging at least one liquid flow and at least one vapor flow leaving the reactor, passing said flow to liquid-vapor separation in a suitable separator separating the recycled liquid phase to the reactor, less purges, from the vapor phase containing the conversion products obtained only in the vapor phase, the said stripping step being carried out by means of feeding stripping gas at a point in the connection conduit between the reactor head and the liquid-vapor separator, characterized in that the said connection conduit is inclined upwards, at least from the point of entry, with a gradient of between 2% and 20% with respect to a horizontal plane.
9. Process according to claim 8, wherein the hydrotreatment step is carried out in a reactor with a hydrogenation catalyst in slurry phase, preferably selected from a bubble column or ebullated bed reactor.
10. Process according to claim 9, wherein at the exit from the reactor the volumetric ratio:

vapor flow rate (Q_v)

(vapor flow rate (Q_v) + slurry flow rate (Q_L))

is greater than 0.75, preferably greater than 0.85, where the slurry comprises the liquid plus solid.

11. Process according to claim 8, wherein the feed conduit for the stripping gas is inclined with respect to the axis of the connection conduit between the reactor head and the liquid-vapor separator at an angle of between 20° and 65°, preferably between 30° and 60°, more preferably between 40° and 50°.

12. Process according to claim 8, wherein the section (A) of the connection conduit between the reactor head and the liquid-vapor separator and the length (L) of the section of said conduit from the point of entry of the stripping gas to the separator point of entry satisfy the following relationships

$$(A \times L) (Q_V + Q_{Vsec} + Q_L) > 10 \text{ s}$$

$$(Q_V + Q_L) / A > 0.5 \text{ m / s}$$

$$2 > Q_{Vsec} / Q_V > 0.25$$

where Q_V and Q_L are the volumetric flows of vapor and slurry (liquid + solid) leaving the head of the reactor and the volumetric flow rate of the secondary gas Q_{Vsec} .

13. Process according to claim 10, wherein the section (A) of the connection conduit between the reactor head and the liquid-vapor separator and the length (L) of the section of said conduit from point of entry for the stripping gas to the separator point of entry satisfy the following relationships

$$(A \times L) (Q_V + Q_{Vsec} + Q_L) > 15 \text{ s}$$

$$(Q_V + Q_L) / A > 1 \text{ m / s}$$

$$1 > Q_{Vsec} / Q_V > 0.5$$

14. Process according to claim 8, wherein the hydrotreatment step is conducted at a temperature between 400 and 450°C and at a pressure of between 100 and 200 atm.
15. Process according to claim 8, wherein the hydrogenation catalyst is based on Mo or

W sulphide.

AMENDED CLAIMS

received by the International Bureau on 21 April 2016 (21.04.2016)

1. System for heavy oils hydroconversion essentially comprising a reactor, a liquid-vapor separator, and a stripping section of conversion products, external to the reactor, comprising a supply conduit of the stripping gas in a point of the connection conduit between the reactor head and the liquid-vapor separator, the said connection conduit being upwardly inclined, at least from the point of supply of the stripping gas, with a gradient of between 2% and 20% with respect to the horizontal plane.
2. System according to claim 1, wherein the supply conduit of the stripping gas is inclined to the axis of the connection conduit between the head of the reactor and the liquid-vapor separator at an angle of between 20° and 65°, preferably between 30° and 60°, more preferably between 40° and 50°.
3. System according to claim 1, wherein the stripping gas flow entering the connection conduit between the reactor head and the separator is in a downward direction.
4. System according to claim 2, wherein the supply conduit lies in the vertical plane passing through the axis of the connection conduit.
5. The system according to claim 1 wherein the reactor is a bubble column or ebullated bed reactor.
6. System according to claim 1, wherein the connection conduit between the reactor head and the liquid-vapor separator, at least from the point of supply of the stripping gas, is inclined upward with a gradient of between 3% and 12%.
7. System according to claim 1, wherein obstacles of suitable geometry are inserted inside the connection conduit between the reactor head and the vapor-liquid separator, preferably along the upper wall inside the said conduit, which facilitates intimate mixing of the liquid and vapor phases and makes it possible for liquid / vapor equilibrium to be achieved.

8. Process for heavy oils hydroconversion comprising passing the heavy oil to a hydrotreatment stage carried out in a reactor with a suitable hydrogenation catalyst, to which reactor hydrogen or a mixture of hydrogen and light hydrocarbons are fed, performing a step of stripping with suitable stripping gas on the flow of liquid and vapor phase leaving the reactor, or on the flow obtained merging at least one liquid flow and at least one vapor flow leaving the reactor, passing said flow to liquid-vapor separation in a suitable separator separating the recycled liquid phase to the reactor, a part from purges, from the vapor phase containing the conversion products obtained only in the vapor phase, the said stripping step being carried out by means of feeding stripping gas at a point in the connection conduit between the reactor head and the liquid-vapor separator, characterized in that the said connection conduit is inclined upwards, at least from the point of supply of the stripping gas, with a gradient of between 2% and 20% with respect to a horizontal plane.
9. Process according to claim 8, wherein the hydrotreatment step is carried out in a reactor with a hydrogenation catalyst in slurry phase, preferably selected from a bubble column or ebullated bed reactor.
10. Process according to claim 9, wherein at the exit from the reactor the volumetric ratio:
- $$\frac{\text{vapor flow rate (Q}_v\text{)}}{\text{(vapor flow rate (Q}_v\text{)) + slurry flow rate (Q}_L\text{))}}$$
- is greater than 0.75, preferably greater than 0.85, where the slurry comprises the liquid plus solid.
11. Process according to claim 8, wherein the feed conduit for the stripping gas is inclined with respect to the axis of the connection conduit between the reactor head and the liquid-vapor separator at an angle of between 20° and 65°, preferably between 30° and

60°, more preferably between 40° and 50°.

12. Process according to claim 8, wherein the section (A) of the connection conduit between the reactor head and the liquid-vapor separator and the length (L) of the section of said conduit from the point of entry of the stripping gas to the separator point of entry satisfy the following relationships

$$(A \times L) (Q_V + Q_{Vsec} + Q_L) > 10 \text{ s}$$

$$(Q_V + Q_L) / A > 0.5 \text{ m / s}$$

$$2 > Q_{Vsec} / Q_V > 0.25$$

where Q_V and Q_L are the volumetric flows of vapor and slurry (liquid + solid) leaving the head of the reactor and the volumetric flow rate of the secondary gas Q_{Vsec} .

13. Process according to claim 10, wherein the section (A) of the connection conduit between the reactor head and the liquid-vapor separator and the length (L) of the section of said conduit from point of entry for the stripping gas to the separator point of entry satisfy the following relationships

$$(A \times L) (Q_V + Q_{Vsec} + Q_L) > 15 \text{ s}$$

$$(Q_V + Q_L) / A > 1 \text{ m / s}$$

$$1 > Q_{Vsec} / Q_V > 0.5$$

14. Process according to claim 8, wherein the hydrotreatment step is conducted at a temperature between 400 and 450°C and at a pressure of between 100 and 200 atm.
15. Process according to claim 8, wherein the hydrogenation catalyst is based on Mo or W sulfide.

STATEMENT UNDER ARTICLE 19 (1)

The present application has been filed in Italian. Observations relating to the mistranslation from Italian to English are contained in the Written Opinion of the International Searching Authority. According to such observations amended claims 1, 6 and 8 are now submitted. A corresponding amendment has to be performed on the description.

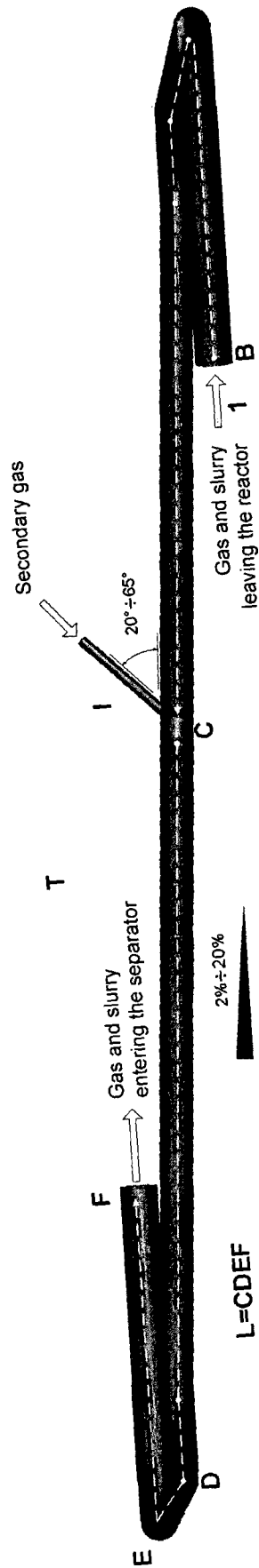


Fig. 1

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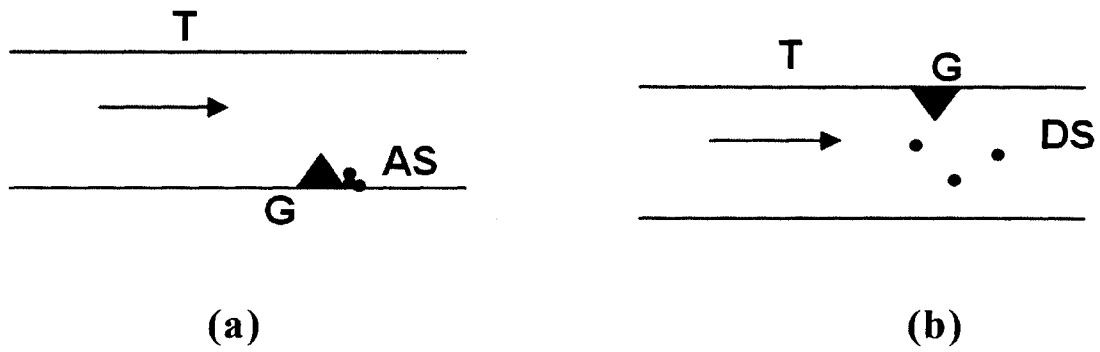


Fig. 2

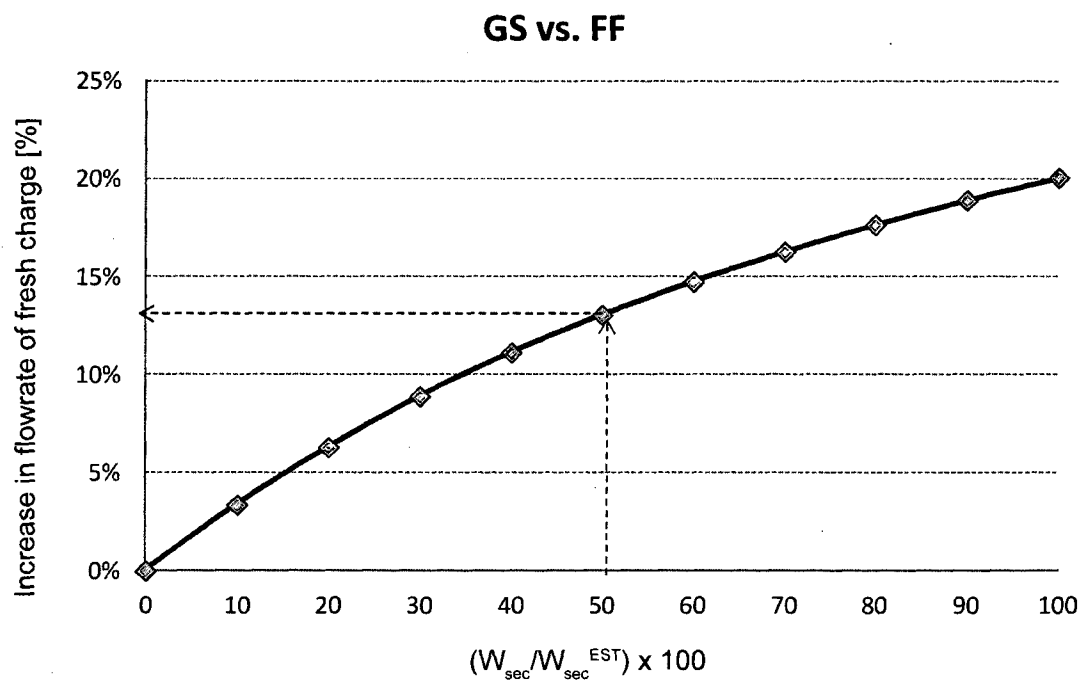


Fig. 3

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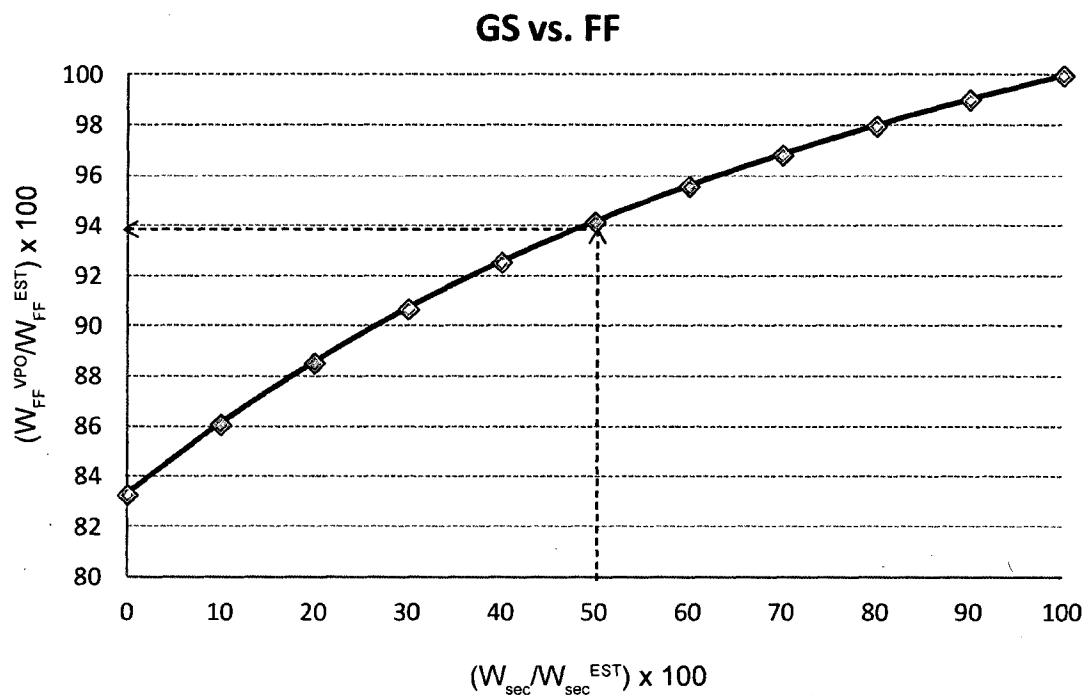


Fig. 4

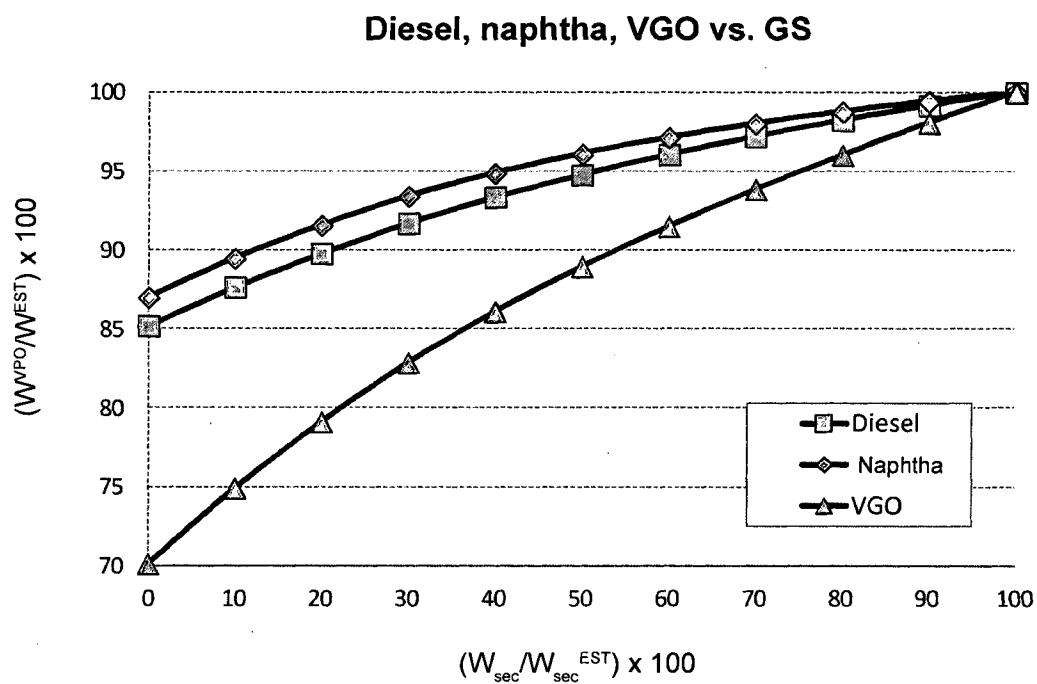


Fig. 5

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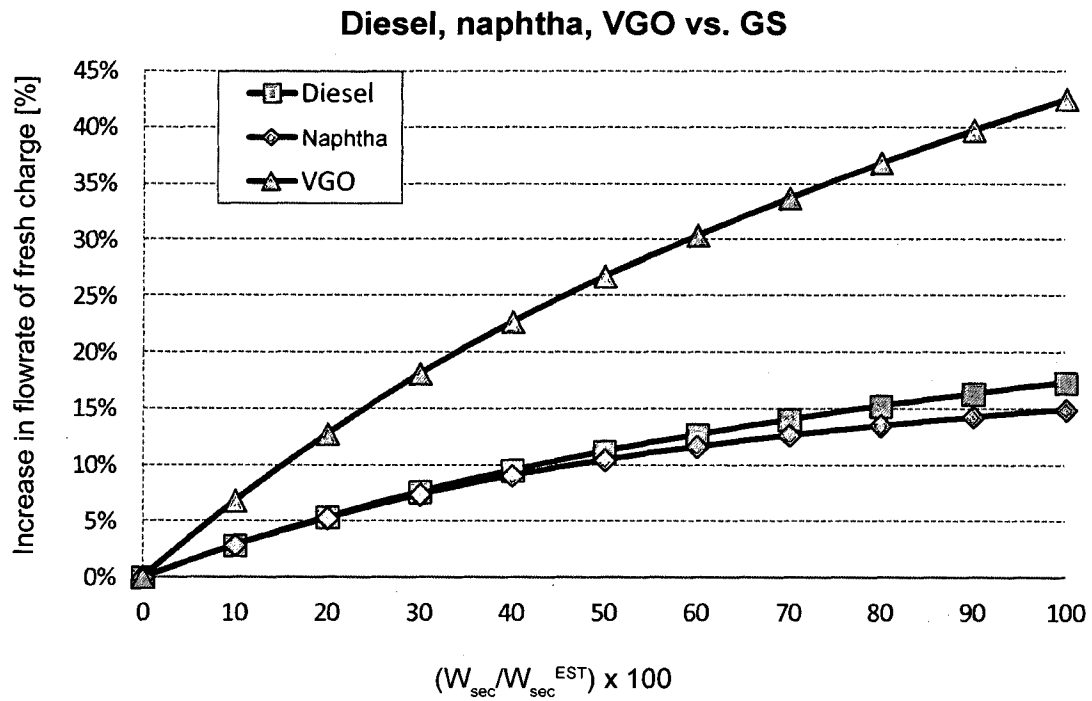


Fig. 6

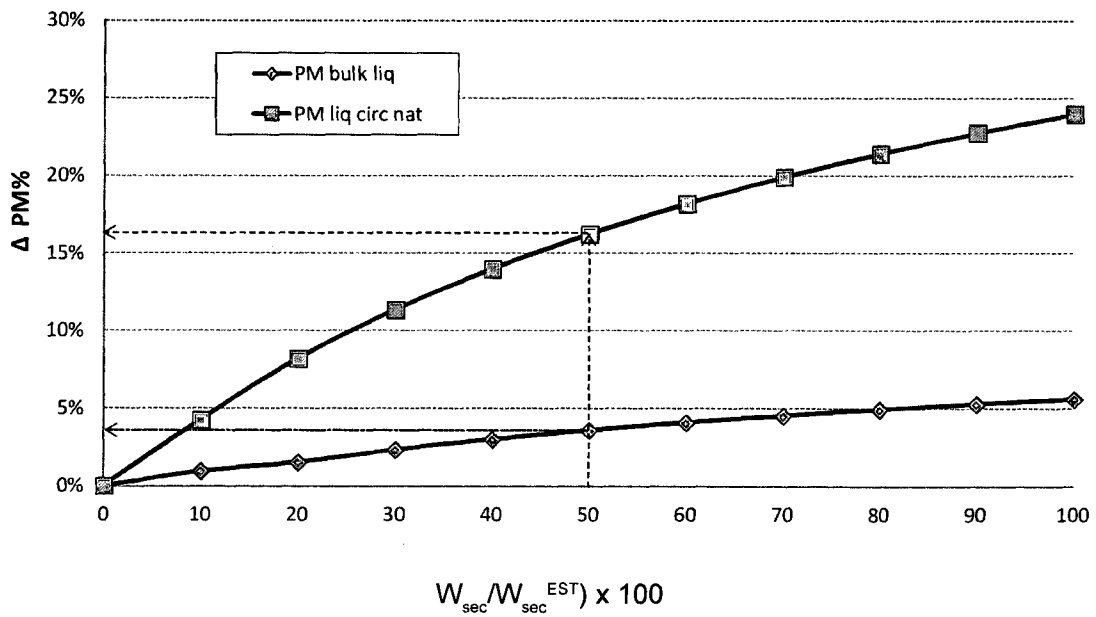


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2015/059911

A. CLASSIFICATION OF SUBJECT MATTER

INV. C10G47/26 C10G49/22
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10G B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2008/141831 A1 (ENI SPA [IT]; PATRON LUIGI [IT]; BELLUSSI GIUSEPPE [IT]; TAGLIABUE LOR) 27 November 2008 (2008-11-27) claims 1, 4, 6 page 8, lines 2-8 page 15, lines 2-22 -----	1-15
A	US 6 436 279 B1 (COLYAR JAMES J [US]) 20 August 2002 (2002-08-20) claims 1, 2; figure 1 -----	1-15
A	US 2011/160505 A1 (MCCALL MICHAEL J [US]) 30 June 2011 (2011-06-30) paragraphs [0029] - [0033]; figures 1, 2 -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

18 February 2016

Date of mailing of the international search report

26/02/2016

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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