A system and a methodology is utilized in a wellbore to collect samples of formation fluid. A single expandable packer is moved downhole into the wellbore for collection of a fluid sample. The single packer has a sample collection portion disposed in an intermediate location that is sealed off when the single packer is expanded against a wellbore wall. Once engaged with the wellbore wall, a formation fluid sample can be drawn into the single expandable packer for distribution to a sample collection location.
COMBINE MDT TOOL AND SINGLE PACKER

POSITION PACKER IN WELLBORE PROXIMATE A DESIRED FORMATION

EXPAND SINGLE PACKER TO SEAL OFF FLUID SAMPLE COLLECTION REGION BETWEEN SEAL MEMBERS

DRAWN IN FORMATION FLUID SAMPLE

DIRECT FORMATION FLUID SAMPLE TO SAMPLE COLLECTION LOCATION

COLLAPSE SINGLE PACKER

MOVE SINGLE PACKER TO ANOTHER SAMPLE COLLECTION LOCATION

FIG. 3

FIG. 4
SYSTEM AND METHOD FOR OBTAINING FORMATION FLUID SAMPLES FOR ANALYSIS

BACKGROUND

[0001] The invention generally relates to a system and method for obtaining fluid samples from a surrounding formation. The samples are collected for analysis in determining characteristics of the formation and fluids contained in the formation.

[0002] A variety of sampling tools, such as modular dynamics formation tester tools (MDT tools) can be run into a wellbore to obtain and evaluate formation fluid samples. MDT tools have been used with single probes or two separate inflatable packers. The probe or separate packers are designed to insulate the formation fluid sample from well fluid in the wellbore while a pump in the MDT tool draws in the formation fluid sample.

[0003] However, the single probe type of tool is only capable of placing a limited surface in contact with the formation, and this limited contact can create difficulty in collecting formation fluid in a variety environments, including low formation permeability environments. The dual packer configuration can overcome some of these problems, but depressurization between the separate packers during sampling generates significant mechanical stress on the packers. Accordingly, the packers must be designed to withstand this mechanical stress which places substantial limitations on the range of applications for which the system can be designed. For example, the expansion capabilities of the packers may be limited and/or the packers can be subjected to severe damage when cycled multiple times. An additional problem associated with the dual packer configuration is the heightened stress placed on the formation.

SUMMARY

[0004] The present invention comprises a system and method for taking formation fluid samples from within a wellbore. A sole or single expandable packer is utilized to insulate the formation fluid sample from well fluid while the formation fluid sample is obtained. The design of the single packer enables the collection of formation fluid samples through a relatively large area without incurring detrimental mechanical stresses.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Certain embodiments of the invention will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements, and:

[0006] FIG. 1 is a front elevation view of a modular dynamics formation tester tool and a single expandable packer structure deployed in a wellbore, according to one embodiment of the present invention;

[0007] FIG. 2 is a view similar to that of FIG. 1 but showing the single expandable packer structure in an expanded state, according to an embodiment of the present invention;

[0008] FIG. 3 is a front elevation view of a modular dynamics formation tester tool and a single expandable packer structure deployed in a wellbore, according to an alternate embodiment of the present invention; and

[0009] FIG. 4 is a flowchart illustrating one example of a sampling methodology, according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0010] In the following description, numerous details are set forth to provide an understanding of the present invention. However, it will be understood by those of ordinary skill in the art that the present invention may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0011] The present invention relates to a system and methodology for obtaining and analyzing fluid samples from a formation. A system having an MDT tool and a single packer is deployed in a wellbore along a desired formation. The single packer is expanded against the wellbore wall adjacent the desired formation to seal off a sample collection region. A pump within the MDT tool is activated to create a suction in the sample collection region which draws in a formation fluid sample. The formation fluid sample can then be analyzed or directed to an appropriate collection location for analysis.

[0012] The use of the single packer design ensures the mechanical stress generated on the packer structure is substantially lower than the stress that would otherwise be generated on two or more separate packers. The single packer design further enables the construction of a formation fluid sample collection region along the packer that is at least as large as the surface area available when separate packers are utilized. Accordingly, in some applications, it becomes possible to reduce or weaken the structural capability of the single packer without sacrificing functionality or durability. The single packer design also facilitates substantially higher expansion ratios and an increase in the number of expansion/contraction cycles of the packer before failure.

[0013] Referring generally to FIG. 1, an embodiment of a formation fluid sampling system 20 is illustrated as deployed in a wellbore 22 formed in a formation 24 from which a formation fluid sample is to be obtained. The formation fluid sampling system comprises a single inflatable packer 26 combined with a modular dynamics formation tester (MDT) tool 28. The MDT tool 28 and single inflatable packer 26 are deployed in wellbore 22 via a deployment system 30 that can comprise, for example, a cable, wireline, coiled tubing or other suitable deployment system.

[0014] The MDT tool 28 can be constructed in a variety of configurations depending on the specific sampling application. For example, the MDT tool may comprise sample sections, multi-sample sections, pump system sections, electric sections, hydraulic sections, OFA modules and other sections or modules in a variety of arrangements. MDT tools, in several configurations, are commercially available from Schlumberger Corporation. To facilitate explanation of the formation fluid sampling system 20, however, the MDT tool 28 is illustrated as having an electric section 32, a pumping system section 34, and a sample section 36 for storing a formation fluid sample obtained through packer 26. In some applications, sample section 36 may comprise a plurality of sample chambers individually activated by a
surface control 38. For example, when pumping system 34 is operated to draw formation fluid samples from a desired location, electromechanically actuated throttle/seat valves (not shown) can be controlled by surface control 38 to direct each individual formation fluid sample into an appropriate corresponding sample chamber.

[0015] In the illustrated embodiment, MDT tool 28 is able to selectively expand single packer 26 when desired for the collection and analysis of a formation fluid sample. For example, MDT tool 28 and single packer 26 can be designed so the MDT tool is able to selectively inflate the packer which causes it to expand against the surrounding wellbore wall. Once expanded, a formation fluid sample can be drawn in through the packer structure.

[0016] The illustrated single packer 26 comprises fixed mechanical ends 40 and 42 which define the longitudinal extremities of the packer. An inner sealing bladder 44 is positioned between fixed ends 40 and 42 and may be selectively inflated by pumping system 34 via a supply conduit 46, such as a hydraulic tube. Radially outward of inner sealing bladder 44, an expandable mechanical structure 48 is positioned to provide support for the overall packer structure. The expandable mechanical structure 48 also can be used to provide space for routing one or more conduits 50, e.g. hydraulic hoses, through which fluid samples are obtained and directed to a collection location, such as sample section 56. The expandable mechanical structure 48 may comprise a variety of mechanical elements, including longitudinal slats, crisscrossing slats, mesh material or other materials or structures that accommodate repeated cycles of expansion and contraction.

[0017] The single expandable packer 26 further comprises at least two seal members 52 and 54 that are longitudinally separated to create a formation fluid sample intake region 56 through which formation fluid samples are drawn into packer 26 from the surrounding formation 24. The seal members 52 and 54 are designed to form a seal against a surrounding wall 58 that defines wellbore 22. The seal members are formed from appropriate sealing materials and may comprise elastomeric covers, e.g. rubber covers. In the embodiment illustrated, seal members 52 and 54 are positioned along the exterior of expandable mechanical structure 48 and may be located adjacent fixed ends 40 and 42, respectively. In fact, the longitudinally outlying ends of seal members 52 and 54 may be connected to fixed ends 40 and 42, respectively.

[0018] With further reference to FIG. 1, an expandable screen 60 may be positioned along an exterior of expandable mechanical structure 48 in the fluid sample intake region 56. Expandable screen 60 blocks the influx of sand or other fines that would otherwise enter single packer 26 with the formation fluid sample. The fluid sample intake region 56 is generally enclosed other than expandable screen 60 and the one or more conduits 50. Thus, when single packer 26 is expanded and pumping system 34 is operated to create a decreased pressure or suction along conduit 50, formation fluid is drawn in through expandable screen 60 and along conduit 50 to the desired collection location. In the embodiment illustrated, the seal members 52 and 54 are located at opposed longitudinal ends of expandable screen 60.

[0019] Referring generally to FIG. 2, the single expandable packer 26 is illustrated in its expanded configuration. A fluid, such as well fluid, has been directed by pumping system 34 into the interior of inner sealing bladder 44 via supply conduit 46. The delivery of fluid via supply conduit 46 causes inner sealing bladder 44 to expand radially which forces mechanical structure 48, screen 60 and seal members 52, 54 to also expand radially outward. The radial expansion drives seal members 52, 54 against wellbore wall 58 to seal off fluid sample intake region 56. The seal members 52, 54 create sealing contact regions 62 that enable the creation of a low-pressure area within conduit 50 and expandable mechanical structure 48 proximate fluid sample intake region 56. It should be noted the pumping system 34 can be designed to pump fluid in a manner similar to that used in conventional dual packer configurations.

[0020] By creating a low-pressure area, i.e. suction, a formation fluid sample is drawn into sample intake region 56 from the surrounding formation 24. The seal at contact regions 62 enables passage of the formation fluid sample through expandable screen 60 and into the one or more conduits 50 for transport to sample section 56 without being contaminated by wellbore fluid. The suction can be created by operation of pumping system 34. For example, the pump used to inflate inner sealing bladder 44 can be reversed to draw the formation fluid sample into the packer structure. Alternatively, separate pumps can be used to expand the packer and to draw in the fluid sample, respectively. A valve system 64 also can be incorporated into the design and controlled via surface control 38 and/or electric section 32 to selectively control flow through supply conduit 46 and sample conduit 50. In one embodiment, the single pump can be used to inflate the inner sealing bladder 44 and to subsequently draw in the fluid sample while valve system 64 holds fluid within inner sealing bladder 44 to prevent premature contraction and release of packer 26.

[0021] In another embodiment, single expandable packer 26 is provided with at least one heating element 66, as illustrated in FIG. 3. Heating elements 66 can be positioned within expandable mechanical structure 48, as illustrated, or they can be positioned in other regions along the flow path followed by the formation fluid sample as it enters and flows through the packer structure. Power can be supplied to heating elements 66 via conductors 68 to heat the incoming fluid sample for analysis. The ability to heat the fluid sample enables analysis of a greater variety of fluid samples from a greater number of environments, including the analysis of high viscosity/cold fluids and the taking of other measurements that are not readily performed without the addition of heat.

[0022] The single expandable packer design also is conducive to constructing an overall packer wall thickness that is thinner than conventional systems. Thus, even if the packer does not fully recover its initial diameter after many cycles, the packer can be retrieved through the wellbore even when restrictions exist in the wellbore. Furthermore, the single expandable packer design allows the creation of a large communication area between the packer structure and the well fluid. This allows the packer structure to maintain balance with the hydrostatic pressure, thus reducing any negative impact of hydrostatic pressure on packer performance. The single expandable packer design also enables an increased expansion ratio relative to conventional systems. For example, the diameter of the single expandable packer 26 can increase by a ratio of more than 2 to 1 when expanded.
from its contracted state, as illustrated in FIG. 1, to its expanded state, as illustrated in FIG. 2. By way of one specific example, the single expandable packer can be manufactured with an outside diameter of approximately 5 inches and inflated to seal against the inside diameter of a well, i.e. wellbore wall 58, having a diameter of approximately 11 inches. Of course, the actual diameter of single packer 26 and the expansion ratio selected depends on the specific application parameters, including size of the wellbore and type of equipment with which the packer is utilized.

[0023] One embodiment of a methodology for operating the formation fluid sampling system 20 can be described with reference to the flowchart illustrated in FIG. 4. In this embodiment, MDT tool 28 is initially combined with single expandable packer 26, as illustrated by block 70. Subsequently, the single packer 26 is moved downhole into wellbore 22 by deployment system 30 until the single packer is positioned at a desired formation location, as illustrated by block 72. Once properly positioned, pumping system 34 directs a fluid, such as well fluid, through supply conduit 46 to the interior of inner sealing bladder 44. The filling of inner sealing bladder 44 expands single expandable packer 26 until seal members 52 and 54 seal against the surrounding wellbore wall 58 to seal off fluid sample collection region 56, as illustrated by block 74. The sealed sample collection region 56 enables pumping system 34 to create a low-pressure region in conduit 50 and fluid sample intake region 56, the low-pressure region effecting drawing fluid into single packer 26 from the surrounding formation, as illustrated by block 76. The formation fluid sample is then directed to a desired sample collection location, such as sample section 36, via the one or more conduits 50, as illustrated by block 78.

[0024] Following collection of the formation fluid sample, single packer 26 can be collapsed by removing fluid from the interior of inner sealing bladder 44, as illustrated by block 80. The removal of well fluid from bladder 44 can be achieved by pumping system 34 and the appropriate reversal of the pumping system or adjustment of the valve system 64 to route fluid out of the inner sealing bladder. The removal of fluid from bladder 44 allows the bladder, along with mechanical structure 48, screen 60 and seal members 52, 54, to collapse inwardly away from surrounding wellbore wall 58. Once collapsed or contracted, the single packer can be moved to another desired formation location to obtain one or more additional samples, as illustrated by block 82.

[0025] As described above, the single expandable packer system provides a unique and desirable system and methodology for collecting formation fluid samples. It should be noted, however, that a variety of components other than those illustrated can be used with the MDT tool or incorporated into the single expandable packer. For example, expansion mechanisms other than inflatable inner sealing bladder 44 can be used to selectively expand the packer structure. Additionally, a variety of materials and configurations can be used to construct expandable mechanical structure 48, expandable screen 60 and seal members 52 and 54.

[0026] Accordingly, although only a few embodiments of the present invention have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this invention. Such modifications are intended to be included within the scope of this invention as defined in the claims.

What is claimed is:

1. A system for deployment in a wellbore to sample a formation fluid, comprising:

   a single expandable packer structure having a sample collection portion disposed longitudinally between a plurality of seal members positioned for expansion against a wellbore wall, the plurality of seal members being selectively expandable against the wellbore wall to block contamination of a formation fluid sample with external well fluid while the formation fluid sample is drawn through the sample collection portion.

2. The system as recited in claim 1, further comprising an expandable screen disposed in the sample collection portion.

3. The system as recited in claim 2, wherein the single expandable packer structure further comprises an inner bladder that can be filled with a fluid to expand the plurality of seal members and the expandable screen.

4. The system as recited in claim 3, wherein the plurality of expandable seal members comprises a pair of rubber covers.

5. The system as recited in claim 3, wherein the single expandable packer structure comprises an expandable mechanical structure, the inner bladder being disposed along a radial interior of the expandable mechanical structure, the expandable screen and the plurality of seal members being disposed along a radial exterior of the expandable mechanical structure.

6. The system as recited in claim 5, further comprising a pumping system fluidly coupled to the sample collection portion to draw in a sample of formation fluid.

7. The system as recited in claim 6, wherein the pumping system also is coupled to the inner bladder to enable selective inflation of the inner bladder.

8. The system as recited in claim 6, wherein the pumping system is coupled to the sample collection portion with at least one hydraulic hose.

9. The system as recited in claim 1, wherein the single expandable packer structure comprises a heater element to heat the formation fluid sample.

10. A method of collecting formation fluid, comprising:

   constructing a modular dynamic formation tester tool with a single expandable packer;

   moving the single expandable packer downhole into a wellbore;

   expanding the single expandable packer against a wall of the wellbore to seal an internal sample collection region; and

   drawing in a formation fluid sample through the sample collection region without exposure to wellbore fluid.

11. The method as recited in claim 10, wherein constructing comprises locating an intake screen at the internal sample collection region between a pair of seal members.

12. The method as recited in claim 11, wherein constructing comprises positioning an inflatable bladder radially inward of the intake screen and the pair of seal members.
13. The method as recited in claim 12, wherein constructing comprises separating the inflatable bladder from both the intake screen and the pair of seal members with an expandable mechanical structure.

14. The method as recited in claim 10, wherein expanding comprises pumping a fluid into an inflatable bladder.

15. The method as recited in claim 13, wherein drawing comprises moving the formation fluid sample through a conduit routed along the expandable mechanical structure.

16. An expandable packer system, comprising:
   a single expandable packer structure having: an inflatable bladder, an expandable mechanical structure positioned radially outward of the inflatable bladder, a screen radially outward of the expandable mechanical structure, a first seal member positioned at a longitudinal end of the screen, a second seal member positioned at an opposite longitudinal end of the screen, and a conduit to route a formation fluid sample from the screen, along the expandable mechanical structure and to a sample collection location.

17. The expandable packer system as recited in claim 16, further comprising a pumping system for supplying a fluid to the inflatable bladder to expand the single expandable packer structure.

18. The expandable packer system as recited in claim 16, wherein the single expandable packer structure further comprises a heating element to heat the formation fluid sample.

19. The expandable packer system as recited in claim 16, wherein the single expandable packer structure as an expansion ratio of at least two to one.

20. A method of collecting formation fluid, comprising:
   positioning an expandable screen between a pair of longitudinally spaced seal members;
   using an internal expandable member to simultaneously expanded the pair of longitudinally spaced seal members into engagement with the wellbore wall; and
   drawing a formation fluid sample radially inward through the expandable screen.

21. The method as recited in claim 20, further comprising locating an expandable mechanical structure between the internal expandable member and the pair of longitudinally spaced seal members.

22. The method as recited in claim 20, wherein using comprises using an inflatable bladder.

23. The method as recited in claim 20, wherein drawing comprises using a pumping system to create suction between the longitudinally spaced seal members proximate the expandable screen.

24. The method as recited in claim 23, further comprising routing the formation fluid sample from the screen to the pumping system via a conduit.

25. The method as recited in claim 20, further comprising heating the formation fluid sample as it is collected.