Title: A METHOD OF SEALING A PIPELINE

Abstract: The method comprises introducing into a pipeline in a gas pressurised system a sealing means comprising first and second sealing members (10, 11) that are spaced apart but connected to each other and are adapted to block and seal the bore of the pipeline. The space (17) between the sealing members is pressurised with inert gas and the pressure in the space is monitored to check for leakage or failure of the seal.
A Method of Sealing a Pipeline

The present invention relates to a method of sealing or blocking a pipeline and, more particularly, to a method of sealing or blocking a pipeline in a gas pressurised system.

Gas pressurised systems may include pipelines which are connected to a source of gas pressure and which house or contain equipment, such as spool pieces, butterfly valves, ball valves or other valves or equipment that needs to be inspected, removed, replaced, repaired, maintained or otherwise accessed and attended to. Such pipeline valves or equipment may in fact be the primary means of isolation for the pressurised system. One example of the kind of gas pressurised system in respect of which a method according to the present could be useful would be a system which comprises a pressurised storage tank containing liquefied natural gas and such gas in gaseous form above the surface of the liquefied gas. In such an example, an outlet pipe or pipeline having an in-line primary isolation valve is connected to the tank and is in communication with the gaseous form of the natural gas within the tank. A method according to the invention may be used to facilitate access to the isolation valve.

An object of the present invention is to provide a method which facilitates access to equipment in a pipeline in a pressurised system under "live" conditions, that is without depressurising the system.
According to the present invention, a method of sealing a pipeline in a gas pressurised system so as to isolate a region of the pipeline from a source pressurising the system, comprises introducing into the pipeline through an access opening in the pipeline under sealed or substantially fluid tight conditions a sealing means, the sealing means comprising a first sealing member, a second sealing member and connection means connecting the first and second members together, moving the sealing means into position in the pipeline so that the first and second sealing members are spaced from each other longitudinally within the pipeline and each engages the internal surface of the pipeline to block the interior of the pipeline, pressurising the space between the sealing members with an inert gas to a predetermined pressure greater than the pressure on the pressure source side of the sealing means and regulating and monitoring the pressure and flow of the inert gas between the first and second members to check for fall in pressure or increase in flow indicating excessive leakage or failure of the seal.

The method allows access into the pipeline region on the side of the sealing means remote from the gas pressurising source without depressurising the system on the other side of the sealing means.

Preferably, in response to a fall in pressure or increase in flow of the inert gas between the two sealing members being detected, the space is pressurised further and
regulated to return the pressure in the space to the predetermined pressure or to a pressure greater than the pressure on the pressure source side of the sealing means. The intention here is that any leakage that occurs will be in the direction of the source of pressure in the system with the purpose of avoiding escape of pressurised gas within the system.

Conveniently, each sealing member of the sealing means is an inflatable bag-like structure with each bag-like structure being connected (or connectable) by conduit means to a source of pressurising inert gas for inflating the bag-like structures, the method further including inflating the two bag-like structures to ensure engagement with the internal surface of the pipeline to block the pipeline. The bag-like structures would be in collapsed or in relatively deflated conditions when introduced into the pipeline and moved along the pipeline to desired positions.

The bag-like structure more remote from the source pressurising the system may be pressurised to a pressure which is greater than the pressure to which the bag closer to the source pressurising the system is pressurised. The intention here is that any leakage that occurs will be in the direction of the source of pressure in the system with the purpose of avoiding the escape of pressurised gas.
The predetermined pressure to which the space between the two bag-like structures is pressurised may be less than that in the bag-like structure which is closer to the source pressurising the system and less than that in the other bag-like structure but greater than the pressure on the pressure source side of the sealing means. The intention here is that any leakage that occurs will be in the direction of the pressure source.

The sealing means may be introduced into the pipeline through an access opening that is generally in line with the longitudinal direction of the pipeline.

Alternatively, the sealing means may be introduced into the pipeline through an access opening that is transverse to the longitudinal direction of the pipeline. It will be appreciated that the sealing means has to be sufficiently flexible and/or dimensioned or sized to be able to negotiate a bend so as to be movable round into and along the pipeline when introduced in a transverse direction into the pipeline.

In the method, prior to the introduction of the sealing means into the pipeline, the region of the pipeline through which the sealing means is to be moved into position may be purged with an inert gas, via an access opening to the pipeline under sealed or substantially fluid tight conditions. The access opening via which the region of the pipeline is purged with inert gas may be generally in line with the longitudinal direction of the pipeline or may be generally transverse to the longitudinal direction of the pipeline. The purpose of purging with an inert gas is to displace the pressurised
gas and minimise as far as practically possible the venting of pressurised gas.

Prior to the introduction of the sealing means into the pipeline, the internal surface of the pipeline at least up to the position/region to which the sealing means is to be moved, may be inspected by visual inspection means introduced into the pipeline via an access opening in the pipeline under sealed or substantially fluid tight conditions.

The purpose of this is so that burrs or other flaws or features that may potentially damage the sealing means, particularly the sealing members when in the form of inflatable bag-like structures can be detected prior to introduction of the sealing means into the pipeline and a decision can be made, for example, as to the choice of sealing members or even if it is feasible to proceed with the method.

The visual inspection means may comprise a flexible/rigid visual probe attached to a light source and viewing/image recording equipment.

The visual inspection means may be introduced into the pipeline via an access opening that is generally transverse to the longitudinal direction or, alternatively, is generally in line with the longitudinal direction of the pipeline.
The choice of whether to use an inline opening or a transverse opening for any of the above mentioned operations depends on various factors, including the way in which equipment in the pipeline can be or must be accessed, removed, etc., and this choice will be determined in a known manner by those skilled in the art.

It will also be appreciated that methods by which pipelines and the like can be tapped into and provided with access openings through which to introduce devices or equipment into, or withdraw devices or equipment from, pipelines under sealed or substantially fluid tight conditions and subsequently closing off the access openings are well known to those skilled in the art.

The inert gases referred to above may be helium or nitrogen. Helium may be used for purging and displacing the pressurised gas. Nitrogen may be used for purging and displacing the pressurised gas and also for inflating the bag-like structures if required.

The present invention will now be described, by way of example only, with reference to the accompany drawings, in which:-

Figure 1 shows in schematic form a gas pressurised system having a pipeline region which is to be sealed or blocked in accordance with a method of the invention;

Figure 2 shows in schematic form an embodiment of sealing means and
associated equipment that can be used in an example method of sealing;

Figures 3a, 3b, 3c and 3d show in schematic form different stages during the carrying out of one form of the method; and

Figures 4a, 4b, 4c and 4d show in schematic form different stages during the carrying out of another form of the method.

With reference to Figure 1 of the drawings, a gas pressurised system comprises a pressurised storage tank 1 which contains liquefied natural gas 2 and gaseous form of the gas 3 above the surface of the liquefied gas. An upwardly extending outlet pipeline or riser 4 communicating with the gaseous form of the gas passes in a sealed manner through the roof or upper wall 5 of the tank 1. The pipeline 4 has, in this example, an in-line primary isolation valve 6 for the tank, which has to be accessed.

The example methods to be described below employ sealing means 7 and associated equipment 8 as illustrated in schematic form in Figure 2, which will now be described.

The sealing means 8 comprises an umbilical tube 9 on which are fixedly mounted two inflatable bag-like structures 10 and 11 (hereafter referred to as bags 10 and 11, or bag 10 and bag 11) that are spaced apart. In Figure 2, the bags 10 and 11 are shown in semi-collapsed or deflated states. The interior of bag 10 is connected by a hose 10a
which runs along the inside of the umbilical tube 9 to a controllable source of pressurised inert gas 12 to inflate bag 10, e.g. nitrogen, associated with which is gas pressure regulating and monitoring equipment 13. In a similar manner, the interior of bag 11 is connected by a hose 11a to a controllable source of inert gas 14, to inflate bag 11, associated with which is gas pressure regulating and monitoring equipment 15.

Opening from the wall of the umbilical tube 9 in the region 16 between the two bags into the space 17 between the two bags 10 and 11 are two hoses 18 and 19. Hose 18 runs from the region 16 along the inside of the umbilical tube 9 and is connected to a controllable source of pressurised inert gas 20, e.g. helium or nitrogen, associated with which is gas pressure regulating and flow monitoring equipment 21. In a similar manner, hose 19 is connected to a gas pressure monitor or gauge 22 but is not connected to a source of pressurised inert gas.

The following described methods are carried out essentially on the region of the pipeline 4 designated “A” in Figure 1 and shown on an enlarged scale in Figures 3a to 3b, and in Figures 4a to 4b. In these figures, for the sake of simplicity very schematic forms of the sealing means is indicated.
Turning to the method illustrated in Figures 3a to 3d, a small transverse access hole
is tapped into the wall of the pipeline 4 below the isolation valve 6 and a branch
pipe 26 provided with an isolation valve 27 is attached to the pipeline. A visual
inspection apparatus or probe 30 on the end of a flexible rod or tube 31, which is
connected to a light source (not shown), is inserted into the branch pipe 26 via a
stuffing box 28 and moved into the pipeline 4 so that the condition of the interior of
pipeline 4 can be inspected by viewing on viewing/image monitoring and recording
means 32 to which the inspection apparatus is connected, prior to deciding whether or
not to proceed with insertion of the sealing means.

If it is decided to proceed, after the inspection apparatus has been withdrawn the
sealing means is introduced into the branch pipe 26 and manipulated and moved
round and along into position in the pipeline 4 so that the bags 10 and 11 are spaced
from each other longitudinally within the pipeline as shown in Figure 3c. The two
bags are then inflated with inert gas so as to ensure engagement of the bags with the
internal surface of the pipeline to block or seal off the pipeline as shown in Figure 3d.
The space 17 between the two bags is pressurised by operating the source of
pressurised inert gas, via hose 18, to a predetermined pressure which is greater than
the pressure exerted by the pressure in tank 1. The sequence of pressuring the bags 10
and 11, and the space and the relative pressures involved is as follows: bag 11 is
inflated to a predetermined pressure less than it’s final working pressure, this is
followed by inflating bag 10 to a predetermined pressure. Bag 11 is then inflated to
the predetermined working pressure. When the pressures in bags 10 and 11 have
stabilised the space 17 is pressurised to a predetermined level greater than the pressure
source. The pressures in bags 10 and 11 are continuously regulated and monitored,
and the pressure and flow in space 17 is continuously monitored and regulated.

The pressure of the inert gas in the space 17 between the bags is monitored by gas
pressure monitor 22 via hose 19 to check for or detect fall in pressure indicating
excessive leakage or failure of the seal. In response to a small deviation in the
pressure in space 17 being detected, the space can be pressurised further and regulated
in a manner to maintain the predetermined pressure with the purpose being to prevent
leakage of natural gas from the tank 1 through the seal.

Once the seal has been established or stabilised, it will be appreciated that access can
be gained to the isolation valve under “live” conditions without having to depressure
the tank 1. For example, the isolation valve may have to be removed and replaced. It
will be appreciated that the umbilical tube 9 and the hoses 10a, 11a, 18 and 19 have to
be sufficiently flexible and robust to be able to be manipulated and manoeuvred
around a bend from the branch pipe 26 and along the pipeline 4.
Turning to Figures 4a to 4d, it is being assumed that introduction of the sealing means 8 through a side or branch pipe is not possible, and therefore an alternative method of introducing the sealing means into the pipeline is illustrated.

Initially, in view of very restricted space (not shown) a much smaller diameter branch pipe 35 is attached to the pipeline 4 after tapping into the pipeline to provide an access opening 36 with an isolation valve 37 being added. This access opening branch pipe and isolation valve serve only to enable an inert purging gas as indicated by arrow “B” to be fed into the pipeline 4 beneath the isolation valve 6 in order to displace the existing gas originating from the tank 1.

Once the gas purging has been judged sufficiently to have displaced existing pressurised gas in the pipeline 4, the pipe work above the isolation valve 6 is stripped back whilst allowing the gas purging to continue and run continuously so that an in-line access opening 38 can be made and an access equipment or a stuffing box 39 with its own integral isolation valve (not shown) can be attached to provide a leak tight or substantially leak tight access into pipe 4. Subsequently, the primary isolation valve 6 is opened and a visual inspection apparatus 30 may be introduced via the stuffing box 39, and the open primary isolation valve 6 into the pipeline 4 in a similar manner to that described in relation to Figures 3a to 3d. On withdrawal of any visual inspection apparatus, the sealing means comprising the two bags 10 and 11 can be introduced
through the stuffing box 37 and access opening 38 and the open isolation valve 6 into the pipeline and thereafter moved down into position as described earlier. Similar bag inflating and gas pressurising procedures, and monitoring of the gas pressure in the space 17 between the inflated bags can be carried out as described earlier. Once the seal has been established or stabilised, access can be had to the isolation valve from the top of the pipeline as shown in Figure 4d. However, as the umbilical tube 9 runs through the open primary isolation valve 6 and the stuffing box 37 and would prevent removal and replacement of the isolation valve, the umbilical tube comprises a connector portion (not shown) via which two joined opposing complementary portions of the umbilical and associated hoses can be disconnected from each other to leave sealed off hose portions, with gas pressures being maintained, that can be reconnected to provide full communication again through the hoses. While the umbilical tube and hoses are in the separated condition, the primary isolation valve 6 may be moved along and over the end of the umbilical tube part connected to the sealing means so that the valve may be completely removed and then replaced under "live" conditions without depressurising the tank.
CLAIMS

1. A method of sealing a pipeline in a gas pressurised system so as to isolate a region of the pipeline from a source pressurising the system, the method comprising introducing into the pipeline through an access opening in the pipeline under sealed or substantially fluid tight conditions a sealing means, the sealing means comprising a first sealing member, a second sealing member and connection means connecting the first and second members together, moving the sealing means into position in the pipeline so that the first and second sealing members are spaced from each other longitudinally within the pipeline and each engages the internal surface of the pipeline to block the interior of the pipeline, pressurising the space between the sealing members with an inert gas to a predetermined pressure greater than the pressure on the pressure source side of the sealing means and regulating and monitoring the pressure and flow of the inert gas between the first and second members to check for fall in pressure or increase in flow indicating excessive leakage or failure of the seal.

2. A method as claimed in claim 1, in which in response to a fall in pressure or increase in flow of the inert gas between the two sealing members being detected, the space is pressure regulated to return the pressure in the space to the predetermined pressure or to a pressure greater than the pressure on the pressure source side of the sealing means.
3. A method as claimed in claim 1 or claim 2, in which each sealing member of the sealing means is an inflatable bag-like structure with each bag-like structure being connected (or connectable) by conduit means to a source of pressurising inert gas for inflating the bag-like structures, the method further including inflating the two bag-like structures to ensure engagement with the internal surface of the pipeline to block the pipeline.

4. A method as claimed in claim 3, in which the bag-like structure more remote from the source pressurising the system is pressured to a pressure which is greater than the pressure to which the bag closer to the source pressurising the system is pressurised.

5. A method as claimed in claim 4, in which the predetermined pressure to which the space between the two bag-like structures is pressurised is less than that in the bag-like structure which is closer to the source pressurising the system and less than that in the other bag-like structure.

6. A method as claimed in any of claims 1 to 5, in which the sealing means is introduced into the pipeline through an access opening that is generally in line with the longitudinal direction of the pipeline.
7. A method as claimed in any of claims 1 to 5, in which the sealing means is introduced into the pipeline through an access opening that is transverse to the longitudinal direction of the pipeline.

8. A method as claimed in any of the previous claims, in which, prior to the introduction of the sealing means into the pipeline, the region of the pipeline through which the sealing means is to be moved into position is purged with an inert gas, via an access opening to the pipeline under sealed or substantially fluid tight conditions.

9. A method as claimed in claim 8, in which the access opening via which said region of the pipeline is purged with the inert gas is generally in line with the longitudinal direction of the pipeline.

10. A method as claimed in claim 8, in which the access opening via which said region of the pipeline is purged with inert gas is transverse to the longitudinal direction of the pipeline.

11. A method as claimed in any of the previous claims, in which, prior to the introduction of the sealing means into the pipeline, the internal surface of the pipeline (at least) up to the position/region to which the sealing means is to be moved, is inspected by visual inspection means introduced into the pipeline via an access opening in the pipeline under sealed or substantially fluid tight conditions.
12. A method as claimed in claim 11, in which the access opening via which the visual inspection means is introduced into the pipeline is generally in line with the longitudinal direction of the pipeline.

13. A method as claimed in claim 11, in which the access opening via which the visual inspection means is introduced into the pipeline is transverse to the longitudinal direction of the pipeline.

14. A method substantially as hereinbefore described with reference to Figures 1, 2 and 3a, 3b, 3c and 3d; and to Figures 1, 2 and 4a, 4b, 4c and 4d.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

| IPC   | F16L55/128 |

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)

| IPC   | F16L |

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 practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Date of the actual completion of the international search**

20 April 2004

**Date of mailing of the international search report**

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