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(54) **Title**: METHOD OF MODIFYING A PIPELINE LAY-OUT PROFILE

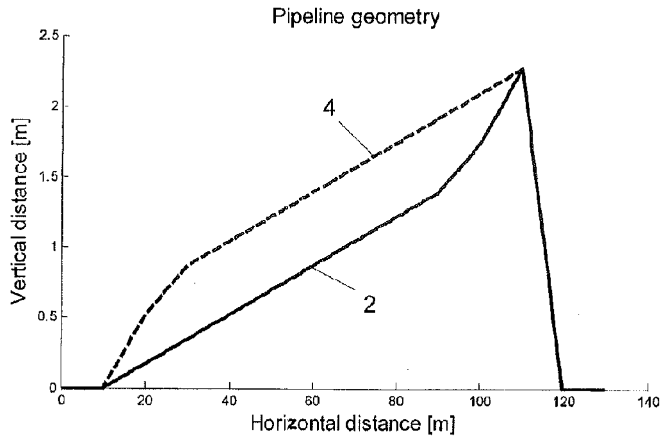

Fig. 2

(57) **Abstract**: A method of modifying a pipeline lay-out profile, the method comprising: assessing an initial pipeline lay-out profile (2) that is to be modified, the pipeline lay-out profile being made up of a number of sections of pipe, in order to: 1 a) identify sections of pipe that have a positive gradient in a downstream direction that is greater than a threshold gradient; and 1 b) identify regions of the initial pipeline lay-out profile made up of consecutive sections of pipe identified in step 1 a) wherein the gradient of the pipe changes over the length of the region and wherein consecutive pipe sections of the region each have a gradient which is equal to or greater than the gradient of the adjacent upstream pipe section; and modifying the initial pipeline lay-out profile (2) to form a modified pipeline lay-out profile (4) by replacing the pipe sections in each of the identified regions with one or more replacement pipe sections such that the gradient of the pipe in the region does not increase in a downstream direction.

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METHOD OF MODIFYING A PIPELINE LAY-OUT PROFILE

The invention relates to a method of modifying a pipeline lay-out profile.

A pipe carrying a fluid will have a certain liquid holdup. The liquid holdup (H_L) is defined as the fraction of an element of pipe which is occupied by liquid (i.e. H_L = volume of liquid in a pipe element / volume of the pipe element). The liquid holdup in a pipe will depend on a number of factors such as the properties of the fluids being transported, flow pattern, flow rate, pipe diameter and pipe inclination etc.

It has been found that under certain conditions two and three-phase flows in upwardly inclined sections of pipe can have multiple holdup solutions (low, intermediate and high holdup). This means that the pipe can have either a low liquid holdup or high levels of liquid holdup depending on the conditions.

It has also been found that in the lengths of pipes that have multiple holdup solutions, the downstream holdup of a pipe section can determine if the high holdup or low holdup solution will be the prevailing solution in that length of pipe for a given flow rate.

It is desirable to avoid high holdup in a pipeline. This is because, in the case of high holdup, the pressure drop and the potential for liquid surges are considerably higher. Thus, it is desirable to be able to provide a pipeline lay-out profile that permits a lower flow rate before there is a transition to high holdup in the lengths of pipe which have multiple holdup solutions.

According to a first aspect, the present invention provides a method of modifying a pipeline lay-out profile, the method comprising: assessing an initial pipeline lay-out profile that is to be modified, the pipeline lay-out profile being made up of a number of sections of pipe, in order to: 1a) identify sections of pipe that have a positive gradient in a downstream direction that is greater than a threshold gradient; and 1b) identify regions of the initial pipeline lay-out profile made up of consecutive sections of pipe identified in step 1a) wherein the gradient of the pipe changes over the length of the region and wherein consecutive pipe sections of the region each have a gradient which is equal to or greater than the gradient of the adjacent upstream pipe section; and modifying the initial pipeline lay-out profile by replacing the pipe sections in each of the identified regions with one or more replacement pipe sections such that the gradient of the pipe in the region does not increase in a downstream direction.

It has been realised that by modifying the pipeline lay-out profile, as outlined above, a modified pipeline lay-out profile can be provided which will be less likely to transition to a high holdup solution in certain sections of the pipe. Specifically, it is possible for the minimum flow rate of fluid, before the transition to high holdup solutions occurs in the pipe, to be lower. This is because the modified pipe lay-out profile may be designed such that lengths of pipe which have multiple hold-up solutions are not forced into a high holdup regime by the downstream pipe profile.

This means that the operational window/envelope (i.e. the difference between the maximum flow rate and the minimum flow rate before high holdup solutions are experienced) can be increased. By increasing the operational window (by designing a pipe that can transport a lower flow rate before high holdup solutions are experienced) it may be possible to extract more fluid (e.g. natural gas) from a field or to develop a field which was not previously considered to be economical to exploit.

This method may also enable multiphase transport over longer distances. This is because the method may provide a pipeline profile which has reduced risk of hydrate plugs and/or liquid surging. The flow rate at which liquid accumulation occurs may be decreased.

Typically, for extremely long flow lines the operational window will be small, i.e. the flow rate cannot be reduced much from the design flow rate before liquid significantly accumulates. Generally an operator will not risk entering far in to the region of accumulation. As a result the increased turn down flexibility, i.e. increased operational window, which can be achieved by the present invention is desirable. A lower minimum flow rate (rate at minimum pressure drop) of the flow line also results in increased recovery for the field.

The pipeline lay-out profile may be modified so as to reduce liquid accumulation, pressure drop and liquid surge potential in the pipeline.

This method is particularly useful in larger pipe diameters since the regions over which multiple holdup solutions occur increases with diameter.

The pipeline lay-out profile arising from modifying the initial pipeline lay-out profile by replacing the pipe sections in each of the identified regions with one or more replacement pipe sections may be referred to as a modified pipeline lay-out profile.

The modified pipeline lay-out profile may have no lengths of positively inclined pipes greater than a threshold gradient which are followed in the downstream direction by a positively inclined pipe of greater gradient without there being a length of pipe therebetween which has a gradient less than the threshold gradient (i.e. a pipe with a negative incline, a horizontal section of pipe or a pipe with a positive gradient less than the threshold). In other words in the modified pipe lay-out profile a length of positively inclined pipe with a gradient greater than a threshold gradient may always be immediately followed (i.e. adjacent) in the downstream direction by a length of pipe of a lesser gradient (i.e. either less positive, horizontal or negative).

Positively inclined or having a positive gradient may mean that the vertical height of the pipe is increasing in a downstream direction and negatively inclined or having a negative gradient may mean that the vertical height of the pipe is decreasing in a downstream direction. Horizontal or not inclined may mean that the vertical height of the pipe does not change over distance.

The downstream direction may be defined as the net fluid flow direction or the direction from the inlet of the pipe to the outlet of the pipe. The upstream direction is the opposite direction to the downstream direction.

A region may be a length of pipe which is made up of a plurality of sections of pipe.

The identified regions may be replaced with the same number of sections as the number of sections which make up the identified region. In this case the replaced sections and the replacement sections may be equal in length. Alternatively, the replacement sections may be of different length, such as longer, than the pipe sections they are replacing. The sections in the identified region may be replaced by a single pipe section. This single replacement pipe section may be a straight pipe section. In this case the gradient in the region would be constant.

The identified regions may be considered to be 'concave' regions, i.e. regions in which the gradient of the pipe increases over distance in a downstream direction. These 'concave' regions may result in a high holdup solution for a pipe section which is operated in a multiple holdup region. This is because a downstream pipe section with a high gradient (and thus which may transition to high holdup at a relatively high flow rate) may force an upstream pipe section with a lower gradient into high holdup even though, with all other things being equal, it would not normally have transitioned to high holdup at that flow rate.

'These 'concave' regions may be replaced by straight or 'convex' regions, i.e. regions in which the gradient of the pipe is constant over horizontal distance or in which the gradient decreases over horizontal distance.

The 'convex' regions may be made up of a number of pipe sections which all have a positive gradient, but the gradients of which are decreasing in a downstream direction.

Replacing a 'concave' region with a 'convex' region may result in a pipe profile which can be operated at lower flow rates before high holdup is experienced than if the concave regions are replaced with straight regions. However, replacing the 'concave' regions with 'convex' regions may require more extensive modifications, e.g. more rock dumping to modify the installation site to support the modified pipe profile. Thus financially it may be preferable to replace the 'concave' regions with straight regions. Which option is preferable will depend on a number of factors such as the financial advantage associated with maximising the operational window and environmental considerations. The method may involve replacing some of the identified regions ('concave' regions) with regions which have a constant gradient (straight regions) and some of the identified regions with regions which have a gradient which decreases in a downstream direction ('convex' regions).

The start and the end points of the identified regions may remain the same (i.e. may have the same (i.e. unchanged) vertical and horizontal location) but the pipe profile between these points may be modified to result in the pipe overall having sections which transition to high holdup at a lower flow rate than in if the profile were not modified.

The sections of pipe which make up the initial pipeline lay-out profile may all be equal (i.e. approximately equal or exactly equal) in length. For example, each section may be less than 100m, less than 50m, less than 10m, 3 to 7m or about 5m. The length of the pipe section will depend on factors such as the length of the pipeline lay-out profile being modified and the possible resolution of a simulator if a model is being used.

The sections of pipe which make up the initial pipeline lay-out profile may each be straight pipe sections, i.e. each section may have a constant gradient. The initial pipeline lay-out profile may be made up of sections which start and end when the gradient of the pipe lay-out profile changes. In this case the length of the sections may vary between sections. This is because the length of the section may be dependent on the length of pipe until the gradient changes.

The sections of pipe which make up the initial pipeline lay-out profile may be equal in length and each have a constant gradient (i.e. be straight pipe sections). In this case, adjacent pipe sections may have the same gradient and thus together form a straight length of pipe, i.e. there is not necessarily a change of gradient between adjacent pipe sections.

The method involves identifying sections of pipe that have a positive gradient greater than a threshold. The threshold may be greater than 0°. It is beneficial to have a threshold gradient below which the pipe sections are not taken into account in the modifying process. This is because it can significantly reduce the extent to which the pipe lay-out profile is modified.

A negative gradient may be considered to be a gradient less than 0°.

When the threshold gradient is greater than 0°, pipe sections with a small positive gradient are not included in the modifying process. Whilst these positively inclined sections with small gradient can have multiple holdup solutions at certain flow rates it has been found that there may be a threshold gradient below which the flow rate at which the multiple hold up solutions exists is so low that it would be unlikely to be realistic to operate a system at these low flow rates during typical operation. This is because it is likely that liquid accumulation would occur in other sections of the pipe before the pipe sections with a positive incline (i.e. gradient) less than the threshold would reach the multiple hold up solution regime.

The chosen threshold gradient will depend on a number of factors such as the desired operating window and the gradients of other sections of pipe which will vary between each field development. Therefore, the threshold will need to be determined based on physical and commercial constraints for each field development. The method may involve a step of determining a threshold positive gradient.

The threshold gradient may be 1° or less (i.e. between 1 and 0°), 0.5° or less, between 0.1° and 0.7° or about 0.5°. The method may involve choosing a threshold gradient, e.g. 0.5°, and modifying the pipeline lay-out profile in accordance with the method based on this threshold gradient to provide a first modified pipeline lay-out profile. The method may further include changing the threshold gradient and again modifying the pipeline lay-out profile in accordance with the method based on this changed threshold gradient to provide a second modified pipeline lay-out profile. The method may comprise comparing the first modified pipeline lay-out profile with the second modified pipeline lay-out profile to determine a desired threshold gradient. The comparing of the two pipeline lay-out profiles may involve comparing the extent of modification required to achieve each of the modified pipeline lay-out profile and/or the operational window of each of the modified profiles (this may be among other factors which are compared). This process may be repeated multiple times with different threshold gradients. The process may therefore be an iterative process to determine a desired or optimum threshold gradient based on commercial factors such as cost to modify the pipeline lay-out profile compared with the change in operational window.

The initial pipeline lay-out profile may be a model (such as a computer model) of a pipeline lay-out profile. The profile may be modelled by a simulator such as OLGA Dynamic Multiphase Flow Simulator.

Alternatively the pipeline lay-out profile may be an actual, i.e. in situ, pipeline lay-out profile.

The initial pipeline lay-out profile may be based on the profile of the surface of the installation site for the pipe (e.g. the sea bed). The method may involve obtaining the profile of the installation site and providing the initial pipeline lay-out profile based on the profile of the installation site. For example, the method may comprise surveying (i.e. taking measurements of) a surface, such as a sea bed, to determine the profile of the installation site and providing an initial pipeline lay-out profile.

The step of modifying the initial pipeline lay-out profile may result in a modified pipeline lay-out profile. This modified pipeline lay-out profile may be a model (such as a computer model) of a pipeline lay-out profile. Alternatively the pipeline lay-out profile may be an actual, i.e. in situ, pipeline lay-out profile.

When the initial pipeline lay-out is a model the replacing of the pipe sections may be replacing pipe sections of the model with one or more replacement pipe sections. In this case, the method may further comprise a step of laying a pipeline according to the modified pipeline lay-out profile.

The method may comprise modifying the profile of the installation site based on the modified pipeline lay-out profile. For example, the method may comprise changing the profile of the installation site, such as by rock dumping or trenching, to more closely match the profile of the modified pipe sections and then laying the pipeline. The method may comprise determining the modified pipeline lay-out profile, determining the required modifications to the installation site profile so that it matches the modified pipeline lay-out profile, modifying the installation site profile (e.g. by means of rock duping and/or trenching) and laying a pipeline according to the modified pipeline lay-out profile.

The pipeline may be a pipeline for transporting dry gas-condensate, i.e. the pipeline may be a dry gas-condensate pipeline. Dry gas condensate is a multi-phase flow (e.g. two or three phase flow) comprising gas and liquid and possibly water. For example the dry gas-condensate may comprise greater than 90%, greater than 95%, or about 96% methane. These pipelines typically have a low liquid loading, e.g. a loading which is such that the gas volume flow rate is at least 1000 times the liquid volume flow rate.

The liquid content of the pipeline may vary along its length. This is due to condensation which may occur as the fluid is transported. For example, the pipe inlet may have a liquid content of between 0.001 and 0.01%, such as about 0.005%, and the pipe outlet may have a liquid content of about 0.005 to 0.1%, such as about 0.01%.

As will be apparent to a person skilled in the art, the method may be performed by software.

Thus the present invention also relates to a software product comprising instructions which when executed by a processor cause the processor to perform the above described method of the first aspect of the invention (including one or more of the optional features).

Preferably the software product is a physical data carrier. For example, a CD or flash memory card.

Alternatively or in addition, the software product could be provided in the form of instructions transmitted over a network, such as downloaded over the Internet, for example.

The present invention also relates to a method of manufacturing a software product which is in the form of a physical carrier, comprising storing on the data carrier instructions which when executed by a processor cause the processor to perform the method of the first aspect of the invention (including one or more of the optional features).

Certain preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a plot of liquid holdup versus the superficial gas velocity (Usg) for a pipe with multiple hold up solutions;

Figure 2 is a plot which shows exemplary initial and modified pipeline lay-out profiles;

Figure 3 is a turndown curve for the pipeline lay-out profiles of Figure 2;

Figure 4 shows other exemplary initial and modified pipeline lay-out profiles;

Figure 5 shows a pipeline lay-out profile (solid line) from a field development and a modified pipeline lay-out profile (dashed line);

Figure 6 shows the pressure drop as a function of flow rate for the pipeline lay-out profiles of Figure 5; and

Figure 7 shows the liquid accumulation as a function of mass flow rate for the pipeline lay-out profiles of Figure 5.

Figures 1 illustrates the liquid holdup versus the superficial gas velocity (Usg) for a pipe modelled by standard OLGA. This graph is the output for a pipe with an inclination of 2.5°, a pipeline diameter of 0.1937m, a superficial liquid velocity of 0.0001 m/s, a gas density of 68.3 kg/m^3 and liquid density of 757 kg/m^3 and a surface tension of 0.016859 Pa/m. Figure 1 shows that in a multiphase pipeline with low liquid loading level there exists multiple hold up solutions. Specifically it can be seen that in this case at a superficial gas velocity of between about 1.6 and 2.5 m/s there is all of low, intermediate and high holdup solutions. This means that this section of pipe can operate in either high or low liquid hold up regime depending on the conditions.

It has been realised that, in a steady state, a downstream liquid hold up solution will determine whether a low or high holdup will be experienced by a section of pipe which is operated in the multiple holdup regime. It has been realised that this knowledge can be used to modify pipeline lay-out profiles to provide a pipeline lay-out profile which can have a higher turn down flexibility.

The method of modifying an initial pipeline lay-out profile to provide a modified pipeline lay-out profile involves assessing an initial pipeline lay-out profile that is to be modified. This initial pipeline lay-out profile is made up of a number of sections of pipe. The sections of pipe may all be straight, i.e. have a constant gradient over their length.

The assessment of the initial pipeline lay-out profile involves identifying the sections of pipe that have a positive gradient in a downstream direction that is greater than a threshold gradient, for example a gradient greater than 0.5°. The method can then involve identifying regions (wherein a region is a length of pipe made up of two or more sections of pipe) of the initial pipeline lay-out profile which are made up of consecutive sections of pipe with a gradient greater than the threshold. The regions should have a gradient which changes over the length of the region (i.e. the regions should not be straight lengths of pipe) and consecutive pipe sections of the region should each have a gradient which is equal to or greater than the gradient of the adjacent upstream pipe section. The method then involves modifying the initial pipeline lay-out profile by replacing the pipe sections in each of the identified regions with one or more replacement pipe sections such that the gradient of the pipe in the region does not increase in a downstream direction so as to make a modified pipeline lay-out profile.

A simplified illustration of the effect of this method is illustrated in figure 2. The figures shows a plot of vertical distance (y) versus horizontal distance (x) to illustrate a pipeline geometry. The plot shows an initial pipeline lay-out profile 2 and a modified pipeline lay-out profile 4.

The length of pipe of the initial pipeline lay-out profile 2 between about 10m and 110m would be an identified region in which the gradient of the pipe changes, all the sections have a gradient above a threshold gradient and consecutive pipe sections of the region each have a gradient which is equal to or greater than the gradient of the adjacent upstream pipe section. Therefore, the sections of this region are replaced with sections such that the gradient in the region decreases in a downstream direction.

Each of the regions (of the initial and modified geometries) consists of one section with a 1° inclination, a section with a 2° inclination and a section with a 3° inclination. In the initial geometry in a downstream direction the inclination between adjacent pipe sections is increasing whereas in the modified geometry in a downstream direction the inclination between adjacent the pipe sections is decreasing. In the initial geometry the identified region has a concave shape and by following the method it is replaced with a length of pipe which has a convex shape.

The modified pipeline lay-out profile 4 may not obtain high hold up in the 1° section before the flow rate becomes so low that the pipe is no longer in the multiple holdup region. In contrast, in the initial pipeline lay-out profile 2 the 1° section may be forced into the high holdup region at a certain flow rate at which it may normally be in the low holdup region due to the downstream 3° section being in the high holdup region.

Figure 3 is a turndown curve which shows the effect the geometry has on accumulation. For the initial pipeline lay-out profile 2 the oil content verses superficial gas velocity is shown by line 6 and for the modified pipeline lay-out profile 4 the oil content verses superficial gas velocity is shown by line 8. It can be seen that for the initial geometry severe accumulation begins when the superficial gas velocity reaches about 1.8 m/s whereas for the modified geometry 4 the superficial gas velocity can drop to about 1.3 m/s before severe accumulation starts. As a result the modified pipeline lay-out profile 4 can have an increased operational window, i.e. it has a greater turn down flexibility.

Another simplified example is shown in Figure 4 which shows an initial pipeline lay-out profile 10 and a replacement length of pipe 12. The concave portion 10a of the pipeline lay-out profile 10, which is the identified region in this initial pipeline layout profile, is replaced with a length of straight pipe 12. In this case the modified pipeline lay-out profile will have a transition to high holdup at a lower flow rate than the last section (the section determining hold up 10b) of the concave part of the initial pipeline lay-out profile 10. If the last part of the concave portion 10b of the initial geometry 10 has high holdup this will enforce high holdup in the sections upstream that are operated in the multiple holdup region. This can be avoided by replacing the concave region with pipe sections that provide a straight region or a convex region of pipe.

Figure 5 shows a pipeline lay-out profile 16 from a field development (survey profile) that was deemed not economical at present market conditions. This profile is based on a survey of the sea bed and is modelled using standard OLGA. This is a pipeline for dry gas condensates which is very dry and contains about 96% methane. The liquid content varies from about 0.005% at the inlet and 0.01% at the outlet. The liquid flow rate increases along the flow line due to condensation.

The initial profile contains 1000 pipe sections evenly distributed alone 200km. Each section is about 5m long.

The parameters defining this case are shown below in Table 1.

Parameter		Unit
Total length	200	km
Diameter	0.864	m
Liquid load Usl/Usg	0.005-0.01	%
Outlet pressure	100	bara

Table 1

The initial profile 16 is modified according to the above described method to result in a modified profile 18. As a result of following the method the identified regions (i.e. concave regions with all pipe sections having a gradient greater than a threshold, which in this case is 0.5%) are replaced by straight sections.

It can be seen that the modifications between the initial (i.e. survey) profile 16 and the modified pipeline lay-out profile 18 are fairly modest in most cases. This can be achieved because only pipeline sections with a greater than a threshold, which in this case is 0.5%, are taken into account when modifying the pipeline lay-out profile. This means that the profile can be modified to improve the operational window at a relatively modest cost.

Figure 6 shows the pressure drop as a function of flow rate for the initial geometry 20 and for the modified geometry 22. Figure 7 shows the liquid accumulation as a function of flow rate for the initial geometry 24 and for the modified geometry 26.

From these plots it can be seen that the operational window will be increased for the modified pipeline lay-out profile 18.

A lower minimum flow (rate at minimum pressure drop) of the flow line also results in increased recovery for the field. The turndown capacity of the pipeline can be increased further if low points and high points are reduced by either trenching of rock dumping of the installation profile. Such modification will generally reduce high inclination angles.

CLAIMS:

1. A method of modifying a pipeline lay-out profile, the method comprising:

assessing an initial pipeline lay-out profile that is to be modified, the pipeline lay-out profile being made up of a number of sections of pipe, in order to:

1a) identify sections of pipe that have a positive gradient in a downstream direction that is greater than a threshold gradient; and

1b) identify regions of the initial pipeline lay-out profile made up of consecutive sections of pipe identified in step 1a) wherein the gradient of the pipe changes over the length of the region and wherein consecutive pipe sections of the region each have a gradient which is equal to or greater than the gradient of the adjacent upstream pipe section; and

modifying the initial pipeline lay-out profile to form a modified pipeline lay-out profile by replacing the pipe sections in each of the identified regions with one or more replacement pipe sections such that the gradient of the pipe in the region does not increase in a downstream direction.

2. The method according claim 1, wherein the threshold gradient is between 0° and 1°.

3. The method according to claim 1 or 2, wherein the method comprises determining the threshold gradient.

4. The method according to claim 1, 2 or 3, wherein the identified regions are each replaced by regions in which the gradient of the pipe is constant.

5. The method according to any preceding claim, wherein the modified pipeline lay-out profile has no lengths of positively inclined pipe greater than a threshold gradient which are followed in the downstream direction by a positively inclined pipe of greater gradient without there being a length of pipe therebetween which has a gradient less than the threshold gradient.

6. The method according to any preceding claim, wherein the start and end points of the identified regions are unchanged in the modified pipeline lay-out profile.

7. The method according to any preceding claim, wherein the sections of pipe which make up the initial pipeline lay-out profile are each straight sections.

8. A method according to any preceding claim, wherein the initial pipeline lay-out profile is a model of a pipeline lay-out profile and/or wherein the modified pipeline lay-out profile is a model of a pipeline lay-out profile.

9. A method according to any preceding claim, wherein the initial pipeline lay-out profile is based on the profile of a surface of an installation site for the pipeline.

10. A method according to any preceding claim, wherein the method comprises laying a pipeline according to the modified pipeline lay-out profile.

11. A method according to any preceding claim, wherein the method comprises modifying the profile of an installation site based on the modified pipeline lay-out profile.

12. A method according to any preceding claim, wherein modified pipeline lay-out profile is for a pipeline which is a pipeline for transporting dry gas-condensate.

13. A software product comprising instructions which when executed by a processor cause the processor to perform the method of any preceding claim.

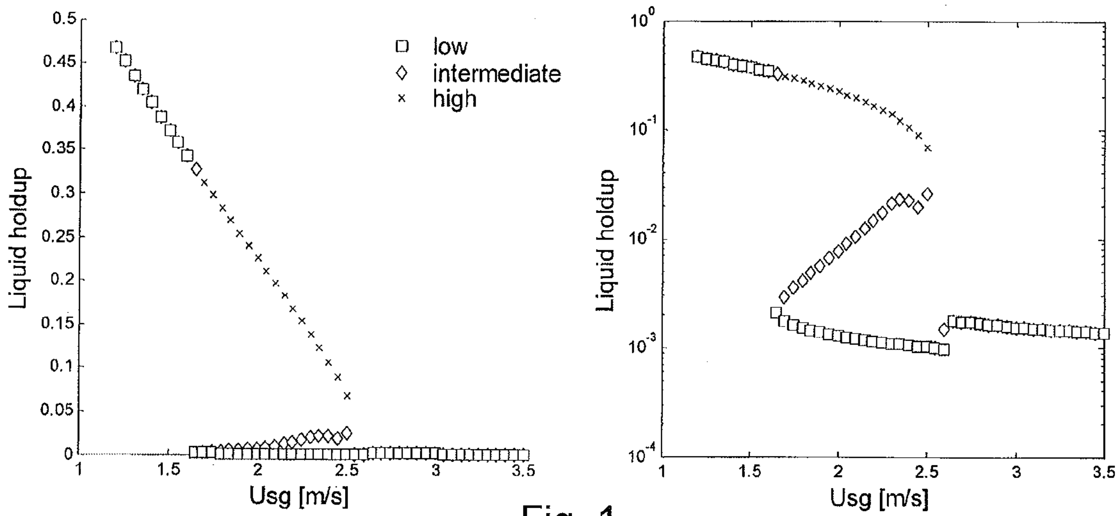


Fig. 1

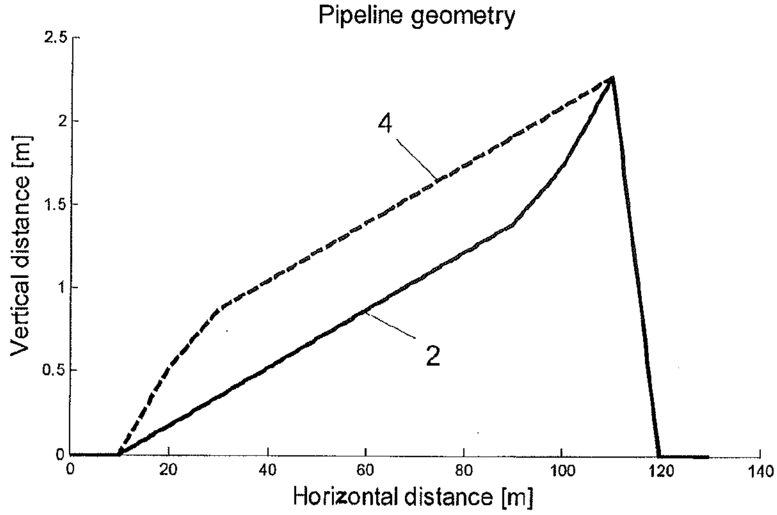


Fig. 2

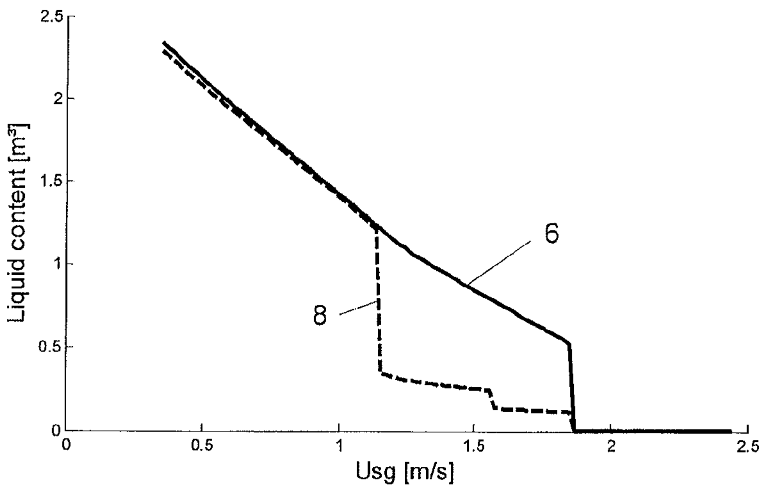
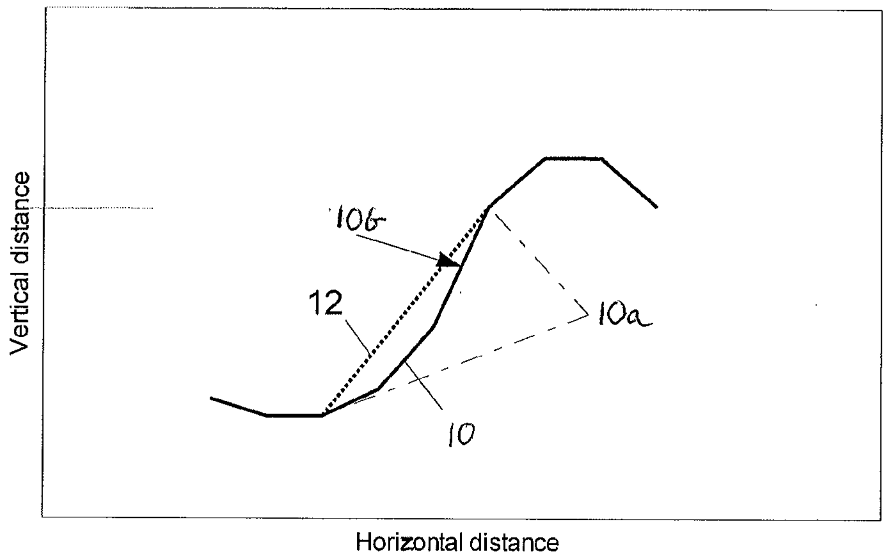


Fig. 3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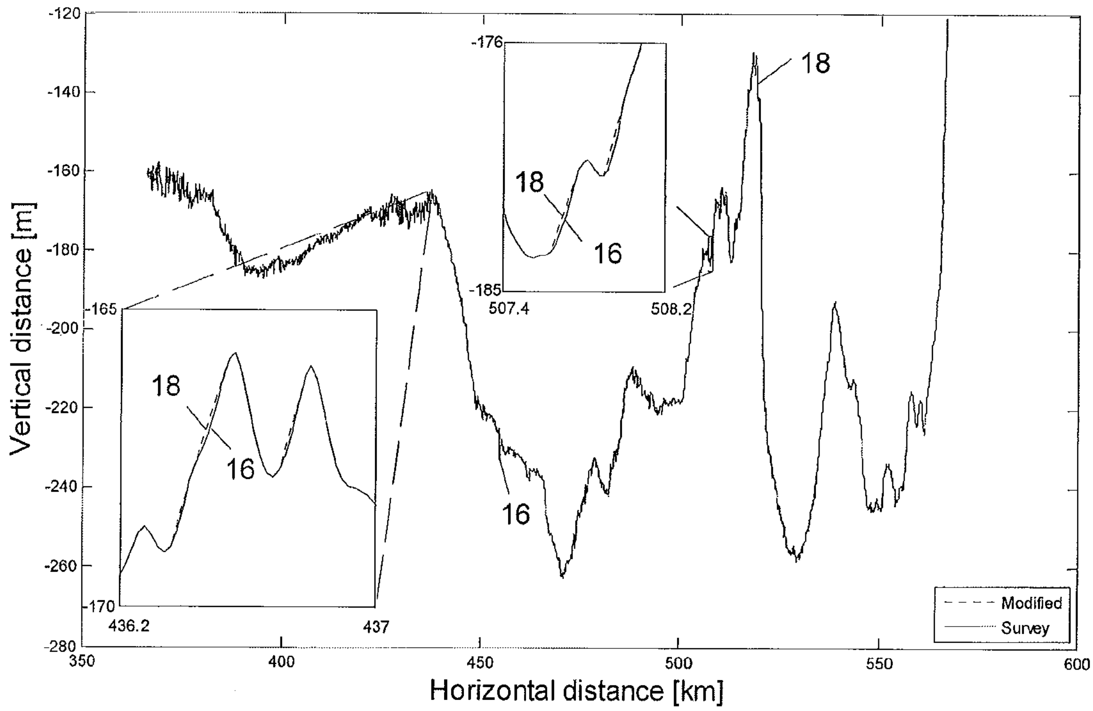
Horizontal distance
10b
12
10a
10

Fig. 4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Horizontal distance [km]
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-140
-160
-180
-200
-220
-240
-260
-280
350
400
450
500
550
600
-165
-170
436.2
437
-176
-185
507.4
508.2
18
16
Modified
Survey

Fig. 5

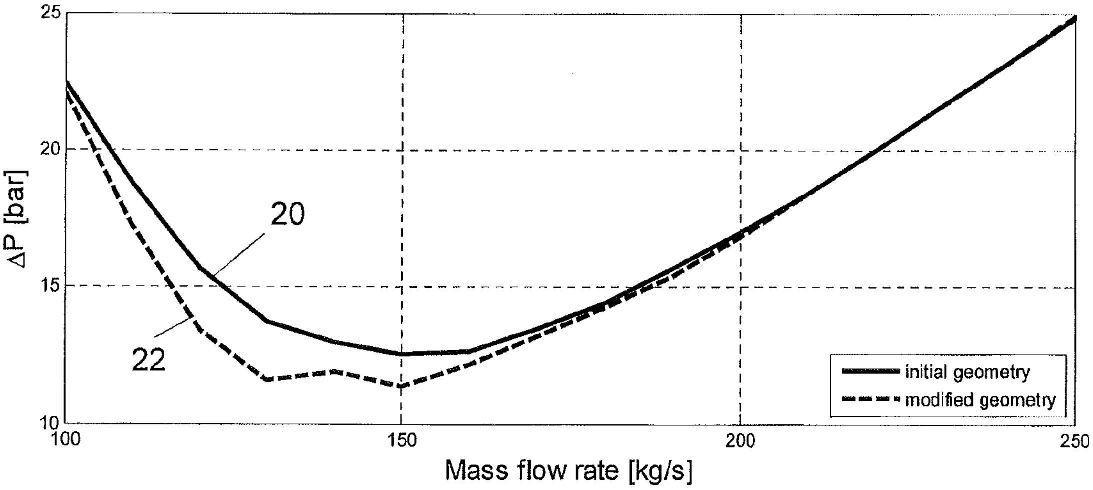
25
20
15
10
ΔP [bar]
100
150
200
250
Mass flow rate [kg/s]
20
22
initial geometry
modified geometry

Fig. 6

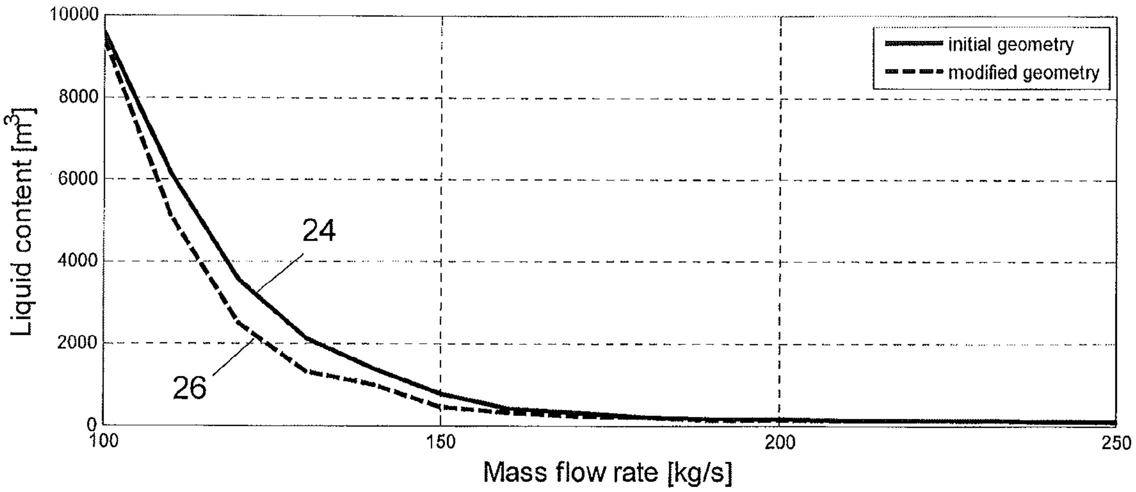
10000
8000
6000
4000
2000
0
Liquid content [m3]
100
150
200
250
Mass flow rate [kg/s]
24
26
initial geometry
modified geometry

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/058885

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16L1/00 E21B43/00 G06F17/50
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)
F16L E21B G06F

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 2014/082916 A1 (SINVENT AS [NO]; TOTAL E & P NORGE AS [NO]; CONOCOPHILLIPS SKANDINAVIA) 5 June 2014 (2014-06-05) abstract; figures page 19, lines 1-16; claim 1 page 1, lines 18-23 -----	1-13
A	US 2014/172382 A1 (ANDREWS PAUL I [GB] ET AL) 19 June 2014 (2014-06-19) abstract; figures paragraph [0003] -----	1-13
A	EP 2 829 993 A1 (DASSAULT SYSTÈMES [FR]) 28 January 2015 (2015-01-28) abstract; figures paragraph [0004] ----- -/--	1-13

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 December 2015	19/01/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Untermann, Nils

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/058885

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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