HYDRAULIC FRACTURING PROCESS FOR DEVIATED WELLBORES

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ABSTRACT

A method of stimulating an interval in a hydrocarbon reservoir equipped with a deviated wellbore having a casing, wherein said interval comprises at least two sequential stages in said wellbore without isolation means, said method comprising:

i) introducing a first stage

ii) introducing a second stage in the same wellbore wherein said first stage, and second stage are not separated by any isolation means; and optionally

iii) recovering hydrocarbon from said hydrocarbon reservoir to a surface.
## AFTER FRACT TRACER PERFORATED INTERVAL EVALUATION FOR c-C001-J (MUSKWA C)

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<th>ACTUAL PERF DEPTHS</th>
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<th>2nd FRAC ISOTOPED TAGGED</th>
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**FIGURE 11**

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HYDRAULIC FRACTURING PROCESS FOR DEViated WELLBORES

FIELD OF THE INVENTION

[0001] This invention is directed to a method of fracturing a plurality of fractures, without the need of any isolation or diversion means, in a subterranean formation from a deviated wellbore penetrating a hydrocarbon-containing formation.

BACKGROUND OF THE INVENTION

[0002] In the production of hydrocarbons from subterranean rock formations penetrated by wells, a commonly used technique for stimulating such production is to create and extend fractures in the formations. Most often, the fractures are created by applying hydraulic pressure to the subterranean formations from the wellbore penetrating them. That is, a fracturing fluid or a combination of fluids are pumped through the wellbore and into a formation to be fractured at a rate and pressure such that the resultant hydraulic pressure exerted on the formation causes one or more fractures to be created therein and/or extends any existing fractures (natural or otherwise) in the formation. The fractures are extended by continued pumping, and optionally, the fractures are: i) either propped open by a propping agent (a proppant), e.g., sand, deposited therein; or ii) the fracture faces are etched by a reactive fluid such as an acid whereby hydrocarbons contained in the formation readily flow through the fractures into the wellbore.

[0003] Several fracturing techniques are known for use in stimulation of hydrocarbon recovery. Examples of several prior art techniques are provided in the following patents: U.S. Pat. No. 4,415,035 (the ‘035 patent) teaches, for example, a method for forming fractures in a plurality of hydrocarbon-bearing formations communicating with a vertical well penetrating a subterranean earth formation during a single fracturing treatment without having to resort to separate and individual fracturing through use of mechanical packers, limited entry, ball sealers, diverting agents or other plugging means as taught in the prior art (column 2 lines 26-34). The ‘035 patent also teaches that the perforations of all stages are to be completed prior to introduction of the fracturing fluid in the vertical wellbore. This is known in the art as “Hail Mary” fracturing. The ‘035 patent pertains solely to vertical wells with no mixing of perforating in horizontal or deviated wells. It is known and agreed that the geometry of the well plays a significant role in fracture creation and propagation.

[0005] Love, T. G. et al., “Selectively Placing Many Fractures in Openhole Horizontal Wells Improves Production” SPE International Conference on Horizontal Well Technology, 1-4 Nov. 1998, Calgary, Alberta, Canada teaches a method of fracturing a wellbore by hydraulically fracturing the technology comprises fracturing the entire wellbore using acid. A sand pill is inserted in the wellbore after each fracture prior to fracturing the next location. Although the article alleges that the fracturing process does not require any plugs, it does require sand plugs (i.e. diverter or isolation means) in order to establish and maintain the pressure. Further this reference requires perforation of all the areas of interest in the wellbore prior to the fracturing process.

[0006] U.S. Pat. No. 4,850,431 (“the 431 patent”) teaches a method of forming a plurality of spaced, substantially parallel fractures from a deviated or horizontal wellbore. In this method, a casing is placed in the deviated wellbore, and a plurality of spaced fracture initiation points are created therein by forming a set of perforations of predetermined number and size through the casing and into the formation. Hydraulic pressure is applied under predetermined conditions to the perforations at the fracture initiation points simultaneously to extend a plurality of spaced substantially parallel fractures in the formation from the deviated wellbore (i.e. simultaneous multi-stage fracturing).

[0007] After the sets of perforations at the fracture initiation points are created throughout the entire wellbore, each set of perforations at each fracture point is isolated, and hydraulic pressure is applied thereto (column 2 lines 41-46). At the paragraph bridging columns 5 and 6, the 431 patent states this is the most preferred technique. The only example in the 431 patent specifically states at column 7 lines 29-32 “Prior to pumping the fracturing fluid containing propping agent into the wellbore, each of the sets of perforations at the fracture initiation points is isolated . . . .”

[0008] U.S. Pat. No. 4,977,961 (“the 961 patent”) teaches a method of creating parallel vertical fractures in horizontal or inclined wells. The 961 patent teaches two ways of fracturing a horizontal well with regard to second perforations following the first perforations.

[0009] The 961 patent teaches the following steps:

a) Perforating a casing at a first perforation point;

b) Perforating a casing at a second perforation point;

c) Applying hydraulic pressure at first and second perforations simultaneously; and

d) Producing the formation fluids to the surface.

[0010] An alternative process comprises the following steps:

a) Perforating the casing at the first perforation point with a first pair of perforations;

b) Applying hydraulic pressure to propagate a fracture;

c) Isolating the first pair of perforations from fluid communication;

d) Perforating the casing at the second perforation point with a second pair of perforations; and

e) Applying hydraulic pressure to initiate and propagate the fracturing at the second pair.

[0010] PCT Application WO 2012/054139 (“the 139 patent”) teaches a method of creating a network of fractures in a reservoir. This method includes creation of fractures by injecting fracturing fluid fluid, monitoring of the stress and then expanding the fractures by continuous injection of fracturing fluids in the wellbore. The 139 patent also requires the use of isolation or diversion means such as packers, fracturing ports, mechanical plugs, sand plugs, sliding sleeves, and other devices known in the art.

[0021] The cost of stimulating production from horizontal wellbores often requires hydraulic fracture stimulation for the well to be commercial. The cost of hydraulic fracture equipment and wellbore intervention equipment required for these operations are often based on the amount of time the equipment is on location regardless of whether the equipment is in use. If the amount of this "stand-by" time on location can be reduced, the cost of the hydraulic fracture stimulation operation can be reduced, and in many cases significantly. A typical hydraulic fracture treatment might take 3 to 8 hours or more to complete. The operations performed during this time are often wellbore preparation such as setting plugs and perfor-
rating the pipe while the fracturing equipment is shut down and nonproductive. Equipment providers may charge standby charges for this down time, or they may charge a day rate or a flat rate for the equipment per day regardless of whether the equipment is in operation. If the amount of time required to set plugs and perforate the wellbore were eliminated and/or taken off the production path, that is, these operations were performed while the hydraulic fracturing stages were being pumped, the operator would finish the fracturing project sooner and one benefit would be a reduction in overall cost associated with the process.

[0022] There is a process referred to above know in the industry as Just In Time Perforating, (JITP). It is our understanding that the process requires a mechanical isolation method to divert the fracturing fluids from one perforated interval to the next. These perforations are created with shaped explosive charges or high velocity fluids, such as Hydra-Jet or Abrasive-Jet processes. It is our understanding that the initial interval is perforated by means understood in the industry. After a flow path is established from the casing into the subterranean strata via these holes (perforations) in the casing, hydraulic fracturing begins by pumping fluid or gas into the casing at sufficient pressure to gain entry into the zone of interest to stimulate production of the fluid or gas i.e. hydrocarbons contained therein. The next step is the first part of the existing JITP process. The perforating device, (e.g.: a “Select Fire” wireline perforating (“perf”) gun), is pulled up the wellbore to the next zone of interest in preparation for perforating operations, while pumping of the previous interval continues.

[0023] In traditional applications of multistage hydraulic fracturing, the next step would have been to pull the perforating device completely out of the wellbore, with the exception of some coil tubing operations where perforating takes place with high velocity abrasive fluid pumped down the coil tubing at sufficient rates to create holes in the casing. In this exception, the fracturing fluid may be pumped down the annular path only, down the tubing or via a common manifold, that is, both tubing and annular space. The JITP process utilizes the Annular Path Method (see for example “Packerless Multi-stage Fracture-Stimulation method Using CT Perforation and Annular Path Pumping”, L. East, J. Rosato, M. Farabee, and B. W. McDaniel, SPE Annual Technical Conference and Exhibition, 9-12 Oct. 2005, Dallas, Tex.) to continue the fracturing process while the wireline remains in the wellbore. The annular path in this case is the annular space between the wireline and the internal diameter of the hole, e.g.: production casing. This method includes stimulation via the annular path method that utilizes a mechanical isolation/diversion method, e.g.: perforation ball sealers (“Perf Balls”). Perforation ball sealers are stiff balls of sufficient strength that will seal a perforation from flow in the direction of the wellbore into the zone of interest during high pressure stimulation operations understood by those knowledgeable in hydraulic fracturing and/or acidization.

[0024] When sufficient fracturing fluid has been pumped into the zone of interest per the pumping schedule or at such point where the end of treatment is determined, preferably by independent means by those supervising the treatment, preparations are made to perforate the subsequent zone of interest via select fire perforating. “Select fire” is a term understood by those skilled in the oil and gas extraction industry as a perforating device (“perf gun”) capable of multiple operations with expendable perforation charges. Multiple perf guns are deployed on a wireline to permit multiple perforation operations via technology know to the person skilled in the wireline perforation industry. Each perf gun is either selected to fire on demand via multiple conductor wires deployed in the wireline from the surface to the perf gun, or selected to fire on demand via Internet Protocol devices built into both ends of the wireline, one a sender at the surface and one a receiver at the perf gun. Other methods in the common domain to form multiple interval perforations along sections of a wellbore casing may also be implemented.

[0025] Since the perf gun is pulled along the wellbore to the next zone of interest during the first step, the perf gun when fired will perforate the next zone of interest just in time for fluid or gas to enter the perforations. The perf gun however is not fired until the previous interval has been mechanically sealed off from further injection of fracturing fluid or gas. The sealing method deployed is understood to be the use of perforation ball sealers of sufficient size to seal off the existing perforations, but small enough to be carried down the casing with the stimulation fluid past the wireline and perf gun tools. Once these perforation balls seal existing perforations and begin shutting off flow of fracturing fluid to the previous zone of interest, the pressure in the casing rises due to what is referred to as perforation friction. To those knowledgeable in limited entry theory, perforation friction increases with increased flow into perforations. The sealing of the perforation by the perf balls forces excess fluid into the remaining unsealed perforations. This is seen at the surface as an increase in surface treating pressure. At this instance, the operators are warned it is time to fire their perf guns as the pressure increases to a predetermined pressure within the working limits of the production casing in the wellbore. Once this pressure is reach, the perf guns are fired resulting in new perforations in the casing proximate the next zone of interest, and if sufficient perf balls are deployed, all perforations in the previous zone are now plugged. The fracturing fluid or gas enters the new interval without a change in rate required at the surface.

[0026] As discussed above, the prior art requires the use of isolation or diversion means to isolate one stage from another, prior to fracturing. The use of isolation or diversion means at each stage is costly, both financially and temporally. The cost associated with deploying, setting and removing plugs in a typical wellbore setup can run up to $1 MIL/wellbore. It is known that the removal of a plug is more expensive than the setting of the plug. Generally the plugs have to be drilled out or otherwise extracted from the bore prior to commencing hydrocarbon recovery. The time involved in drilling out the plugs is also costly. Furthermore, the use of diesel fuel or other hydrocarbon energy sources used to drive pumps and machinery during drilling operations to remove the plugs and the associated waste may have a negative impact on the environment.

[0027] Some of the costs associated with the prior art processes include (but are not limited to): cost of setting a bridge plug; cost of the bridge plug; cost of drilling out bridge plugs; cost of surface equipment; cost of fluids pumped plus expendables such as bits motors etc.; and the time value of money for delayed hydrocarbon production.

[0028] Therefore there is a need for a process of generating a plurality of fracture points in the hydrocarbon formation with greater efficiency, and optionally lower cost, and further optionally with less deleterious impact on the environment.
The current invention presents an improved method of forming a plurality of fractures from a single deviated wellbore. The process presented in the current invention is an improvement of the above described processes. This process in one embodiment, saves the operator the down time normally required to do the following steps:

0029] a) pulling the wireline deployed perf gun to the surface;

0030] b) treating the wellbore for isolating the previous perforation stage; and

0032] c) redeploying of the perf gun after treatment is completed.

SUMMARY OF THE INVENTION

0033] The following terms are used herein to better understand the present invention:

0034] Interval—a plurality of stages without any isolation or diverter means therein.

0035] Stage—a discrete event comprised of a sequence of activities with a beginning and an ending.

0036] Generally a stage comprises a perforation of the wellbore casing and fracturing proximate said perforation.

0037] Isolation means—a device used in isolating one or more stages from another stage in order to isolate, restrict or direct the acceptance of fracturing fluids at the appropriate time at a predetermined interval.

0038] Examples of isolation means include but are not limited to:

0039] Bridge Plugs—solid in cross section with sealing elements that make contact with the wellbore casing internal diameter (ID) providing a hydraulic seal where fluids are not able to transmit from one side of the plug to the other per design.

0040] Fracking Plugs or Frac Plugs—solid mandrels that have a conduit through the center to permit flow in one direction or both. Ultimately, flow is only permitted in one direction during stimulation operations. Frac plugs do not permit flow from the surface through the device, but will permit flow from below the device in a direction toward the surface, in the case of a wellbore with one surface access point. The various mechanisms employed are known to those well versed in the art oilfield tools and casing attachments to be, darts check valves, ball and seats, ball valves, caged balls that are provided by various oilfield service companies.

0041] Sand Plugs (Sand Pills)—early references to placing sand in vertical well casings called this the “Pine Island” technique. Sand is placed by various means to form a restriction to flow above existing access points in the direction below the next or subsequent stage. In the Pine Island technique, sand was mixed with water and dumped into the well casing such that it would fall into the bottom of the well, covering existing casing access points, in this case perforations in pipe. In the case of horizontal wellbores, the sand plug is placed by mixing and pumping sand via tubular conduits established with their bottom ends near existing casing access points. Well fluid is permitted to circulate between conduits either up the tubing well casing annulus, or up the tubing when pumping on the well tubing casing annulus. Once in place, the sand plug provides sufficient resistance to fluid flow such that the underlying casing access points are isolated from receiving additional stimulation fluid.

Solid Plugging Material

0042] Perforation ball sealers—rigid spherical devices designed to follow stimulation fluids to openings in the well casing where they effectively lodge restricting flow of additional fluid. The openings are rendered isolated from the bulk of the fluid introduced into the well casing from that point, until released from said opening or it loses its solid form as in the case of Santrol product marketed as “BioBalls™”. Early devices were described as R&C Perlapacs balls, R&C being Rubber Counted Nylon.

0043] Rock Salt—graded water soluble salts that will bridge any opening in the well casing capable of accepting fluid. Once in place, the material restricts flow of subsequent fluid entering said access point. One of the examples is marketed as TBA-110 or under various other trade names. Another example is Benzoc Acid Flakes or any other solid material that is soluble in water or oil, or loses its solid form by any means in time. This material isolates any opening capable of accepting fluid as with all others in this category. This may be marketed as TIC80.

0044] Any material or device introduced into a well casing in a position directly opposite or above existing access points in said well casing with the intention to divert fluid past said access points, or to stop fluid from entering said well casing access points. Examples may include: packers, slick line plugs, sliding sleeves and more.

0045] Well casing—Any device or method that serves as a conduit and a lining or barrier of petroleum wellbore, preventing said wellbore from collapse, protecting the ground water from contamination and safely conducting drilling and subterranean fluids to the surface. For example, but not limiting, steel pipe cemented in place.

0046] Fracturing or Fracking Fluid—Water and water containing various chemical and mineral additives known to those well versed in the art and science of general oil and gas well stimulation as fracturing fluid. Said fracturing fluid, also referred to as fracturing fluid or stimulation fluid, may include various industrial gases such as, carbon dioxide, nitrogen, or various compositions of natural gas such as methane, ethane, propane or butane, or hydrocarbon liquids such as lease crude, or diesel.

0047] “Plug and Perf”—one of many methods for fracturing a hydrocarbon reservoir. The wellbore for a plug and perf job is generally composed of standard joints of steel casing, either cemented or uncemented, which is set in place at the conclusion of the drilling process. Once the drilling rig has been removed, a wireline truck is used to perforate near the end of the well, following which a fracturing job is pumped (commonly called a stage). Once the stage is finished, the wireline truck will set a plug in the well to temporarily seal off that section, and then perforate the next section of the wellbore. Another stage is then pumped, and the process is repeated as necessary along the entire length of the horizontal part of the wellbore.

0048] Access (access point)—this is a point of communication between the wellbore and the formation. The access point can be created by any means known in the art. For example, but not limiting, it can be made by a perforation using a perforating gun (“perf gun”), or other means. The access point can have at least one passage through the casing of the wellbore, or have a plurality of passages through the casing also referred to as a cluster. The plurality of perforations may be in one line along the length of the casing, opposite each other along the diameter of the casing, and/or
positioned in a specific direction corresponding to a point of interest in the formation, or may be randomly positioned throughout the casing.

[0049] Formation—a subterranean zone, such as rock or shale development, comprising a hydrocarbon deposit.

[0050] The process of the current invention reduces and/or eliminates the use of an isolation plug (or diverter means) and although not being limited to this mechanism, it is believed relies on pressure differences/rock stress changes to naturally divert the fracturing fluid into the new perforations.

[0051] The process of the current invention, in one embodiment stimulates a new fracture in the new perforations by the introduction of fracturing fluid in the new perforations, therefore stimulating new rock/shale (resulting in new fractures), rather than having the fracturing fluid go into the previous fracture without stimulating new rock/shale through the new perforations. This is accomplished without the need for isolation or diverter means, as is needed in the prior art.

[0052] According to one aspect of the invention, there is provided a method of stimulating a new interval, in the recovery of hydrocarbons, in an underground hydrocarbon reservoir, from a deviated wellbore. The method comprises the introduction of at least two sequential stages into said wellbore without isolation means. Said method comprises the following steps:

(i) introducing a first stage by:

[0053] a) creating a first access point through a wellbore casing into a hydrocarbon formation;

[0054] b) introducing at least one fracturing fluid to said first access point, at a predetermined rate and pressure to create at least one fracture in the formation, proximate said access point to stimulate hydrocarbon production from said hydrocarbon formation;

(ii) introducing a second stage in the same wellbore by:

[0055] a) creating a second access point, distant said first access point, through said wellbore casing into said hydrocarbon formation proximate the first stage;

[0056] b) introduce at least one fracturing fluid to said second access at a predetermined rate and pressure to create at least one fracture in the formation, proximate said access point to stimulate hydrocarbon production from said hydrocarbon formation;

[iii] recovering said hydrocarbons from said hydrocarbon reservoir by means known in the art.

[0057] According to another aspect of the invention, there is provided a method of fracturing a plurality of stages, without the need of any isolation or diversion means, in a wellbore, preferably a deviated wellbore, penetrating a subterranean hydrocarbon formation. In one embodiment, the method comprises:

[0058] i) drilling a substantially vertical wellbore into the formation and deviating from said substantially vertical wellbore to form a deviated wellbore from said substantially vertical wellbore at an angle and direction substantially parallel to the ground;

[0059] ii) introducing a casing in the deviated wellbore;

[0060] iii) introducing a first stage by creating an access point through the casing into the formation;

[0061] iv) introducing at least one fracturing fluid to said access point, preferably at a predetermined rate and pressure to create at least one fracture in the formation, proximate said access point of said first stage;

[0062] v) introducing a second stage by creating an access point through the casing into the formation;

[0063] vi) introducing at least one fracturing fluid to said access point, preferably at a predetermined rate and pressure to create at least one fracture in the formation, proximate said access point of said second stage; and

[0064] vii) recovering the hydrocarbon from said formation,

wherein said first stage and second stage are not isolated from each other.

[0065] In a preferred embodiment, the pressure conditions of the wellbore are monitored to determine the moment of completion of the first stage and the commencement of forming the second stage.

[0066] In yet another preferred embodiment, proppants are introduced with the fracturing fluid to prop the fractures in the formation.

[0067] Preferably, the deviated wellbore extends substantially horizontally or at any operational angle of up to 45° from the heel of an initial substantially vertical wellbore. More preferably, the deviated wellbore extends substantially horizontally or at any operational angle substantially 90° of vertical, preferably ±10°, more preferably ±5°. Alternatively the wellbore may be of variable geometry and its substantially horizontal part can vary its direction and elevation angles.

[0068] Preferably the access point is comprised of at least one perforation in a direction substantially perpendicular to the wellbore casing. More preferably, the access point is comprised of a plurality of perforations. The perforation or perforations may be positioned along the length of said casing, or along the perimeter of said casing. In a further embodiment, the direction of any of the perforations may vary from substantially perpendicular to allow access by the fracturing fluid to the formation in order to cause or propagate a fracture in the formation proximate said perforation.

[0069] Preferably, the fracturing fluid may comprise at least one liquid, gas, or combination thereof, preferably with at least one solid. While several types of fracturing fluid compositions may be introduced consecutively through the access point to the formation, in a preferred embodiment, the fracturing fluid may further comprise proppants, to prop the fracture. Examples of proppants include, but are not limited to, natural sands, manmade ceramics, bauxites etc.

[0070] Preferably, the recovery process of hydrocarbons comprises:

[0071] i) terminate the injection of fracturing fluids;

[0072] ii) reduce the pressure at the wellbore to allow entry of the hydrocarbons from the fracture in the formation into the wellbore via the perforations;

[0073] iii) optionally transfer the hydrocarbons to the surface; and

[0074] iv) collect the hydrocarbons.

[0075] Preferably the recovery process of hydrocarbons is implemented with the use of recovery equipment which may comprise electrical, mechanical, active or passive equipment. In some instances some or all of the hydrocarbons may be recovered by the resultant pressure build up in the wellbore from the introduction of the fracturing fluid(s).

[0076] According to yet another aspect of the invention, the stimulation of a new interval involves an introduction of at least two stages not separated by any isolation means. In one instance, the range of stages may comprise between three to thirty stages, or more if desired. The number of stages in an interval may depend on the type of formation, length of well-
bore, overall thickness of the formation, proximity of the well and wellbore to other wells and wellbores.

According to yet another aspect of the invention there is provided a method of stimulating a hydrocarbon reservoir comprising stimulating at least two intervals according to the methods described above, wherein said at least two intervals comprise at least two stages, preferably at least three stages, and wherein said at least two intervals are separated by isolation means. Prior to hydrocarbon recovery said isolation means are altered to allow flow from said interval into the wellbore, preferably said isolation means is removed from the wellbore.

According to yet another aspect of the invention, there is provided a method of stimulating a new interval, in a substantially horizontal wellbore, in a hydrocarbon reservoir. Said method comprises introducing two or more sequential stages into said wellbore without isolation means between said stages, said method comprising:

i) introducing a first stage by:

a) creating a first access point through a wellbore casing into a hydrocarbon formation;

b) introducing at least one fracturing fluid to said first access point, preferably at a predetermined pressure and rate, to stimulate hydrocarbon production from said hydrocarbon formation;

c) monitoring operating conditions of said wellbore at a predetermined time throughout said method;

ii) introducing a second stage in the same wellbore by:

a) creating a second access point, proximate said first stage, through a wellbore casing into a hydrocarbon formation;

b) introducing at least one fracturing fluid to said second access point, preferably at a predetermined pressure and rate, to stimulate hydrocarbon production from said hydrocarbon formation;

c) monitoring operating conditions of said wellbore at a predetermined time throughout said method;

wherein said first stage, and second stage are not separated by any isolation means.

In another embodiment, the method of stimulating hydrocarbon recovery further comprises introducing a consecutive stage (or stages) in the same wellbore by:

a) creating at least one consecutive access point through a wellbore casing into a hydrocarbon formation proximate a previous stage;

b) introducing at least one fracturing fluid to said consecutive access point, preferably at a predetermined pressure and rate, to stimulate hydrocarbon production from said hydrocarbon formation;

c) monitoring operating conditions of the wellbore at a predetermined time throughout said method;

d) terminating stimulation to allow for recovery of hydrocarbons; and

e) recovering hydrocarbons from said hydrocarbon reservoir by means known in the art;

wherein said first stage, second stage and the consecutive stage (or stages) are not separated by any isolation means.

The length of each stage will be determined by the overall length of the wellbore, the location of the wellbore and formation characteristics. Preferably the length of each stage may be from about 10 to about 300 meters, more preferably from about 100 to about 200 meters.

The interval between stages can range from a predetermined length, preferably from about 10 to about 100 meters, in another instance, the interval can also be more than 100 meters.

The distance between each access point may be determined by techniques common to those knowledgeable in the art. These techniques may include, but are not limited to analytic or numeric models or analog laboratory models as deemed necessary to effectively stimulate hydrocarbon production. Such models may include, but are not limited to fracture growth simulations as well as economic evaluations such as Net Present Value or Return on Investment calculations based on the cost of goods and services employed as well as the current or future selling price of Natural Gas and/or Oil. Preferably, the distance between each access point in each stage may be up to 25 meters. For example, a 1000 meter interval in a wellbore may have 10 stages of 100 meters/stage, with each stage comprising as few as one and as many as 10 or more access points.

Preferably, each access point comprises at least one perforation or point of access. More preferably each access point comprises a cluster or plurality of perforations proximate each other at a predetermined distance from each other. Preferably each perforation in the cluster is positioned at a distance of less than one meter from each other in the same wellbore.

According to yet another aspect of the invention there is provided a method of fracturing multiple stages in hydrocarbon deposits from intervals in a horizontal wellbore, without using isolation means. Examples of isolation means include but are not limited to ball sealers, mechanical packers, or particulate bridging material, or any other isolation means or mechanical means as discussed herein.

Said method comprising the steps of:

a) selecting a wellbore appropriate for carrying out the method of fracturing without the use of isolation means;

b) selecting an appropriate stage location in said wellbore, optionally based on seismic and/or other measurements and studies such as but not limited to geophysics, petrophysics, petroleum geology, structural geology and reservoir engineering;

c) providing at least one perforation, preferably a set of perforations at a first opening for the first stage of the wellbore;

d) pumping at least one stimulation fluid or sequence of stimulation fluids into said at least one perforation;

e) observing the injection rates and pressure in the stage selected;

f) selecting an appropriate stage location in said wellbore, optionally based on seismic and/or other measurements and studies such as but not limited to geophysics, petrophysics, petroleum geology, structural geology and reservoir engineering,
[0104] g) providing at least one perforation, preferably a set of perforations at a consecutive opening for the consecutive stage of the wellbore without use of isolation means.

[0105] h) pumping at least one stimulation fluid or sequence of stimulation fluids into said at least one perforation;

[0106] i) observing the injection rates and pressure in the stage; and

[0107] j) optionally repeating steps (f) to (i) without isolation means between the stages.

[0108] The present invention results in effective preparation of the hydrocarbon reservoir for hydrocarbon production by reduction of time spent performing fracturing operations; and/or by reducing the non-pumping time which is achieved by reducing and/or eliminating the requirement of placing isolation or diverting means such as plugs between the stages; and/or by reducing and/or eliminating the need of removal of the plugs prior to hydrocarbon production.

[0109] Preferably, according to the present invention, the process of hydraulic fracturing, involves fracturing of at least two stages without the need for a diverting or isolation device. Examples include, but are not limited to ball sealers, concrete, bridge or sand plug or plugs.

[0110] Preferably the fracturing fluid is introduced at a fluid injection rate with pressure limitations determined by modern wellbore construction methods. The expected surface wellhead pressure is dependent on the depth of the wellbore and the length of the wellbore. The depth of the wellbore affecting expected bottom hole injection pressure and the length of the wellbore affecting the total fluid friction that must be overcome at a specified injection rate. Typical surface pressure ranges for a wellbore about 2500 meters below surface, and about 2500 meters in lateral length can range from about more than 15 MPa to about 100 MPa, more preferably from about 35 MPa to about 65 MPa. Furthermore, the pressure may also be dependent on the formation the wellbore is situated. The bottom hole injection pressure required to initiate and extend a hydraulic fracture is dependent on the in-situ rock properties including regional tectonic stress. These values can be approximated by those skilled in the process of hydraulic fracture treatment design, utilizing petro physical, sonic, nuclear and electrical wellbore measurements along with knowledge of petroleum and structural geology and geophysics. The person of ordinary skill in the art will adjust the method of introduction, injection rate and fluid composition and volume as well as the amount and concentration of oilfield propping agents to allow adequate hydrocarbon production stimulation and recovery.

[0111] Preferably the fracturing fluid is introduced at a rate ranging from about one cubic meter per minute with the lower limit determined by the minimum design rates necessary to effectively create a hydraulic fracture opening within or directly adjacent to a hydrocarbon bearing strata or strata by those knowledgeable in the art of the stimulation of horizontal wellbores within hydrocarbon bearing strata to about 18 cubic meters per minute or more limited on the upper injection rate only by the available surface pumping equipment delivery pressure and rate limits and the casing safe working pressures, more preferably from 5 to 15 cubic meters per minute.

[0112] According to yet another aspect of the invention, the stimulation or fracturing fluid optionally comprises a tracer or marker, preferably a radioactive material to assist in monitoring operation conditions in the wellbore and determine effectiveness of the fracturing process of the current invention.

[0113] Preferably, at least two stages of the horizontal wellbore subsequent to the first stage are fractured without using conventional diverting techniques and the location of the subsequent stages are selected by observing at least one of the injection rates, fluid path and pressure in the stage selected by recording micro-seismic emissions during stimulation operations via commercial geophysical emission recording devices know in the oil and gas industry as geophones deployed either at the surface in a focused array or deployed into vertical and/or horizontal wellbores by means known and practices as well as recording the presence of gamma emitting tracer element indications in said deposit post stimulation operations via the process or processes know in the industry capable of detecting gamma ray spectrum to ascertain the presence of said gamma emitting isotopes, preferably scandium, iridium and antimony.

[0114] According to yet another aspect of the invention there is provided a continuous fracturing process. Once it has been determined by following a pumping schedule as described above or by decisions based on well treatment responses, that the current stage should be ceased, the perforation guns would be fired while pumping continues. It has been observed that this process results in the newly opened perforations taking the majority of the incoming fracturing fluid. It has been observed via pressure rate responses that if less than 80% of the fracturing fluid enters the new perforations according to the present invention, the last stage perforated would be pumped as planned, however, at this stage an isolation means or diverting means will be required to continue with the process of the present invention. At this stage, pumping would cease and the wireline perforation gun is pulled out of the wellbore. Preparations would then be made by those knowledgeable of horizontal plug and perf operations to perform a plug and perf operation.

[0115] Surprisingly, the novel process results in a substantial improvement of the fracturing process. In one example, shale gas wells in the Horn River Basin have been stimulated without the need for mechanical isolation and led to unexpectedly positive results discussed in more detail below. Therefore the present invention is also applicable to a continuous fracturing process.

[0116] The invention in one instance is a continuous process for use in horizontal/deviated multi-stage fracturing operations. The process may utilize wireline deployed select fire type perforating devices in a continuous fracturing stimulation process without mechanical diverters or isolation means during the stimulation process. These diverters however may be deployed following an either planned or unplanned pumping operations cessation. It is generally accepted in the industry that the use of mechanical devices known in the Oil and Gas industry such as, perforation ball sealers, bridge plugs or packers are required to isolate previous frac intervals from current frac intervals when diversion is necessary, and these devices are planned to be deployed after the completion of each successive hydraulic fracture stimulation stage. The current invention reduces the frequency of use of these tools and/or eliminates these mechanical diversion methods in practical application.

[0117] In the prior art describing multiple perforations followed by a single fracturing event, there is only one stage in the interval. In the current invention there are a minimum of two stages (more than one stage) in each interval.
A stage begins after one or more access points are created in a well casing to provide direct access to adjacent hydrocarbon bearing subterranean strata and ends with the creation of subsequent access points in said well casing with hydraulic fracture stimulation activities performed. To those well versed in Oil and Gas well stimulation activities, a stage is defined as an activity performed in sequence with other physical well activities that are often repeated with the intent to achieve a desired well response. In the case of horizontal wellbore, hydraulic fracture stimulation operations, the stage is stimulating production from a hydrocarbon bearing reservoir rock at rates that will exceed the natural un-stimulated production rates.

The number of stages performed in this operation is limited only by the dimensional constraints of the wellbore placed adjacent to the hydrocarbon bearing reservoir. In the current state of the art, a stage sequence is performed over a zone of interest between 25 meters to 150 meters more or less, with available horizontal wellbore lengths between 1000 meters and 3000 meters in length. For example: a 1000 meter horizontal wellbore might be stimulated with 10 stages with stage lengths of 100 meters of zone per stage and one access point every 25 meters for a total of 4 access points per stage. Another example might be to perform the same number of stages in a horizontal wellbore 2000 meters in length with 200 meters per stage and one access point every 20 meters for a total of 10 access points per stage.

In one embodiment, the process of the present invention may be applied to at least two stages. That is, following a traditional plug & perf stage, at least two "plugless" stages may be executed. A plug may be placed up hole subsequent to the plugless stages and the remaining stages may be completed with traditional plug and perf, or with plugless stages or a combination of plugless and perf & plug stages.

In another embodiment of the invention, the entire well may be stimulated for hydrocarbon recovery entirely with plugless stages.

In another embodiment of the invention, a well may be completed with plugless stages until surface pressure and rate measurements suggest fracturing fluid is entering previous stages, or rather than a hydraulic fracture being created in the stimulation process, the fracturing fluid is entering a fault in the subterranean strata, negating the benefits of continuing the stimulation process as the benefits of stimulating a fault are either undetermined, undesirable, or ineffective, at which point the plugless process should be suspended. In this case, a plug would be run following the last stage and the process would either continue with plugless stages until once more pressure and rate measurements suggest the process should again be suspended with the application of a traditional plug & perf.

In another embodiment of the invention, perforations may be placed in any position within the wellbore. In one example: the interval traditionally referred to as zone three based on sequential stage increments from the bottom or toe section of the wellbore toward the heel of the lateral section of the wellbore, may be perforated before the interval traditionally positioned in the wellbore as zone two, which would be in a position closer to the toe than zone three. Zone one is traditionally the first interval closest to the toe or deepest portion of the accessible cased wellbore. Zone two is traditionally the next interval in the cased wellbore at a predetermined position in the wellbore, often at equally spaced intervals of fixed length. The zones are named such from toe to the upper most accessible portion of the casing sequentially in numeric order, (1, 2, 3, 4...40). The number of these zones has increased from just two intervals as performed in the early development of the Barnett Shale, to as many as 40 or more zones. In the present invention, the zone three interval position when applying the plugless fracturing process can now be considered as stage two chronologically, even though it is placed sequentially within the wellbore in the zone three position based on wellbore length. Once this stage two fracturing treatment is pumped into this zone three position, the stage three interval would be perforated at the zone two position, a step backward in the normal sequence as per the prior art. One benefit of this plugless fracturing process is it gives the operator the opportunity to perform fracturing treatments out of sequence when compared to traditionally plug and perf methods that require a sequential progression from toe of the accessible cased wellbore to the heel section. Typically, operators would not place a mechanical plug in the wellbore and then drill one out and work backwards as an embodiment of the present invention suggests. Other benefits to this out of sequence fracturing process takes into consideration the way the subterranean strata will respond to hydraulic fracture induced stresses and the pattern of fractures that will be developed when placing a fracture initiation point between existing hydraulic fractures. The inventors believe by placing hydraulic fracture initiation points within existing hydraulic fractures will take advantage of the altered stress field within the fractured strata resulting in improved stimulated reservoir volumes when compared to the traditional sequential fracturing process. This process is novel as no hydraulic or mechanical diversion method or isolation means are employed permitting the fracturing fluid to enter various positions along the wellbore.

In another embodiment, this process may be applied readily as a refracturing application for existing wellbores. These existing wellbores may have been stimulated with the Plug & Perf method or one of various other multi-stage fracturing methods for cased horizontal wells. That is, cased cemented monobores, cased cemented liner, or cased un-cemented wellbores such as those referred to by tradename, Packers Plus STACKFRAC®, Baker FracPoint™, etc., that utilize mechanical isolation methods deployed on the casing in the form of, mechanical external casing packers, rock packers, and swellable packers. Or in some cases, no mechanical isolation methods are deployed on the external portion of the casing string. In addition, these methods employ internal diversion devices (such as ball activated sliding sleeves) to divert fluid to various zones along the casing string. Other multi-stage methods may have utilized perforation ball sealers as the primary diversion method, or no diversion at all such as often referred to as a “Hail Mary” frac where the entire wellbore or a portion of the wellbore is completely perforated and the ability of the fracturing fluid introduced into the wellbore to enter all intervals is a risk like a “Hail Mary” pass in American Football.

During a refracturing operation with this plugless fracturing invention, operators may introduce the fracturing fluid into all of the existing perforations to sufficiently stress the previously hydraulic fractured intervals. In another embodiment, they may perforate an unperforated zone and then begin the process. Once a sufficient volume of fracturing fluid has been pumped, the next interval in between existing perforations would be perforated and fractured sequentially.
from toe to heel or in a reverse order as discussed above, or in any order deemed suitable to result in hydrocarbon recovery from the formation. In the case where other methods such as ball activated sliding sleeves or other stage tools are present within the wellbore, perforations may be introduced at any point in between said stage tools.

[0126] Other and further objects, features and advantages of the present invention will be readily apparent to those skilled in the art upon a reading of the description of preferred embodiments which follows when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0127] FIG. 1 is a schematic illustration of an interval in a wellbore having three stages not separated by plugs or isolation means according to the present invention.
[0128] FIG. 2 is a schematic illustration of the prior art having three fracturing stages separated by plugs.
[0129] FIG. 3 is a schematic illustration of the prior art depicting removal of plugs prior to the recovery stage.
[0130] FIG. 4 is a schematic illustration of an example between the prior art method and the method of the present invention.
[0131] FIGS. 5A-F are schematic illustrations of the steps of creating an interval with three stages not separated by a plug according to the present invention.
[0132] FIG. 6 is a schematic illustration of two segments of a well, separated by a plug according to the present invention.
[0133] FIG. 7 is a schematic illustration of the prior art method in an uncemented wellbore.
[0134] FIG. 8 is a schematic illustration of the fracturing process in an uncemented wellbore according to the present invention.
[0136] FIGS. 10A-B-C provide an illustration of the microseismic data of well c-CJ-94-0-8.
[0137] FIG. 11 depicts the data of stages 11, 12 and 13 that were RA traced to track the distribution of the fracturing fluid introduced using the present invention.
[0138] FIG. 12 depicts a pressure log from a completion test on well c-E1-J.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0139] FIG. 1 is a schematic illustration of a multiple stage fracturing process according to the present invention. As can be seen, the wellbore 20 has a horizontal section 24 extending from a vertical section 22. The wellbore 20 is equipped with a “Christmas tree” segment 21 of the wellbore above the ground 10. Underground below the shale rock 11 there is a hydrocarbon containing reservoir 112 which is of interest in hydrocarbon recovery. The horizontal section 24 extends between the heel 23 and the toe 27 of the wellbore 20. The horizontal section 24 has a casing 25 that is cemented 26. Two complete stages, stage 201 and stage 202 of the fracturing operation are depicted. Stage 201 has an access point 39 made up of perforations 30 and 31 to allow fracturing of the hydrocarbon reservoir 112 with a fracturing fluid 34 resulting in fractures 32 and 33. Stage 202 has an access point 49 with perforations 40 and 41 and fractures 42 and 43. Perforations 30, 31, 40, 41, 50 and 51 in FIG. 1 are created by means known to the person skilled in the art such as a perforation gun. Stage 203 depicts the process of introducing the fracturing fluid 34 through access point 59 via perforations 50 and 51 creating a stimulating pressure resulting in the fracture the reservoir 112. FIG. 1 illustrates an interval having three stages 201, 202 and 203 not separated by any diverting means. In this instance, stages 201 and 202 are separated by a predetermined length 29.

[0140] FIG. 2 is a schematic illustration of the prior art traditional “Plug and Perforate” method. There are two fractured stages, 101 and 102, with a third stage 103, perforated and undergoing fracturing. According to this method the reservoir 112 has a horizontal well 124 comprising a casing 125 and cemented casing 126. In the first stage 101, perforations 130 and 131 are created, followed by introduction of a fracturing fluid 134 to create fractures 132 and 133. After completion of stage 101 this “Plug and Perforate” method requires the positioning of a first plug 28. After positioning of the plug 28, stage 102 is perforated to create perforations 130 and 131 followed by the introduction of a fracturing fluid to create fractures 132 and 133. After completion of fracturing of stage 102, a second plug 28 is positioned after stage 102. This “Plug and Perforate” process continues until the full length of the horizontal wellbore is fractured and the reservoir 112 is stimulated for hydrocarbon production.

[0141] FIG. 3 illustrates FIG. 2 after the “Plug and Perforate” process has been completed and shows a fully stimulated well 124. The well has a casing 125 which is cemented 126. Well 124 consists of several stages 101-105, with each stage being separated by plugs 28. Consequently, in order to recover the hydrocarbons from the reservoir 112, plugs 28 have to be drilled out by the means of drilling apparatus 70. This “Plug and Perforate” prior art process involves several steps adding time and cost to the process. For example, the coil tubing or other mechanical drill out device is required to remove the plugs (5 plugs here) as discussed above.

[0142] FIG. 4 illustrates an experiment comparing the traditional fracturing process with the present invention.

[0143] FIGS. 5A-D illustrates the current invention of forming multiple stages and fracturing each stage without the need of isolation means. The wellbore 22 has a horizontal segment 24 and a Christmas tree segment 21. FIG. 5A illustrates an introduction of an access point 39 into the wellbore 24 through the casing 25, proximate the toe 27 and distant the heel 23, providing access to the hydrocarbon reservoir 20. In this example the access 39 consists of perforations 30 and 31. FIG. 5B illustrates the fracturing of the hydrocarbon reservoir 20 by a fracturing fluid 34 through the first access 39. The introduction of the fracturing fluid 34 through the first access point 39 creates fractures 32 and 33, resulting in a first stage. FIG. 5C illustrates the start of a second stage, consecutive to said first stage and not separated from the first stage by a plug. A second access 49 is created with perforations 40 and 41 followed by the introduction of the fracturing fluid 34 proximate the second access point to create fractures 42 and 43 (see FIG. 5D). FIGS. 5E and 5F illustrate a third stage consecutive to said previous stages and not separated from the previous stages by plugs or diverters. This third stage consists of the creation of a third access point 59 created with perforations 50 and 51 and then fracturing to form fractures 52 and 53. This process may continue by introducing further stages, wherein the stages are not separated by any plugs.

[0144] FIG. 6 illustrates a first interval 271 comprising a set of several consecutive stages 201, 202, 203, and 300 separated from the second interval 272 by plug 28. The second
interval 272 comprises three consecutive stages 201', 202' and 203' once again not separated by any plugs. The casing 225 of the wellbore is cemented 226.

[0145] Each wellbore 224 may comprise a plurality of intervals separated by plugs while each interval may comprise a plurality of stages not separated by plugs. The number of stages in each interval may vary based on the geological limitations of the hydrocarbon reservoir, operational conditions of the well, operational decision of the operator or other conditions known to persons skilled in the art.

[0146] FIG. 7 illustrates another embodiment of the prior art where the wellbore 324 is uncemented. The uncemented wellbore 324 has external casing packers 327 to separate the stages 301 from each other. This “plug and perf” method in the uncemented wellbore 324 also requires positioning of plugs 328 after each perforation 330 has been fractured 332. These plugs 328 are used to direct fluid 334 between fractured stages inside the casing 325. Bridge plugs 328 must be removed before recovery of hydrocarbons unless frac plugs are employed. However, operators often drill out frac plugs to improve flow characteristics.

[0147] FIG. 8 illustrates the novel process wherein the number of bridge plugs 328 are significantly reduced compared to current fracturing techniques as depicted in FIG. 7. In the present invention, a bridge plug 328 is introduced after 5 fractured stages. Each of stages 301, 302, 303, 304, and 305 comprises a perforation step 330, 340, 350 and fracturing step 332, 342, 352 respectively by the fracturing fluid 334. Bridge plugs 328 may be required after pumping several fractured stages in order to increase the flow into new perforations once losses to previous fractures become unacceptable. Alternatively, the effectiveness and efficiency of the fracturing step can be monitored from recording of micro seismic events. The monitoring of micro seismic events in the well can take place from a proximate offset well or by other means known in the art.

[0148] The novel method illustrated in FIG. 8 reduces the number of bridge plugs in the wellbore and therefore effectively reduces the down time and the costs associated with positioning and removal of plugs.

Example

[0149] In the following example, traditional “Plug and Perf” was performed, followed by the method of the present invention, in a horizontal wellbore with a casing, to assess the viability thereof. Referring now to FIG. 4, the following was conducted:

[0150] Stages 101, 102, 103 up to 300 were created using the prior art technology “Plug and Perf” and then fractured with use of a plug 28 between each of the stages.

[0151] Upon completion of fracturing stage 300, a plug 28 was introduced into the wellbore 124. Wellbore 124 has a casing 125 which is cemented 126. Stage 201 was perforated 230 and 231 and fractured 232 and 233, followed by the perforation 241, 240, 251, 250 and fracturing 242, 243, 252, 253 of stages 202 and 203. R/A tracer was pumped (not shown) in stages 202 and 203 during fracturing. Three tracers were used: 1 isotope in test stage 202 and 2 isotopes in test stage 203. A finding of 2 isotopes of R/A material in these stages, indicated perforations in all stages and confirmed fracturing coverage using the present invention which resulted in stimulation of all intervals 201, 202 and 203.

[0152] This operation was performed on a non-continuous basis in two example wells. In these example wells, the pumping schedule was such that three zones of interest were perforated without any plugs between them. Radioactive isotopes and micro seismic hydraulic fracture mapping confirmed the success of the process of the present invention.

[0153] Referring now to FIGS. 9A, 9B, 10A, 10B—two wells (C-CL4/94-O-8 and C-E1-L94-O-8) were selected for testing of the present invention. Stages 11, 12 and 13 in well C1 and stages 12, 13, 14 in well E1 were selected. Micro seismic and radioactive material, were employed to determine the effectiveness of each “plugless” stage. All test stages were pumped as planned with some injection rate and pressure differences observed in stages 12 and 13 indicating some fracturing fluid was entering open perforations from previous stages.

[0154] Microseismic events suggest new stimulated reservoir volume was created in the area around new perforations in the direction of maximum horizontal stress as predicted. Also radioactive isotopes were measured in the area around the entire test perforations with the highest concentration of material linking stage fluid pumped to the “Plugless” test stage.

First Well:

[0155] See FIGS. 9A and 9B

[0156] Plugless Fracturing Experiments, Well C-E1-L94-O-8, Muskwa Stages 12, 13 and 14 Microseismic Events Recorded C-E1-L94-O-8 Otter Park A well with following technical specifications:

[0157] No plug set between stages

[0158] 5 perf clusters/stage

[0159] 125 m stage interval

[0160] 150 T sand, 3575 m3 per stage

[0161] Field processed data

[0162] Micro-seismic events, colored dots, are recorded opposite new perforals and very few events opposite previous stage intervals. As best illustrated in FIG. 9B the majority of the events of stage 13 are positioned away from the majority of the events of stage 12. In the same manner the majority of the events of stage 14 are positioned away from the majority of the events of stage 13.

[0163] FIG. 12 indicates the productivity from stages 12, 13 and 14 of well C-E1-L. These stages were not separated by any diverting means. The productivity of the three plugless stages is greater than the average productivity of the entire wellbore.

Second Well:

[0164] See FIGS. 10A, 10B, 10C and 11

[0165] Plugless Fracturing Experiments, Well C-CL4/94-O-8, Muskwa Stages 11, 12 and 13 Microseismic Events Recorded technical specifications:

[0166] No plug set between stages

[0167] 5 perf clusters/stage

[0168] 125 m stage interval

[0169] 250 T sand, 3575 m3 per stage

[0170] Field processed data

[0171] Micro-seismic events recorded opposite new perforals intervals and very few events opposite previous stage intervals as best illustrated in FIG. 10C with respect to stages 13 and 12.

[0172] As can be seen in FIG. 11, stages 11, 12 and 13 that were Radio Active traced exhibited favourable overall distribution of the fracturing fluid introduced in the stages.
If it is determined by observing pressure and rate responses that the majority of fluid is entering the newly perforated interval during the scheduled pumping operations, then that stage will end on schedule terminating with the firing of the perf guns opposite the next zone of interest, while pumping continues.

However, if it is determined that an insufficient percentage of fluid pumped is entering the new perforations, and it is desired to continue pumping, particulate diverting material may be introduced into the fracturing treatment prior to firing the perforation guns across the next zone of interest. This diverting material, while not a perforation ball sealer or other mechanical tool that seals off the flow to the zones below, will permit continuous pumping operations to proceed. When these particulate materials reach all perforated intervals, fluid injection into these previous perforated intervals will be sufficiently reduced for the fracturing operation to continue on to the next perforated interval once the material is displaced past the next zone of interest. Once the particulates have cleared the perforation tool opposite the next zone of interest, the guns are fired, creating new perforations and the plugless process continues without pumping cessation.

As many changes therefore may be made to the preferred embodiment of the invention without departing from the scope thereof. It is considered that all matter contained herein be considered illustrative of the invention and not in a limiting sense.

1. A method of stimulating an interval in a hydrocarbon reservoir equipped with a deviated wellbore having a casing, wherein said interval comprises at least two sequential stages in said wellbore without isolation means, said method comprising:
   i) introducing a first stage by:
      a) creating at least one access point through said wellbore casing into a hydrocarbon reservoir;
      b) introducing at least one fracturing fluid to said aforementioned access point to stimulate hydrocarbon production from said hydrocarbon reservoir;
   ii) introducing a second stage in the same wellbore by:
      a) creating a second access point through said wellbore casing, proximate said first stage, into a hydrocarbon reservoir;
      b) introducing at least one fracturing fluid to said second access point to stimulate hydrocarbon production from said hydrocarbon reservoir;
      wherein said first stage, and second stage are not separated by any isolation means; and optionally
   iii) recovering hydrocarbon from said hydrocarbon reservoir to a surface.

2. The method of claim 1 wherein the access point through the wellbore casing comprises at least one perforation.

3. The method of claim 2 wherein said at least one perforation is substantially perpendicular to the wellbore casing.

4. The method of claim 3 wherein said access point comprises several perforations.

5. The method of claim 3 or 4 wherein the perforations are positioned on the wellbore casing selected from: substantially one line along said wellbore casing, or substantially around said wellbore casing.

6. The method of claim 1 wherein the at least one fracturing fluid is selected from the group consisting of liquids, gases and a combination thereof.

7. The method of claim 6 wherein said fracturing fluid further comprises at least one solid.

8. The method of claim 1 wherein the recovery of hydrocarbon further comprises the steps of: ceasing the introduction of the at least one fracturing fluid; reduction of pressure at the wellbore and recovering the hydrocarbon through the wellbore to the surface.

9. The method of claim 1 wherein the new interval comprises at least three stages not separated by any isolation means.

10. A method of stimulating a hydrocarbon reservoir by stimulating at least two intervals according to the method of claim 9, wherein said at least two intervals are separated by isolation means.

11. A method of stimulating a new interval in a hydrocarbon reservoir equipped with a deviated wellbore and casing by introducing at least two sequential stages into said wellbore without requiring any isolation means, said method comprising:
   i) introducing a first stage having a predetermined length by:
      a) creating at least one access point through said wellbore casing into a hydrocarbon reservoir;
      b) introducing at least one fracturing fluid to said at least one access point to stimulate hydrocarbon production from said hydrocarbon reservoir;
   ii) introducing a second stage having a predetermined length in the same wellbore by:
      a) creating a second access point through said wellbore casing into a hydrocarbon reservoir proximate the first stage;
      b) introducing at least one fracturing fluid to said second access point to stimulate hydrocarbon production from said hydrocarbon reservoir;
   wherein said first stage, and second stage are not separated by any isolation means;
   iii) recovering hydrocarbon from said hydrocarbon reservoir.

12. The method of claim 11 wherein each access point comprises at least one perforation.

13. The method of claim 12 wherein each access point comprises a plurality of perforations proximate each other.

14. The method of claim 13 wherein each perforation is at a distance of less than one meter from each other in the same stage.

15. A method of fracturing multiple stages in hydrocarbon deposits for horizontal wellbore intervals without using isolation means, said method comprising the steps of:
   a) selecting a wellbore appropriate for carrying out the method of fracturing without the use of isolation means;
   b) selecting an appropriate stage location in said wellbore;
   c) perforating at least one perforation, preferably a set of perforations at a first opening for the first stage of the wellbore;
   d) pumping at least one stimulation fluid or sequence of stimulation fluids into said at least one perforation;
   e) observing the injection rates, and pressure in the stage selected;
   f) selecting an appropriate stage location in said wellbore;
   g) perforating at least one perforation, preferably a set of perforations at a consecutive opening for the consecutive stage of the wellbore without use of isolation means;
   h) pumping at least one stimulation fluid or sequence of stimulation fluids into said at least one perforation;
   i) observing the injection rates, and pressure in the stages;
j) optionally repeating steps (f) to (i) without isolation means between the stages.

16. The method of claim 15 wherein the at least one stimulation fluid further comprises radioactive material to determine effectiveness of fracturing steps in said perforations.

17. A process of hydraulic fracturing multiple hydrocarbon deposits in horizontal wellbore intervals comprising fracturing of at least two stages according to claim 15.

18. A method of hydraulic fracturing a horizontal wellbore as per claim 15 wherein at least two stages of the well subsequent to the first stage are fractured without using conventional diverting techniques and the location of the subsequent stages are selected by observing the injection rates, fluid path and pressure differences in the stage selected by optionally charting micro-seismic and radioactive indications in said deposit.

19. A method of stimulating a new interval, in a substantially horizontal wellbore, in a hydrocarbon reservoir, said method comprises introducing two or more sequential stages into said wellbore without isolation means between said stages, said method comprising:
   i) introducing a first stage by:
      a) creating a first access point through a wellbore casing into a hydrocarbon formation;
      b) introducing at least one fracturing fluid to said first access point at a sufficient rate, to stimulate hydrocarbon production from said hydrocarbon formation;
      c) monitoring operating conditions of said wellbore at a predetermined time throughout said method;
   ii) introducing a second stage in the same wellbore by:
      a) creating a second access point, proximate said first stage, through a wellbore casing into a hydrocarbon formation;
      b) introducing at least one fracturing fluid to said second access point at a sufficient rate, to stimulate hydrocarbon production from said hydrocarbon formation;
      c) monitoring operating conditions of said wellbore at a predetermined time throughout said method;
   iii) introducing a consecutive stage (or stages) in the same wellbore by:
      a) creating at least one consecutive access point through a wellbore casing into a hydrocarbon formation proximate a previous stage;
      b) introducing at least one fracturing fluid to said consecutive access point at a sufficient rate, to stimulate hydrocarbon production from said hydrocarbon formation;
      c) monitoring operating conditions of the wellbore at a predetermined time throughout said method;
      d) terminating stimulation to allow for recovery of hydrocarbons; and
      e) recovering hydrocarbons from said hydrocarbon reservoir;

wherein said two or more sequential stages are not separated by any isolation means.

20. An interval in a hydrocarbon reservoir equipped with a deviated wellbore, said interval comprising at least two sequential stages not isolated by any isolation means.

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