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(54) Title: NON-INTRUSIVE FLOW INDICATOR

(57) Abstract: Perforating devices, temporary dissolvable plugs, and dissolvable indicator devices for downhole tools all having at least one tracer are disclosed. Upon detonation of the perforating charge, dissolution of the temporary plug, or actuation of a downhole tool, the tracer is released and carried to the surface as an indicator to the operators of the well that the perforating charge detonated, the temporary plug dissolved, or the downhole tool actuated.
TITLE: NON-INTRUSIVE FLOW INDICATOR

RELATED APPLICATION

This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/839,880, filed August 24, 2006.

BACKGROUND

1. Field of Invention

The invention is directed to downhole devices having tracers for monitoring and detecting flow contribution in oil and gas wells and for indicating that such devices have been activated or actuated and, in particular, to perforating charges and dissolvable plugs containing tracers for monitoring and detecting flow contribution.

2. Description of Art

Perforating a well involves a special gun that shoots several relatively small holes in the casing. The holes are formed in the side of the casing opposite the producing zone. These communication tunnels or perforations pierce the casing or liner and the cement around the casing or liner. The perforations go through the casing and the cement and a short distance into the producing well formation. Well formations fluids, which include oil, water, and gas, flow through these perforations and into the well.
The most common perforating gun uses shaped charges, similar to those used in armor-piercing shells. A high-speed, high-pressure jet penetrates the steel casing, the cement and the formation next to the cement. Other perforating methods include bullet perforating, abrasive jetting or high-pressure fluid jetting.

The characteristics and placement of the communication paths (perforations) can have significant influence on the productivity of the well. Therefore, a robust design and execution process should be followed to ensure efficient creation of the appropriate number, size and orientation of perforations. A perforating gun assembly with the appropriate configuration of shaped explosive charges and the means to verify or correlate the correct perforating depth can be deployed on wireline, tubing or coiled tubing.

Despite advances in perforation methods and devices, currently running a second tool string to log the well is how operators of a well determine whether new hydrocarbons, e.g., oil and gas, are entering the wellbore through the perforations. Running a logging string after the perforating string increases the costs, and time, associated with recovery of hydrocarbons. Therefore, it is desirable to have releasable indicator material as part of the perforating apparatus that can indicate to operators at the surface of the well that new hydrocarbons are being recovered from the formation.

Additionally, there are a number of procedures and applications that involve the formation of a temporary seal or plug devices within the wellbore for other steps or processes to be performed, where the seal or plug devices must be later removed. Often such seal or plug devices are provided to temporarily inhibit or block a flow pathway or the movement of fluids or other materials, such as flowable particulates, in a particular direction for a short period of time, when later movement or flow is desirable.
A variety of applications and procedures where temporary coatings or plug devices are employed are involved in the recovery of hydrocarbons from subterranean well formations where operations must be conducted at remote locations, namely deep within the earth, where equipment and materials can only be manipulated at a distance. One particular such operation concerns perforating and/or well completion operations incorporating filter cakes and the like as temporary coatings.

In the perforating context, the communication paths of the perforations can be temporarily blocked, filled or plugged while other operations are conducted that would cause problems if the perforations were left open. Such problems include, but are not necessarily limited to, undesirable leak-off of the working fluid into the well formation, and possible damage to the well formation. Upon completion of the other operations, the temporary plug, filter cake, and coating devices, dissolve, or degrade or disintegrate, so that hydrocarbon flow from the formation can resume. As with the perforating apparatus, it is desirable to have releasable indicator materials as part of the temporary plugs, filter cakes, and coatings that can indicate to operators at the surface of the well that hydrocarbon flow from the formation through the previously plugged perforations has resumed.

Accordingly, prior to the development of the present invention, there has been no perforating devices, temporary plugs, or methods for indicating hydrocarbon flow that: provide an indication to operators at the surface of a well that specific perforating charges have detonated; provide an indication to operators at the surface of the well as to which perforations are contributing to flow; provide an indication to operators at the surface of a well that a temporary plug has been removed; provide an indication to operators at the surface of the well that new hydrocarbons are being recovered from the formation; and/or provide an indication to
operators at the surface of the well that hydrocarbon flow from the formation through the previously plugged perforations has resumed.

SUMMARY OF INVENTION

Broadly, the invention is directed to downhole devices, having at least releasable indicator material, such as a tracer, to indicate that a fluid flow path has been formed in a wall of a wellbore. In one particular embodiment, the downhole devices are perforating charges having at least one tracer that is placed in contact with the perforation formed by, or that is otherwise released by, the detonation of the perforating charge. In the event that the perforation is formed in a hydrocarbon production zone, the hydrocarbon flowing from the perforation carries the tracer to the surface of the well where it is detected. Detection of such tracers by an operator at the surface of the well indicates to the operator that the perforation formed by the perforating device successfully provided hydrocarbon flow from the hydrocarbon reservoir, or formation surrounding the well. Alternatively, the tracers could be carried to the surface by some other fluid, e.g., drilling fluid, to indicate that the perforating charge properly detonated, regardless of whether hydrocarbon flows from the formation through the perforation formed by the perforating charge.

In another aspect, the downhole device is directed to temporary plugs that are disposed in the casing of oil and gas wells. These plugs include a tracer that, when released indicates that the casing is no longer plugged. Preferably, the temporary plugs are formed from a dissolvable material. As with the perforating charge, the tracer could be carried to the surface by hydrocarbon flowing from the well formation or by drilling fluid.
In still another aspect, the invention is directed to the use of tracers in downhole tools to indicate that the downhole tool has actuated, e.g., set. Like the temporary plugs, a dissolvable material can comprise the releasable indicator material, e.g., tracers. Upon dissolution, for example, due to the tool actuating and drilling fluid coming into contact with the dissolvable material, the tracer is released and carried to the surface of the well for detection by the operator.

In one embodiment, a device for forming a fluid flow path in a wall of a wellbore is disclosed. The device comprises a releasable indicator material, the releasable fluid flow path indicator material being releasable from the device to indicate formation of a fluid flow path in a wall of a wellbore.

A further feature of the device is that the device may be a perforating charge having an explosive material and the releasable fluid flow path indicator material is disposed within the explosive material. Another feature of the device is that the device may be a perforating charge having an explosive material and a protective layer disposed over the explosive material, and protective layer comprising the releasable fluid flow path indicator material. An additional feature of the device is that the device may be a temporary plug disposed within an opening in the wall of the wellbore, the temporary plug comprising the releasable fluid flow path indicator material. Still another feature of the device is that the temporary plug may comprise a dissolvable material, wherein the dissolution of the dissolvable material releases the releasable fluid flow path indicator material.

In another embodiment, a downhole tool for forming an opening in a wall of a wellbore is disclosed. The downhole tool comprises a tracer operatively associated with a tracer release actuator, the tracer release actuator releasing the tracer from the downhole tool to indicate formation of an opening in a wall of a wellbore.
A further feature of the downhole tool is that the downhole tool may be a perforating charge comprising an explosive material, the tracer release actuator is the explosive material, and the tracer release actuator is actuated by ignition of the explosive material so that the tracer is released from the perforating charge to indicate formation of the opening in the wall of the wellbore. Another feature of the downhole tool is that the tracer may be disposed within the explosive of the perforating charge. An additional feature of the downhole tool is that the tracer may be disposed as part of a layer disposed over the explosive material of the perforating charge. Still another feature of the downhole tool is that the downhole tool may be a temporary plug disposed in the opening in the wall of the wellbore, the temporary plug comprising the tracer, and wherein the tracer release actuator is the temporary plug and the tracer release actuator is actuated by removing the temporary plug from the opening in the wall of the wellbore. A further feature of the downhole tool is that the tracer may be disposed within a dissolvable material of the temporary plug.

In an additional embodiment, an improved perforating device having a case and an explosive material disposed therein is disclosed. The improvement comprises at least one releasable indicator material for indicating activation of the perforating device. A further feature of the improved perforating device is that the releasable indicator material may be disposed within the explosive material of the perforating device. Another feature of the improved perforating device is that the releasable indicator material may be disposed as part of a layer disposed over the explosive material of the perforating device.

In still another embodiment, an improved temporary plug for insertion in an opening in a wall of a wellbore is disclosed. The improvement comprises a releasable indicator material for indicating removal of at least a portion of the temporary plug. A further feature of the improved
temporary plug is that the temporary plug may comprise a dissolvable material having the releasable indicator material disposed therein so that dissolution of the dissolvable material releases the releasable indicator material thereby indicating the removal of at least a portion of the temporary plug.

In a further embodiment, a method of indicating formation of a fluid flow path in a wall of a wellbore is disclosed. The method comprises the steps of: (a) disposing a device comprising a releasable indicator material in a wellbore; (b) activating the device causing formation of a fluid flow path in a wall of the wellbore and releasing the releasable indicator material from the device; (c) transporting the releasable indicator material toward a surface location of the wellbore; and (d) detecting the releasable indicator material thereby indicating to an operator at the surface location of the wellbore that the device was activated and a fluid flow path was formed in the wall of the wellbore.

A further feature of the method is that the device may be activated by ignition of a perforating device having an explosive material, the ignition of the perforating charge causing formation of the fluid flow path in the wall of the wellbore and releasing the releasable indicator material from the device. Another feature of the method is that the device may be a temporary plug, the temporary plug being disposed within an opening in the wall of the wellbore thereby restricting fluid flow through the opening, and wherein the temporary plug is activated by dissolving the temporary plug, the dissolution of the temporary plug causing formation of the fluid flow path in the wall of the wellbore and releasing the releasable indicator material from the device. An additional feature of the method is that the releasable indicator material may be transported toward the surface location of the wellbore by fluid being circulated through the wellbore. Still another feature of the method is that the releasable indicator material may be
transported toward the surface location of the wellbore by a fluid entering the wellbore through the fluid flow path.

The perforating devices, plugs, and methods for indicating hydrocarbon flow have the advantages of: providing an indication to operators at the surface of a well that specific perforating charges have detonated; providing an indication to operators at the surface of the well as to which perforations are contributing to flow; providing an indication to operators at the surface of a well that a perforating charge has detonated; providing an indication to operators at the surface of a well that a temporary plug has been removed; providing an indication to operators at the surface of the well that new hydrocarbons are being recovered from the formation; and/or providing an indication to operators at the surface of the well that hydrocarbon flow from the formation through the previously plugged perforations has occurred.

**BRIEF DESCRIPTION OF DRAWINGS**

FIG. 1 is a cross-sectional view of one specific embodiment of a perforating charge having tracers.

FIG. 2 is a cross-sectional schematic view of an oil well casing or conduit in a borehole having four temporary plugs, two on either side of the casing.

FIG. 3 is a cross-sectional schematic view of an oil well casing or conduit in a borehole having two flow paths, one on either side of the casing, where the temporary plugs have been dissolved, disintegrated, or degraded.

While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the
contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be
included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

Referring now to FIG. 1, downhole device 20 is perforating charge 21. Perforating
charge 21 has a shaped case or outer shell 22 with opening 24 at a discharge end and attachment
member 26 at an initiation end. Attachment member 26 facilitates placement of perforating
charge 21 within a perforating gun (not shown). Attachment member 26 also facilitates
connection of perforating charge 21 to detonator cord 27, such as primer cord or other
detonating cord or device known in the art to facilitate detonation of perforating charge 21.

Primer 30 is adjacent to or in communication with detonating cord 27 and with explosive
material 32. Explosive materials 32 are known to persons of ordinary skill in the art and include
RDX, HMX, PYX, and HNS. Liner 34 is disposed over explosive material 32 to protect
explosive material 32 from the environment. Due to primer 30 being in communication with
detonating cord 27 and explosive material 32, when primer 30 is detonated by detonating cord
27, explosive material 32 is also detonated and the explosive force is directed out of opening 24.

It is to be understood that downhole device 20 is not limited to the structure discussed
above. To the contrary, downhole device 20 may be any perforating device known to persons of
ordinary skill in the art. For example, downhole device 20 may be any other type of case gun
charge, shaped charge, or encapsulated charge.

As illustrated in FIG. 1, tracers 36 are disposed within explosive material 32. Alternatively,
or in addition to, tracers 36 may be included within or on the surface of liner 34 or within a chamber, cavity, or other compartment or carrier that releases tracers 36 upon
detonation of perforating charge 21. Each tracer 36 may be, for example, a microscopic encoded tag such as those available from MicroTrace located at 3100 84th Lane NE, Suite A, Minneapolis, Minnesota 55449-7264, a colored dye, a radio-frequency tag, a radioactive material, a florescent material, or any other tracer element or device known to persons of ordinary skill in the art that can be detected in drilling fluid.

In one specific embodiment, different tracers 36 are disposed in different perforating charge 21 comprising a string of perforating charges 21, thereby providing different indications as to which perforating charge 21 exploded and/or which perforation is the source of the hydrocarbon flow. For example, one perforating charge 21 may have tracer 36 that is a microscopic tag that is different from the microscopic tag of tracer 36 disposed in a second perforating charge 21. If the operator detects only one of tracer 36, the operator can determine, based upon his knowledge of the location of each perforating charge 21 and the microscopic tag tracer 36 associated with each perforating device, which perforating charge 21 detonated and/or which perforating charge 21 created the perforation for the flow of hydrocarbon. Alternatively, the different tracers 36 for each perforating charge 21 may be different from the others, i.e., one perforating charge 21 has tracer 36 that is a colored dye, one perforating charge 21 has tracer 36 that is a radio-frequency tag, and one perforating charge 21 has a tracer 36 that is a microscopic encoded tag.

Therefore, various combinations of the different types of tracers 36 can be used to better educate the operator as to the location of the perforation as well as the source of the hydrocarbon flowing through the perforation. As a result, the amount or type of information imparted to the operator by each tracer 36 can be modified as desired by the operator.
In operation, perforating charge 21 is placed within a perforating gun and the perforating gun is included as part of a perforating string (not shown). The perforating string is lowered into the wellbore to the desired depth and orientation. Perforating charge 21 is then detonated to form a perforation (not shown) in the side of the wellbore and into the well formation, generally, through the casing. Upon detonation, one or more tracers 36 are forced out of perforating charge 21 and into the perforation and area around the perforation.

Therefore, presuming that a fluid such as oil, water, gas, or other hydrocarbon fluid is released from the well formation tracers 36 are picked up by the flowing fluid and carried to the surface of the well. Upon reaching the surface of the well, tracers 36 are detected by an operator of the well, such as the operator of the perforating string, or other downhole tool string, either visually or using equipment designed specifically for the detection of tracer 36. Identification of tracers 36 by the operator provides an indication that fluid is flowing through perforations.

Alternatively, drilling fluid or some other type of fluid may also be present in the wellbore, such as by circulating the fluid through the wellbore from a surface location of the wellbore, so that if fluid such as hydrocarbon fluid or water is not released from the well formation, tracer 36 will be carried to the surface of the well to indicate that perforating device 20 detonated.

In one specific embodiment, tracers 36 may be formed integral with the explosive material 32 or liner 34 that forms perforating charge 21. In other words, in these embodiments, one or more tracers 36 is embedded or disposed within explosive material 32 or liner 34 during the formation of explosive material 32 or liner 34.
As illustrated in FIGS. 2-3, in another embodiment the downhole device is temporary plug 40 comprising tracers 36. As shown in FIG. 2, in this particular embodiment, tracers 36 are disposed within temporary plug 40. Temporary plug 40 is formed from a dissolvable material. "Dissolvable" means that the material is capable of dissolution in a fluid disposed within the well such as oil, gas, or drilling fluids and muds. The term "dissolvable" is understood to encompass the terms degradable and disintegrable. Likewise, the terms "dissolved" and "dissolution" also are interpreted to include "degraded" and "disintegrated," and "degradation" and "disintegration," respectively.

The dissolvable material may be any material known to persons of ordinary skill in the art that can be dissolved, degraded, or disintegrated over an amount of time by a temperature or fluid such as water-based drilling fluids, hydrocarbon-based drilling fluids, or natural gas, and that can be calibrated such that the amount of time necessary for the dissolvable material to dissolve is known. Suitable dissolvable materials include polymers and biodegradable polymers, for example, polylactide ("PLA") polymer 4060D from Nature-Works™, a division of Cargill Dow LLC; TLF-6267 polyglycolic acid ("PGA") from DuPont Specialty Chemicals; polycaprolactams and mixtures of PLA and PGA; solid acids, such as sulfamic acid, trichloroacetic acid, and citric acid, held together with a wax or other suitable binder material; polyethylene homopolymers and paraffin waxes; polyalkylene oxides, such as polyethylene oxides, and polyalkylene glycols, such as polyethylene glycols. These polymers may be preferred in water-based drilling fluids because they are slowly soluble in water.

In calibrating the rate of dissolution of the dissolvable material, generally the rate is dependent on the molecular weight of the polymers. Acceptable dissolution rates can be achieved with a molecular weight range of 100,000 to 7,0000,000. Thus, dissolution rates for a
temperature range of 50°C to 250°C can be designed with the appropriate molecular weight or mixture of molecular weights.

In one embodiment, the dissolvable material dissolves, degrades, or disintegrates over a period of time ranging from 1 hour to 240 hours and over a temperature range from about 50°C to 250°C. It is to be understood that both time and temperature can act together to dissolve the dissolvable material. Additionally, water or some other chemical could be used alone or in combination with time and/or temperature to dissolve the dissolvable material. Other fluids that may be used to dissolve the dissolvable material include alcohols, mutual solvents, and fuel oils such as diesel.

It is to be understood that the dissolvable materials are considered successful if the dissolvable material disintegrates or degrades sufficiently to remove a sufficient amount of temporary plug 40 to release the tracer and permit flow through the pathway or opening within the wall of the wellbore. In other words, the dissolvable materials are considered effective even if not all of the dissolvable material disintegrates, degrades, dissolves or is displaced and/or not all of temporary plug 40 across the flow pathway is removed.

In an alternative embodiment, the dissolvable material is considered successful if at least 50% of the dissolvable material disintegrates, degrades, dissolves or is displaced, and/or at least 50% of the dissolvable material across or within the flow pathway is removed. In another embodiment, at least 90% of the dissolvable material in the flow pathway is disintegrated, removed or otherwise displaced. Either of these rates of removal may be considered "substantial removal" as that term is used herein.

As illustrated in FIGS. 2-3, vertically oriented, cylindrical casing or well liner 50 has opening or orifice 52 on either side thereof. Orifice 52 may be created by a perforating gun, by
machining prior to run-in of the casing to the well, or other suitable technique. Casing 50 is placed in wellbore or borehole 56 having walls 58 through a subterranean reservoir or well formation 60. Borehole wall 58 may have filter cake 62 thereon as may be deposited by a drilling fluid or, more commonly, a drill-in fluid. Filter cake deposition is a well known phenomenon in the art. If present, filter cake 62 prevents the flow of liquids and must be removed prior to the flow of hydrocarbons from well formation 60, or the injection of water into well formation 60. Therefore, as discussed in greater detail below, in circumstances in which filter cake is present, temporary plug 40 and filter cake 62 must both be removed before hydrocarbon flow can occur.

In one specific embodiment, two temporary plugs 40 define a cavity 42 into which a specially sized gravel pack material 42 is disposed. In this embodiment, the specially sized gravel pack material 42 may also include one or more tracers 36.

Although it is expected that temporary plugs 40 are generally cylindrical in shape and have a circular cross-section, due to ease of manufacture, this is not a requirement of, nor critical to, temporary plugs 40. Temporary plugs 40 are surrounded and fixed in place (but not made permanent) by cement 70 introduced into annulus 72 of the well. It is to be understood that cement 70 (or other suitable rigid material, e.g. a non-biodegradable polymer different from temporary plug 40) forms a pathway around each temporary plug 40 that is more evident once temporary plug is removed (FIG. 3, discussed in greater detail below).

Alternatively, collars, sleeves, barriers, or tubes (not shown) may encompass temporary plugs 40 to provide additional support.
Between the states of the wells shown in FIGS. 2 and 3, temporary plugs 40 are dissolved, degraded or disintegrated through a mechanism such as heat, fluid flow, the passage of a sufficient amount of time, e.g. a few hours, or a combination thereof.

In embodiments in which a filter cake 62 is present, temporary plug 40 is preferably formed out of a dissolvable material that, upon dissolution, disintegration, or degradation, a product is formed, such as an acid or other agent, that in turn removes filter cake 62 from adjacent the former location of temporary plug 40. The resulting structure would appear schematically similarly to FIG. 3 where flow pathways 74 are left through cement 70 between orifices 52 and well formation 60. After this point, the well would be ready to be produced (hydrocarbons flowing through flow pathways 74 from well formation 60 into casing 50), or the well would be ready to have water injected in the direction from casing 50 through flow pathways 74 into well formation 60.

While temporary plug 40 could be degraded by the application of a liquid, such as an acid or other chemical, it should be understood that one difficulty with doing so is getting the liquid to distribute effectively through the entire length of casing 50. As noted above, one aspect of the removing temporary plug 40 and resuming hydrocarbon flow is that when temporary plugs 40 dissolve or degrade, the product is locally formed and directly delivered at many sites along the length of borehole 56. If a liquid such as an acid or other agent is delivered downhole to dissolve or degrade temporary plugs 40, filter cake 62 next to temporary plugs 40 would likely also be removed and the liquid would be free to leak off into well formation 60, instead of continuing down casing 50 to subsequent temporary plugs 40.

In operation, drilling fluid or other fluid may not be present in the wellbore that could carry tracers 36 from temporary plug 40 to the surface of the well. Presuming that oil, gas, or
other hydrocarbon fluid is released from the well formation 60 through flow pathways 74, tracers 36 are picked up by the flowing hydrocarbon fluid and carried to the surface of the well. Upon reaching the surface of the well, tracers 36 are detected by an operator of the well either visually or using equipment designed specifically for the detection of tracer 36. Identification of tracers 36 by the operator provides an indication that flow has resumed through previously plugged perforations in the well.

Alternatively, drilling fluid or some other type of fluid may also be present in the wellbore that, if hydrocarbon fluid or water is not released from the well formation, tracer 36 will be carried to the surface of the well to indicate that temporary plug 40 dissolved and flow pathway 74 was formed; however, no fluid flowed from formation 60 through flow pathway 74 and into the wellbore.

The concept of inclusion of tracers 36 in temporary plugs 40 could be advantageously used in other applications besides the completions embodiment discussed herein. For instance, temporary plugs having tracers 36 may be included in downhole tools to provide an indication to the operator that the downhole tool as actuated. For example, in downhole tools such as setting tools that use drilling fluid pressure to set the tool, upon setting the tool, temporary plug 40 may be placed in contact with the drilling fluid, thereby causing temporary plug 40 to dissolve or disintegrate, thereby releasing tracers 36 into the drilling fluid. The drilling fluid then carries tracers 36 to the surface of the well for detection in the same manner as discussed above.

It is to be understood that the invention is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. For example, the tracers may be included
in any perforating device, such as bullet perforating charges, abrasive jetting perforating
devices, or as part of high pressure fluid jetting devices, in addition to the shaped charged discussed herein. Additionally, as discussed above, the mechanism for dissolving dissolvable material could include, but is not necessarily limited to, heat, time, contacting with drilling fluid, contacting with water or some other chemical agent. Moreover, the dissolvable materials with tracers could be used to control the release of chemicals or activate a downhole switch such as upon the influx of water into the production stream and to indicate that such downhole switch has been activated. The dissolvable materials with tracers also could be used to place temporary plugs into orifices that stay closed until water (or other agent) dissolves or degrades them and the tracers are released to indicate that the orifices are opened. An example might be a tool wear indicator where the dissolvable material and tracer are located within a closed orifice. Once worn through, the wellbore fluids dissolve the material and release the tracer for detection at the surface. Further, downhole hydraulic circuits could also be constructed for "intelligent" well completion purposes. In general, the dissolvable materials with tracers could be applied to any situation where isolation from well fluids is desired until a known or predetermined event occurs to remove them and in which confirmation of the removal of the dissolvable material is desired. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.
CLAIMS

WHAT IS CLAIMED IS:

1. A device for forming a fluid flow path in a wall of a wellbore, the device comprising:
   a releasable indicator material, the releasable fluid flow path indicator material being releasable from the device to indicate formation of a fluid flow path in a wall of a wellbore.

2. The device of claim 1, wherein the device is a perforating charge having an explosive material and the releasable fluid flow path indicator material is disposed within the explosive material.

3. The device of claim 1, wherein the device is a perforating charge having an explosive material and a protective layer disposed over the explosive material, and protective layer comprising the releasable fluid flow path indicator material.

4. The device of claim 1, wherein is the device is a temporary plug disposed within an opening in the wall of the wellbore, the temporary plug comprising the releasable fluid flow path indicator material.

5. The device of claim 4, wherein the temporary plug comprises a dissolvable material, wherein the dissolution of the dissolvable material releases the releasable fluid flow path indicator material.
6. A downhole tool for forming an opening in a wall of a wellbore, the downhole tool comprising:
   a tracer operatively associated with a tracer release actuator, the tracer release actuator releasing the tracer from the downhole tool to indicate formation of an opening in a wall of a wellbore.

7. The downhole tool of claim 6, wherein the downhole tool is a perforating charge comprising an explosive material, the tracer release actuator is the explosive material, and the tracer release actuator is actuated by ignition of the explosive material so that the tracer is released from the perforating charge to indicate formation of the opening in the wall of the wellbore.

8. The downhole tool of claim 7, wherein the tracer is disposed within the explosive of the perforating charge.

9. The downhole tool of claim 7, wherein the tracer is disposed as part of a layer disposed over the explosive material of the perforating charge.

10. The downhole tool of claim 6, wherein the downhole tool is a temporary plug disposed in the opening in the wall of the wellbore, the temporary plug comprising the tracer, and wherein the tracer release actuator is the temporary plug and the tracer release actuator is actuated by removing the temporary plug from the opening in the wall of the wellbore.
11. The tool actuating indicator of claim 10, wherein the tracer is disposed within a dissolvable material of the temporary plug.

12. An improved perforating device having a case and an explosive material disposed therein, the improvement comprising at least one releasable indicator material for indicating activation of the perforating device.

13. The improved perforating device of claim 12, wherein the releasable indicator material is disposed within the explosive material of the perforating device.

14. The improved perforating device of claim 12, wherein the releasable indicator material is disposed as part of a layer disposed over the explosive material of the perforating device.

15. An improved temporary plug for insertion in an opening in a wall of a wellbore, the improvement comprising a releasable indicator material for indicating removal of at least a portion of the temporary plug.

16. The improved temporary plug of claim 15, wherein the temporary plug comprises a dissolvable material having the releasable indicator material disposed therein so that dissolution of the dissolvable material releases the releasable indicator material thereby indicating the removal of at least a portion of the temporary plug.
17. A method of indicating formation of a fluid flow path in a wall of a wellbore, the method
comprising the steps of:

(a) disposing a device comprising a releasable indicator material in a wellbore;
(b) activating the device causing formation of a fluid flow path in a wall of the
wellbore and releasing the releasable indicator material from the device; and
(c) transporting the releasable indicator material toward a surface location of the
wellbore;
(d) detecting the releasable indicator material thereby indicating to an operator at the
surface location of the wellbore that the device was activated and a fluid flow path was formed in
the wall of the wellbore.

18. The method of claim 17, wherein the device is activated by ignition of a perforating
device having an explosive material, the ignition of the perforating charge causing formation of
the fluid flow path in the wall of the wellbore and releasing the releasable indicator material from
the device.

19. The method of claim 17, wherein the device is a temporary plug, the temporary plug
being disposed within an opening in the wall of the wellbore thereby restricting fluid flow
through the opening, and
wherein the temporary plug is activated by dissolving the temporary plug, the dissolution
of the temporary plug causing formation of the fluid flow path in the wall of the wellbore and
releasing the releasable indicator material from the device.
20. The method of claim 17, wherein the releasable indicator material is transported toward the surface location of the wellbore by fluid being circulated through the wellbore.

21. The method of claim 17, wherein the releasable indicator material is transported toward the surface location of the wellbore by a fluid entering the wellbore through the fluid flow path.
INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/018671

A. CLASSIFICATION OF SUBJECT MATTER

INV. E21B43/11 E21B47/10 E21B43/1185

According to International Patent Classification (IPC) and both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B

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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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate of the relevant passages</th>
<th>Relevant to claim No</th>
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[ ] Further documents are listed in the continuation of Box C
[ ] See patent family annex

* Special categories of cited documents
  *A* document defining the general state of the art which is not considered to be of particular relevance
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  *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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Date of the actual completion of the international search

13 December 2007

Date of mailing of the international search report

27/12/2007

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