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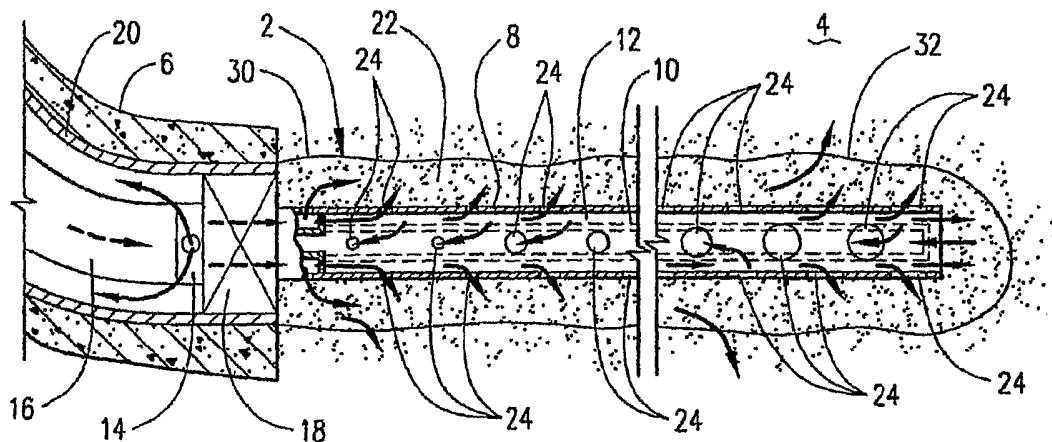
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(54) Title: METHOD AND APPARATUS FOR COMPLETING UNCONSOLIDATED LATERAL WELL BORES



(57) Abstract: Improved methods and apparatus for completing unconsolidated subterranean zones penetrated by well bores are provided. The methods basically comprise the steps of placing a slotted pipe having openings formed therein which vary in size or in the number of openings along the length of the slotted pipe or both in the subterranean zone, isolating the annulus between the slotted pipe and the well bore and injecting particulate material into the annulus whereby the particulate material is uniformly packed therein.

METHOD AND APPARATUS FOR COMPLETING UNCONSOLIDATED LATERAL WELL BORES

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to improved methods and apparatus for completing unconsolidated lateral well bores.

2. DESCRIPTION OF THE PRIOR ART

Lateral well bores, i.e., well bores that are drilled horizontally or substantially in a horizontal direction from a vertical or substantially vertical primary well bore are often completed in unconsolidated formations containing loose and incompetent fines and sand which migrate with fluids produced from the formations. The presence of formation fines and sand in the produced fluids is undesirable in that the particles abrade tubular goods, producing equipment, pumps and the like and reduce the fluid production capabilities of the formations.

In order to terminate or reduce the presence of formation fines and sand in produced fluids, completions utilizing gravel packs are often utilized. In a typical gravel pack completion, a screen is placed in the well bore and positioned within the unconsolidated subterranean zone which is to be completed. The screen is connected to a tool which includes a production packer and a crossover and the tool is in turn connected to a work or production pipe string. A particulate material which is usually graded sand, often referred to in the art as gravel, is pumped in a slurry down the work or production pipe string and through the crossover whereby it flows into the annulus between the screen and the well bore. The liquid forming the slurry leaks off into the subterranean zone and/or through the screen which is sized to prevent the gravel in the slurry from flowing therethrough. As a result, the gravel is deposited in the annulus around the screen whereby it forms a gravel pack. The size of the gravel in the gravel pack is selected such that it prevents formation fines and sand from flowing into the well bore with produced fluids.

Gravel packs have also been formed in well bores using slotted pipes. The gravel is placed in the annulus between a slotted pipe and the walls of the well bore as well as

within the pipe. The gravel is usually coated with a hardenable resin composition which consolidates the gravel into a hard permeable pack. Thereafter, the gravel deposited within the slotted pipe can be drilled out of the slotted pipe or left in the slotted pipe as desired.

Another more recent gravel pack procedure which prevents the formation of gravel bridges in the annulus between the walls of a well bore and a screen or slotted pipe has been developed and utilized successfully. Gravel bridges occur as the result of non-uniform gravel packing in the annulus due to the loss of carrier liquid from the gravel slurry into high permeability portions of the subterranean zone. The gravel bridges occur before all of the gravel has been placed and they block further flow of the slurry and gravel through the annulus which leaves voids in the annulus. When the well is placed on production, the flow of produced fluids is concentrated through the voids in the gravel pack which soon causes the migration of fines and sand with the produced fluids.

Gravel bridges have heretofore been prevented by utilizing a slotted pipe, i.e., a pipe with openings formed therein, with a sand screen disposed within the slotted pipe. The gravel slurry is injected into the annulus between the slotted pipe and the walls of the well bore and between the slotted pipe and the sand screen. This arrangement allows the gravel slurry to flow around gravel bridges and deposit gravel in voids produced.

Another problem very often encountered in the completion of lateral well bores involves unequal production of formation fluids along the length of the lateral well bore. Lateral well bores are utilized in subterranean formation producing zones to increase the area of well bore penetration in the subterranean zones to thereby increase hydrocarbon production. However, the portion of a subterranean formation penetrated by the heel of a lateral well bore often experiences higher draw-down pressure than the portion of the well bore closest to the toe. The term "heel" refers to the portion of the lateral well bore where the well bore begins its curvature to horizontal and the term "toe" refers to the end portion of the lateral well bore. As a result of the higher draw-down pressure, higher hydrocarbon production rates result from the heel than from the toe. The higher hydrocarbon production rates from the heel can bring about early water break through or early gas break through. This in turn can cause the full production potential of the toe section to never be realized.

Thus, there are needs for improved methods and apparatus for completing lateral wells bores in unconsolidated subterranean zones using gravel packs whereby gravel bridges are prevented and produced formation fluids are caused to flow into the slotted pipe at substantially equal rates over the length of the slotted pipe.

SUMMARY OF THE INVENTION

The present invention provides improved methods and apparatus for completing unconsolidated subterranean zones subject to migration of formation fines and sand with produced formation fluids penetrated by lateral well bores which meet the needs described above and overcome the deficiencies of the prior art. The improved methods basically comprise the steps of placing a slotted pipe in the lateral well bore having openings formed therein through which produced formation fluids flow. The openings vary in size or vary in the number of the openings along the length of the slotted pipe or both so that the produced formation fluids flow into the slotted pipe at substantially equal flow rates over the length of the slotted pipe. The annulus between the slotted pipe and the well bore is isolated and particulate material is injected into the annulus whereby the particulate material is uniformly packed in the annulus and in the interior of the slotted pipe so that the migration of formation fines and sand with produced formation fluids is prevented.

The lateral well bore can be cased with perforations formed therein or completed open-hole and the particulate material is preferably graded sand. The particulate material utilized is preferably coated with a hardenable resin composition which hardens and consolidates the particulate material into a hard permeable uniform mass. Once the hardenable resin has hardened whereby the particulate material is consolidated into a hard permeable pack in the annulus between the slotted pipe and the well bore as well as in the interior of the slotted pipe, at least a portion of the hard permeable mass within the interior of the slotted pipe can be drilled out if desired.

Another method of the present invention is comprised of the following steps. A slotted pipe is placed in the lateral well bore having openings formed therein through which the produced formation fluids flow and having an internal sand screen disposed therein. The slotted pipe includes openings that vary in size or vary in the number of openings along the length of the slotted pipe or both so that the produced formation fluids flow into the slotted pipe at substantially equal flow rates over the length of the slotted

pipe. The annulus between the slotted pipe and the well bore and the annulus between the sand screen and the slotted pipe are isolated. Thereafter, particulate material is injected into the annulus between the slotted pipe and the well bore and the annulus between the slotted pipe and the sand screen whereby the particulate material is uniformly packed in the annuluses and the migration of formation fines and sand with produced fluids is prevented.

The 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

FIGURE 1 is a side cross-sectional view of a lateral open-hole well bore penetrating an unconsolidated subterranean producing zone having a slotted pipe, a production packer and a crossover connected to a production string disposed therein. The drawing illustrates the placement of gravel between the well bore and the slotted pipe and between the slotted pipe and the sand screen.

FIGURE 2 is a side cross-sectional view of the lateral well bore, the slotted pipe with an internal sand screen, the production packer and the cross-over of FIGURE 1 after the gravel has been placed and produced fluids are flowing to the surface.

DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention provides improved methods and apparatus for completing an unconsolidated subterranean zone subject to the migration of formation fines and sand penetrated by a lateral well bore having unequal produced formation fluid flow rates over the length of the well bore. The term "lateral well bore" is used herein to mean the portion of a well bore in an unconsolidated subterranean producing zone to be completed which is substantially horizontal or at an angle from vertical in the range of from about 65° to about 105°. The term "slotted pipe" is used herein to mean pipe which includes slots, holes or other shaped openings therein.

Referring now to the drawings, the improved apparatus of the present invention is illustrated disposed in an open hole lateral well bore 2. The lateral well bore 2 is illustrated extending into an unconsolidated subterranean zone 4 from a cased and cemented well bore 6 which extends to the surface. A slotted pipe 8 having a plurality of openings 24 therein is disposed in the lateral well bore 2 whereby an annulus 22 is formed

between the walls of the well bore 2 and the slotted pipe 8. A sand screen 10 is disposed within the slotted pipe 8 in a manner whereby an annulus 12 is formed between the slotted pipe 8 and the sand screen 10. The slotted pipe 8 and sand screen 10 are connected to a removable cross-over 14 which is in turn connected to a production or work string 16. A production packer 18 is connected to the slotted pipe 8 which is set within the casing 20 in the well bore 6. As will be described further hereinbelow, FIG. 1 illustrates the operation of the apparatus of this invention when a slurry of particulate material is pumped into the annulus 12 between the slotted pipe 8 and the sand screen 10 and into the annulus 22 between the slotted pipe 8 and the walls of the well bore 2. FIG. 2 illustrates the apparatus of the invention after the particulate material 26 has been packed into the annuluses 12 and 22 and the well is returned to production. The pack of particulate material 26 within the annuluses 12 and 22 filters out and prevents the migration of formation fines and sand with produced formation fluids that enter the well bore 2 from the unconsolidated subterranean zone 4.

As is understood by those skilled in the art, the removable cross-over 14 is a sub-assembly which allows fluids to follow a first flow pattern whereby particulate material suspended in a slurry can be packed in the annuluses 12 and 22 between the sand screen 10 and the slotted pipe 8 and between the slotted pipe 8 and the well bore 2. That is, as shown by the arrows in FIG. 1, the particulate material suspension flows from inside the production or work string 16 into the annulus between the sand screen 10 and the slotted pipe 8 and into the annulus between the slotted pipe 8 and the well bore 2 by way of ports in the cross-over 14. Simultaneously, fluid is allowed to flow from inside the sand screen 10 through the cross-over 14 to the other side of the packer 18 outside the production string. By pipe movement or other procedure, flow through the cross-over 14 can be changed to a second flow pattern whereby fluid from inside the sand screen 10 flows directly into the production string.

As shown in the drawings, the slotted pipe 8 includes a plurality of circular openings 24 formed therein through which the produced formation fluids flow. The openings 24 are of varying sizes extending over the length of the slotted pipe 8. That is, the openings 24 are small at the inlet end of the slotted pipe 8 adjacent to the heel portion of the well bore 2 (identified in the drawings by the numeral 30) and increase in size over the length of the slotted pipe to the toe portion of the well bore (identified in the drawings

by the numeral 32). The openings 24 can be of varying size over the length of the slotted pipe 8 as shown in the drawings or the openings 24 can be of the same size over the length of the slotted pipe 8 with the number of openings increasing or otherwise varying over the length of the slotted pipe 8.

As is well known and generally the case, the production of produced hydrocarbon fluids near the heel portion of a lateral well bore have a high flow rate while the production of hydrocarbons near the toe of the well bore are much lower. This unequal production of hydrocarbons from the heel to the toe often leads to premature gas or water coning at the heel portion of the well bore, i.e., the area of high flow rate, which reduces the total volume of hydrocarbons that can be produced from the well bore. In accordance with the present invention, this problem is prevented by varying the size or the number of openings 24 over the length of the slotted pipe 8 whereby the flow rate of produced fluids into the slotted pipe 8 from the lateral well bore is distributed substantially equally over the length of the slotted pipe 8. The required sizes of the openings 24 or the number of the same size openings 24 allocated over the length of the slotted pipe 8 is determined by production tests conducted in the lateral well bore prior to the placement of the slotted pipe 8 and related apparatus in the well bore or by estimation of the pressure drop from the heel of the well bore to the toe of the well bore. Depending on the particular lateral well bore involved and the particular areas of high or low formation fluid production, the sizes and/or number of openings required in the slotted pipe 8 to produce substantially equal flow rates of produced fluids into the slotted pipe 8 over its length are determined. A slotted pipe 8 with those openings is then placed in the lateral well bore along with the other apparatus required.

Referring again to FIGS. 1 and 2, the methods of the present invention for completing the well bore 2 in the unconsolidated subterranean zone 4 are as follows. The slotted pipe 8 containing the openings 24 required to produce equal produced fluid flow over the length of the slotted pipe 8 with the sand screen 10 therein is placed in the well bore 2. As will be understood, the sand screen can be omitted if the procedure described above is utilized whereby the particulate material placed in the well bore is consolidated into a permeable pack or is otherwise prevented from flowing out of the well bore with produced formation fluids. The annulus 22 between the slotted pipe 8 and the walls of the well bore 2 as well as the annulus between the sand screen 10 and the slotted pipe 8 are

isolated by setting the packer 18. Thereafter, a slurry of particulate material is injected into the annulus 12 between the sand screen 10 and the slotted pipe 8 and into the annulus 22 between the walls of the well bore 2 and the slotted pipe 8. Because the particulate material slurry is free to flow through the openings 24 as well as the open end of the slotted pipe 8, the particulate material is uniformly packed into the annulus 22 between the well bore 2 and slotted pipe 8 and into the annulus 12 between the sand screen 10 and the slotted pipe 8. The pack of particulate material 26 formed filters out and prevents the migration of formation fines and sand with fluids produced into the well bore 2 from the subterranean zone 4. The methods and apparatus of this invention are particularly suitable and beneficial in forming gravel packs in long-interval lateral wells without the formation of sand bridges.

The particulate gravel material utilized in accordance with the present invention is generally of a size such that formation fines and sand that migrate with produced fluids are prevented from being produced. Various kinds of particulate gravel materials can be utilized including graded sand, bauxite, ceramic materials, glass materials, polymer beads and the like. Generally the gravel particles have a size in the range of from about 2 to about 400 mesh, U.S. Sieve Series. The preferred particulate gravel material is graded sand having a particle size in the range of from about 10 to about 70 mesh, U.S. Sieve Series. Preferred sand particle size distribution ranges are one or more of 10-20 mesh, 20-40 mesh, 40-60 mesh or 50-70 mesh, depending on a particular size and distribution of formation solids to be screened out by the particulate gravel material.

As mentioned, the particulate gravel material can be coated with a hardenable resin composition. After the hardenable resin composition coated gravel is placed in the well bore, the hardenable resin composition hardens and consolidates the gravel into a hard permeable mass. A variety of resin compositions are well known to those skilled in the art as is their use for consolidating gravel material into hard permeable masses. Examples of hardenable organic resins which are suitable for use in accordance with this invention are novolac resins, polyepoxide resins, polyester resins, phenol-aldehyde resins, urea-aldehyde resins, furan resins, urethane resins, and mixtures of such resins. These resins are available at various viscosities depending upon the molecular weights of the resins. The resin or mixture of resins utilized is generally diluted with a diluent. For example, polyepoxide resins can be diluted with methanol, butanol, dipropylene glycol

methyl ether or dipropylene glycol dimethyl ether; whereas furan or phenolic resins can be diluted with phenols, formaldehydes, furfuryl alcohol, furfural or 2-butoxy ethanol. Also, silane coupling agents are generally utilized in the hardenable resin compositions to promote coupling or adhesion to sand or other similar particulate gravel materials. Particularly suitable coupling agents are aminosilane compounds or mixtures of such compounds. A preferred coupling agent is N-beta-(aminoethyl)-gamma-aminopropyltrimethoxysilane. The hardenable resin composition used is caused to harden by allowing it to be heated in the formation or by contacting it with a hardening agent. When a hardening agent is utilized, it can be included in the resin composition. Examples of suitable internal hardening agents for polyepoxide resins include, but are not limited to, amines and amides, preferably 2-ethyl 4-methyl imidazole and 4,4'-diaminodiphenyl sulfone. The suitable internal hardening agents for resin compositions containing furan resin, phenol aldehyde resin or urea-aldehyde resin include, but are not limited to, hexachloroacetone, 1,1,3-trichlorotrifluoroacetone, benzotrichloride, benzylchloride and benzalchloride. The hardenable resin compositions can also include other components such as surfactants, dispersants, esters and other additives which are well known to those skilled in the art.

When particulate gravel material coated with a hardenable resin composition is utilized, the sand screen disposed within the slotted pipe can be eliminated. When the sand screen is not utilized, resin composition coated particulate material is injected into the annulus between the walls of the well bore and the slotted pipe as well as into the interior of the slotted pipe. After the hardenable resin composition coated proppant has hardened into a strong permeable pack within the annulus and within the slotted pipe, all or a portion of the consolidated proppant can be removed from the interior of the slotted pipe if desired.

When a sand screen within the slotted pipe is utilized as illustrated in the drawings, the sand screen prevents the proppant material from flowing out of the well bore with produced fluids. In addition to the sand screen, the particulate material can also be coated with a hardenable resin composition whereby the particulate material is consolidated into a strong permeable pack.

The particulate gravel material carrier liquid utilized can be any of the various viscous carrier liquids utilized heretofore including gelled water, oil based liquids, foams

or emulsions. The most common carrier liquid utilized heretofore which is also preferred for use in accordance with this invention is comprised of an aqueous liquid such as fresh water or salt water combined with a gelling agent for increasing the viscosity of the carrier liquid. The increased viscosity reduces fluid loss and allows the carrier liquid to transport significant concentrations of particulate gravel material into the subterranean zone to be completed.

A variety of gelling agents have been utilized including hydratable polymers which contain one or more functional groups such as hydroxyl, cis-hydroxyl, carboxyl, sulfate, sulfonate, amino or amide. Particularly useful such polymers are polysaccharides and derivatives thereof which contain one or more of the monosaccharide units galactose, mannose, glucoside, glucose, xylose, arabinose, fructose glucuronic acid or pyranosyl sulfate. Various natural hydratable polymers contain the foregoing functional groups and units including guar gum and derivatives thereof, cellulose and derivatives thereof and the like. Hydratable synthetic polymers and copolymers which contain the above mentioned functional groups can also be utilized including polyacrylate, polymethylacrylate, polyacrylamide and the like.

Particularly preferred hydratable polymers which yield high viscosities upon hydration at relatively low concentrations are guar gum and guar derivatives such as hydroxypropylguar and carboxymethylguar and cellulose derivatives such as hydroxyethylcellulose, carboxymethylcellulose and the like.

The viscosities of aqueous polymer solutions of the types described above can be increased by combining cross-linking agents with the polymer solutions. Examples of cross-linking agents which can be utilized are multivalent metal salts, alkali metal borates, borax, boric acid and other boron compounds. The gelled or gelled and cross-linked carrier liquids can also include gel breakers such as those of the enzyme type, the oxidizing type or the acid buffer type which are well known to those skilled in the art. The gel breakers cause the viscous carrier liquids to revert to thin fluids that can be produced back to the surface after they have been utilized.

An improved method of the present invention for completing an unconsolidated subterranean zone subject to migration of formation fines and sand with produced formation fluids penetrated by a lateral well bore comprises the steps of: (a) placing a slotted pipe in the lateral well bore having openings formed therein through which the

produced formation fluids flow, the openings varying in size or varying in the number of the openings along the length of the slotted pipe or both so that the produced formation fluids flow into the slotted pipe at substantially equal flow rates over the length of the slotted pipe; (b) isolating the annulus between the slotted pipe and the well bore; and (c) injecting particulate material into the annulus between the slotted pipe and the well bore whereby the particulate material is uniformly packed in the annulus and in the interior of the slotted pipe whereby the migration of formation fines and sand with produced formation fluids is prevented.

Another preferred method of this invention for completing an unconsolidated subterranean zone subject to migration of formation fines and sand with produced formation fluids penetrated by a lateral well bore comprises the steps of: (a) placing a slotted pipe in the lateral well bore having openings formed therein through which the produced formation fluids flow and having an internal sand screen disposed therein, the openings in the slotted pipe varying in size or varying in the number of the openings along the length of the slotted pipe or both so that the produced formation fluids flow into the slotted pipe at substantially equal flow rates over the length of the slotted pipe; (b) isolating the annulus between the slotted pipe and the well bore and the annulus between the sand screen and the slotted pipe; and (c) injecting particulate material into the annulus between the slotted pipe and the well bore and the annulus between the slotted pipe and the sand screen whereby the particulate material is uniformly packed in the annuluses and the migration of formation fines and sand with produced fluids is prevented.

A preferred apparatus of the present invention for completing an unconsolidated well bore comprises: a slotted pipe having openings formed therein through which produced formation fluids flow, the openings varying in size or varying in the number of the openings along the length of the slotted pipe or both so that the produced formation fluids flow into the slotted pipe at substantially equal flow rates over the length of the slotted pipe; a removable cross-over adapted to be attached to a production or work string attached to the slotted pipe; and a production packer attached to the slotted pipe.

As mentioned above, the production packer and the cross-over are selectively operable from the surface. When operated, the packer is set and the cross-over changes from a first flow pattern to a second flow pattern.

As will be understood by those skilled in the art, instead of the single slotted pipe or single slotted pipe with a sand screen disposed therein as described and claimed herein, other arrangements of one or more slotted pipes of this invention having openings varying in size or varying in the number of the openings along the length thereof, or both, with or without sand screens can be substituted therefore. Examples of such other arrangements that can be utilized are described in detail in U.S. Patent No. 6,516,881B2 issued to Hailey, Jr. on February 11, 2003 and in U.S. Patent No. 6,516,882B2 issued to McGregor, et al. on February 11, 2003, which are incorporated in their entireties herein by reference thereto.

Thus, the present invention is well adapted to carry out the objects and attain the ends and advantages mentioned as well as those which are inherent therein. While numerous changes can be made by those skilled in the art, such changes are encompassed within the spirit of this invention as defined by the appended claims.

What is claimed is:

1. An improved method of completing an unconsolidated subterranean zone subject to migration of formation fines and sand with produced formation fluids penetrated by a lateral well bore comprising the steps of:

(a) placing a slotted pipe in said lateral well bore having openings formed therein through which said produced formation fluids flow, said openings varying in size or varying in the number of said openings along the length of said slotted pipe or both so that said produced formation fluids flow into said slotted pipe at substantially equal flow rates over the length of said slotted pipe;

(b) isolating the annulus between said slotted pipe and said well bore; and

(c) injecting particulate material into said annulus between said slotted pipe and said well bore whereby said particulate material is uniformly packed in said annulus and in the interior of said slotted pipe whereby the migration of formation fines and sand with produced formation fluids is prevented.

2. The method of claim 1 wherein said well bore in said subterranean zone is open-hole.

3. The method of claim 1 wherein said particulate material is graded sand.

4. The method of claim 1 wherein said particulate material is coated with a hardenable resin composition which hardens and consolidates said particulate material into a hard permeable uniform mass.

5. The method of claim 4 which further comprises the step of drilling at least a portion of said hard permeable mass of particulate material out of the interior of said slotted pipe.

6. The method of claim 1 wherein said annulus between said slotted pipe and said lateral well bore is isolated in accordance with step (b) by setting a packer in said well bore.

7. The method of claim 3 which further comprises an internal sand screen disposed within said slotted pipe which forms an annulus between said sand screen and said slotted pipe which is also isolated.

8. The method of claim 7 wherein said particulate material is also injected into said annulus between said sand screen and said slotted pipe.

9. The method of claim 8 wherein said particulate material is coated with a hardenable resin composition which hardens and consolidates said particulate material into a hard permeable uniform mass.

10. The method of claim 3 wherein said graded sand has a particle size in the range of from about 10 to about 70 mesh, U.S. Sieve Series.

11. An improved method of completing an unconsolidated subterranean zone subject to migration of formation fines and sand with produced formation fluids penetrated by a lateral well bore comprising the steps of:

(a) placing a slotted pipe in said lateral well bore having openings formed therein through which said produced formation fluids flow and having an internal sand screen disposed therein, said openings in said slotted pipe varying in size or varying in the number of said openings along the length of said slotted pipe or both so that said produced formation fluids flow into said slotted pipe at substantially equal flow rates over the length of said slotted pipe;

(b) isolating the annulus between said slotted pipe and said well bore and the annulus between said sand screen and said slotted pipe; and

(c) injecting particulate material into said annulus between said slotted pipe and said well bore and said annulus between said slotted pipe and said sand screen whereby said particulate material is uniformly packed in said annuluses and the migration of formation fines and sand with produced fluids is prevented.

12. The method of claim 11 wherein said well bore in said subterranean zone is open-hole.

13. The method of claim 11 wherein said particulate material is graded sand.

14. The method of claim 11 wherein said particulate material is coated with a hardenable resin composition which hardens and consolidates said particulate material into a hard permeable uniform mass.

15. The method of claim 11 wherein said annulus between said slotted pipe and said well bore and said annulus between said sand screen and said slotted pipe are isolated in accordance with step (b) by setting a packer in said well bore.

16. The method of claim 13 wherein said graded sand has a particle size in the range of from about 10 to about 70 mesh, U.S. Sieve Series.

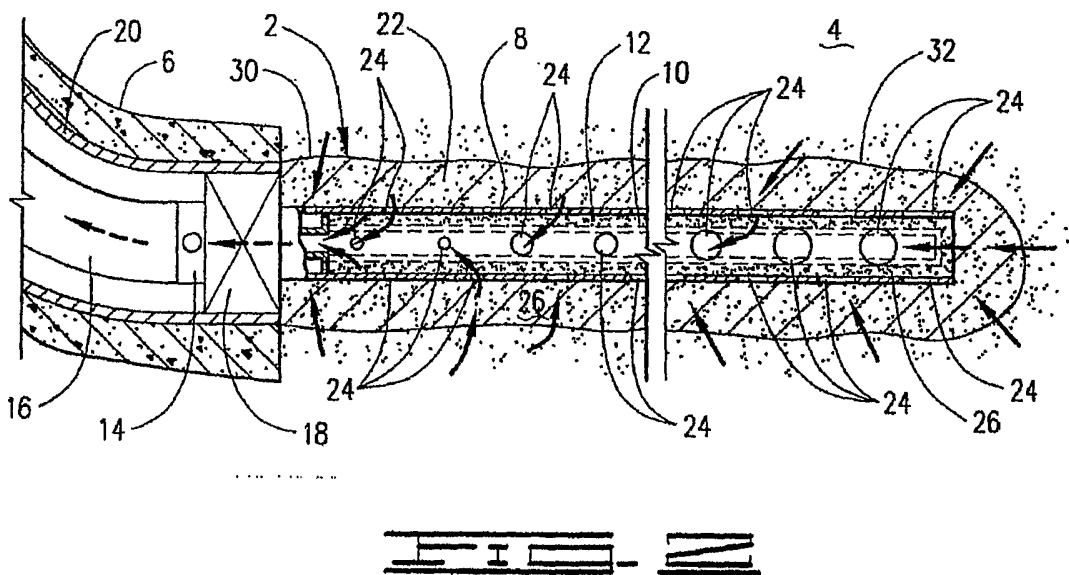
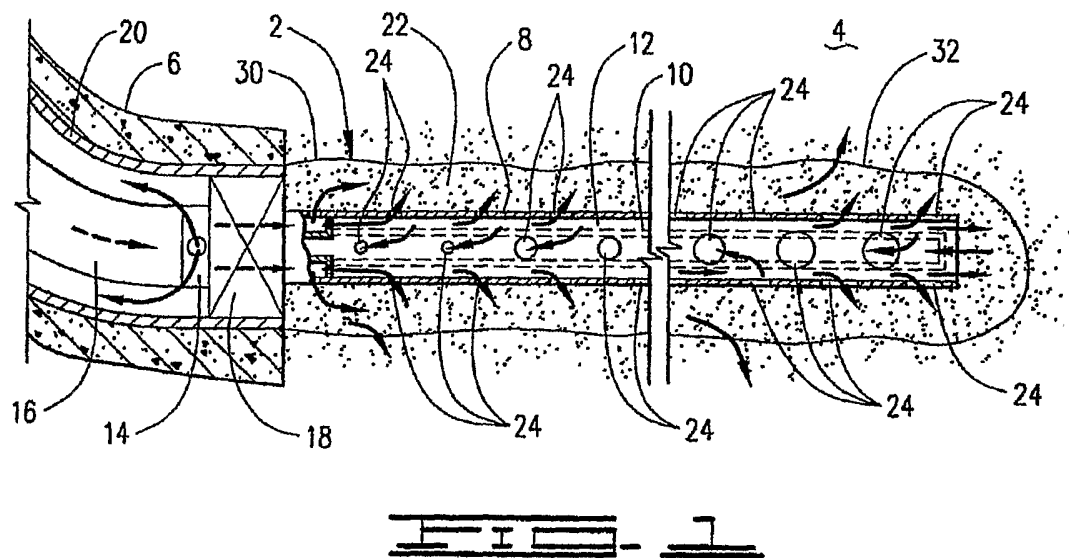
17. An apparatus for completing an unconsolidated well bore comprising:
a slotted pipe having openings formed therein through which produced formation fluids flow, said openings varying in size or varying in the number of said openings along the length of said slotted pipe or both so that said produced formation fluids flow into said slotted pipe at substantially equal flow rates over the length of said slotted pipe;
a removable cross-over adapted to be attached to a production or work string attached to said slotted pipe; and
a production packer attached to said slotted pipe.

18. The apparatus of claim 17 which further comprises a sand screen disposed within said slotted pipe and attached thereto.

19. The apparatus of claim 17 wherein said production packer is selectively operable from the surface when located in said well bore.

20. The apparatus of claim 17 wherein said cross-over is selectively operable from the surface when located in said well bore to change from a first flow pattern to a second flow pattern.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER IPC 7 E21B43/04 E21B43/08 E21B43/12		
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B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 E21B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, TULSA, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/075315 A1 (DUSTERHOFT RONALD G ET AL) 24 April 2003 (2003-04-24) the whole document	1-20
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° Special categories of cited documents: *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *&* document member of the same patent family		
Date of the actual completion of the international search 14 July 2004		Date of mailing of the international search report 27/07/2004
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Schouten, A

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