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(54) METHOD AND STRUCTURE FOR PROTECTING A CRUSHABLE PLUG IN A PIPE SECTION FOR HYDROCARBON PRODUCTION, AND USE THEREOF

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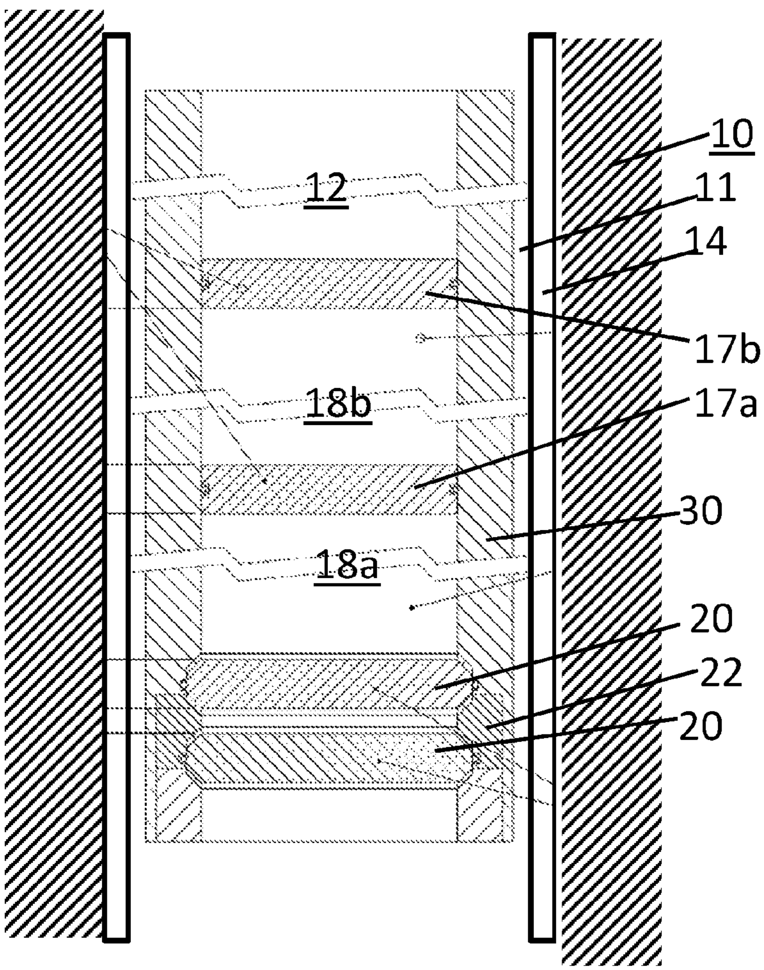
(57) **ABSTRACT**

A method to protect a crushable plug in a pipe section for hydrocarbon production against falling objects is described, and it is characterised in that one or more layers of a thick, viscous liquid is arranged on the topside of the crushable plug, where the topside of the thick, viscous liquid is given a completely covering protective layer to cover and seal the liquid layer on top of the plug, and in particular, several layers of viscous liquid are placed on top of the plug and between each layer of viscous liquid a completely covering protective layer is arranged to protect the plug. Also described is a construction of a plug unit comprising a crushable plug. The invention can be used to protect test plug units fitted in a section of casing tubing to carry out pressure testing.



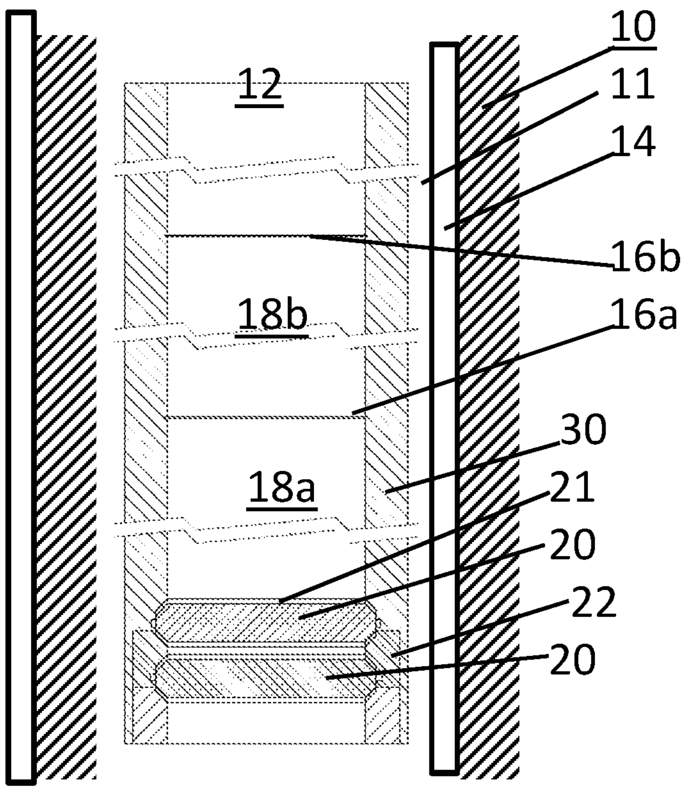


FIG. 1

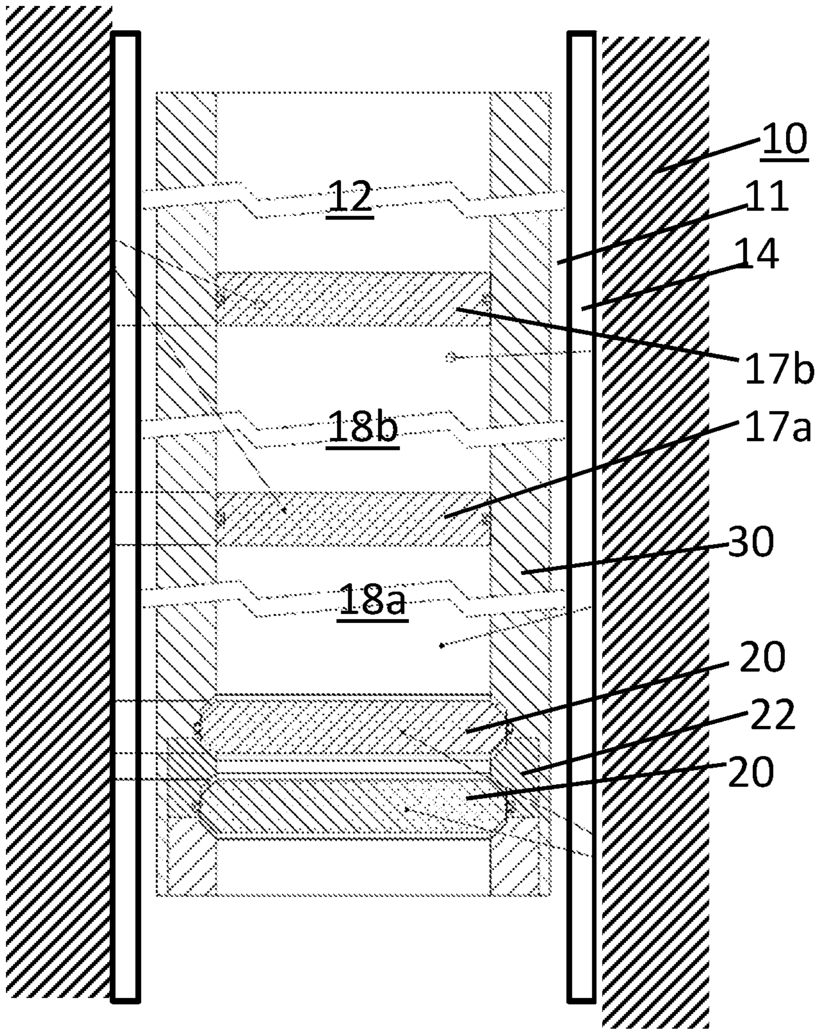


FIG. 2

METHOD AND STRUCTURE FOR PROTECTING A CRUSHABLE PLUG IN A PIPE SECTION FOR HYDROCARBON PRODUCTION, AND USE THEREOF

[0001] The present invention relates to a method to protect a crushable plug in a pipe section for hydrocarbon production against impacts from falling objects. The invention also relates to a construction of a crushable plug unit for testing of a production pipe for oil and/or gas production. The invention can also be used to test how leakproof the casing tube is against the bore hole. The invention also relates to a particularly preferred application for test plugs for production pipes and casing tubes.

[0002] When one drills for oil and gas from formations the drill hole that runs into and through the formation is designated as a well. Normally, casing tubes are inserted out against the walls in the well hole, before an independent production pipe is lowered down in sections and is fitted together and cemented to the casing/formation walls outside.

[0003] Wells for oil and gas production are subjected to very high pressures, due to a combination of atmospheric pressure (because of the depth of the wells) and the pressure from the hydrocarbon-carrying layers in the formation.

[0004] Therefore, it is common that the production pipes must be able to withstand such pressure conditions and they are therefore tested thoroughly for their ability to tolerate pressures both before they are used in the production and during production or when changes are to be implemented. The tests relate to placing a plug down in the well hole, where the plug blocks for passage of fluids. Pressure is exerted from the surface with the help of a suitable fluid such as drilling fluid, and one checks for leaks by, for example, measuring the pressure loss over time. When the well pipe has been found to be sufficiently leakproof, the plug is removed so that the well is opened and the production can start. The same goes for the casing tubing that one, in certain cases, will have an overview of how leakproof they are with respect to the conditions of a hydrocarbon-carrying formation lying outside the wells.

[0005] Plugs that are used for such well testing are well known in this field. They must be strong enough to be able to seal and close the well completely and at the same time it must be possible to remove them—preferably quickly and of course without damaging the well. Most of the known solutions are plugs made of glass, but other materials that can easily be dissolved, such as rubber, or be crushed, are also known. Glass and ceramic materials are suitable in plugs as they are resistant to such gases and liquids one finds in the well, even at high pressures and high temperatures. Furthermore, they can be manufactured so that they tolerate a specific pressure load and can thereby be adapted to the specific conditions that are in any given well. At the same time, glass and ceramic materials are easy to crush at predetermined conditions, such that the plug is removed.

[0006] A glass or ceramic plug can be manufactured as a solid plug or it can be made up in several layers of glass/ceramics, possibly with other materials between the layers. Such materials can be solid materials, such as ceramic materials, plastics, felts or cardboard materials, but they can also be fluids in liquid or gas form between each glass layer. Areas or pockets can be incorporated in the plug at lower pressures or vacuum. The plug is normally placed in a seat in a holder in a dedicated pipe section that is inserted in the production pipe, pre-calculated to be placed at a correct depth in the well. The section also comprises a device to crush the plug.

[0007] Glass is normally pre-treated/refined to make it harder so that it can withstand higher pressures on the one side of the glass where the treatment is carried out, but which also makes the glass more brittle on the opposite side. The glass that is used is relatively strong, as it is recommended that material for such plugs has a safety factor of 3.

[0008] Devices to crush glass plugs can be partially built into the plug itself and in the carrying pipe section. The plug can be removed by crushing by detonating explosive charges placed inside the plug or on top of the plug. This is a well-known technology from NO B1 321976. As there are disadvantages with the use of explosive charges in production wells, mechanical crushing methods are also used. This is described in the Norwegian patent applications NO20081229 and NO20081192 which show a peg that is moved radially and penetrates into the plug by leading a release element in the axial direction. There are also known solutions where a crushing tool is led down into the well instead and crushes the plug mechanically, by a blow or drilling.

[0009] When the plug is made from crushable materials it can be subjected to blows from objects that drop into the well itself. The plug can then be damaged as it does not withstand a higher mechanical load, although it can withstand high pressures. When it sits deep down in a production well, such as in its horizontally running part, it is relatively safe as falling objects will not reach it.

[0010] The consequence of this is that the plug is opened at an unintended and normally very unfortunate point in time so that the testing must be stopped. This is a threat to all plugs made of a crushable material such as glass and ceramic materials, although some types of plugs are more vulnerable than others. Multi-layer plugs, for example, and in particular when there are fluids between the layers, as described in NO20061308, are especially vulnerable. Such uppermost glass layer tolerates little mechanical loads, something which is often sufficient to crush something, which leads to the plug being unstable and being damaged.

[0011] With regard to protecting plugs against falling objects, reference is made to US patent applications 2011/0277988, 2007/0163776 and 2011/0168152.

[0012] The first mentioned US patent application no. 2011/0277988 describes a crushable plug for use in a well and comprises two crushable discs/plates **5**,**6**. On the uppermost crushable disc **5** a layer or stratum **21** of a soft material is arranged to prevent falling objects from damaging the plug.

[0013] The US application no. 2007/0163776 describes a crushable plug for use in a well where a layer of a different material than glass is placed between the discs. However, the fluid-exposed plug itself is not covered with such a layer.

[0014] Furthermore, US application no. 2011/0168152 describes that the topside of a water soluble glass plug is covered with a layer of oil that shall prevent the plug coming into contact with water before it is required.

[0015] Consequently, solutions that directly can protect glass plugs against damaging blows from falling objects, as one aims in the present application, are not known from before.

[0016] It is an aim of the invention to provide a new method and construction that can prevent glass plugs fitted in a pipe section for hydrocarbon production being damaged or crushed before this is intended, i.e. one wants to prevent that the plug is damaged, ruined or crushed before the necessary pressure tests of the pipe have been carried out, such as, for example, as a consequence of blows from heavy objects that may fall down into the production well during its fitting in the well.

[0017] It is also an aim of the invention to provide several variants of the basic principle of the invention.

[0018] The present invention provides a solution to the problem this danger implies, safeguarding plugs manufactured from crushable materials against unintended destruction due to objects that fall down through the tube.

[0019] The method according to the invention is characterised in that one or more layers of a thick, viscous liquid is placed on the topside of the crushable plug, where the topside of the thick, viscous liquid is supplied with a completely covering protective layer to cover and seal the liquid layer on top of the plug, as can be seen in the subsequent claim **1**.

[0020] The preferred embodiments of the method appear in the claims **2-7**.

[0021] The construction of a crushable plug unit for testing of a pipe section for oil and/or gas production according to the invention is characterised in that the topside of the crushable plug comprises one or more layers of a thick, (dilatant) viscous liquid and the topside of the viscous liquid layer comprises a completely covering protective layer to cover and seal the thick, viscous liquid layer on top of the plug.

[0022] Several layers of viscous liquid are preferably placed on the topside of the plug, and a completely covering protective layer can be found between each layer of viscous liquid. According to a preferred embodiment, the thick, viscous liquid is based on clay, different forms of gels with a paste-form, such as polymer-based gels, gel-formed lubricating means such as silicone lubricating means, glycerol, different forms of oil such as Castor oil, a thick oil corresponding to gear oil with the designation W90, as the layer has a higher viscosity than normal well fluids so that when completely fitted, the layer remains lying on top of the glass plug as a protective layer.

[0023] It is particularly preferred that the protective layer is an elastic membrane of rubber or synthetic plastic materials such as polymers, such as polyethylene or polypropylene, and which are leakproof and impermeable to viscous liquids, or the protective layer is a disc/plug of an inelastic material of metal, ceramic materials, stiffer plastic materials and glass, and the disc is prefabricated and can be placed on top of the viscous protective layer by moving in the axial direction of the pipe.

[0024] The uppermost protective layer that is exposed to the well fluids is preferably leakproof and impermeable to well fluids and the applied viscous protective layer.

[0025] According to a preferred embodiment the crushable plug and one or more of the layers of viscous liquid and the in-between lying protective layer are fitted in advance in a separate pipe section for insertion in a production pipe in a suitable location with respect to its actual position down in the well.

[0026] The invention mentioned above can be used for protection of test plug units fitted in a section of casing tubes for carrying out pressure and leak tests.

[0027] "The other side of the plug" refers here to the side of the plug that faces upwards toward any falling objects that are dropped into the well.

[0028] The invention shall be illustrated with reference to the enclosed FIGS. **1** and **2**.

[0029] FIG. **1** shows a first variant of the invention where a number of viscous liquid layers are mutually separated by respective layers of membranes.

[0030] FIG. **2** shows a second variant of the invention where the liquid layers are mutually separated by respective stiff discs.

[0031] With reference to FIG. **1**, a well **11** is shown schematically that is bored down in an underground rock formation **10** that encompasses hydrocarbon-containing fluids that shall be extracted. A casing tube **14** is inserted in the well **11**. A production pipe is inserted inside the casing tube/well, where a section **30** of this comprises a plug unit with glass plugs **22** (two pieces shown in the figure) fitted in a seat **22** of the pipe section so that it seals. A liquid in the production pipe **30** is shown at **12**.

[0032] During manufacture of the section, a layer **18***a* of a thick, viscous liquid is placed on the top surface **21** of the glass plug **20**. Furthermore, a flexible membrane **16** that seals the liquid layer **18** is fitted on top of the liquid layer, and prevents its contact with pipe fluids from above the pipe. This is one of the versions of the invention with only one liquid layer **18***a* with an above-lying membrane **16***a*.

[0033] In the second version, fitted on top of the first membrane **16***a* there is a second liquid layer **18***b* and on top of this a second membrane **16***b*.

[0034] When this pipe section unit is completely assembled, it can be inserted in the production pipe string at a suitable location in the well.

[0035] FIG. **2** shows a second embodiment of the invention where the reference numbers for the formation **10**, drilling **11**, liquid layer **18**, glass plugs **20**, mounting seat **22** and pipe fluid **12** over the plug **20** are the same as in FIG. **1**.

[0036] In this version the elastic layers **16** in FIG. **1** are replaced by inelastic lower **17***a* and upper **17***b* discs or plates each of which separates the respective layers of the thick, viscous liquid.

[0037] Starting with this construction of the pipe-plug unit in the FIGS. **1** and **2**, the present invention shall be explained in more detail in the following:

[0038] The, at least, one layer of viscous liquid and the, at least, one elastic membrane or disc are placed on the crushable plug before the plug is installed in the production well. This can be carried out after the plug itself is manufactured as a post-installation of the, at least, one layer of viscous liquid and the, at least, one elastic membrane to safeguard the plug against crushing due to falling objects. According to one particularly preferred embodiment of the present invention the, at least, one layer of viscous liquid and the, at least, one elastic membrane are placed on the crushable plug as a part of the production of the plug. According to a most preferred embodiment of the present invention the, at least, one layer of viscous liquid and the, at least, one elastic membrane or disc will be placed on the crushable plug as a part of the production of a piece of production pipe, that is as an integrated part of a section with tubing (the inner pipe in the production well), with the plug and the, at least, one layer of viscous liquid and the, at least, one disc or elastic membrane placed therein.

[0039] With "crushable plug" is meant a plug that can be crushed by mechanical influence, such as in that it is subjected to blows from objects. With regard to the present invention this relates, in particular, to plugs for use in the oil and gas production wells that are made of hard and porous materials such as glass and ceramics, that can be crushed when they are subjected to stresses from objects that are hard (with respect to the plug) and/or have sharp points or edges (which then can hit the plug with a large point load) and/or hit the plug with a large moment of movement (great speed and/or weight). Objects that drop down into oil wells will normally meet these criteria and will thereby be able to crush such "crushable plugs". Such objects are typically tools or parts that are used in connection with said testing of production wells.

[0040] How the glass or ceramic plug itself is manufactured is not described further herein, as this is well known in this field. The glass itself in such a plug will then be treated in different ways to achieve the right thickness, size and strength with regard to the parameters in the specific production well in which it is intended to be used, such as pressure and temperature. Other materials that are used, and the holder the plug sits in, and also how it is arranged and in a controlled way is damaged, are also technical issues and are therefore not described in more detail.

[0041] Viscous, Thick Liquid Layer Viscosity describes the inherent flow characteristics of fluids and depends on the friction between parts of the fluid that move at different speeds. A force is required to overcome this friction and the fluid is therefore moving slower and can absorb and distribute the force from, for example, blows from falling objects, and is applied for dampening purposes. The higher the force, the more viscous is the fluid/liquid. At the temperatures that exist in a well, nearly all fluids will have some viscosity, that is they will exhibit some resistance to movement, but variations are great from, for example, gases (air has a viscosity of 1.86×10^{-8} Pa·s (Pascal seconds that corresponds to 1 N·s/m^2) at 27° C.) to fluids that are so viscous that they appear over a short time period as solids (but move over time), such as pitch (2.3×10^8 Pa·s at 25° C.). The viscosity is a measurable quantity, which is measured with a viscometer or rheometer that measures the resistance in a fluid to be deformed by a shear force, and is normally given the unit Pa·s.

[0042] Thus viscosity is a wide concept, but the concept of "being viscous" is more limited both in common use and with regard to the present patent application, where "viscous liquids" are defined as thick liquids that have a thick, sticky consistency between solid and liquid forms. Thus, a viscous fluid can be a thick liquid, or a gel-like or a cream-like mass or a paste. In other words, a viscous liquid appears to be more solid and slow-flowing than water, but is not completely solid. Viscous liquids in connection to the present invention will have a viscosity of 0.01-1000 Pa·s, preferably 0.1-500 Pa·s, and most preferred 1-100 Pa·s at the temperature and pressure conditions in the well where the plug shall be used. Examples of viscous liquids that can be applied according to the invention are fat clay, different forms of gels with a paste-form, such as, for example, polymer-based gels, different forms of lubricating means, such as, for example, silicon lubricating means, glycerol, different forms of oil such as Castor oil, an oil corresponding to gear oil with the designation W90. Thereby, viscous liquids also can be a mixture of different materials, either liquids or liquids with fluids or solid matter mixed in and which are viscous at the conditions in which they are used.

[0043] For viscous liquids the viscosity normally falls with increasing temperature, i.e. it gets less viscous, while it is independent of the pressure apart from at very high temperatures or in cases of non-Newtonian fluids (when the fluid can be compressed, the viscosity is naturally pressure dependent). Most viscous liquids are Newtonian fluids and the viscosity is thereby constant for a wide range of shear rates. As the viscosity of viscous liquids is temperature dependent one must take into consideration the temperatures one can expect in the production well, the plug in accordance with the present invention shall be used when one chooses the viscous liquid. The temperature will normally increase the deeper in the well one gets. Production wells are normally at a temperature of 40-200° C. In a normal production well on the Norwegian shelf the temperature at the bottom of the well is often 60-130° C., while for wells with a high pressure and high temperature the temperature can often reach 200° C. As the temperature dependence for the viscosity of viscous liquids is known, this is not a problem for a person skilled in the arts.

[0044] According to a preferred embodiment of the present invention a dilatant liquid is used, also called a shear thickening fluid, as the viscous liquid. Dilatant fluids do not have a constant viscosity for different shear rates; the viscosity increases with increased supply of shear force. In other words, the harder and faster that blows are given, the more the dilatant fluid will harden (become more viscous) and distribute the forces of the blow onto the whole of the fluid. Such fluids are used, among other things, for bullet-proof clothing that comprises layers of such fluids and make normal body movements possible, but hardens completely under the great shear force that arises when a projectile or a bullet hits the clothing. Therefore, such dilatant fluids are, according to the invention, especially suited to protect glass plugs against falling objects that come at a great speed and hit the plug with a small part (a sharp corner of an object and the like) and thereby exhibits a large shear force.

[0045] How thick the layer of the viscous liquid shall be, depends on the liquid that is used and what kind of elastic membrane or disc is applied and must be adapted so that they together can protect the plug sufficiently. Normally the membrane or the disc is thin compared to the liquid layer, as it is the viscous liquid that is intended to be able to distribute most of the force of the blow that comes from falling objects, while the main aim of the membrane/disc is to seal and hold in place the fluid on top of the plug and protect or defend the liquid against fluids present in the well, even if the membrane in itself can take some of the force from the blow. The thickness of the viscous liquid can be 1-1000 mm, more preferred 10-100 mm. The thickness of the elastic membrane/disc with respect to the thickness of the layer of the viscous liquid will therefore be of the order 1: 1-10000, more preferred 1: 10-100. Both the membrane/disc and the viscous liquid layer are normally evenly thick layers, but if the plug has an uneven surface the viscous liquid layer will adjust accordingly, so that this layer will have a somewhat uneven thickness, while the elastic membrane or disc on top of the liquid will remain evenly thick and relatively flat with respect to the cross-section of the well the plug is installed in.

[0046] Protection and/or separation layer of elastic membrane or inelastic disc.

[0047] Even if one normally will use a single layer with viscous liquid with one disc or elastic membrane on top of the plug, and this is the preferred embodiment of the present invention, one can, of course, also use several layers of viscous liquid, optionally of the same or different types, optionally separated and protected by several layers of elastic membranes or discs.

[0048] The membrane in accordance with the present invention must be elastic. If it is not elastic, but rather of a hard material that seals in the viscous liquid, it will not be able to work as intended with respect to the present invention as, if it is not very thick, it will easily be crushed when it is subjected to blows from falling objects (one risks that the viscous liquid leaks out and the plug becomes unprotected). If it is too thick so that it does not crush, the power from the blow will easily transmit through the membrane via the casing/holder and all the way up to the plug which is then exposed to be crushed. Therefore, the membrane must be elastic and be able to be squeezed together so that the force from blows can be distributed in it, but not damage it, so that the force is transmitted to the viscous liquid, which will then dampen/distribute this before it reaches the plug. The thickness of the membrane is therefore dependent on the material from which the membrane is manufactured so that the membrane appears as elastic.

[0049] According to a preferred embodiment of the invention the membrane is relatively thin, of the order 0.01-100 mm, more preferred 1-10 mm.

[0050] The choice of material for the elastic membrane for the present invention is considered to be a technical issue. These materials must, of course, be able to withstand the pressure and temperature stresses in a well and must not be broken down by the fluids that exist in a well, such as oil, gas and different test fluids that are used during said testing of the well. As the purpose of the membrane is to hold the viscous liquid in place, it is, of course, necessary that the membrane is not permeable with regard to the viscous liquid so that this cannot penetrate through and out of the membrane and also that the membrane is not permeable with respect to the fluids that exist in the well above the plug, such as oil, gas and the fluids that are used during the well testing itself and with which it can come into contact.

[0051] If more than one membrane or disc is used, i.e. that several alternating viscous liquid layers and membranes/discs are fitted, the permeability is, of course, then only relevant for the uppermost disc/membrane that comes into contact with the well fluids. The inside lying layers of membranes/discs down towards the plug itself do not need to be impermeable with respect to the fluids in the well.

[0052] Such materials are known for different types of use in wells, such as in seals and also for rubber-based plugs which, as mentioned above, can be used instead of glass plugs in said testing of the wells. Examples of suitable elastic materials are natural materials such as rubber and synthetic plastic materials such as polymers, such as polyethylene (in particular with a medium or low density) or polypropylene (in particular with a high density).

[0053] As an alternative to protect the viscous layer with one (or more) membranes, one can use a disc that can move in the axial direction of the production pipe. According to this embodiment of the invention the disc will cover the topside of the viscous liquid corresponding to the elastic membrane. One achieves the same effect with an inelastic disc as with an elastic membrane in that the disc is free to move in the axial direction of the pipe, while it seals against the pipe wall (the inside wall of the production pipe or alternatively the holder if the plug is placed in a holder). In other words, the disc forms a seal against the wall, but can be moved axially so that it can be pressed against and lifted up from the layer of viscous liquid, similar to the membrane, and can therefore move with blows to the disc.

[0054] With the expression "disc" is meant a mainly circular disc-formed inelastic disc with, in the main, flat surfaces (on top and under). The choice of materials for the disc is a technical issue, but one can use the same materials which are used for other components in equipment for production wells, for example, metals, ceramic materials, different artificial materials such as plastic materials and glass. The disc can also be flexible and thus be manufactured from the same materials as the membrane according to the present invention. As for the membrane, the disc ought to be impermeable to the viscous liquid or fluids in the production pipe it comes into contact with. It is preferred that the material is strong, or hard enough so that it is not crushed/damaged by a falling object, but this is not a prerequisite. If the material can be crushed/damaged by a falling object, the protective effect of the layers of viscous liquid and the disc will be reduced or lost so that further falling objects can damage the plug. The same goes for the elastic membrane according to the invention.

[0055] Further application of the invention.

[0056] In addition to testing production pipes as described here, the invention can also be applied to testing of casing tubing as shown by **14** in the FIGS. **1** and **2**. In this case a glass plug set is fitted in connection to a casing tubing section that is inserted in a separate section of casing tubing sections. The construction of a protective layer of thick, viscous liquid and the in-between lying membranes is then the same as in the examples above.

1.-**14**. (canceled)

15. Method to protect a crushable plug in a pipe section against falling objects, wherein one or more layers of a thick, viscous liquid is arranged on the topside of the crushable plug, where the topside of the thick, viscous liquid is given a completely covering protective layer to cover and seal the liquid layer on top of the plug.

16. Method according to claim **15**, wherein several layers of viscous liquid are arranged on the top side of the plug, and a completely covering protective layer is arranged between each layer of viscous liquid.

17. Method according to claim **15**, wherein a thick, viscous liquid based on clay, different forms of gels with a paste-form are used, such as polymer-based gels, gel-formed lubricating means such as silicone lubricating means, glycerol, different forms of oil such as Castor oil, a thick oil corresponding to the gear oil with the designation W90, as the layer has a higher viscosity than common well fluids so that the layer, when completely fitted, remains lying on top of the crushable plug as a protecting layer.

18. Method according to one of the claim **15**, wherein the protective layer or layers is an elastic membrane or a disc movable in the axial direction of the pipe

19. Method according to claim **18**, wherein said elastic membrane is an elastic membrane of rubber or synthetic plastic materials such as polymers, such as polyethylene or polypropylene, is used which is leakproof and impermeable to a viscous liquid.

20. Method according to claim **18**, wherein said movable disc is a disc/plug of an inelastic material of metal, ceramic materials, stiffer plastic materials and glass are used, and the disc is prefabricated and adjusted to be placed on top of the viscous liquid layer by a movement in the axial direction of the pipe.

21. Method according to one of the claim **15**, wherein the uppermost protective layer that is exposed to the well fluids is leakproof and impermeable to well fluids and the viscous liquid layer used.

22. Method according to claim **15**, wherein the crushable plug and the one or more of the layers of viscous liquid and the in-between lying protective layer are fitted in advance in a separate pipe section which is then inserted in the production pipe in a suitable location with respect to its actual position in the well.

23. Crushable plug unit for testing of a pipe section for oil and/or gas production, wherein the topside of the crushable plug unit comprises one or more layers of a thick (dilatant) viscous liquid and the topside of the viscous liquid layer comprises a completely covering protective layer to cover and seal the thick, viscous liquid layer on top of the plug, where said protective layer is movable in the axial direction of the pipe in response to blows from falling objects in the pipe.

24. Crushable plug unit according to claim **23**, wherein several layers of viscous liquid are placed on the topside of the plug and a completely covering protective layer is placed between each layer of viscous liquid.

25. Crushable plug unit according to claim **23**, wherein the thick, viscous liquid is based on clay, different forms of gels with a paste-form are used, such as polymer-based gels, gel-formed lubricating means such as silicone lubricating means, glycerol, different forms of oil such as Castor oil, a thick oil corresponding to gear oil with the designation W90, as the layer has a higher viscosity than common well fluids so that the layer, when completely fitted, remains lying on top of the crushable plug as a protecting layer.

26. Crushable plug unit according to one of the claim **23**, wherein

the protecting layer is an elastic membrane of rubber or synthetic plastic materials such as polymers, such as polyethylene or polypropylene, and which is leakproof and impermeable to a viscous liquid, or

the protecting layer is a disc/plug of an inelastic material of metal, ceramic materials, stiffer plastic materials and glass, and the disc is prefabricated and can be placed on top of the viscous protective layer by a movement in the axial direction of the pipe.

27. Crushable plug unit according to claim **23**, wherein the top protecting layer that is exposed to the well fluids is leakproof and impermeable to well fluids and the applied viscous liquid layer.

28. Crushable plug unit according to claim **23**, wherein the crushable plug and the one or more layers of viscous liquid and the in-between lying protecting layer are fitted in advance in a separate pipe section for insertion in a production pipe at a suitable location with respect to the actual position down in the well.

29. A method of protecting a test plug unit fitted in a section of casing tubes to carry out pressure testing comprising the steps:

fitting a glass plug set into a casing tubing section;

arranging at least one layer of a thick, viscous liquid on the topside of the plug set in the section;

arranging a completely covering protective layer over the liquid layer on the topside to create a test plug unit; and

inserting the test plug unit into a separate section of casing tubing section to carry out pressure testing.

* * * * *