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(71) Applicant (for all designated States except US): **NGL**

TECH SDN. BHD. [MY/MY]; 90A, 1st Floor jalan
Burhanuddin Helmi, Taman Tun Dr. Ismail, 60000 Kuala
Lumpur (MY).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **JOTHY, Arul**

[MY/MY]; Ngl Tech Sdn. Bhd., 90A, 1st Floor jalan
Burhanuddin Helmi, Taman Tun Dr. Ismail, 60000 Kuala
Lumpur (MY). **OOI, Boon Lee** [MY/MY]; Ngl Tech Sdn.
Bhd., 90A, 1st Floor jalan Burhanuddin Helmi, Taman Tun
Dr. Ismail, 60000 Kuala Lumpur (MY). **HUM, Weng**
Loong [MY/MY]; Ngl Tech Sdn. Bhd., 90A, 1st Floor
jalan Burhanuddin Helmi, Taman Tun Dr. Ismail, 60000
Kuala Lumpur (MY).

(74) Agents: **JEFFREY, Fiona Teresa** et al.; Marks & Clerk

(Malaysia) Sdn Bhd, PO Box 11182, 50738 Kuala Lumpur
(MY).

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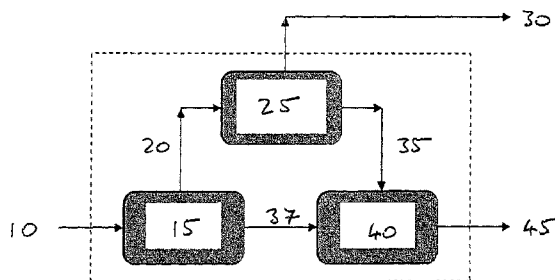


Figure 1

(57) **Abstract:** A method for the production of stabilized crude oil, the method comprising the steps of: providing a stream of crude oil; injecting steam into said stream and so stripping C3- from said stream; providing a gas stream; extracting C4+ from the gas stream, and so; producing a stream from the extracted C4+; co-mingling the stripped stream with the C4+ stream, and so; producing a stream of stabilized crude oil.

A PROCESS FOR THE RECOVERY OF CRUDE

Field of the Invention

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The invention relates to the production of crude oil, and in particular to the maximizing the recovery of stabilized crude oil from an oil and gas producing facility.

Background

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The current global situation of depleting crude oil reserves, escalating crude oil price, coupled with an increasing environmental awareness and legislation on the management of CO₂ emissions requires more responsible development of hydrocarbon assets. To address these issues, operating companies are investigating and implementing strategies to enhance crude oil recovery by maximizing recovery of NGLs and minimizing flaring.

15

Raw natural gas comes from predominantly two types of wells: oil wells and gas wells. Natural gas that comes from oil wells is typically termed “associated gas”. This gas can exist separate from oil in the formation (free gas), or dissolved in the crude oil (dissolved gas). Natural gas from gas wells, in which there is little or no crude oil, is termed “non-associated gas”. Gas wells typically produce raw natural gas along with a semi-liquid hydrocarbon condensate. Whatever the source of the natural gas, once separated from the associated liquid it commonly exists in mixtures of predominantly methane and ethane and other hydrocarbons; principally propane, butane, and pentanes.

20

Natural gas coming directly from a well contains many natural gas liquids that are commonly removed. In most instances, natural gas liquids (NGL's which includes ethane, propane, butanes and pentanes) have a higher commercial value as separate products, and it is thus economical to remove them from the gas stream. The processes for removal of natural gas liquids are relatively complex requiring gas pretreatment facilities like CO₂ removal systems and gas dehydration, NGL extraction processes like lean oil absorption or cryogenic expander processes, NGL processing and fractionation facilities like de-methanizer, de-ethanizer, de-propanizer, de-butanizer and butane splitter. In addition, pressurized storage and off-loading facilities are also required. This results in facilities, where NGL extraction and processing are undertaken, being very complex with significant safety issues and requires large real estate with significant capital investment. For these reasons these processes are generally built as centralized processing plants and are not considered particularly for offshore facilities and many onshore developments.

On many gas processing facilities, NGL recovery facilities are not installed due to economic reasons and the gas exported will contain significant quantities of C₄+ components. C₄+ components, particularly LPGs (C₄'s) are cumbersome to handle in many cases, as they predominantly cannot be stabilized with the light condensate stream and, cannot be spiked into the export gas stream due to export gas dew point limitations. As such, in many cases, these valuable hydrocarbon components that can neither be spiked into the export gas stream or the stabilized condensate stream are utilized within the site as fuel gas or flared.

Where pipeline gas export dew-point specifications are less stringent, many gas producers export significant quantities of C4+ components with the sales gas instead of recovering the NGLs. In this case, the revenue earned is solely from the heating value
5 (BTU) of the gas which is significantly lower than what it would be worth as liquids.

While condensates produced with non-associated gas have generally limited capacity to absorb and retain LPG components within the stabilized condensate stream, crude oil if produced in parallel has significantly higher capacity to retain these LPG and tail end
10 C5+ components as stabilized liquids.

There are growing concerns over greenhouse gas emissions and its impact on global warming. Currently, many oil producers are still flaring associated gas produced, which is a by-product of crude oil production. According to estimates made in year 2005 to
15 2009, some 14 to 16 bcf is flared daily in the world. Gas flaring also has a global impact on climate change by adding some 400 million tons of CO₂ in annual emissions.

Apart from being flared associated gas is currently:

- Re-injected back into the reservoirs
- 20 • Utilized as fuel gas and/or transmitted via pipeline
- Processed in NGL extraction facilities

In addition, there are a number of new technologies that are being considered for the processing and utilization of the associated gas. These include mini LNG, Gas to Liquid (GTL), Compressed Natural Gas (CNG) and Gas to Solid processes.

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The implementation of the above facilities to utilize associated gas requires significant capital investment which may not be economically feasible, particularly for marginal fields. In the past, one major contributor that discourages investment in gas processing facilities is the low price of gas compared to crude oil. The tendency is for producers to
10 focus on crude oil production with associated gas being more of an undesirable by-product.

In recent years, with the escalation of crude oil prices, the value natural gas and in particular NGLs (C3+ components) have also increased in tandem with crude oil prices.
15 However, with crude oil reserves depleting and field sizes getting smaller, economics are still not favourable for many developments to take-off without re-injecting or flaring the associated gas produced.

In addition, many marginal fields discovered are not developed as the recoverable
20 reserves are not sufficient to make the development economically viable. Yet another scenario is early abandonment of a field due to declining production. Increasing the recovery of NGLs and /or crude oil will make many of these marginal fields viable and stretches production life of fields, thus facilitating more responsible utilization of oil reserves.

Summary of Invention

In a first aspect, the invention provides a method for the production of stabilized crude oil, the method comprising the steps of: providing a stream of crude oil; injecting steam into said stream and so stripping C3- from said stream; providing a gas stream; extracting C4+ from the gas stream, and so; producing a stream from the extracted C4+; co-mingling the stripped stream with the C4+ stream, and so; producing a stream of stabilized crude oil.

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In a second aspect, the invention provides a system for the production of stabilized crude oil comprising: a steam injection station arranged to receive a stream of unstabilised crude oil, said station arranged to subject said stream to an injection of steam; said steam injection station including a first outflow to deliver a stripped stream of crude to a stabilizer and a second outflow to deliver a flow of gas to a condensation station; said condensation station arranged to condense the gas to produce a condensate, said station further including an outflow to direct the condensate to the stabilizer for comingling the condensate with the stripped stream of crude; wherein the stabilizer is arranged to outflow a stream of stabilized crude resulting from said comingled streams.

20

In a third aspect, the invention provides A system for stripping light components from a crude oil stream, comprising a crude stripping column for receiving the crude oil stream, said column arranged to receive steam for applying to the crude oil stream; a surge vessel for receiving the stripped crude stream and arranged to separate water from

said stripped crude stream; wherein the surge vessel and crude stripping column are selectively coupled so as on de-coupling the crude oil stream is permitted to by-pass the crude stripping column and flow directly into the surge vessel.

- 5 Therefore, the invention provides a process and system that maximizes the absorption of C4+ components into the stabilized crude stream.

The process involves three operating steps where the crude is first stripped of C3- components. Heavy components, such as C4+, that are in a gas stream are extracted
10 through condensation of the hydrocarbons, which may be through use of a dew-point control system, said control system may further be coupled with a de-propanizer. Finally the crude stream and condensate streams are co-mingled, possibly under conditions that will ensure that the vapor pressure specifications of the product liquid stream are met.

15

The process configuration and controls may be such that irrespective of the amount or proportion of crude and condensate produced, the amount of C4+ components in the stabilized product stream is maximized and the amount of C3- components minimized.

20

This may yield increased stabilized liquid production compared to a conventional multi-stage separation process and improved stabilized crude quality.

An advantage of the recovery of this process includes the minimization of the amount of propane and lighter molecular weight components in the stabilized crude stream, which will enable larger quantities of C4+ components to be absorbed into the crude stream and thus improve stabilized crude recovery, among others, whilst maintaining the

5 TVP/RVP specification of the stabilized crude.

Brief Description of Drawings

It will be convenient to further describe the present invention with respect to the
10 accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible, and consequently the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

15 Figure 1 is a flow chart of a process according to one embodiment of the present invention;

Figure 1A is a sequential table of results during the process according to one embodiment of the present invention;

Figure 2 is a schematic view of a stabilization system according to a further
20 embodiment of the present invention;

Figure 3 is a schematic view of an LPG and condensate stabilization system according to the prior art;

Figure 3A is a schematic view of multi-stage separation system according to the prior art;

Figure 3B is a schematic view of a multi-stage Separation and Condensate stabilization system according to the prior art;

Figure 4 is a schematic view of crude stabilization system according to one embodiment of the present invention;

5 Figure 5 is a schematic view of a crude stripping column according to one embodiment of the present invention

Figure 6 is a graph of equivalent volumetric light components (C3-) in stabilized crude oil comparing the prior art to an example of the present invention;

Figure 7 is a further graph of equivalent volumetric heavy components (C4+) in
10 stabilized crude oil comparing the prior art to an example of the present invention;

Figures 8A to 8D are pie charts comparing the recovery rate of C4+ of the prior art processes compared with an example of the present invention.

Detailed Description

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The process according to the present invention may increase the recovery of oil by between 5 to 30% over conventional processes. This is achieved by using crude oil and/or condensates from production wells to absorb intermediate hydrocarbon components (C4+) from a natural gas stream whilst maintaining the stabilized crude
20 product within its vapor pressure specifications (TVP/RVP). This also results in improved crude oil quality (increased API gravity, reduced viscosity) and reduction of greenhouse gas emissions by up to 50% depending on whether associated gas is flared and due to the use of leaner fuel gas.

The process according to the present invention may also reduce environmental emissions of hydrocarbon gases and safety issues due to vaporization of volatile hydrocarbon components (C1, C2 and C3) from stabilized crude in the storage tanks by minimizing these components in the stabilized crude.

5

The present invention may be applicable for both onshore and offshore installations. The present invention may also be suitable for facilities where it is not economically viable to install a gas plant with NGL or LPG extraction facilities.

10 Figure 1 shows a flow chart of one embodiment of the present invention. The process 5 is carried out in three main steps:

1. Crude Stripping Section

The unstabilised crude 10 is stripped of propane and lower molecular weight components in a steam stripping column 15 using superheated steam and
15 operated in the range of 0.5 barg to 5 barg. This operation step also strips out salts from the crude stream prior to the crude being routed to the electrostatic coalesce. Thus the process also carries out desalting of the crude.

2. Condensate Recovery Section

This section 25 of the process extracts C4+ components and condensates from
20 the associated and/or non-associated gas streams 20 whilst expelling 30 lighter components from the condensate stream using a depropanizer column. NGLs from associated and non-associated gas stream 20, laden with C3+ components stripped from the crude stream, is extracted from the gas stream using either a conventional dew-point control system or membranes and the condensate is

routed to a de-propanizer column to produce condensate 35 predominantly laden with C4+ components. Alternatively, condensate extracted from the condensate recovery section may be routed to the stripping column surge vessel. This may avoid the need for a flash vessel downstream. In this case the operating pressure and temperature of the fluid in the surge drum may be adjusted such that the crude/condensate mix existing the surge drum meets the TVP specifications. This may be achieved by adjusting the temperature of the condensate stream from the condensate recovery section using a cooler.

3. Crude and Condensate Mixing and Stabilization Section

Crude 37 from the Crude Stripping Section 15 and that is de-watered with an electrostatic coalesce and condensate 35 from the de-propanizer of the Condensate Recovery Section 25 are both routed to the Crude and Condensate Mixing and Stabilization Section 40. Here the crude and condensate are mixed, cooled and routed 45 to the Flash Vessel. The Flash Vessel is operated at a temperature and pressure such that the liquids produced are stabilized to meet the TVP/RVP specification of the product. To maximize stabilized liquid production, offgas produced from the flash vessel is maintained at a preset value by adjusting the reboiler temperature of the de-propanizer column. The reboiler temperature of the depropanizer column controls the amount of C3/C4 component split in the column bottoms product and the column overhead gas stream, thus ensuring that the amount of C4s in the condensate stream is maximized without generating significant flash gas when the crude and condensate are comingled.

This process configuration maximizes the recovery of stabilized crude and ensures that valuable liquids from the associated and non-associated gas streams are recovered as stabilized product suitable for storage in atmospheric tanks.

5

The process is particularly suitable for facilities that handle difficult crudes that includes crudes that are waxy, highly emulsifying, high salt content and/or with high asphaltene content. This is because the process is configured to operate the crude processing section at high temperature (above wax appearance temperature and above emulsion
10 breaking temperature) and is stripped of its light ends when operating at high temperature, thus minimizing risk of asphaltene deposition at the high temperatures in the steam stripping column. In addition, steam stripping of the crude also functions to water wash the crude, thus diluting salt concentrations. This minimizes risk of scale and salt deposition in the system and significantly enhances the performance of the
15 downstream electrostatic coalescer. Foaming tendencies of the crude is also minimized both due to the dilution effect of condensed steam on the salts and also due to the stripping action that reduces the light end content in the crude.

Whilst the Crude Stripping Section minimizes the C3- content in the crude stream, the
20 Condensate Recovery Section maximizes the recovery C4+ components thus ensuring that the final crude and condensate that is mixed in the Crude and Condensate Mixing and Stabilization Section has maximum C4+ components and thus maximum stabilized liquid recovery within its TVP and RVP specification. As a reboiled column is only provided for the condensate depropanizer column at the Condensate Recovery Section,

the heat duty and column size is minimized compared to the case when crude is routed to a stabilizer column. In addition, as condensates extracted are clean, issues associated with fouling of the reboiler tubes are avoided.

- 5 For crude that have high asphaltene content and which have a tendency for asphaltene deposition when mixed with condensates at high temperatures, the temperature at which the mixing occurs can be adjusted by appropriately pre-cooling the gas and condensate stream prior to mixing at the Crude and Condensate Mixing and Stabilization Section.
- 10 The present invention uses the ability of crude oil to absorb some of the C3 components and essentially all the C4+ components from the gas stream and to retain within the stabilized crude oil product these valuable NGL products. This results in increased stabilized crude oil recovery and improved quality of crude, namely, higher API gravity and reduced crude oil viscosity.

15

As demonstrated in Figure 1A. Crude oil stabilized with conventional methods, i.e. using multiple stages of flash separation, is inherently inefficient with small quantities of C2- components still remaining in the stabilized crude stream.

- 20 In the Figure 1A, 1000 barrels of crude oil stabilized by conventional means to a TVP of 12 psia is considered. De-ethanizing the crude i.e. removing the C1 and C2 components from the crude results in marginal reduction in crude volume to 999 barrels but dramatically reduces the TVP of crude to 5 psia. This is because, although the quantities of C1 and C2 components in the crude sample are low, the TVP of these

components are very high (approx 5075 psia and 870 psia respectively compared to 51 psia for nC4), thus significantly contributing to the overall vapor pressure of the stabilized crude.

- 5 In subsequent operations shown in the Figure 1A, the crude is progressively loaded with C3+ components present in the associated gas stream until the crude TVP is back up to 12 psia. With this operation the overall crude volume increases by 7.3%. If further, the crude is stripped of the C3 components and loaded with C4+ components up to its TVP limit of 12 psia, the crude volume increases by a total of 10.6%. The overall crude
10 quality also improves in the process with API gravity of crude increasing from 40.4 to 44.1 and the viscosity of crude reducing from 1.95 cP to 1.45 cP.

The process utilizes this concept to absorb C4+ components from the natural gas stream. The absorbent crude oil stream that has been stripped of C3- components is mixed with condensate that has been de-propanized to a level that allows the mixture of crude and
15 condensate to meet the TVP/RVP specification of the stabilized liquid.

Figure 2 shows a schematic view of a system according to one embodiment of the present invention. Full well stream crude 55 with associated gas and produced water is routed to the Inlet Separator 65 where 3 phase separation is carried out. The Inlet
20 Separator 65 is typically operated in the range of 5 to 20 barg and a temperature in the range of 60°C for emulsion breaking. Crude oil from the Inlet Separator is then heated via a crude-crude heat exchanger 70 by the hot crude/condensate stream from the downstream system 90 to recover as much heat as possible from the hot stream.

The crude is then letdown in pressure, typically in the range of 0.5 to 4 barg and then fed to the crude stripping column 80. Ideally, the operating pressure of the crude stripping column 80 is set at as low a pressure as possible at approximately the same pressure as the downstream Flash Vessel 110. This is to minimize steam requirements

5 and to enable common suction pressure to the Flash Gas Compression train 140.

Alternatively, the stripping column 80 may be operated at a higher pressure to enable inter-stage feed to the Flash Gas Compressors. Superheated stripping steam 90 is fed at the base of the column 80.

The amount of superheated steam used is dependent on the composition of the crude
10 and operating pressure of the column but is typically approximately 1 lb steam per gallon of crude feed to the stripping column. The number of theoretical trays used is in the range of 3 to 10 theoretical stages. The number of theoretical trays used is a trade-off between steam consumption requirements, compression power and column height to minimize the amount of C3- components in the stripped crude stream whilst the C4+
15 components are maximized. To avoid decomposition of the heavy ends of the crude, the temperature of the bulk crude at the bottom of the stripping column is typically maintained within approximately 100°C. The temperature of the steam supply should be such that localized decomposition of crude (when in contact with hot superheated steam) is minimized whilst high enough to provide sufficient heat and minimize steam
20 consumption for stripping. Typically steam supply temperature is in the range of 120 to 180°C and includes a superheat of approximately 30°C.

The process 50 selectively displaces the light (C3-) components in the crude whilst maintaining as much of the C4+ components within the crude stream. Nonetheless, the

overall process is configured such that any C4+ components that are stripped out of the crude in this section are recovered from the gas stream in the dew-point control section 130 of the process. As such, the main objective of this section of the process is to strip as much of the C3- components from the crude stream. As a result, the vapor pressure of the crude is dropped to well below the TVP/RVP specification of the stabilized crude. 5 The use of steam stripping (as opposed to heating the crude using a reboiler) minimizes the temperature rise of the crude during the stripping process, thus minimizing decomposition of the crude and preventing coking. It also avoids the need for a reboiler which for dirty and fouling crude with high asphaltene content, will cause scale and 10 asphaltene deposition at the reboiler tubes.

In addition, the benefits of crude stripping include:

- Crude is desalted as the salts in the crude stream are essentially water washed by the condensing steam.
- 15 • Foaming tendencies of the crude is also minimized both due to the dilution effect of condensed steam on the salts and also due to the stripping action that reduces the light end content in the crude.
- The process is configured to operate the crude processing section at high temperature (above wax appearance temperature and above emulsion breaking 20 temperature) and is stripped of its light ends when operating at high temperature, thus minimizing risk of asphaltene deposition at the high temperatures in the steam stripping column.
- Salt and scale deposition are prevented by avoiding the use of reboilers for the crude stripping column.

The steam stripping column can be a conventional column with trayed, structured, random packing or other internals suitable to promote vapor liquid contact. For a conventional column, a liquid hold-up boot is required to provide sufficient liquid residence time for vapor liquid separation and to provide adequate surge volume for the
5 downstream pump.

Alternatively, the column 80 may be configured as shown in Figure 2. This column configuration enables the system 50 to be operated as a conventional separation train when the column is off-lined for maintenance, etc. It also results in a shorter column as liquid holding is accommodated in the surge vessel 85. This is particularly suited for a
10 floating facility where the motion effects can significantly impair the performance of tall columns.

When crude production begins to decline, crude from the downstream crude transfer pumps may be recycled to the stripping column to ensure that minimum column
15 turndown is not exceeded.

Offgas from the crude stripping column, depending on the operating pressure is either comingled with offgas from the downstream Flash Vessel 110, is cooled and routed to the Flash Gas Compression Train 140. Alternatively, if the stripping column 80 is
20 operated at a higher pressure than that of the Flash Vessel 110, the offgas from the stripping column may be cooled and routed to the inter-stage of the Flash Gas Compression train.

Hot stripped crude from the Stripping Column is routed to the Stripping Column Surge Vessel where 3 phase (gas, crude and water) separation is performed. Any gas separated is comingled with superheated stripping steam and routed to the Stripping Column. Crude is discharged from the vessel under level control via a pump to the electrostatic
5 coalescer.

The process recovers C4+ components from the associated and non-associated gas streams. The condensates may be extracted from the gas stream by a dew-point control system using JT-Valve, turbo-expander, mechanical refrigeration, membranes or a
10 combination. Liquids recovered from the dew-point control system 135 and possibly the compression train scrubbers are letdown in pressure and routed to de-propanizer column.

The reboiler temperature of the depropanizer 145 is set to maximize the recovery of
15 C4+ components. The de-propanizer column 145 rejects into the overhead gas stream, most of the C3 and lower molecular weight components whilst the C4+ components are routed to the column bottoms. The TVP of the column bottoms is adjusted, such that, when the condensate comingles with the crude stream, the combined crude and condensate stream TVP/RVP (typically approximately 12 psia) specification is met.
20 This is accomplished by adjusting the reboiler temperature set-point. A flash gas flow control signal from the Crude Condensate Mixing and Stabilization section of the process provide a cascade control set-point to reboiler temperature controller. This ensures that the recovery of stabilized liquid is always maximized irrespective of the actual flowrate of crude and associated gas (and thus condensate) or their flow ratios.

The process is essentially configured such that the condensate is stabilized (in the depropanizer column 145) to a level that is just adequate that the TVP/RVP of the combined crude and condensate product stream meets the storage and export specification. The depropanizer column will ensure that light ends from the condensate stream are displaced into the offgas stream and heavier ends are routed to the column bottom stream.

The Depropanizer column 145 can be a conventional column with trayed, structured, random packing or other internals suitable to promote vapor liquid contact. For a conventional column, a liquid hold-up boot is required to provide sufficient liquid residence time for vapor liquid separation and to provide adequate surge volume for the downstream pump.

Crude that is stripped of C3- components in the Crude Stripping Section of the process is then routed to the electrostatic coalescer 100, if required, to dehydrate the crude to meet crude BS&W content. The steam stripping operation also functions to water wash the crude and thus enhances the operation of the electrostatic coalescer 100. The dewatered crude is then comingled with condensate from condensate de-propanizer. Alternatively, if dehydration of the condensate stream is required, mixing of the crude and condensate streams can be done upstream of the electrostatic coalescer 100. In this case, the condensate may need to be pre-cooled and the operating pressure of the electrostatic coalescer maintained such that vapor break-out will not occur within the electrostatic coalescer.

The mixed stream is then routed to the crude-crude heat exchanger 70 for heat recovery and then to a cooler 105 before the pressure is letdown typically to a pressure of approximately 0.5 to 1 barg. The operating pressure is such that there will be sufficient head for the liquid to overcome the downstream system pressure drop en-route to storage. The fluid is then routed to a flash vessel 110 for vapor liquid separation. The operating temperature of the flash vessel is set such that crude and condensate mix will be stabilized to the desired TVP/RVP specification. Typically, the temperature is set at approximately 60 to 70°C.

Offgas from the Flash Vessel is comingled with offgas from the stripping column, cooled and routed to the flash gas compression train. To maximize the recovery of stabilized liquid, the offgas rate from the Flash Vessel is always maintained at a pre-set value, typically at approximately 0.5 to 1 MMscfd. This is done by means of a cascade control loop, where the flow controller output of the offgas from the Flash Vessel is used as the control set point of the depropanizer reboiler temperature controller. This ensures that the amount of butanes (C4s) that is extracted from the condensates routed to the depropanizer column is maximized to the limit that can be handled by the mixed crude and condensate stream whilst meeting the TVP/RVP specification. This ensures that the recovery of stabilized liquid is always maximized irrespective of the actual flowrate of crude and associated gas (and thus condensate) or their flow ratios. The process is essentially configured such that the condensate is stabilized (in the depropanizer column) to a level that is just adequate that the TVP/RVP of the combined crude and condensate product stream meets the storage and export specification. Liquids from the Flash Vessel is then routed to a cooler 115 and sent to storage via a level control valve. Alternatively, the crude may be pumped to storage.

Example

The process of the present invention has application in production facilities where crude and gas are produced simultaneously and where it is not economical to install

5 conventional NGL extraction facilities. This includes onshore and offshore facilities that simultaneously produce and process crude with associated and non-associated gas.

The case study in the following sub-section demonstrates how the process of the present invention can be used on facilities that produce and process non-associated gas and crude in parallel.

10

A case study is carried out for a gas well stream of 160 MMscfd of non-associated gas and 16,000 bpd of condensate; another feed from oil well of 21,000 bpd of crude oil and 11 MMscfd associated gas. Four different processing facilities are considered, they are:

- i. LPG fractionation
- 15 ii. Conventional multi stage separation and stabilization
- iii. Conventional multi stage separation plus condensate stabilization
- iv. One embodiment of the present invention

(i) *LPG Fractionation*

20 A LPG facility designed for a nominal capacity of 170 MMscfd of export gas, 10,000 bpd of LPG and 34,000 bpd of crude oil. Figure 3 shows typical mixed LPG extraction and condensate stabilization system 155.

The process utilizes multistage separation 165, 175, 185 to stabilize the condensate.

Off-gas from the multi stage stabilization system is re-compressed 195, 200 and co-mingled with non-associated gas. The gas will be treated and dehydrated to the water dew point specification.

5

Condensate rich in LPG components will be extracted at the hydrocarbon dew point control unit 225. The condensate is then routed to the LPG fractionation unit 255. The LPG fractionation unit consist de-ethanizer and debutanizer columns 255 to produce mixed LPG and stabilized condensate products. The stabilized condensate will mix

10 with stabilized crude oil and send to oil storage tank whereas the LPG 260 will be stored in pressurized LPG bullets or refrigerated tanks.

Considering the initial year of production, the following tabulation gives the material balance of pertinent streams for the process depicted in the figure above.

15 **Table #1: Material Balance for LPG and Condensate Stabilization System (Dry Basis)**

	Feed	Full Well	Off gas	LPG	Stabilized
	NAG	Stream	(Export	Product	Oil
Mass Flow (ton/hr)	235.6	119.8	149.1	32.6	173.7
Liquid Flow (bpd)	15,530	20,930	-	9199	33,260
Gas Flow (MMscfd)	162	10.5	166	-	-
Composition (mole%)					
Methane (& lighter)	80	36.2	90.7	0.0	0.0
Ethane	6.9	5.6	8.1	0.4	0.1
Propane	5.0	6.4	1.2	61.9	1.5
i-Butane	1.2	1.9	0.0	16.2	1.9
n-Butane	1.7	3.0	0.0	20.8	4.4
i-Pentane	0.7	1.6	0.0	0.6	6.5
n-Pentane	0.5	1.4	0.0	0.1	5.6
Hexane Plus	4.0	43.9	0.0	0.0	80

Total	100	100	100	100	100
-------	-----	-----	-----	-----	-----

(ii) *Conventional multi stage separation*

A multi stage separation is a more commonly used process configuration for offshore facilities due to its simplicity and as traditionally the industry focus has not been to enhance recovery of stabilized liquid and reduce environmental emissions at the expense of capital expenditure (CAPEX) and facility complexity. It comprises several stage of separation and heating to separate water and gas and in the process stabilizes the crude oil to the specified TVP specification. Commonly, flash gas compression will be installed to recovery vapor from the liquid separation train.

Figure 3A shows typical configuration of 3 stage separation system. Considering the same inlet feed stream, the following tabulation gives the material balance of pertinent streams for the process depicted in the figure above.

Table #2: Material Balance for Conventional Multi Stage Separation System (Dry Basis)

	Feed	Full Well	Off gas	Stabilized
	NAG	Stream	(Export	Oil
Mass Flow (ton/hr)	235.6	119.8	189.3	166.1
Liquid Flow (bpd)	15,530	20,930	-	31,500
Gas Flow (MMscfd)	162	10.5	181	-
Composition (mole%)				
Methane (& lighter)	80	36.2	83	0.0
Ethane	6.9	5.6	7.5	0.2
Propane	5.0	6.4	5.6	1.9
i-Butane	1.2	1.9	1.2	2.1
n-Butane	1.7	3.0	1.6	4.6
i-Pentane	0.7	1.6	0.4	3.8
n-Pentane	0.5	1.4	0.3	3.6

Hexane Plus	4.0	43.9	0.4	83.8
Total	100	100	100	100

(iii) Conventional multi stage separation plus condensate stabilization

This process configuration, shown in Figure 3B, is similar to above multi stage separation and stabilization but has in addition a hydrocarbon dew point control unit and condensate stabilizer column. The condensate (C4+ components) is extracted from gas stream at the dew point control unit and routed to stabilizer column to where the condensate is stabilized to meet the required TVP specification. The stabilized condensate will then be comingled with the stabilized crude oil from the separation train. The comingled stream is then cooled prior to being routed to the storage tanks.

Figure 3B shows a typical configuration of the system with 3 stages of separation plus a condensate stabilization system. Considering the same inlet feed streams, the following tabulation gives the material balance of pertinent streams for the process depicted in the figure above.

Table #3: Material Balance for Conventional Multi Stage Separation Plus Condensate Stabilization System (Dry Basis)

	Feed	Full Well	Off gas	Stabilized
	NAG	Stream	(Export	Oil
Mass Flow (ton/hr)	235.6	119.8	184.8	170.6
Liquid Flow (bpd)	15,530	20,930	-	32,520
Gas Flow (MMscfd)	162	10.5	180	-
Composition (mole%)				
Methane (& lighter)	80	36.2	83.6	0.0
Ethane	6.9	5.6	7.5	0.2

24

Propane	5.0	6.4	5.6	1.8
i-Butane	1.2	1.9	1.2	2.0
n-Butane	1.7	3.0	1.6	4.4
i-Pentane	0.7	1.6	0.3	4.3
n-Pentane	0.5	1.4	0.2	4.5
Hexane Plus	4.0	43.9	0.0	82.8
Total	100	100	100	100

(iv) One Embodiment of the Present Invention

- 5 Figure 4 shows a process configuration of one embodiment of the system of the present invention. The system comprises of a dew-point control system 225 for condensate extraction 230, a condensate depropanizer column 250 and at the crude handling side, a crude steam stripping column 171 in which the liquid surge and residence time for vapour liquid separation is achieved.

10

Considering the same inlet feed stream, the following tabulation gives the material balance of pertinent streams for the process depicted in the figure above.

Table #4: Material Balance for a System of the Present Invention (Dry Basis)

	Feed	Full Well	Off gas	Stabilized
	NAG	Stream	(Export	Oil
Mass Flow (ton/hr)	235.6	119.8	179.9	175.5
Liquid Flow (bpd)	15,530	20,930	-	33,720
Gas Flow (MMscfd)	162	10.5	179	-
Composition (mole%)				
Methane (& lighter)	80	36.2	84.2	0.0
Ethane	6.9	5.6	7.6	0.0
Propane	5.0	6.4	5.9	0.0
i-Butane	1.2	1.9	1.2	2.3
n-Butane	1.7	3.0	1.0	8.3
i-Pentane	0.7	1.6	0.1	6.2

n-Pentane	0.5	1.4	0.0	5.3
Hexane Plus	4.0	43.9	0.0	77.9
Total	100	100	100	100

Table #5 gives the comparison in terms of product recovery and properties of the product stream for the above four process configurations considered.

- 5 Among all the four processes considered, the system of the present invention recovered the most amount of stabilized crude, in the range of an incremental production of 460 to 2220 bpd compared to the other 3 processes with improved stabilized crude properties (lowest RVP/TVP, highest crude API gravity and lowest crude viscosity).

10 **Table #5: Comparison of various processes**

	LPG	3 Stages	3 Stages	Present
	Extraction	Separation	Separation	Invention
Oil Flow (bpd)	33,260	31,500	32,520	33,720
Off Gas Flow (MMscfd)	166	181	180	179
LPG Flow (bpd)	9199	-	-	-
(Oil Properties)				
RVP (psia)	9.0	9.0	9.0	8.7
TVP (psia)	11.3	12.1	11.8	9.4
Density (API°)	53.56	50.85	51.99	53.42
Viscosity (cP)	1.198	1.425	1.334	1.228
(Off Gas Properties)				
C4+ in off gas (mole%)	0.3	3.9	3.3	2.3
Lower Heating Value (kJ/scf)	1017	1162	1156	1135
Fuel gas ⁽²⁾ (MMscfd)	8.0	3.3	6.0	6.4
CO ₂ Emission (ton/d)	171	81	146	153
(Utilities Required)				
Compression (MW)	18.4	7.4	15.5	15.8
Heating (MW)	12.9	2.0	9.5	11.6 ⁽¹⁾
Cooling (MW)	39.3	17.2	32.4	34.9

Note:

1. Total heating duty included 8000 kg/h of superheated steam for stripping.
2. Fuel gas consumption calculation based on 30% thermal efficiency of power gas turbine, 80% thermal efficiency of boiler and 5 MW power load of miscellaneous.

5

Based on the above tabulation the following conclusions are drawn:

1. The 3 stage separation process gives the lowest stabilized liquid product recovery among all the cases considered. A significant quantity of the C4+ components end up in the export gas stream which has significantly lower economic value than if
10 exported as stabilized liquid. This process configuration, however, is the most widely used for offshore applications due to its simplicity and low utility requirements.
2. The addition of a dew-point control system with a condensate stabilizer only
15 marginally improves the recovery of stabilized liquids over the more conventional 3 stage separation system. This indicates that it is not economically justified to invest in the incremental CAPEX associated with the additional dew-point control system and condensate stabilizer column which is why the majority of offshore facilities do not have such systems.
- 20 3. With LPG recovery, the incremental crude recovery is significant, approximately 1,760 bpd compared to a multi-stage separation system. In addition, approximately 9200 bpd of mixed LPG is also produced. There appears to be significant merits to installing LPG recovery facilities for this case study. However with LPG recovery,

both CAPEX and OPEX are significantly increased. For offshore facilities apart from the incremental CAPEX associated with the LPG extraction and fractionation facilities, dedicated LPG storage and offloading facilities, usually provided by dedicated FSOs, are also required. OPEX includes additional manning for the LPG recovery and fractionation facilities, LPG storage FSO and dedicated shuttle tankers for LPG transport. In addition, LPG storage and offloading facilities offshore significantly increases the facility complexity, risk and HSE (Health, Safety and Environment) profile of the facility. For these reasons these facilities are seldom installed offshore unless in few cases where there is significant economic drivers for LPG storage and recovery.

4. Compared to the multi-stage (3 stage) separation process (which is predominantly used in offshore facilities), the results from the process of the present invention in an incremental stabilized liquid production of approximately 2,220 bpd. The system also results in higher stabilized crude recovery than the LPG recovery system although it does not produce a separate mixed LPG product stream. However, much of the C4 components are instead absorbed into the stabilized crude stream. Compared to the LPG extraction process, this embodiment of the present invention is significantly less complex and does not require LPG storage and offloading facilities.

It is noted that significant quantities of light component like C2-, C3 components are stripped from the stabilized oil in the present process.

Figure 5 shows a detailed view of the crude stripping column system 273. Further details show the unstabilised crude stream, having being separated from a multiphase crude stream, with the entry of the superheated steam 295 into the base of the stripping column 280, and the outlet of the stabilized crude 291 to be co-mingled with the
5 condensate stream.

A feature of the crude stripping column system of Figure 5 is that it may be used with the stabilized system of Figure 4, or as a separate invention in its own right with a different system. Accordingly, a crude stripping arrangement of the prior art may be
10 replaced by the coupled system 273 shown in Figure 5, whereby the column 280 is selectively coupled to the surge vessel 285. It follows that, in this arrangement, the addition of selectively operable valves 277, 278 permit by-passing of the column 280 and allows the remaining surge vessel 285 to act as a conventional 3 stage separation system. Thus the flexibility provided by the selective coupling offers significant
15 advantage in savings of capital infrastructure and operating cost.

In Figure 5, the liquid volume to handle surge and residence time is handled by a separate vessel i.e. the Stripping Column Surge Vessel 285. This enables the stripping column 280 to be isolated from the surge 285 (when the column is taken out of service
20 for maintenance, etc) and enables the system to continue operation as a multistage separation system, albeit at lower recovery, corresponding to a multistage separation system. If the isolation valves 277, 278 shown in Figure 5 are actuated, the operation can be performed from the control room without operator field intervention.

Thus the main advantages of the column configuration according to the present invention, and as depicted in the embodiment of Figure 5 are:

1. The system availability remains high and the introduction of the column does not impact the availability of the system compared to a multistage separation system.
- 5 2. The column height is significantly reduced as the liquid hold-up requirements are now housed in a separate vessel. This is particularly beneficial for floating facilities where tall columns can impair its performance.

Figure 6 shows equivalent volumetric light components (propane, ethane and lighter) in
10 the stabilized oil. For the LPG extraction process 315, conventional three stages separation process 320 and three stages separation plus condensate stabilization process 325, due to the inherent in-efficiency of a multi-stage stabilization process for the crude stream, small quantities of ethanes 335 and propanes 340 remain in the crude stream. Although relatively small quantities, due to their high vapor pressure, these components
15 significantly contribute to the increase in the vapor pressure of the stabilized liquid product. This results in high vaporization losses at the storage tanks which in-turn results in shrinkage of crude in the storage tanks and hydrocarbon venting at the storage tank vents. However, only present invention process 330 virtually strips-out almost all the propane 340, ethane 335 and lighter components from the crude stream, thus
20 producing a stabilized crude stream that has a lower TVP which in turn minimizes vaporization losses and product shrinkage and also significantly reduces greenhouse gas emissions. With the lighter components stripped from the crude stream, it also enables more of the C4+ components to be absorbed into the crude stream within its vapor pressure specification. Figure 7 shows comparison of C4+ components, the present

invention process results 360 in higher C4+ components in stabilized oil compare to rest other three processes 345, 350, 355.

Figure 8A shows a pie chart providing percentage of C4+ recovery in the conventional 3 stage separation process. Approximately 84.7% of C4+ is recovered in the crude oil, but 15.3% of C4+ is not recovered and end up in the export gas stream. This process configuration gives very low recovery of stabilized liquids and in many cases results in export gas not meeting the dew-point and Wobbe Index specification of export gas. The 3 stage separation process is thus the most inefficient among the four processes mentioned.

The performance of C4+ recovery only improves marginally (approximately 87.5% recovery of C4+ components) with the addition of a dew-point control system and a condensate stabilizer column as reflected in Figure 8B. Corresponding, it is also noted that the gas export C4+ content is also reduced marginally down to 12.5 mole%.

Considering the marginal improvement in C4+ recovery into the stabilized liquid product and slight improvement in export gas quality with this process configuration, the additional CAPEX required for this process is not expected to be justifiable.

Figure 8C gives a similar pie-chart for the LPG extraction process. In this case, it is noted that with LPG recovery, the C4+ content in export gas is virtually nil and in addition to stabilized crude, a mixed LPG product stream is also produced. 89.5% of C4+ recovered in crude oil and 10.3% C4+ recovered as mixed LPG product. Clearly this process configuration results in maximum recovery of C4+ components from the

export gas stream and thus maximizes product sales revenue stream. However, as previously discussed, this process configuration also entails significant facility complexity, increased CAPEX, OPEX and HSE issues which makes this process configuration virtually prohibitive for offshore facilities except for a small number of large developments where the economics are favorable.

Figure 8D shows 91.4% of C4+ is recovered in crude oil by the present invention process which gives the highest recovery of C4+ components in the stabilized crude product stream among all the four processes considered. Apart from increasing the stabilized crude recovery by approximately 7% over a conventional 3 stage separation process (which is by far the most widely used system offshore), the process also correspondingly leans-out the export gas by reducing the C4+ content thus enabling typical export gas dew-point and Wobbe index specification to be met.

It follows that the system and process of the present invention introduces a process configuration which may increase stabilised liquid yield from an oil and gas processing facility by as much as 30% more than that achievable using a conventional and widely used multistage separation process.

Advantages of the present invention may include:

- **Enhanced Stabilized Crude Recovery**

Maximizes recovery of C4+ components in the stabilized crude and minimizes C3- content in the crude. Incremental stabilized crude recovery is approximately 5 to 30% of that using a conventional multistage separation system.

- **LPG Recovery**

Recovers significant quantities of LPGs (particularly C4s) with the stabilized crude from the gas stream, thus, avoiding the need for complex and costly LPG recovery, storage and offloading facilities.

5 • **Improved Crude Quality**

Apart from increased stabilized crude production, the process also improves the quality of the crude by increasing its API gravity and reducing its viscosity. This is due to the increased amount of intermediate hydrocarbons (C4s and C5s) in the stabilized crude stream. In addition, the steam stripping process also reduces the salt
10 content in the crude as it essentially water washes the crude.

- **Improved Gas Quality**

Export gas and fuel gas quality is also improved as much of the C4+ components in the gas stream is removed and absorbed into the stabilized crude stream thus improving the gas dew-point specifications and the Wobbe Index of the export and
15 fuel gas.

- **Reduced Greenhouse Gas Emissions**

The process strips out volatile hydrocarbon components (C1, C2 and C3) from the crude stream, thus, producing stabilized crude stream with low vapor pressure and with minimal volatile hydrocarbons. This significantly reduces greenhouse gas
20 emissions at the storage tanks. As gas and fuel gas is leaner, the process also reduces CO₂ emission due to fuel gas usage.

- **Suitability for Difficult Crude Types**

Foaming tendencies of the crude is also minimized both due to the dilution effect of condensed steam on the salts and also due to the stripping action that reduces the

light end content in the crude. The process is configured to operate the crude processing section at high temperature (above wax appearance temperature and above emulsion breaking temperature) and is stripped of its light ends when operating at high temperature, thus minimizing risk of asphaltene deposition at the high temperatures in the steam stripping column. This makes the process suitable for virtually all types of crudes, including very heavy crudes.

- **Reduced Utility Consumption**

The process minimizes the amount of intermediate hydrocarbons (NGLs) in the gas stream by absorbing these components into the stabilized crude stream. This effectively minimizes the recycling of intermediate hydrocarbon components that is recycled as the gas is dew-pointed to meet export gas specifications (depending on requirement). This in turn reduces the amount of gas compression power, heating and cooling duty requirements.

- **High System Availability**

Although the process has many benefits over a conventional multi-stage separation system, it nonetheless increases the complexity of the facility and as a result may be viewed as lowering the system availability. This concern is mitigated as the process renders itself to being configured such that, in the event that the system is offlined, the process will continue operation as a conventional multi-stage separation system, albeit with lower stabilized crude recovery corresponding to a multistage separation system performance under this mode of operation. This switching of operation mode can be configured to be initiated from the control room without operator field intervention. Thus the availability of the system will remain similar to that of a conventional multistage separation system.

- **Applications**

The process is suitable for implementation in virtually all oil and gas processing facilities where crude is to be stabilized for storage or pipelined under pressure. It is may be suited for crudes like waxy crudes, crudes with high asphaltene content, 5 crudes with high salt content and with scaling and foaming tendencies, etc. This is because the process includes stream stripping which also water washes the crude, avoids the use of reboiler for the crude handling system and maintains the temperature of the crude stream hot whilst ensuring that C4+ components absorbed into the crude stream is maximized.

10

The process may be suitable for facilities for which it is not techno-economically viable to pipeline produced gas to a centralized gas processing plant with LPG recovery facilities or install an LPG recovery plant with the associated LPG storage and offloading facilities. This includes facilities where gas is re-injected or flared, 15 marginal field developments and for developments in remote locations.

Claims:

1. A method for the production of crude oil, the method comprising the steps of:
providing a stream of crude oil;
5 injecting steam into said stream and so stripping C3- from said stream;
providing a gas stream;
extracting C4+ from the gas stream, and so;
producing a stream from the extracted C4+;
co-mingling the stripped stream with the C4+ stream.
10
2. The method according to claim 1 wherein the extracting step comprises the step
of condensing the C4+ from the gas stream.
3. The method of claim 2 wherein the condensing step comprises applying dew-
15 point control to the gas stream to condense the C4+ from the gas stream.
4. The method according to any one of claims 1 to 3 further including the step of
introducing the crude stream to a steam stripping column, within which injecting
of steam to the crude stream is effected.
20
5. The method according to any one of the preceding claims further including, after
the co-mingling step, the step of separating vapour and liquid from the co-
mingled stream to produce a stream of stabilized crude oil.

6. The method according to claim 5 wherein an offgas rate for vapour separated from the stabilized crude oil stream is maintained at a preset value.

5

7. A system for the production of stabilized crude oil comprising:

a steam injection station arranged to receive a stream of unstabilised crude oil,
said station arranged to subject said stream to an injection of steam;

said steam injection station including a first outflow to deliver a stripped stream
of crude to a stabilizer section and a second outflow to deliver a flow of gas to a
condensation station;

10

said condensation station arranged to condense the gas to produce a condensate,
said station further including an outflow to direct the condensate to the stabilizer
section for comingling the condensate with the stripped stream of crude;

15

wherein the stabilizer section is arranged to outflow a stream of stabilized crude
resulting from said comingled streams.

8. The system according to claim 7, wherein said steam injection station comprises
a steam stripping column.

20

9. The system according to claim 7 or 8, wherein the stabilizer section includes a
cooler.

10. The system according to any one of claims 7 to 9, wherein the condensation station comprises a dew-point control system.
- 5 11. The system according to claims 5 to 7, wherein said condensation station further includes a de-propaniser column.
12. The system according to any one of claims 7 to 11, wherein said stabilizer section includes a flash vessel for receiving said comingled crude stream to separate vapour as an offgas prior to production of said stabilized crude oil.
- 10 13. The system according to claim 12 wherein said flash vessel includes a flow controller to control the rate of offgas at a preset value.
- 15 14. The system according to claim 13 wherein the flow controller provides a cascade control set point for a temperature controller of a reboiler of the de-propaniser column.
- 20 15. A system for stripping light components from a crude oil stream, comprising a crude stripping column for receiving the crude oil stream, said column arranged to receive steam for applying to the crude oil stream; a surge vessel for receiving the stripped crude stream and arranged to separate water from said stripped crude stream;

wherein the surge vessel and crude stripping column are selectively coupled so as on de-coupling the crude oil stream is permitted to by-pass the crude stripping column and flow directly into the surge vessel.

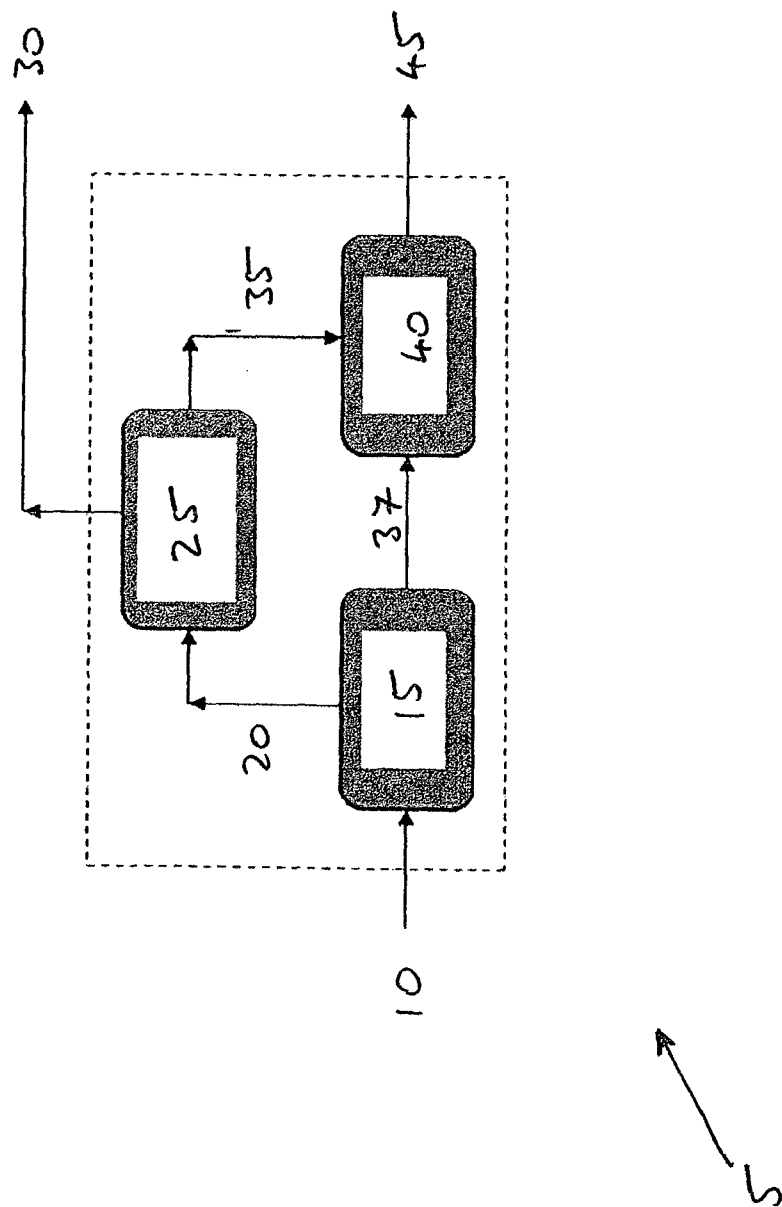


Figure 1

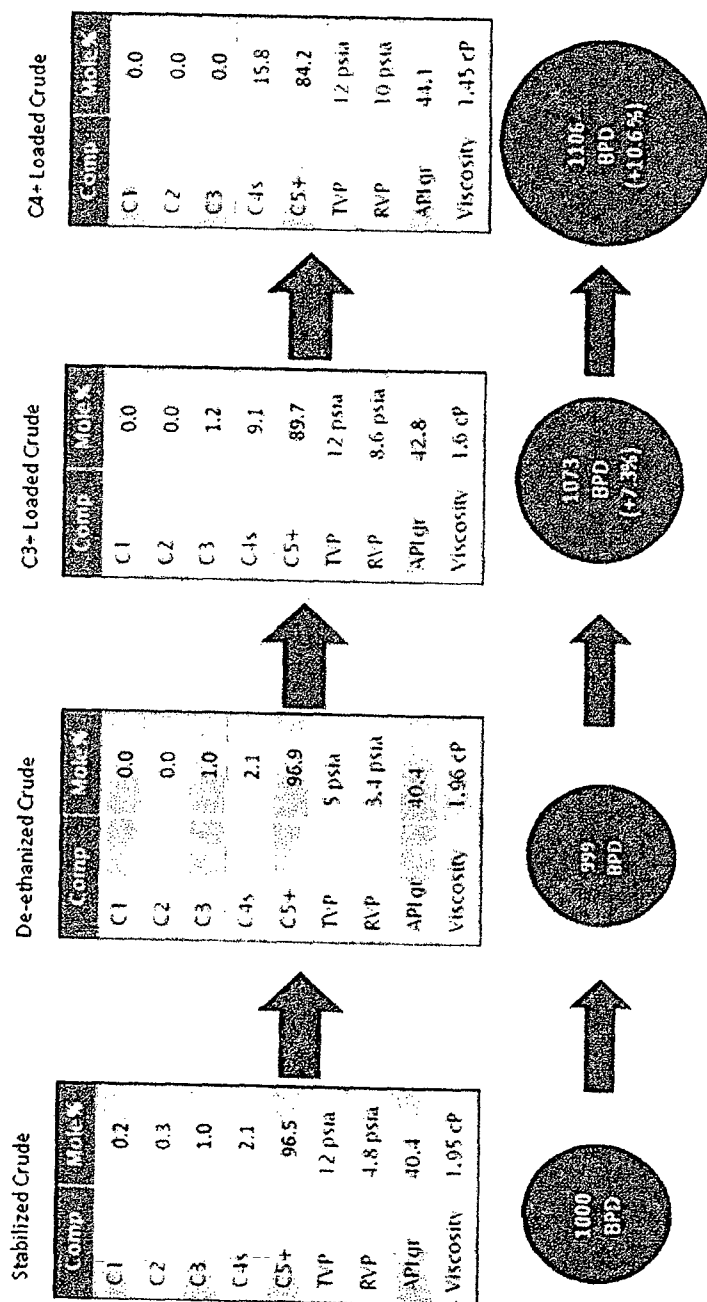


Figure 1A

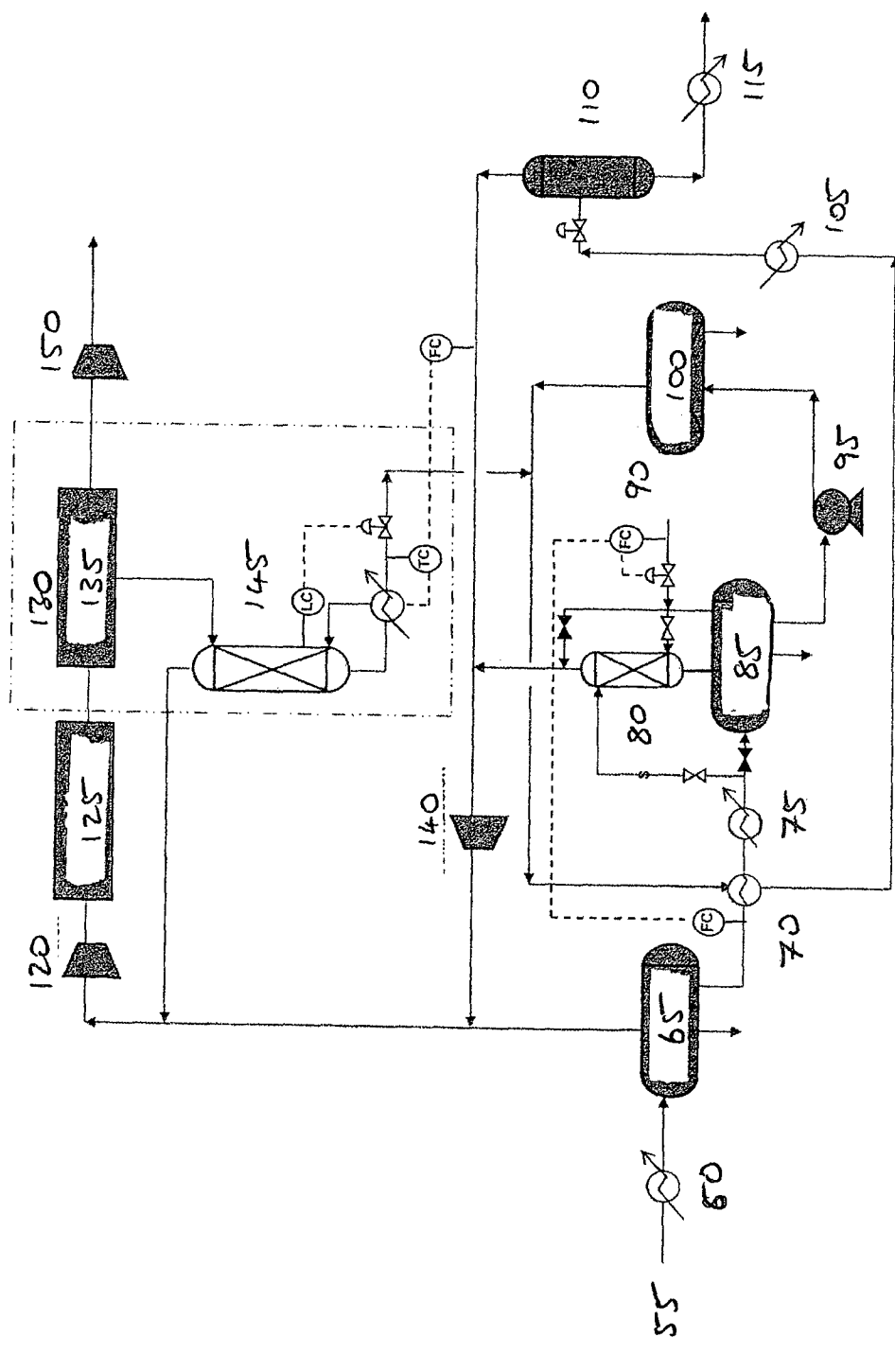


Figure 2

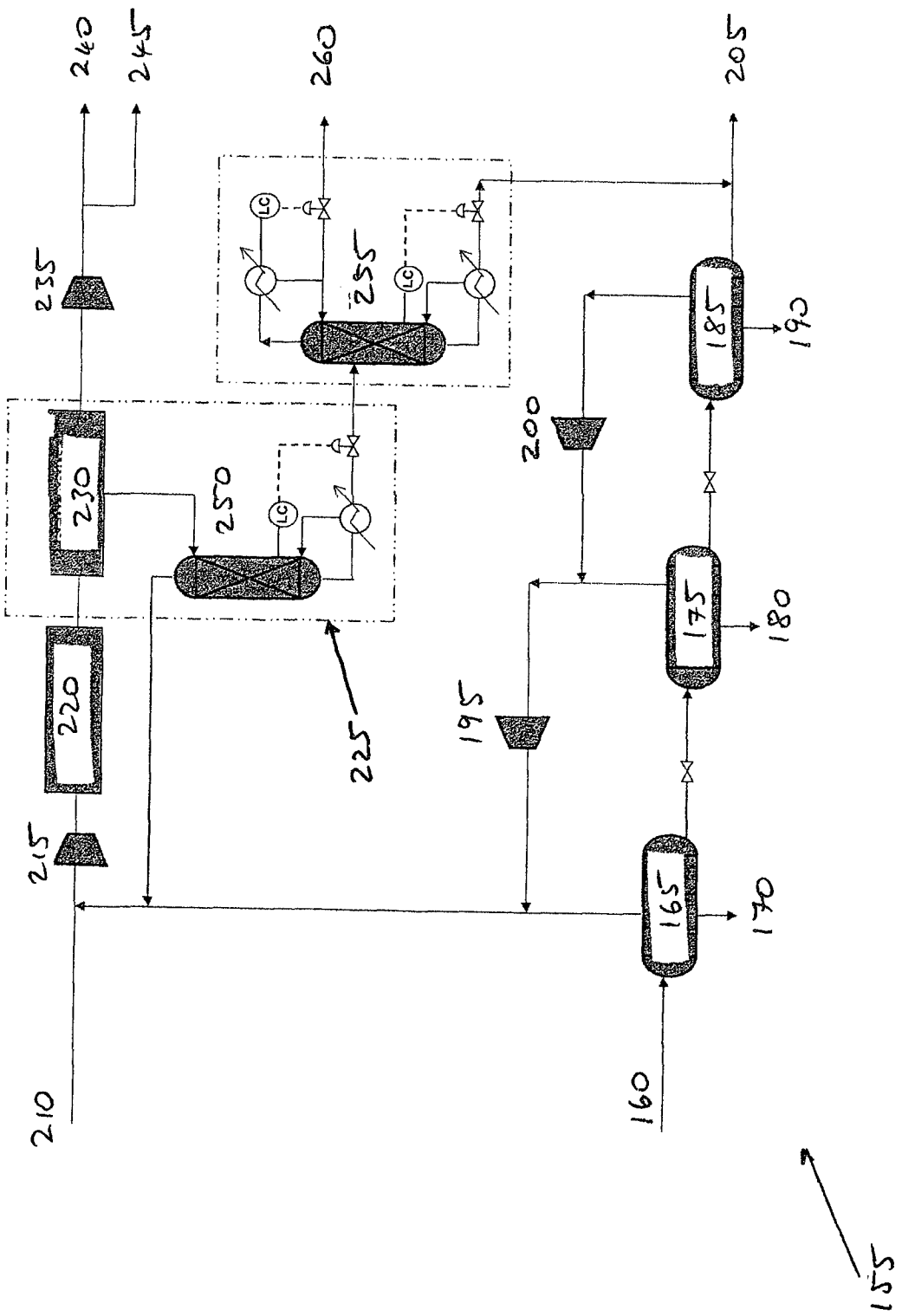


Figure 3

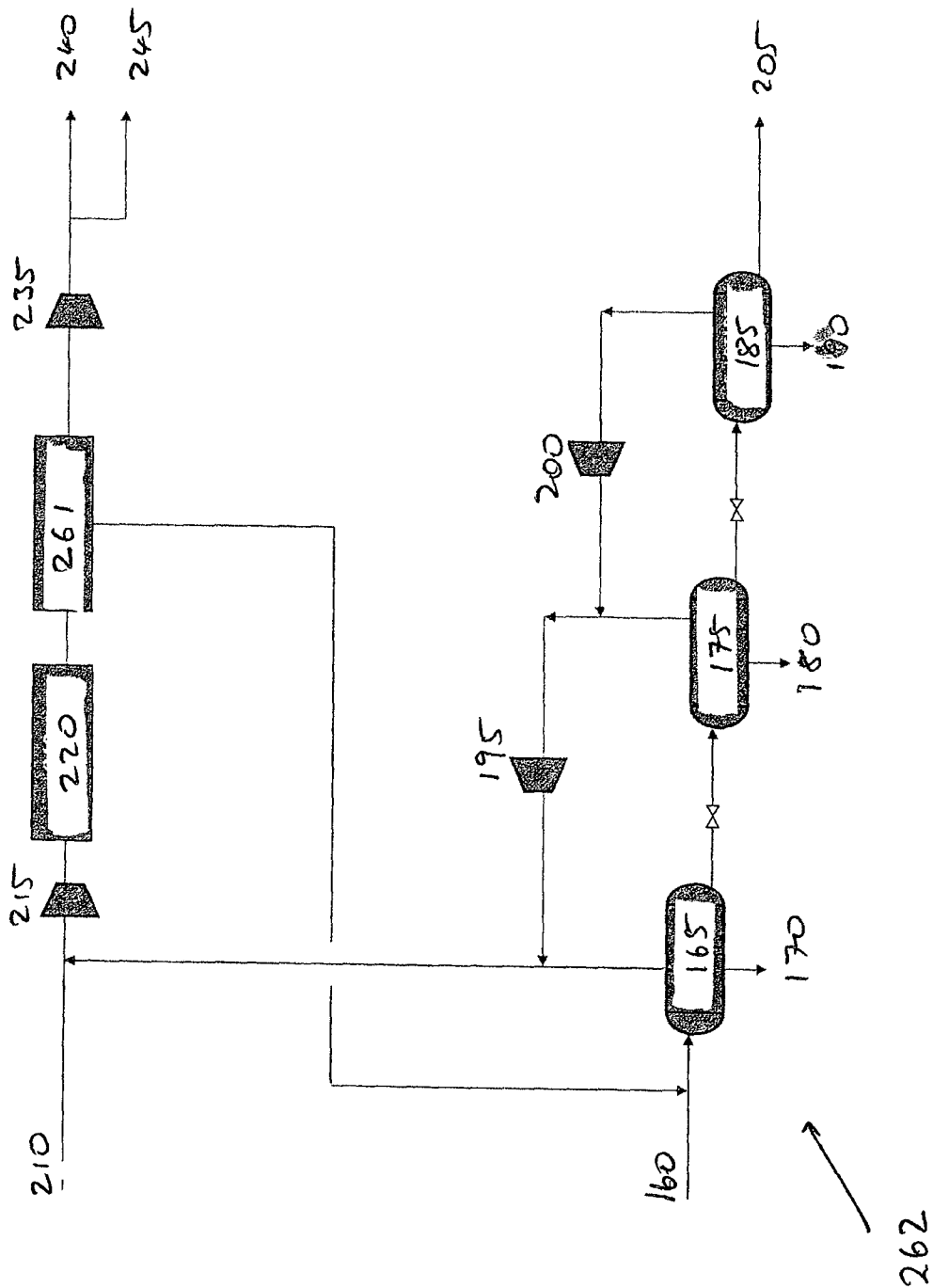
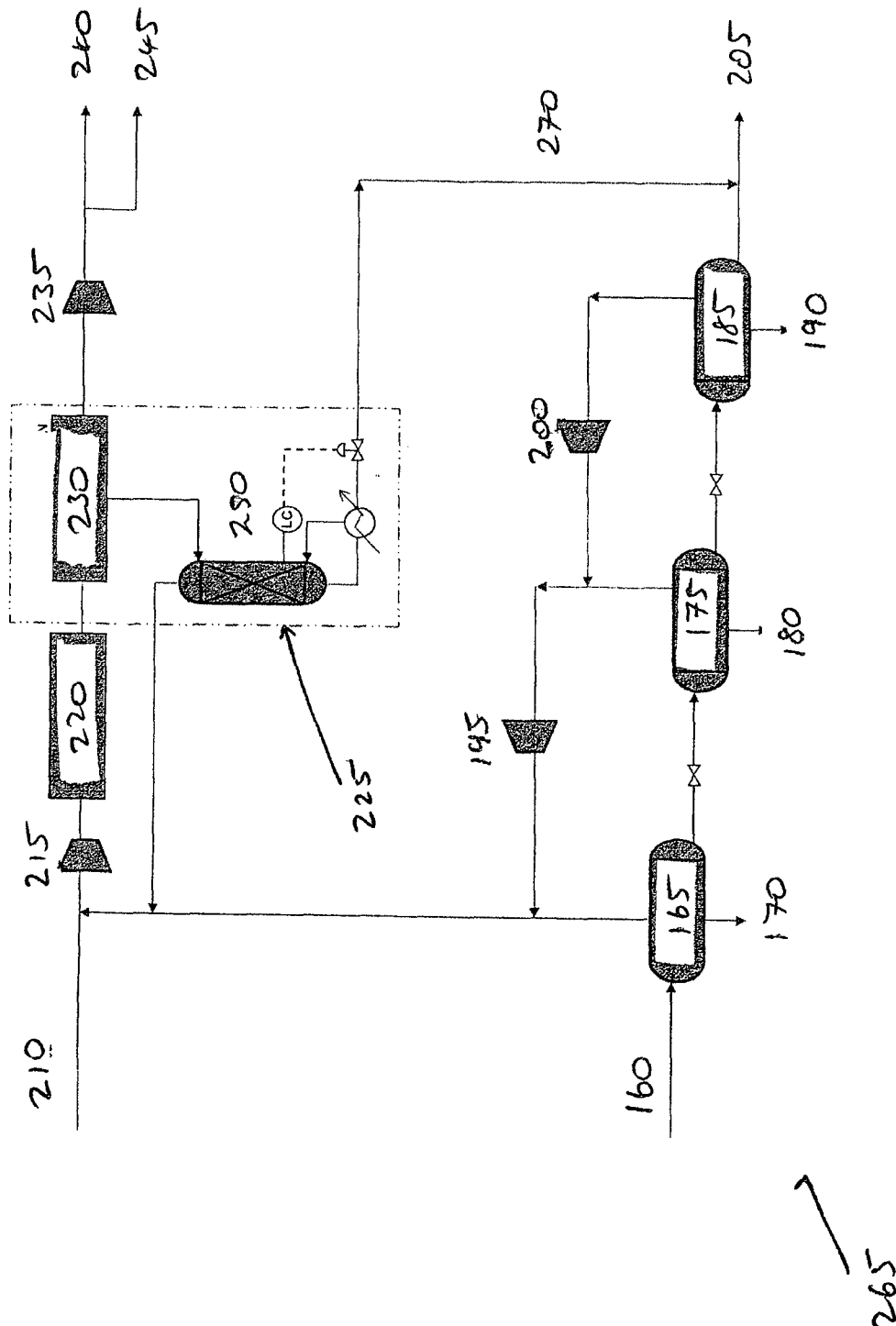


Figure 3A



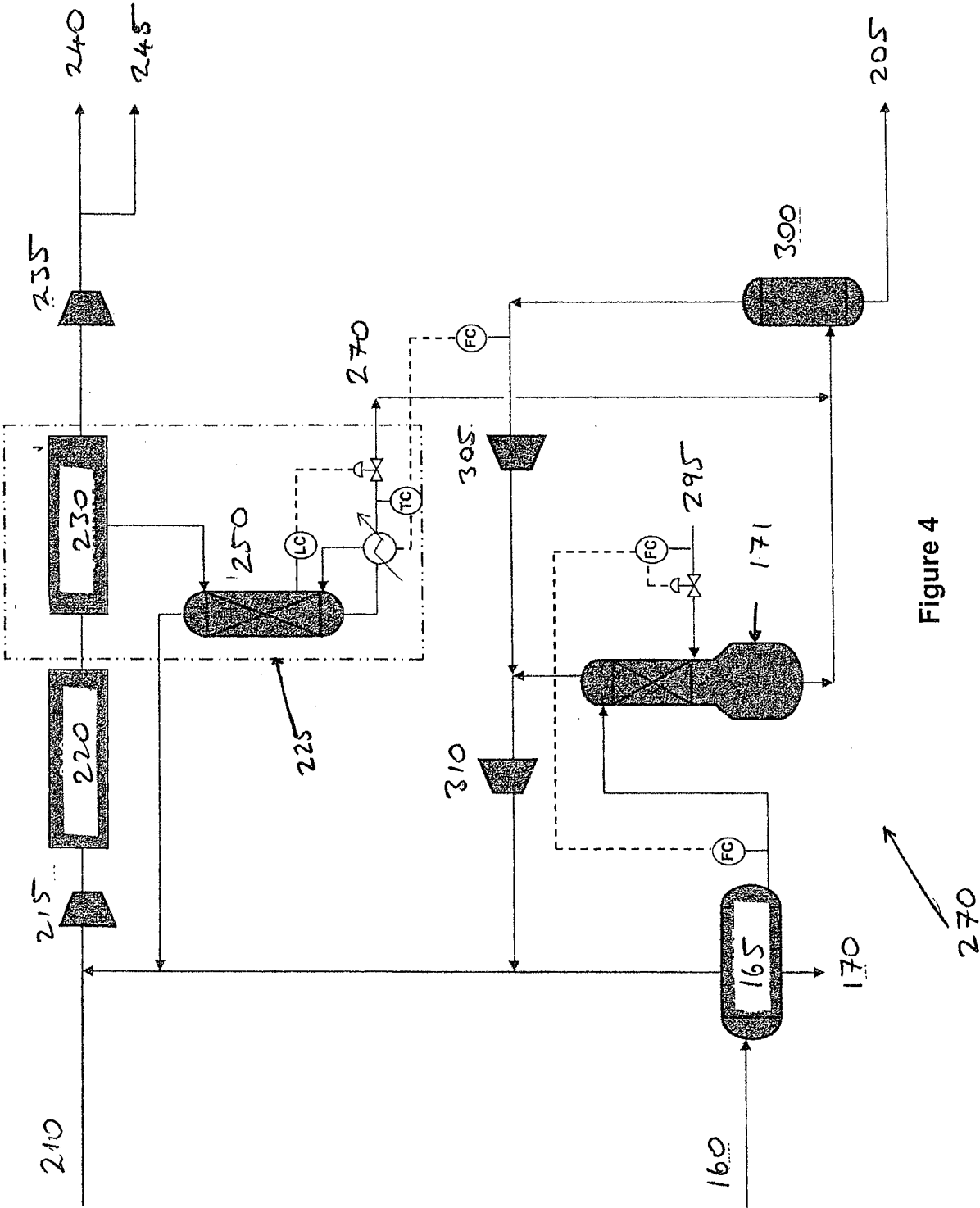


Figure 4

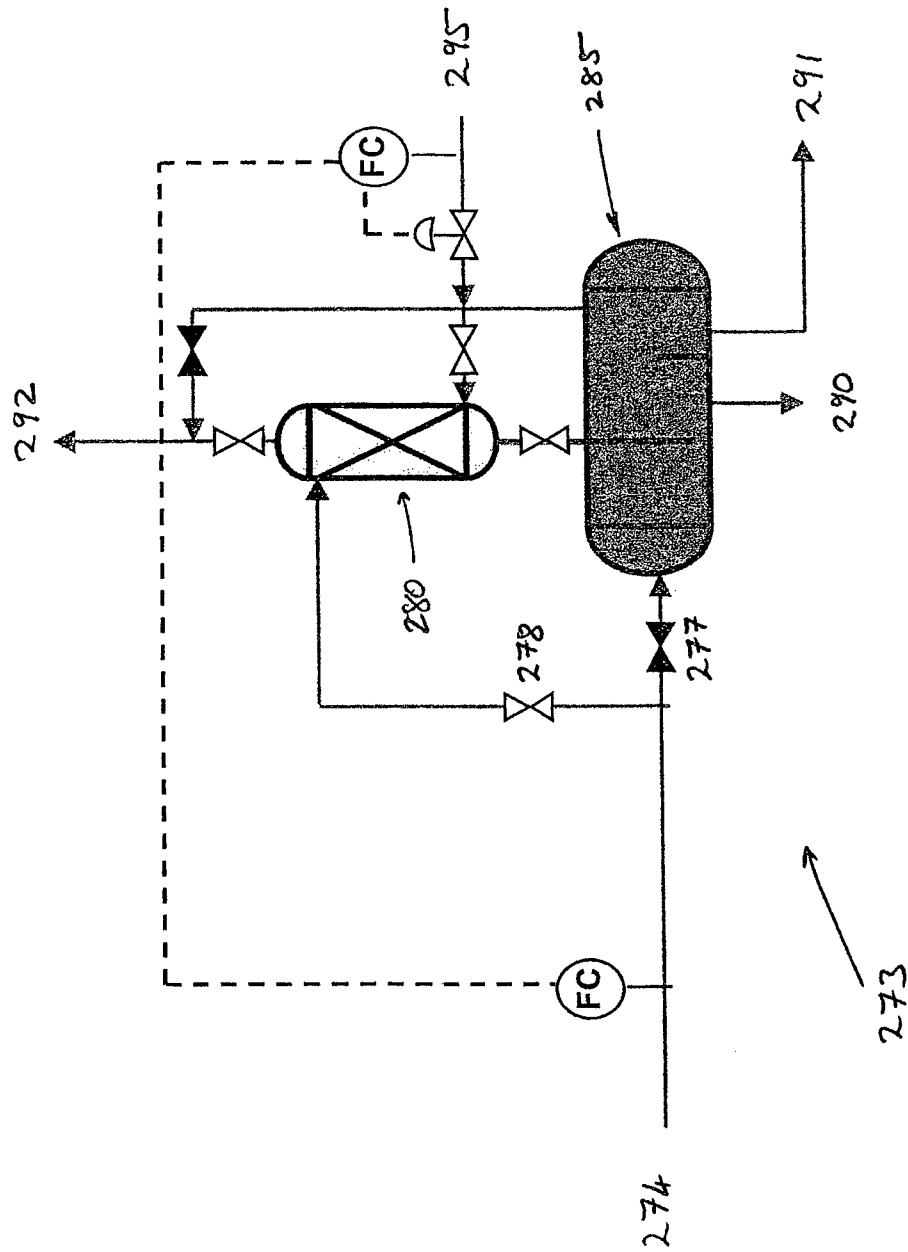


Figure 5

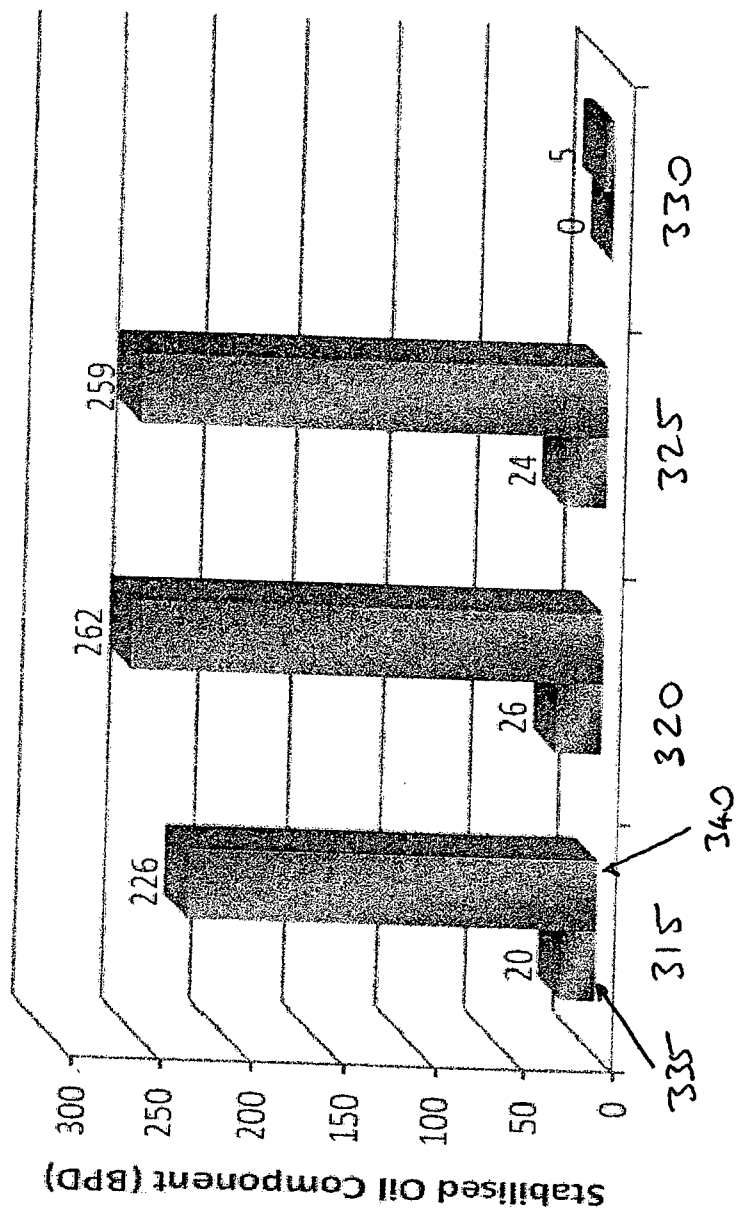


Figure 6

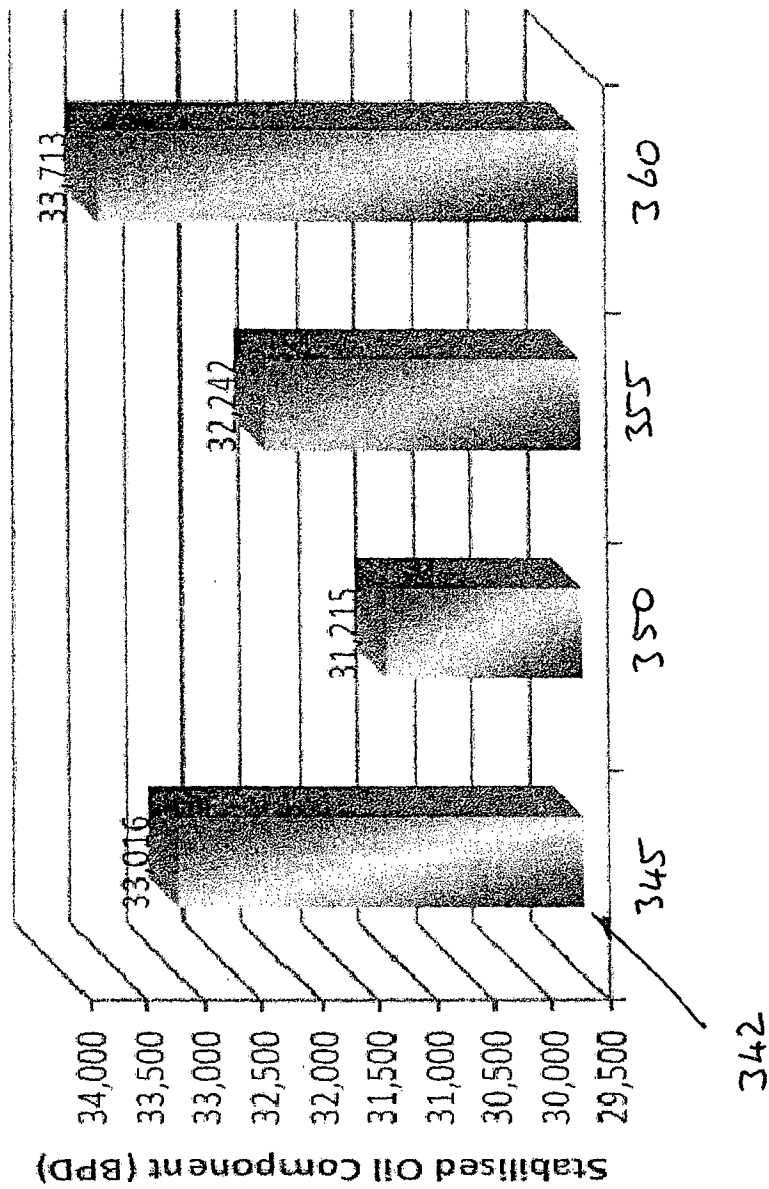


Figure 7

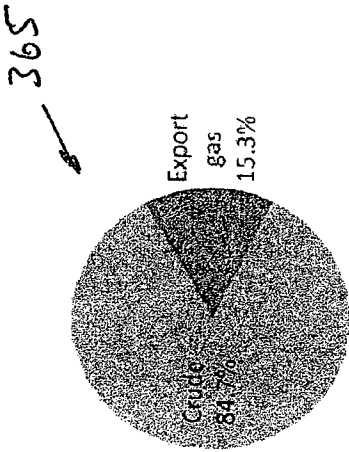


Figure 8A

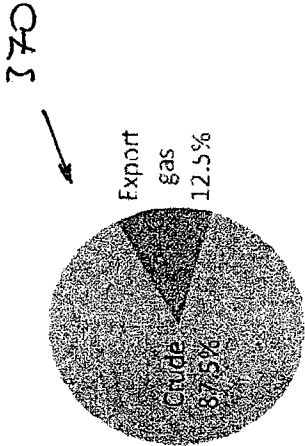


Figure 8B

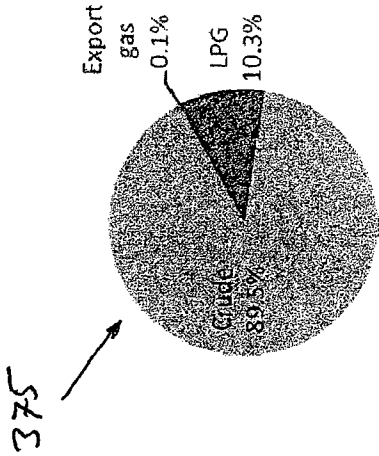


Figure 8C

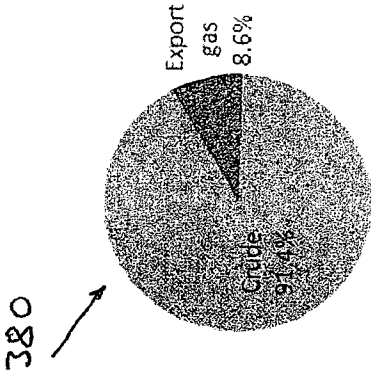


Figure 8D

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2012/000505

A. CLASSIFICATION OF SUBJECT MATTER

C10G 53/00 (OCT 2005) F25J 3/02 (OCT 2005) C10L 3/12 (OCT 2005)

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)

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)

EPODOC, WPI: /IC/EC C10G53/00, F25J3/02, C10L3/12 & Keywords(stabiliz+, upgrad+, crude-oil, steam, stripp+, propane, C3, butane, C4, LPG), Esp@cenet, Google Patents & keywords(crude oil stripping, LPG production, stabilizing crude oil)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

☒ Further documents are listed in the continuation of Box C☒ See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
17 July 2012Date of mailing of the international search report
18 July 2012

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustalia.gov.au
Facsimile No.: +61 2 6283 7999

Authorized officer

Asoka Dias-Abey
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. 0262832141

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/IB2012/000505
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4673490 A (SUBRAMANIAM et al) 16 July 1987 abstract, claim 1, 11, fig.1, column 3, lines 49- column 4, lines 1-45	15
A	US 4897098 A (PATE et al) 30 January 1990 abstract	1-15
A	US 7568363 B2 (RUNBALK) 04 August 2009 abstract	1-15

Form PCT/ISA/210 (fifth sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2012/000505

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Supplemental Box

Continuation of: **Box III**

The specification does not comply with Section 40(4) because the claims do not relate to one invention only. I have found different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-6 are directed to a method for the production of crude oil comprising the steps of providing a stream of crude oil; injecting steam into said stream and so stripping C3- from said stream; providing a gas stream; extracting C4+ from the gas stream and so on; producing a stream from the extracted C4+; co-mingling the stripped stream with the C4+ stream. The feature of providing a stream of crude oil; injecting steam into said stream and so stripping C3- from said stream; providing a gas stream; extracting C4+ from the gas stream and so on; producing a stream from the extracted C4+; co-mingling the stripped stream with the C4+ stream.. is specific to this group of claims.
- Claims 7-14 are directed to a system for the production of stabilized crude oil comprising a steam injection station arranged to receive a stream of unstabilized crude oil, said station arranged to subject said stream to an injection of steam; said steam injection station including a first outflow to deliver a stripped stream of crude to a stabilizer section and a second outflow to deliver a flow of gas to a condensation station; said condensation station arranged to condense the gas to produce a condensate, said station further including an outflow to direct to the stabilizer section for comingling the condensate with the stripped stream of crude; wherein the stabilizer section is arranged to outflow a stream of stabilized crude resulting from said comingled streams. The feature of a steam injection station arranged to receive a stream of unstabilized crude oil, said station arranged to subject said stream to an injection of steam; said steam injection station including a first outflow to deliver a stripped stream of crude to a stabilizer section and a second outflow to deliver a flow of gas to a condensation station; said condensation station arranged to condense the gas to produce a condensate, said station further including an outflow to direct to the stabilizer section for comingling the condensate with the stripped stream of crude; wherein the stabilizer section is arranged to outflow a stream of stabilized crude resulting from said comingled streams is specific to this group of claims.
- Claim 15 is directed to a system for stripping light components from a crude oil stream, comprising a crude stripping column for receiving the crude oil stream, said column arranged to receive steam for applying to the crude oil stream; a surge vessel for receiving the stripped crude stream and arranged to separate water from said stripped crude stream; wherein the surge vessel and crude stripping column are selectively coupled so as on de-coupling the crude oil stream is permitted to by-pass the crude stripping column and flow directly into the surge vessel. The feature of a crude stripping column for receiving the crude oil stream, said column arranged to receive steam for applying to the crude oil stream; a surge vessel for receiving the stripped crude stream and arranged to separate water from said stripped crude stream; wherein the surge vessel and crude stripping column are selectively coupled so as on de-coupling the crude oil stream is permitted to by-pass the crude stripping column and flow directly into the surge vessel is specific to this group of claims.
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Unity of invention is only fulfilled when there is at least one "special technical feature" present in the claims that both:

- provides a technical relationship among all the claims; and,
- makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified distinguishing features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

Supplemental Box

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/IB2012/000505

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
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		EP 0213791 B1	02 Jan 1991
		NO 863366 A	24 Feb 1987
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		US 7309417 B2	18 Dec 2007
		US 2008072620 A1	27 Mar 2008
		US 7568363 B2	04 Aug 2009
		WO 03022958 A1	20 Mar 2003

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

Form PCT/ISA/210 (Family Annex)(July 2009)