Herein disclosed is a downhole tool comprising a dissolvable part, wherein the part is dissolved in the presence of moisture or water, at a temperature in the range of 150°F to 400°F and at a pressure in the range of 2 ksi to 12 ksi. In some embodiments, no solvent other than water is needed for the dissolvable part to dissolve. The dissolvable part is made from a material comprising resin or fiber or both. In some embodiments, at least 20% of the dissolvable part is dissolved. Also disclosed herein is a method for performing a downhole operation comprising: placing a downhole tool within a well bore, wherein the downhole tool comprises a dissolvable part, wherein the part is dissolved in the presence of moisture or water, at a temperature in the range of 150°F to 400°F and at a pressure in the range of 2 ksi to 12 ksi.
DISSOLVABLE DOWNHOLE PLUG
CROSS-REFERENCE TO RELATED APPLICATIONS

0001 This application claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 62/008, 020, filed Jun. 5, 2014, the disclosure of which is hereby incorporated herein by reference in its entirety for all purposes.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

0002 Not Applicable.

BACKGROUND

0003 1. Field of the Invention
0004 The present invention generally relates to a downhole tool, particularly relates to a downhole tool comprising a member made in dissolvable material under a combination of conditions.
0005 2. Background of the Invention
0006 A wide variety of downhole tools may be used within a wellbore in connection with producing hydrocarbons or reworking a well that extends into a hydrocarbon formation. Downhole tools such as frac plugs, bridge plugs, and packers, for example, may be used to seal a component against casing along the wellbore wall or to isolate one pressure zone of the formation from another. Such downhole tools are well known in the art.
0007 Conventionally, after the production or reworking operation is complete, these downhole tools must be removed from the wellbore. Tool removal has been accomplished by complex retrieval operations, or by milling or drilling the tool out of the wellbore mechanically. Thus, downhole tools are either retrievable or disposable. Disposable downhole tools have traditionally been formed of drillable metal materials such as cast iron, brass, and aluminum. To reduce the milling or drilling time, the next generation of downhole tools comprises composites and other non-metallic materials, such as engineering grade plastics. Nevertheless, milling and drilling continue to be a time consuming and expensive operation.

0008 Accordingly, there is continuing need and interest to develop disposable downhole tools that do not interfere with well production and reduce or eliminate the tool retrieval procedure.

SUMMARY

0009 Herein disclosed is a downhole tool comprising a dissolvable part, wherein the part is dissolved in the presence of moisture or water, at a temperature in the range of 150°F to 400°F, and at a pressure in the range of 2 ksi to 12 ksi. In some embodiments, no solvent other than water is needed for the dissolvable part to dissolve. In some embodiments, the dissolvable part is made from a material comprising resin or fiber or both. In some embodiments, the resin or fiber or both are dissolvable. In some embodiments, least 20% of the dissolvable part is dissolved.

0010 In some embodiments, the downhole tool comprises a frac plug, a bridge plug, or a packer. In some embodiments, the dissolvable part of the plug or packer is a wedge or cone. In some embodiments, the plug or packer falls to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time. In some embodiments, the plug or packer is pushed to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time.

0011 Also disclosed herein is a method for performing a downhole operation comprising: placing a downhole tool within a wellbore, wherein the downhole tool comprises a dissolvable part, wherein the part is dissolved in the presence of moisture or water, at a temperature in the range of 150°F to 400°F, and at a pressure in the range of 2 ksi to 12 ksi. In some embodiments, the method comprises dissolving the tool for a period of time. In some embodiments, dissolving the tool for a period of time takes place before performing the downhole operation or during performing the downhole operation or after performing the downhole operation.

0012 In some embodiments, at least 20% of the dissolvable part is dissolved. In some embodiments, no solvent other than water is needed for the dissolvable part to dissolve. In some embodiments, the dissolvable part is made from a material comprising resin or fiber or both. In some embodiments, the resin or fiber or both are dissolvable.

0013 In some embodiments, the downhole tool comprises a frac plug, a bridge plug, or a packer. In some embodiments, the dissolvable part of the plug or packer is a wedge or cone. In some embodiments, the plug or packer falls to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time. In some embodiments, the method comprises pushing the plug or packer to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time.

0014 The present invention comprises a combination of features and advantages which enable it to overcome various problems of prior devices. The various characteristics described above, as well as other features, will be readily apparent to those skilled in the art upon reading the following detailed description of the preferred embodiments of the invention, and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

0015 For a more detailed description of the preferred embodiment of the present invention, reference will now be made to the accompanying drawings, wherein:

0016 FIG. 1 is a schematic, cross-sectional view of an operating environment depicting a dissolvable downhole tool being lowered into a wellbore extending into a subterranean hydrocarbon formation;

DETAILED DESCRIPTION

0017 Overview. Herein described is a dissolvable downhole tool (e.g., a plug) comprising a member made of dissolvable material, which dissolves in the presence of moisture, at a temperature in the range of 150°F to 400°F, and at a pressure in the range of 2 ksi to 12 ksi. In this disclosure, the presence of moisture is equivalent to the presence of water. In some cases, no solvent other than water is needed.

0018 Such dissolvable downhole tools will simplify the production process and reduce or eliminate the tool retrieval procedure. For example, a dissolvable tool is a plug and the wedge or cone of the plug is the dissolvable member. When this part of the plug dissolves, then the slips will no longer be held in place and therefore release the energy stored in the rubber element package. The remnants of the plug will then fall (or be pushed) to the bottom of the well without interfering with the production of the well. In other cases, other parts...
of the tool are made from dissolvable material as well. Any part of the tool may be made of such dissolvable material, depending on the strength requirement and the strength provided the dissolvable material. The dissolvable material comprises, in some embodiments, resin and fiber. In some cases, the resin is dissolvable under the combination of conditions disclosed herein. In some other cases, the fiber is dissolvable under the combination of conditions disclosed herein.

The term “dissolvable” is understood to encompass the terms degradable and disintegrable. Likewise, the terms “dissolved” and “dissolution” also are interpreted to include a “degarded” and “disintegrated,” and “degradation” and “disintegration,” respectively.

It is to be understood that the assemblies/apparatuses and methods disclosed herein are considered successful if the dissolvable material dissolves sufficiently to perform the intended function. In other words, the apparatuses and methods are effective even if all of the dissolvable material does not dissolve. In some cases, at least 20% of the dissolvable material dissolves. In some cases, at least 30% of the dissolvable material dissolves. In some cases, at least 40% of the dissolvable material dissolves. In some cases, at least 50% of the dissolvable material dissolves. In some cases, at least 60% of the dissolvable material dissolves. In some cases, at least 70% of the dissolvable material dissolves. In some cases, at least 80% of the dissolvable material dissolves. In some cases, at least 90% of the dissolvable material dissolves.

Referring to FIG. 1, a dissolvable downhole tool 100 is lowered into a wellbore. As depicted, a drilling rig 110 is positioned on the earth’s surface 105 and extends over and around a wellbore 120 that penetrates a subterranean formation 150 for the purpose of recovering hydrocarbons. At least the upper portion of the wellbore 120 may be lined with casing 125 that is cemented 127 into position against the formation 150 in a conventional manner. The drilling rig 110 includes a derrick 112 with a rig floor 114 through which a cable 118, such as a wireline, jointed pipe, or coiled tubing, for example, extends downwardly from the drilling rig 110 into the wellbore 120. The cable 118 suspends an exemplary dissolvable downhole tool 100, which may comprise a frac plug, a bridge plug, a packer, or another type of wellbore zonal isolation device, for example, as it is being lowered to a predetermined depth within the wellbore 120 to perform a specific operation. The drilling rig 110 therefore includes a motor driven winch and other associated equipment for extending the cable 118 into the wellbore 120 to position the tool 100 at the desired depth. The stationary drilling rig 110 for lowering and setting the dissolvable downhole tool 100 may be replaced with mobile workover rigs, well servicing units, and other assemblies as known to one skilled in the art to lower the tool 100 into the wellbore 120.

In an embodiment, the tool 100 comprises a plug that is used in a well stimulation/fracturing operation, commonly known as a “frac plug.” In other cases, the tool comprises a packer or bridge plug. In this disclosure, the parts/tools are not differentiated by names but only by function. Other tools that perform the same functions as frac plug, packer, bridge plug are also within the scope of this disclosure.

At least one part of the tool 100 is made from materials that dissolve when exposed to moisture/water and a temperature in the range of 150°F to 400°F and a pressure in the range of 2 ksi to 12 ksi. These materials may be any suitable for service in a downhole environment and that provides adequate strength to enable proper operation of the tool 100. For example, one such material is an epoxy resin.

In an embodiment, the downhole tool 100 is a frac plug. It is used in a well stimulation/fracturing operation to isolate the zone of the formation F below the plug. After the wellbore is properly prepared, the frac plug is lowered to the desired depth within the wellbore and a packer element assembly is set against the casing in a conventional manner. After the fluid recovery operations are complete, a part of the plug (e.g., wedge or cone) dissolves under the combination of conditions as discussed above, the plug is no longer held in place and thus falls to the bottom of the well and the well is ready for production. In some cases, the remnants of the plug are pushed to the bottom of the well and the well is ready for production.

While preferred embodiments of this invention have been shown and described, modifications thereof can be made by one skilled in the art without departing from the spirit or teaching of this invention. The embodiments described herein are exemplary only and are not limiting. Many variations and modifications of the system and apparatus are possible and are within the scope of the invention. Accordingly, the scope of protection is not limited to the embodiments described herein, but is only limited by the claims which follow, the scope of which shall include all equivalents of the subject matter of the claims.

What is claimed is:
1. A downhole tool comprising a dissolvable part, wherein said part is dissolved in the presence of moisture or water, at a temperature in the range of 150°F to 400°F and at a pressure in the range of 2 ksi to 12 ksi.
2. The downhole tool of claim 1 wherein no solvent other than water is needed for the dissolvable part to dissolve.
3. The downhole tool of claim 1 wherein the dissolvable part is made from a material comprising resin or fiber or both.
4. The downhole tool of claim 3 wherein the resin or fiber or both are dissolvable.
5. The downhole tool of claim 1 comprising a frac plug, a bridge plug, or a packer.
6. The downhole tool of claim 5 wherein the dissolvable part of the plug or packer is a wedge or cone.
7. The downhole tool of claim 5 wherein the plug or packer falls to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time.
8. The downhole tool of claim 5 wherein the plug or packer is pushed to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time.
9. The downhole tool of claim 1 wherein at least 20% of the dissolvable part is dissolved.
10. A method for performing a downhole operation comprising:
   placing a downhole tool within a well bore, wherein the downhole tool comprises a dissolvable part, wherein said part is dissolved in the presence of moisture or water, at a temperature in the range of 150°F to 400°F and at a pressure in the range of 2 ksi to 12 ksi.
11. The method of claim 10 comprising dissolving the tool for a period of time.
12. The method of claim 11 wherein dissolving the tool for a period of time takes place before performing the downhole operation or during performing the downhole operation or after performing the downhole operation.
13. The method of claim 10 wherein at least 20% of the dissolvable part is dissolved.
14. The method of claim 10, wherein no solvent other than water is needed for the dissolvable part to dissolve.

15. The method of claim 10, wherein the dissolvable part is made from a material comprising resin or fiber or both.

16. The method of claim 15, wherein the resin or fiber or both are dissolvable.

17. The method of claim 10, wherein the downhole tool comprises a frac plug, a bridge plug, or a packer.

18. The method of claim 17 wherein the dissolvable part of the plug or packer is a wedge or cone.

19. The method of claim 17 wherein the plug or packer falls to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time.

20. The method of claim 17 comprising pushing the plug or packer to the bottom of a wellbore after the dissolvable part of the plug or packer is dissolved for a period of time.