Title: A METHOD AND APPARATUS FOR SAMPLING AND/OR TESTING DOWNHOLE FORMATIONS

Abstract: Performing a hydraulic fracture test includes conveying a downhole sub in a borehole to a formation, the downhole sub including a first sealing member, a second sealing member, and an extendable member disposed between the first sealing member and the second sealing member. The first sealing member and the second sealing member are actuated to define a first isolated zone within the borehole. A fluid is introduced to the borehole wall via the extendable member to fracture the formation whether extended or not, and a property of the formation is estimated at least in part using an output signal from a downhole transducer.
Published:
— without international search report and to be republished upon receipt of that report (Rule 48.2(g))
A METHOD AND APPARATUS FOR SAMPLING AND/OR TESTING
DOWNHOLE FORMATIONS

BACKGROUND

1. Technical Field

[0001] The present disclosure generally relates to hydrocarbon recovery from a well and in particular to methods and apparatus for drilling, sampling, and/or testing formations.

2. Background Information

[0002] Oil and gas wells have been drilled at depths ranging from a few hundred feet to as deep as six miles or more. A large portion of the current drilling activity involves directional drilling that includes drilling boreholes deviated from vertical by a few degrees to horizontal boreholes to increase the hydrocarbon production from earth formations.

[0003] Production of fluids from formations may be enhanced using techniques known as fracturing. One type of fracturing is known as hydraulic fracture stimulation or hydraulic fracture treatment, and the purpose of hydraulic fracture stimulation is to maximize the productivity of the well. Hydraulic fracture stimulation methods typically include increasing hydraulic pressure in the borehole at a selected formation area to the point that the hydraulic pressure initially fractures or "cracks" the formation. The pressure at the point of the initial fracture is known as the formation breakdown pressure. The hydraulic pressure used for the hydraulic fracture stimulation may be applied to extend the fracture far into the formation and in one or more directions from the well borehole. The length of the fractures for these stimulation techniques may be up to 1000 ft or more from the borehole and typically extend from about 100 ft to 1000 ft.

[0004] Information about the subterranean formations traversed by the borehole may be obtained by any number of techniques. The more that is known about the properties of the formation prior to performing hydraulic fracture stimulation, the better opportunity there is to design an effective and optimum fracture treatment.
SUMMARY

[0005] The following presents a general summary of several aspects of the disclosure in order to provide a basic understanding of at least some aspects of the disclosure. This summary is not an extensive overview of the disclosure. It is not intended to identify key or critical elements of the disclosure or to delineate the scope of the claims. The following summary merely presents some concepts of the disclosure in a general form as a prelude to the more detailed description that follows.

[0006] An exemplary method for determining formation properties using a hydraulic fracture test includes conveying a downhole sub in a borehole to a formation, the downhole sub including a first sealing member, a second sealing member, and an extendable member disposed between the first sealing member and the second sealing member. The first sealing member and the second sealing member are actuated to define a first isolated zone within the borehole. A fluid is introduced to the borehole wall via the extendable member to fracture the formation, and a property of the formation is estimated at least in part using an output signal from a downhole transducer.

[0007] In several embodiments, a method for performing a hydraulic fracture test includes conveying a downhole sub in a borehole to a formation, the downhole sub including a first sealing member, a second sealing member, and an extendable member disposed between the first sealing member and the second sealing member, actuating the first sealing member and the second sealing member to define a first isolated zone within the borehole, and introducing a fluid to the borehole wall via the extendable member to fracture the formation. One particular embodiment further includes estimating a hydraulic pressure of the introduced fluid when the formation is initially fractured, continuing to introduce the fluid to the formation to extend the fracture, estimating a hydraulic pressure of the introduced fluid during a time interval while one or more fractures are extending, halting the introduction of fluid to the formation after the fracture is extended to allow the fracture to close, estimating a hydraulic pressure of the introduced fluid during a time interval while one or more fractures are closing, and estimating a treatment fluid characteristic at least in part using the estimated hydraulic pressures of the formation.
[0008] Disclosed is an apparatus for performing a hydraulic fracture test includes a downhole sub that is conveyed in a borehole to a formation. A first sealing member is coupled to the downhole sub and a second sealing member is coupled to the downhole sub axially displaced from the first sealing member, the first sealing member and the second sealing member defining a first isolated zone. An extendable member is disposed between the first sealing member and the second sealing member, the extendable member introducing a fluid to the first isolated zone for fracturing the formation. A downhole transducer is coupled to the downhole sub that provides an output signal, the output signal being used at least in part to estimate a property of the formation. In one particular apparatus embodiment, a fracture treatment characteristic is estimated using at least in part the estimated property of the formation. A treatment fluid characteristic may be estimated using at least in part the estimated property of the formation in another particular embodiment.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0009] For a detailed understanding of the present disclosure, reference should be made to the following detailed description of the several non-limiting embodiments, taken in conjunction with the accompanying drawings, in which like elements have been given like numerals and wherein:

- FIG. 1 depicts an elevation view of a non-limiting simultaneous drilling and logging system according to one or more embodiments of the disclosure;
- FIG. 2 depicts a schematic of a non-limiting exemplary downhole sub according to one or more embodiments;
- FIG. 3 depicts an illustrative example of a pressure profile plot of the pressure in an isolated zone as a function of time during an illustrative hydraulic fracture test according to one or more embodiments; and
- FIG. 4 depicts a schematic of a non-limiting downhole sub having an extendable member disposed between two extended packers defining an isolated zone according to one or more embodiments.
DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0010] The present disclosure uses terms, the meaning of which terms will aid in providing an understanding of the discussion herein. For the purposes of the present disclosure, fracture treatment means the fracturing of a given formation within a borehole. Hydraulic fracture stimulation is used synonymously herein with hydraulic fracture treatment to mean hydraulic fracturing methods for increasing the productivity of wells. The length of the fractures for these stimulation techniques may be up to 1000 ft or more from the borehole and typically extend from 100 ft to 1000 ft. A hydraulic fracture test is distinguished from a hydraulic fracture treatment in that the hydraulic fracture test induces small fractures on the order of about 0-10 feet but much less that the fractures propagated during hydraulic fracture stimulation. Breakdown pressure is the pressure required to fracture a surrounding formation. A propagation pressure profile is a pressure profile used to increase the length of a fracture to an estimated desired length. The closure stress of a formation is the stress in the formation at the time when the fracture closes. Closure may not occur at all points in a fracture at the same time. When relative rock movement ceases, then there may still be gaps in the fracture, but nonetheless the fracture is closed.

[0011] FIG. 1 depicts an elevation view of a non-limiting simultaneous drilling and logging system according to one or more embodiments of the disclosure. The drilling and logging system 100 may be used to drill a well borehole 102 into the earth under control of surface equipment including a drilling rig 104. In accordance with a conventional arrangement, the drilling rig 104 may include a drill string 108. The drill string 108 may be a coiled tube, jointed pipes or wired pipes as understood by those skilled in the art. The drill string 108 may include a downhole sub 106 for making measurements of properties of the earth formations 110. The term formation as used herein is inclusive of any subterranean location where hydraulic fracture testing may be performed or desired. The term includes productive formations, formations thought to be unproductive and unproductive strata.

[0012] While-drilling tools may use a drilling fluid 114 circulated from a mud pit 116 through a mud pump 118, past a desurger 120, and through a mud supply line 122. The drilling fluid 114 in the example shown flows down through a longitudinal central bore in the drill string and through jets (not shown) in the lower face of a drill.
bit 124. Return fluid that includes drilling mud, cuttings and formation fluid flows up through the annular space between the outer surface of the drill string and the inner surface of the borehole to be circulated to the surface where it may be returned to the mud pit or mud tanks.

[0013] The system 100 in FIG. 1 may use any conventional telemetry methods and devices for communication between the surface and downhole components. The surface controller 112 may be used for processing commands and other information used in the drilling operations. In one or more embodiments, mud pulse telemetry techniques may be used to communicate information from downhole to the surface during drilling operations. For example, techniques to transmit information with a hydraulic transmission: positive mud-pulse, negative mud-pulse, and continuous mud-pulse.

[0014] Simultaneous recording to a downhole memory device, not shown, may be performed in a while drilling environment as shown, while the drilling is stopped or when using a slickline or wireline to convey the downhole sub to store collected downhole information for analysis and comparison after the downhole sub 106 is removed from the borehole 102. In a wire-line environment, the recorded data may be transmitted to the surface, for example, using a wire-line tool with an inductive coupling. The downhole sub 106 may be configured to convey information to a surface controller 112 using acoustic telemetry, electrical telemetry, optical fiber telemetry with or any other suitable telemetry technique.

[0015] The drill string 108 may carry a downhole drill motor 126 for rotating the drill bit 124. In one or more embodiments, the downhole sub 106 may incorporate an extendable member shown here as an extendable probe 130, which may be used to perform formation sampling, pressure testing and hydraulic fracture tests to be described later in this disclosure. Those skilled in the art with the benefit of the above examples and description will appreciate that the tools described herein may be configured and used in a wire-line or slick-line environment. The several embodiments described herein may be configured for open hole or cased hole environments, and the downhole sub 106 may be configured to perforate a casing pipe using any number of perforating devices without the need for further description or illustration here.
FIG. 2 depicts a schematic of a non-limiting downhole sub according to one or more embodiments. The downhole sub 200 shown may be used with any suitable carrier that may convey the downhole sub 200 in a borehole to a formation. In several examples, the downhole sub 200 may be conveyed using a drilling system substantially as described above and shown in FIG. 1, on a wireline, and/or on a slickline. The exemplary downhole sub 200 is shown disposed in a borehole 102 at a location within the formation 110. The exemplary downhole sub 200 as shown here includes a fluid supply line 202. A pump 204 and a pressure measurement transducer or gauge 206 are coupled in fluid communication with the fluid supply line 202. An upper sealing member, for example an upper packer 208 and a lower sealing member, for example a lower packer 210 are coupled to the downhole sub to straddle an extendable probe 130 shown disposed between the upper packer 208 and the lower packer 210. The fluid supply line 202, the pump 204, the gauge 206, and the extendable probe 130 in several non-limiting embodiments may be in fluid communication with each other. The pump 204 may be disposed anywhere along a drill string, may be disposed on the surface above the borehole 102, or may be disposed anywhere where the pump 206 may be placed in fluid communication with the fluid supply line 202. The fluid supply line 202 may be in fluid communication with a fluid source, for example a fracture fluid source, a drilling fluid source, a borehole fluid source, another fluid source, or combinations thereof. The fluid supply line 202 may deliver a fluid to the extendable probe 130 for introduction into the formation 110 as shown or into non-productive strata not shown here. For example, the fluid supply line 202 may operate in concert with the pump 204 to deliver fluid to or draw fluid from an opening or port, not shown, in the extendable probe 130, for introduction of fluid into or for removal of fluid from the formation 110. In some embodiments, fluid may be introduced to an isolated section of the borehole 102 with sufficient pressure to force the fluid into the formation 110.

In one or more non-limiting embodiments, the packers or sealing members 208, 210 may be selectively expanded or actuated. When actuated, each packer 208, 210 may expand and sealingly engage an adjacent borehole wall area to form at least a partial fluid barrier across an annulus portion of the borehole 102. When the packers 208, 210 are sealingly engaged with the adjacent borehole wall area, an annular section or "isolated zone" may be established between the packers 208, 210.
The packers 208, 210 may be of the fixed head type, the sliding-head type, or of any type known in the art. The packers 208, 210 may be actuated by any number of actuating mechanisms. For example, the packers 208, 210 may be mechanically compressed or actuated using hydraulically actuated pistons or the like. In one or more examples, the packers 208, 210 may include flexible bladders that may deform sufficiently to maintain a sealing engagement with the borehole wall even though the downhole sub 200 may not be centrally positioned in the borehole 102. One or more of several formation tests and sampling techniques disclosed herein may be conducted within the isolated zone.

[0018] It will be appreciated from the present disclosure that isolating a zone along the wellbore axis increases the likelihood that formation fluid may be efficiently extracted from a formation. An isolated axial zone when used with or without an additional extendable sampling probe 130 having a sealing pad provides a greater likelihood that a region or area having favorable flow characteristics will be captured. Utilizing an isolated zone may increase the flow rate of fluid into the borehole isolated zone and therefore reduce the time needed to obtain a fluid sample. The extendable probe 130 may include a pump that may cause the isolated zone between the packers 208, 210 to have an environmental condition different than the environment of the regions above and below the isolated zone. In several examples, the different environmental condition may include a differential pressure. Using an isolated zone also helps in hydraulic fracture testing by directing hydraulic pressure to a selected portion of the borehole wall.

[0019] Referring again to FIG. 2, the exemplary downhole sub 200 in one or more embodiments may be used to perform a hydraulic fracture test on a formation 110 to determine one or more formation properties. In one or more embodiments, the downhole sub 200 may be conveyed in the borehole 102 to one or more productive or non-productive zones of formation 110. The packers 208, 210 may be actuated to sealingly engage the borehole wall and to define, that is, establish an isolated zone 212 within the borehole 102. The fluid in the isolated zone 212 may enter the probe 130 and the pressure in the isolated zone may be determined using the gauge 206. The fluid pressure in the isolated zone may be continuously and/or intermittently monitored using the gauge 206 or any other suitable mechanism or technique.
[0020] At the beginning of one or more hydraulic fracture or other tests, the pump 204 may be engaged to introduce a fluid, for example a borehole fluid from the borehole 102 outside the isolated zone 212 to increase hydraulic pressure in the isolated zone via the extendable probe 130. As the fluid is introduced into the isolated zone, the pressure in the isolated zone may be monitored using the gauge 206. One or more properties of the formation 110 may be determined or estimated from a pressure profile created by plotting the pressure in the isolated zone over time. In one or more embodiments, the slope and curvature of time-based pressure curves may be used to estimate various formation properties.

[0021] Referring to FIGS. 2 and 3 an illustrative example of a pressure profile plot of the pressure in an isolated zone as a function of time during an illustrative hydraulic fracture test according to one or more embodiments is provided. As the pump 204 introduces fluid into the isolated zone, the pressure in the isolated zone increases nonlinearly as shown between t₁-t₂. When the pressure in the isolated zone reaches the formation breakdown pressure, the formation is fractured, and the formation breakdown pressure may be estimated from the pressure at t₂. At formation breakdown, a short, unstable fracture may form having a radial extent that is less than the borehole diameter. When the fracture forms, the deformation modulus of the rock decreases and the rock anisotropy increases. Associated with the decreased formation stiffness are an increase in the volume of the isolated zone and a simultaneous decrease in the pressure in the isolated zone from t₂ to t₃. The pressure from t₃ to t₁ may be substantially constant, and a propagation pressure profile may be estimated from the estimated pressures between times t₃ and t₄.

[0022] The pump 204 may continue to pump fluid into the isolated zone to extend or propagate the fracture at a roughly constant pressure from t₃ to t₄. In one or more embodiments, the fluid is pumped into the isolated zone to propagate the fracture to a desired, estimated length. The length of the propagated fracture may be in a range of about zero to 10 feet. Between times t₂ and t₃, the gauge 206 and pump flow rate information may be used to estimate the pressure decay in the isolated zone as the fracture continues to propagate and the fluid in the fracture leaks off into the formation 110. At time t₄, when the fracture has been propagated to the maximum and/or desired length, the pump 204 may be shut off and the non-linear pressure profile for at least a
portion of the time interval \( t_4 \) to \( t_5 \) may be used to estimate a closure stress. The fracture closing stops at time \( t_5 \) and the non-linear pressure decline will eventually reach the reservoir pressure at time \( t_6 \), and thereafter the pressure is substantially constant. The procedure and sequence of time interval \( t_i \) may be repeated as desired for any number of cycles. For example, multiple fracture pressurization flowback cycles may be performed where the injected volume will be such that the fracture diameter is limited to the design diameter and fluid returned is not greater than the volume injected into the fracture.

[0023] In one or more embodiments, the estimated breakdown pressure, propagation profile, and closure stress may be used to estimate the pore pressure and overburden pressure within the formation \( 110 \). The pore pressure is the pressure of the fluid in the pores of the formation \( 110 \). The overburden pressure is the pressure or stress imposed on the formation \( 110 \) by the weight of the overlying formations.

[0024] Referring again to FIG. 2, in one or more embodiments, the one or more estimated formation properties may be used to determine or estimate one or more hydraulic fracture treatment characteristics. For example, the estimated breakdown pressure, propagation pressure, and closure stress may be used to design a hydraulic fracture stimulation. Fracturing fluids may include water and/or various combinations of water and polymer-water solutions, gels and oil emulsions, foams, acid based fluids, other fluids, and/or combinations thereof. One characteristic of the fracturing fluid may be the particular proppant used in the fracture fluid. Proppants are sized particles that may be mixed with the fracturing fluid to hold fractures open after a hydraulic fracturing treatment. In addition to naturally occurring sand grains, man-made or specially engineered proppants, such as resin-coated sand or high-strength ceramic materials like sintered bauxite, may be used. The particular proppant size and sphericity may also be selected, based on the hydraulic fracture test results. Other fracturing fluid characteristics that may be selected based on the hydraulic fracture test results include the fluid shear thinning or thickening, history dependence, normal stress differences, viscosity change with respect to temperature change, and/or other characteristics. The one or more selected formation properties may be used to engineer the entire fracture treatment including engineering a particular fracturing fluid for a particular hydraulic fracture treatment of the tested formation. In one or
more embodiments, the engineered fracturing fluid may be used to create or establish
an efficient conduit for production of fluid from a reservoir located in the formation
110, to the borehole 102.

[0025] FIG. 4 depicts a schematic of a non-limiting downhole sub 200 having an
extendable probe 130 disposed between two extendable packers 208, 210 according to
one or more embodiments. The downhole sub 200, which may be substantially
similar to the downhole sub described above and shown in FIG. 2, is shown disposed
in the borehole 102 and the extendable probe 130 may be disposed within an
extendable probe mechanism 402. The extendable probe mechanism 402 may be
disposed between the extendable upper packer 208 and the extendable lower packer
210. The extendable packers 208, 210 when extended may define a first or outer
isolated zone 212. The extendable probe 130, when in a retracted position, may
deliver or remove fluid to or from the outer isolated zone 212 via an orifice 404
formed in one end of the probe 130. The extendable probe 130 may be extended to
place the orifice 404 end of the probe in sealing engagement with a portion of the
borehole wall. The extendable probe 130 may include a sealing member or pad 406
for sealing engagement with the portion of the borehole wall. It should be understood
that the extendable probe mechanism 402 may be any suitable mechanism or device
that may be used to extend a probe 130 from a downhole sub 200 toward a borehole
wall and no limitations should be implied by the use of the word "mechanism." Non-
limiting examples of mechanisms for extending the extendable probe 130 include
hydraulic mechanisms, electromechanical mechanisms, and mechanical mechanisms.
In some embodiments, the probe 130 may be in a retracted position and moved to
generate the borehole wall by moving the downhole sub 200 to the borehole wall. This
may be accomplished using a decentralizer, such as a bowspring, a back-up shoe or
other extendable member disposed on the downhole sub opposite the probe 130. The
decentralizer may be axially displaced or disposed diametrically to the extendable
probe 130.

[0026] A second or inner isolated zone 408 may be established by extending the
extendable probe 130 to contact the borehole wall. The inner isolated zone 408 in the
example of FIG. 4 includes the volume within the probe 130 and the borehole wall
that is in pressure communication with the probe adjacent the orifice 404. The inner
isolated zone may be defined within the outer isolated zone 212 as shown. In this
configuration, a pressure in the outer isolated zone 212 may be controlled in relation
to a pressure in the inner isolated zone 408 and in relation to the borehole outside of
the packers 208, 210. In this way, a first pressure differential between the outer
isolated zone 212 and the borehole annulus outside of the packers 208, 210 may be
controlled and a second pressure differential between the outer isolated zone 212 and
the inner isolated zone 408 may be controlled. In one or more embodiments, the
second pressure differential may be controlled to be less than the first pressure
differential.

[0027] Those skilled in the art with the benefit of the present disclosure will
recognize that the inner isolated zone 408 may be established using another
extendable member such as a second set of packers not shown in the example
embodiment of FIG. 4. A four-packer arrangement is therefore considered within the
scope of the disclosure. It is sufficient that the orifice 404 may be in a side of the sub
200 where the extendable probe 130 and seal pad 406 are replaced by a second pair of
packers 208, 210 that are positioned between the shown packers 208, 210. In this
manner, the inner packers may be used to establish the inner isolated zone 408.
Whether using the extendable probe embodiments or four-packer arrangements,
hydraulic fracture tests may be performed for determining one or more formation
properties.

[0028] In one or more embodiments, a hydraulic fracture test may be performed to
determine at least one characteristic of the formation 110. For example, drilling fluid
or another fluid carried by the tool may be introduced into the outer isolated zone 212
to increase the pressure in the outer isolated zone 212. In one or more embodiments,
the pressure in the outer isolated zone 212 may be increased above the pressure in the
borehole annulus above the upper packer 208.

[0029] The extendable probe 130 or a second pair of packers may be extended and
placed in sealing engagement with a portion of the borehole wall to establish the inner
isolated zone 408 with an inner isolated zone pressure. In one or more embodiments,
an extendable sealing member 406 can be used to sealingly engage the borehole wall
to establish the inner isolated zone 408. The hydraulic fracture test may be performed
by selectively introducing fluid into the inner isolated zone 408 to determine the
breakdown pressure, propagation pressure, closure stress, and/or other properties of
the formation 110 by using techniques as described above with reference to FIGS. 2
and 3.

[0030] Returning to FIG. 4, by controlling the pressure differential between the outer
isolated zone 212 and the inner isolated zone 408, the seal establishing the inner
isolated zone may be more easily maintained. An advantage of using a sealed probe
or a second pair of packers for introducing a fracturing fluid include reducing the
amount of fracturing fluid used for fracturing a formation and extending the fracture
into the formation. Another advantage is that the formation fracturing for the
hydraulic fracture test is faster than with other formation fracturing techniques, that is,
the time segment \( t_1 \) to \( t_2 \) in FIG. 3 is reduced. Another advantage is that the location
of the fracture is more precisely controlled.

[0031] In one or more embodiments, a first hydraulic fracture test may be performed
as described above with reference to FIG. 2 and FIG.3 to estimate one or more
formation characteristics, for example breakdown pressure, propagating pressure,
pore pressure, closure stress, etc. One or more subsequent hydraulic fracture tests
may then be performed as described above with reference to FIG 4. During the one or
more subsequent hydraulic fracture tests, the pressure in the outer isolated zone 212
may be set based on the estimated results from a preceding hydraulic fracture test for
controlling the second pressure differential.

[0032] Having described above the several aspects of the disclosure, one skilled in the
art will appreciate several particular embodiments useful in the determination of one
or more properties of a formation. In one particular embodiment a method for
performing a hydraulic fracture test includes conveying a downhole sub in a borehole
to a formation, the downhole sub including a first sealing member, a second sealing
member, and an extendable member disposed between the first sealing member and
the second sealing member. The first sealing member and the second sealing member
are actuated to define a first isolated zone within the borehole. A fluid is introduced
to the borehole wall via the extendable member to fracture the formation, and a
property of the formation is estimated at least in part using an output signal from a
downhole transducer.
In several particular embodiments, a method for performing a hydraulic fracture test includes conveying a downhole sub in a borehole via a drill string, a wireline and/or a slickline.

In another particular embodiment, a method for performing a hydraulic fracture test includes estimating a hydraulic pressure of a fluid introduced to a formation when the formation is initially fractured by the procedure.

In several particular embodiments, a method for performing a hydraulic fracture test includes continuing to introduce a fluid to a formation to extend a fracture. A method for performing a hydraulic fracture test may further include continuing to introduce a fluid to a formation to extend a fracture and estimating a hydraulic pressure of the introduced fluid during a time interval while fracture is extending. A method for performing a hydraulic fracture test may further include continuing to introduce a fluid to a formation to extend a fracture and halting the introduction of fluid to the formation after the fracture is extended to allow the fracture to close. In some aspects, an estimated downhole sub parameter includes estimating a hydraulic pressure of the introduced fluid during a time interval while the fracture is closing.

In one particular embodiment a method for performing a hydraulic fracture test includes estimating a fracture treatment characteristic at least in part using an estimated property of a formation. The fracture treatment may comprise a subsequent fracture treatment. In some particular embodiments, the fracture treatment may comprise a hydraulic fracture treatment and the estimated fracture treatment characteristic includes a treatment fluid characteristic.

In several particular embodiments a method for performing a hydraulic fracture test includes extending an extendable member to define a second or inner isolated zone within a borehole. A method may include controlling a borehole pressure within the first isolated zone and in the second isolated zone to create a first pressure differential between the first isolated zone and the second isolated zone and a second pressure differential between the first isolated zone and a borehole annulus above the first isolated zone, and the first pressure differential may be less than the second pressure differential.
[0038] In a particular apparatus embodiment, an apparatus for performing a hydraulic fracture test includes a downhole sub that is conveyed in a borehole to a formation. A first sealing member is coupled to the downhole sub and a second sealing member is coupled to the downhole sub axially displaced from the first sealing member, the first sealing member and the second sealing member defining a first isolated zone. An extendable member is disposed between the first sealing member and the second sealing member, the extendable member introducing a fluid to the first isolated zone for fracturing the formation. A downhole transducer provides an output signal, the output signal being used at least in part to estimate a property of the formation. In several particular embodiments, a hydraulic fracture stimulation characteristic may be designed, engineered or estimated using at least in part the estimated property of the formation. A hydraulic fracture treatment fluid may be selected, designed or engineered. The additives and the pump volumes of each of the fluids may be selected. The sequence for pumping the fluids may be selected and the treating pressures may be selected based on the information obtained during the hydraulic fracture test. Selected hydraulic fracture treatment parameters may include surface and downhole treating pressures, pump volumes, pump rates, perforating program, charge selection, order of fracture or stage fractures, the intervals of the perforations, the maximum distance for extending the stimulation fracture, or any combination thereof. The stimulation fracture length and the proper management thereof may affect and improve the economics of the project.

[0039] In a particular apparatus embodiment, an apparatus for performing a hydraulic fracture test includes an extendable member that is extended defining a second isolated zone within the borehole, the pressure within a first isolated zone and the second isolated zone establishing a first pressure differential between the first isolated zone and the second isolated zone and establishing a second pressure differential between the first isolated zone and a borehole annulus above the first isolated zone.

[0040] In other particular apparatus embodiments, an apparatus for performing a hydraulic fracture test includes a drill string, a wireline or a slickline conveying a downhole sub in the borehole.

[0041] In one particular method embodiment, a method for performing a hydraulic fracture test includes conveying a downhole sub in a borehole to a formation, the
downhole sub including a first sealing member, a second sealing member, and an extendable member disposed between the first sealing member and the second sealing member, actuating the first sealing member and the second sealing member to define a first isolated zone within the borehole, and introducing a fluid to the borehole wall via the extendable member to fracture the formation. The particular embodiment further includes estimating a hydraulic pressure of the introduced fluid when the formation is initially fractured, continuing to introduce the fluid to the formation to extend the fracture, estimating a hydraulic pressure of the introduced fluid during a time interval while fracture is extending, halting the introduction of fluid to the formation after the fracture is extended to allow the fracture to close, estimating a hydraulic pressure of the introduced fluid during a time interval while fracture is closing, and estimating a treatment fluid characteristic at least in part using the estimated hydraulic pressures of the formation.

[0042] The present disclosure is to be taken as illustrative rather than as limiting the scope or nature of the claims below. Numerous modifications and variations will become apparent to those skilled in the art after studying the disclosure, including use of equivalent functional and/or structural substitutes for elements described herein, use of equivalent functional couplings for couplings described herein, and/or use of equivalent functional actions for actions described herein. Such insubstantial variations are to be considered within the scope of the claims below.
CLAIMS

What is claimed is:

1. A method for performing a hydraulic fracture test comprising:
   (a) conveying a downhole sub in a borehole to a formation, the downhole sub including a first sealing member, a second sealing member, and an extendable member disposed between the first sealing member and the second sealing member;
   (b) actuating the first sealing member and the second sealing member to establish a first isolated zone within the borehole;
   (c) introducing a fluid to the borehole wall via the extendable member to fracture the formation; and
   (d) estimating a property of the formation at least in part using an output signal from a downhole transducer.

2. A method according to claim 1, wherein conveying the downhole sub comprises conveying using one or more of a drill string, a wireline and a slickline.

3. A method according to claim 1, wherein estimating a property of the formation includes estimating a hydraulic pressure of the introduced fluid when the formation is initially fractured.

4. A method according to claim 1 further comprising continuing to introduce the fluid to the formation to extend the fracture.

5. A method according to claim 4, wherein estimating a property of the formation includes estimating a hydraulic pressure of the introduced fluid during a time interval while fracture is extending.

6. A method according to claim 4 further comprising halting the introduction of fluid to the formation after the fracture is extended to allow the fracture to close.
7. A method according to claim 6, wherein estimating a property of the formation includes estimating a hydraulic pressure of the introduced fluid during a time interval while fracture is closing.

8. A method according to claim 1 further comprising estimating a fracture treatment characteristic at least in part using the estimated property of the formation.

9. A method according to claim 8, wherein the fracture treatment comprises a subsequent hydraulic fracture treatment.

10. A method according to claim 8, wherein the fracture treatment comprises a hydraulic fracture treatment and the estimated fracture treatment characteristic includes a treatment fluid characteristic.

11. A method according to claim 1, wherein the extendable member includes one or more of an extendable probe and a pair of packers, the method further comprising establishing a second isolated zone within the borehole by extending the extendable member.

12. A method according to claim 11 further comprising controlling a borehole pressure within the first isolated zone and in the second isolated zone to create a first pressure differential between the first isolated zone and a borehole annulus above the first isolated zone and a second pressure differential between the first isolated zone and the second isolated zone.

13. A method according to claim 12, wherein the second pressure differential is less than the first pressure differential.

14. An apparatus for performing a hydraulic fracture test comprising:
   (a) a downhole sub that is conveyed in a borehole to a formation;
   (b) a first sealing member coupled to the downhole sub;
   (c) a second sealing member coupled to the downhole sub axially displaced from the first sealing member, the first sealing member and the second sealing member defining a first isolated zone;
An extendable member disposed between the first sealing member and the second sealing member, the extendable member introducing a fluid to the formation for fracturing the formation; and

A downhole transducer coupled to the downhole sub that provides an output signal, the output signal being used at least in part to estimate a property of the formation.

An apparatus according to claim 14, wherein a fracture treatment characteristic is estimated using at least in part the estimated property of the formation.

An apparatus according to claim 15, wherein a treatment fluid characteristic is estimated using at least in part the estimated property of the formation.

An apparatus according to claim 14, wherein the extendable member is extended to establish a second isolated zone within the borehole, a first pressure differential being established between the first isolated zone and a borehole annulus above and below the first isolated zone and a second pressure differential being established between the first isolated zone and the second isolated zone.

An apparatus according to claim 14, wherein the downhole sub is conveyed in the borehole using one or more of a drill string, a wireline and a slickline.

A method for performing a hydraulic fracture test comprising:

(a) conveying a downhole sub in a borehole to a formation, the downhole sub including a first sealing member, a second sealing member, and an extendable member disposed between the first sealing member and the second sealing member;

(b) actuating the first sealing member and the second sealing member to define a first isolated zone within the borehole;

(c) introducing a fluid to the borehole wall via the extendable member to fracture the formation;

(d) estimating a hydraulic pressure of the introduced fluid when the formation is initially fractured;
continuing to introduce the fluid to the formation to extend the fracture;

estimating a hydraulic pressure of the introduced fluid during a time interval while fracture is extending;

halting the introduction of fluid to the formation after the fracture is extended to allow the fracture to close;

estimating a hydraulic pressure of the introduced fluid during a time interval while fracture is closing; and

estimating a treatment fluid characteristic at least in part using the estimated hydraulic pressures of the formation.