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(54) **LEAKAGE CONTAINMENT SYSTEM FOR RUN-AWAY SUBSEA WELLS**

LECKAGERÜCKHALTESYSTEM FÜR LECKENDE UNTERSEE BOHRLÖCHER

SYSTÈME DE RETENU DE FUITES POUR DES PUITS SOUS-MARINS FUYANTS

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Description

[0001] The present invention concerns an assembly forming a containment system for run-away subsea wells. Said system comprises a sleeve with dimensions larger than the relevant Blow-Out Preventer (BOP) device of the oil-well topped by a frustrum roof forming a funnel above the BOP, said roof being equipped with an exhaust chimney with a closure valve including a connection device for anchoring sealing and/or anchoring equipment to said exhaust chimney, the assembly further comprising a number of suction anchor pods disposed at the periphery of the sleeve, said sleeve also including an injection inlet for grout at its base and said roof including at least one injection inlet for methanol and at least one outlet oil/water/methanol mixture. The sleeve may in a preferred embodiment include a level gauge for monitoring the level of injected grout.

[0002] US-4,318,442 discloses a containment system according to the preamble of claim 1.

[0003] One of the problems to be solved with the present invention is to provide a containment system for run-away oil wells in deep-sea drilling. An offshore exploration well especially in deep-water and/or under HP/HT conditions (up to 1200 bars pressure and 200 °C temperature) is mandatorily equipped with a blow-out preventer (BOP) which shuts down the well automatically when abnormal pressure is encountered in order to stop the uncontrolled gushing of fluids. No independent barrier exists otherwise if the BOP cannot operate due to the failure of one of its components. Mitigating the oil leakage is complicated further by the formation of hydrates at such depths as water mixes with methane, said hydrates clogging up export lines which convey the oil/water mixture in potential rescue devices.

[0004] Examples of BOPs according to the prior art include the device disclosed in US patent 4.416.565 A comprising a cylinder with a funnel-shaped roof being constructed as a chimney with a valve to be placed over a well with an uncontrolled blow-out. The cylinder has an exit leading oil and gas to the surface.

[0005] Also in US patent 4.318442 A is there shown a cylinder with a chimney being placed over a well with an uncontrolled blow-out and with an exit for oil and gas from the well.

[0006] From US patent application 2006/0225810 there is disclosed a sarcophagus being lowered onto a wreck on the seabed for emptying the wreck for oil and gas. The sarcophagus is anchored to the seabed by the aid of suction anchors and it is injected methanol into the sarcophagus for preventing the formation of hydrates when the wreck is emptied.

[0007] The blow-out rescue device according to the present invention is disclosed infra under reference to the enclosed figure.

[0008] The containment system according to the present invention comprises the following elements:

1. a container lowered over the faulty BOP comprising

- a sleeve (preferably cylindrical) (item 1A), in one embodiment approximately 4 m in diameter and 12 m high (the dimensions being adjusted to the relevant BOP over which the sleeve is to fit, specified by the supplier of the BOP);
- a frustrum roof (item 1B) the slope of which will depend on the internal friction of the hydrate crystals (normally between 30 and 60°);
- an exhaust chimney (item 1C) (in one embodiment with a diameter of up to 36") equipped with a closure valve and crowned by a flange, which can be used as a base for anchoring and sealing equipment or pipe landed at the top of the chimney in the event of unforeseen intervention.

2. at least three suction anchor pods (item 2) disposed at the periphery of the main sleeve (cylinder). The suction anchor pods may in one embodiment have a diameter of about 1.5 m and will include penetration marks and pressure control valves.

3. a grouting system comprising manifolded injection lines (item 3A) at the base of the sleeve and a level gauge (item 3B) at the top of the sleeve.

4. a methanol injection system comprising small bore branched pipes (item 4A) piercing the conical roof of the sleeve and preferably associated with a gauge (4B) which measures the relative concentration of seawater and methanol in the oily mixture trapped under the roof.

5. one or more outlets (item 5) at the base of the chimney each activated by a closure valve and connected to an export riser conveying the oily mixture to the sea surface. While one outlet only should normally be open at any time, the other inactive outlets would enhance the redundancy of the export system in the event of the active line becoming clogged. Furthermore, using a different diameter for each outlet line, e.g. from a diameter of 6" to a diameter of 12", would allow adapting to variations in the debit of the uncontrolled well and hence optimize the flow in the riser throughout the duration of the operation. The number of outlet/export lines (item 5) could be 2, 3 or 4, possibly more, each optionally characterized by a specific diameter different from each other. Using several outlet lines would also make the containment system according to the present invention more versatile. In the event that the outlet line in use is clogging up through the (unforeseen) formation of hydrates or an unexpected production of sand, it may then be possible to open up a second outlet line and

simultaneously reverse the flow direction in the clogged-up line by flushing or purging this line with methanol, thus dissolving the hydrates and clearing the previously clogged-up outlet/export line again. This procedure will ensure continuous export of fluids through the outlet/export lines and avoid pressure build-up under the hood/funnel/roof of the device according to the invention.

[0009] The material of the parts of the device/system according to the present invention is to be metal or a metal alloy withstanding the conditions of pressure and temperature existing at the oil-well in question. Also the metal or metal alloy should be non-corrosive (at least for a period of time relevant for making the oil-well safe). The metal of choice is steel, tempered steel or stainless steel.

[0010] The present invention also includes a process for stopping the oil and gas outflow from a run-away oil-well (uncontrolled blow-out). The process for stopping such outflow includes the following steps:

1. The container/sleeve is lowered over the BOP with the main chimney valve open to allow free exhaust of the oil and gas bursting from the top of the (damaged) BOP. Methanol may be injected through line (4) at this early stage to prevent hydrate formation and clogging of the chimney.

2. The valves of the suction pods (2) are activated in order to create a hydrostatic depression sufficient to drive the main container (1) deep into the sea bottom, and hence achieve adequate sealing at its base.

3. Grout is then injected at the base of the container/sleeve to fill its annulus (space between the BOP and the internal surface of the sleeve) including the BOP and ensure a good bonding of the two objects. Raising of the grout in the annulus is monitored until the free-surface of the grout reaches approximately the top of the sleeve at its intersection with the conical roof. Throughout this phase, the chimney remains open and continues to allow free passage of the fluid bursting from the BOP and also of the seawater trapped inside the container/sleeve and displaced by the grout.

4. After grouting is complete, the remaining volume of trapped seawater more or less corresponds to the volume of the conical roof. This seawater is mixed with oil and gas from the well and with methanol which continues to be injected.

5. As more methanol is injected, its concentration in the mixture increases while that of seawater decreases until the critical threshold of hydrate formation is reached. The chimney valve is then progressively closed as the riser export line (5) opens, which then conveys a mixture consisting almost exclusively of oil, gas and methanol, no longer prone to hydrate formation.

Claims

1. Assembly forming a containment system for run-away oil-wells comprising a container comprising a sleeve (1a) with dimensions larger than the relevant Blow-Out Preventer (BOP) device of the oil-well tapped by a frustrum roof (1b) forming a funnel above the BOP, **characterised in that** said roof is equipped with an exhaust chimney (1c) with a closure valve including an interface for anchoring and sealing equipment to said exhaust chimney, the assembly further comprising a number of suction anchor pods (2) disposed at the periphery of the sleeve, said sleeve also including an injection inlet for grout at its base and said roof including at least one inlet for methanol injection and at least one outlet for export of oil/water/methanol mixture.

2. Assembly according to claim 1, wherein the sleeve includes a level gauge for monitoring the level of injected grout.

3. Process for shutting down a run-away oil-well with a damaged BOP, said process including the steps:

   1. the container of the assembly according to claim 1 or 2 is lowered over the BOP with the chimney closure valve open to allow free exhaust of the oil and gas bursting from the top of the damaged BOP, wherein methanol is injected through said inlet for methanol injection at this early stage to prevent hydrate formation and clogging of the chimney;
   2. the valves of the suction anchor pods (2) are activated in order to create a hydrostatic depression sufficient to drive the container deep into the sea bottom, and hence achieve adequate sealing at its base;
   3. grout is then injected a the base of the sleeve to fill the annulus space between the BOP and the internal wall of the sleeve, including the BOP and ensure a good bonding of the two objects wherein raising of the grouting in the annulus is monitored until the free-surface of the grout reaches the start of the frustrum roof, and throughout this phase, the chimney remains open and continues to allow unimpeded exhaust of the fluid gushing from the BOP and also of the seawater trapped inside the container and displaced by the grout;
   4. after grouting is complete, the remaining volume of trapped seawater more or less corresponds to the volume of the frustrum roof, where

this seawater is mixed with oil and gas from the well and with methanol which continues to be injected;

5. as more methanol is injected, its concentration in the mixture increases while that of seawater decreases until the critical threshold of hydrate formation is reached, the chimney closure valve is then progressively closed as a riser export line (5) connected to the at least one outlet for export of oil/water/methanol mixture opens, which then conveys a mixture consisting almost exclusively of oil, gas and methanol, no longer prone to hydrate formation.

Patentansprüche

1. Ein Konstrukt wie ein Behälter das eines Sicherungssystems für auslaufende Ölquellen bildet, bestehend aus einer Hülse (1a), deren Umfang größer als das entsprechende Bohrlochabsperrventil (BOP) ist, die mit einem kegelförmigen Dach gekrönt ist, wobei das Dach mit einem Abgaskamin mit einem Verschlussventil ausgestattet ist, das wiederum die Verankerungs- und Abdichtungstechnik mit dem Abgaskamin verbindet. Des Weiteren beinhaltet die Konstruktion eine Zahl von Saugankereimer, die am Rand der Hülse angeordnet sind, wobei es an der Unterseite der Hülse eine Einspritzanlage für Fugenmasse und an der Oberseite mindestens eine Einspritzanlage für Methanol und mindestens einen Abfluss für das Öl/Wasser/Methanol Gemisch gibt.

2. Konstrukt entsprechend Anspruch 1, wobei die Hülse eine Füllstandsanzeige für die Überwachung der Menge der injizierten Fugenmasse enthält.

3. Das Verfahren zur Stilllegung einer auslaufenden Ölquelle bei einem beschädigten BOP, umfasst folgende Schritte:

1. der Behälter des Konstrukts wird entsprechend Anspruch 1 oder 2 über das BOP gestülpt, wobei das Abgaskaminventil offen sein muss, um freien Auslass der Öl-und Gas- Mischung zu erlauben, die an der Spitze des (beschädigten) BOP explodiert, wobei Methanol zu diesem frühen Zeitpunkt durch Einlass (4) eingespritzt wird, um Hydratbildung und Verstopfung des Kamins zu verhindern;

2. die Ventile der Saugankereimer (2) werden aktiviert, um einen hydrostatischen Unterdruck zu schaffen, der ausreicht, um den Hauptbehälter (1) tief im Meeresboden zu versenken und so adäquate Abdichtung an der Basis zu erreichen;

3. Fugenmasse wird dann am unteren Ende der Hülse injiziert, um seinen Annulus (Ringraum zwischen dem BOP und der Innenwand der Hülse), einschließlich des BOP zu füllen und so eine gute Verbindung der beiden Objekte sicherzustellen. Der Füllvorgang der Fugenmasse in den Annulus wird überwacht, bis die Freifläche der Fugenmasse die Spitze der Hülse an deren Schnittpunkt mit dem kegelförmigen Dach erreicht. Während dieser Phase bleibt der Kamin offen und erlaubt so weiterhin freien Durchfluss der Flüssigkeit, die aus dem BOP explodiert, und auch des Meerwassers, das innerhalb des Behälters eingeschlossen ist und von der Fugenmasse verdrängt wird;

4. nachdem das Verfugen abgeschlossen ist, entspricht das übriggeblieben Meerwasser mehr oder weniger dem Volumen des konischen Dachs, wo das Meerwasser mit Öl und Gas aus dem Bohrloch und mit Methanol, das weiter injiziert wird, vermischt wird;

5. da immer mehr Methanol injiziert wird, erhöht sich die Methanol Konzentration in der Mischung, während die des Meerwassers solange sinkt, bis der kritische Grenzwert der Hydratbildung erreicht ist. Das Abgaskaminventil wird dann schrittweise geschlossen, während sich eine der Abflussleitungen (5) öffnet, die dann eine Mischung transportiert, die fast usschließlich aus Erdöl, Erdgas und Methanol besteht und nicht mehr anfällig für die Bildung von Hydraten ist.

Revendications

1. Assemblage formant un dispositif de confinement pour résorber les fuites éruptives de puits de pétrole ayant l'aspect d'un conteneur et comprenant une virole (1a) de dimensions supérieures à celles du le bloc obturateur de puits (BOP), coiffée par un toit conique (1b) formant un entonnoir au-dessus du BOP, **caractérisé en ce que** ledit toit étant équipé d'une cheminée d'évacuation (1c) incluant une vanne de fermeture et comprenant un interface assurant l'ancrage étanche d'équipements rajoutés au sommet de ladite cheminée, l'assemblage comprenant en outre un certain nombre d'ancres à succion (2) disposées à la périphérie de la virole, ladite virole incluant également des piquages d'injection de coulis de béton à sa base et ledit toit comprenant au moins un piquage pour l'injection de méthanol et au moins un piquage pour l'évacuation du mélange huile/eau/méthanol.

2. Ensemble selon la revendication 1, dans lequel la virole comporte une jauge de niveau pour contrôler le niveau de coulis de béton injecté.

3. Procédure pour arrêter les fuites d'hydrocarbures

s'échappant d'un BOP endommagé, ledit procédé comprenant les étapes suivantes:

1. le conteneur de l'assemblage selon la revendication 1 et 2 est abaissé sur le BOP, la vanne de cheminée d'évacuation restant ouverte pour permettre la libre évacuation du pétrole et du gaz qui jaillit de la partie supérieure du BOP (endommagé), tandis que du méthanol est injecté au travers du piquage (4) à ce stade précoce afin de prévenir la formation d'hydrates et le colmatage de la cheminée;
2. les robinets des ancres à succion (2) sont activés afin de créer une dépression hydrostatique suffisante qui force le conteneur à s'enfoncer profondément dans le sol marin, établissant ainsi une étanchéité adéquate à sa base;
3. un coulis de béton est par la suite injecté à la base de la virole afin de remplir l'annulaire (espace entre le BOP et la paroi interne de la virole) envelopant le BOP et d'assurer une bonne adhérence entre les deux objets. La remontée du coulis dans l'espace annulaire est surveillée jusqu'à ce que la surface libre du coulis atteigne approximativement le haut de la virole à son intersection avec le toit conique. Tout au long de cette phase, la cheminée reste ouvert et continue d'assurer le libre passage du fluide jaillissant du BOP et aussi de l'eau de mer piégée à l'intérieur du conteneur et déplacée par ce coulis;
4. à la fin de l'opération de remplissage par coulis, le volume subsistant d'eau de mer piégée correspond plus ou moins au volume du toit conique. Cette eau de mer est mélangée avec l'huile et le gaz du puits et avec le méthanol qui continue à être injecté;
5. tandis que du méthanol continue d'être injecté, sa concentration dans le mélange augmente tandis que celle de l'eau de mer diminue jusqu'à ce que le seuil critique de formation d'hydrates soit atteint. La vanne de cheminée d'évacuation est alors progressivement fermée tandis que l'une des colonnes montantes d'export (5) est activée, celle-ci convoyant dès lors un mélange constitué presque exclusivement de pétrole, gaz et méthanol qui n'est plus enclin à la formation d'hydrates.

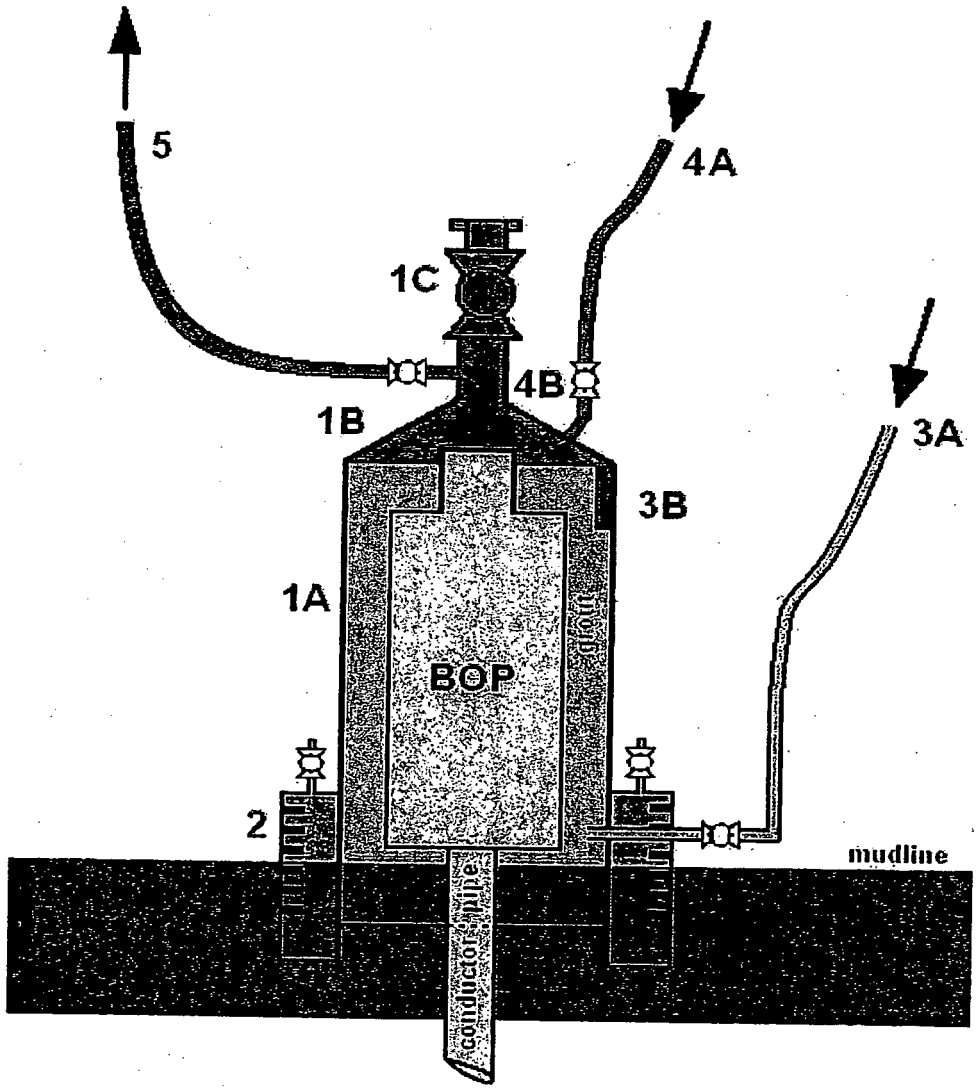

Fig.

REFERENCES CITED IN THE DESCRIPTION

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