SAND CONTROL SCREEN HAVING A MICRO-PERFORATED FILTRATION LAYER

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Publication Classification
Int. Cl. E21B 43/08 (2006.01)
U.S. Cl. 166/230; 166/227

ABSTRACT
A sand control screen (40) includes a perforated base pipe (42) and a filter layer (50) that has micro-perforations (52) therein. The filter layer (50) is attached to the base pipe (42) along the entire length of the filter layer (50). Channels (46) are formed between the base pipe (42) and the filter layer (50) to allow fluid to flow therebetween. The sand control screen (40) is formed by micro-perforating a length of material, such as sheet metal, to form the filter layer (50), creating channels (46) that will allow fluids to flow between the base pipe (42) and filter layer (50), wrapping the filter layer (50) around the base pipe (42), attaching the filter layer (50) to the base pipe (42) along the length of the filter layer (50) and creating a seam between the two edges of the filter layer (50).
Start

Make Openings in Base Pipe 400

Micro-perforate Length of Sheet Metal to Create Filter Layer 402

Create Channels 404

Shape Filter Layer to Fit Base Pipe 406

Attach Filter Layer to Base Pipe 408

Seal Edges of Filter Layer Together 410

End

Fig.11
SAND CONTROL SCREEN HAVING A MICRO-PERFORATED FILTRATION LAYER

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates, in general, to a sand control device used during the production of oil, gas or water and a manufacturing process related to the same and, in particular, to a sand control screen having a micro-perforated filtration layer.

BACKGROUND OF THE INVENTION

[0002] Without limiting the scope of the present invention, its background will be described with reference to producing fluid from a subterranean formation, as an example.

[0003] After drilling each of the sections of a subterranean wellbore, individual lengths of relatively large diameter metal tubulars are typically secured together to form a casing string that is positioned within each section of the wellbore and cemented in place. This casing string is used to increase the integrity of the wellbore by preventing the wall of the hole from collapsing and to prevent movement of fluids from one formation to another formation.

[0004] Once the process of drilling and installing casing is finished, the completion process may begin. The completion process comprises numerous steps including the creation of hydraulic openings or perforations through the casing string, the cement and a short distance into the desired formation or formations so that production fluids may enter the interior of the wellbore. In addition, the completion process may involve formation stimulation to enhance production, installation of sand control devices to prevent sand production and the like. The completion process also includes installing a production tubing string within the well casing. Unlike the casing string that forms a part of the wellbore itself, the production tubing string is used to produce the well by providing the conduit for formation fluids to travel from the formation depth to the surface.

[0005] Typically, the production tubing string extends from the surface to the formations traversed by the well and includes one or more production packers. The purpose of the packers is to support the production tubing and other completion equipment, such as one or more sand control screens that may be placed adjacent to the producing formations, and to seal the annulus between the outside of the production tubing and the inside of the well casing to block movement of fluids through the annulus past the packer locations. Accordingly, once the production tubing string, including the production packers and sand control screens are in place, all production from the formation that enters the production tubing must pass through a sand control screen.

[0006] One purpose of the sand control screens is to prevent the movement of unconsolidated formation particles such as sand into the production tubing. Such particle movement commonly occurs during production from completions in loose sandstone or folktwing hydraulic fracture of a formation. Production of these materials causes numerous problems in the operation of oil, gas or water wells. These problems include plugging of formations, tubing and flow lines, as well as erosion of tubing, downhole equipment and surface equipment. These problems lead to poor productivity, high maintenance costs and unacceptable well downtime.

[0007] Existing screens typically use a wire wrap filter media or a wire mesh filter media attached to a base pipe to achieve sand control. Wire wrap sand screens may comprise a continuous single wire wrapped around the base pipe. More recent versions use a jacket that is fully formed from a single wire prior to attachment to the base pipe, with vertical ribs providing a stand-off from the base pipe. Variations in the gauge of wire and corresponding variations in the spacing between wraps of the wire provide sand screens for different conditions. Wire mesh sand screens use one or more woven metal layers to trap particulate matter. As with wire wrap screens, wire mesh sand screens are available in a number of gauges having openings of various sizes.

[0008] In addition, some screen designs use prepacked sand confined around the perforated base pipe. These prepacked screens are constructed by fabricating the metal components, then forcing sand, either resin coated or uncoated, between the perforated base pipe and an inner wire screen or between an inner wire screen and an outer wire screen of a multi-layer screen. Alternatively or additionally, a gravel pack may be placed in the production interval surrounding the installed sand control screens.

[0009] It has been found, however, that existing sand screens continue to have a number of drawbacks. For example, variations in the gauge of the wire or improper manufacture can result in inconsistencies in the opening size. Larger gauges of wire become increasingly difficult to bend, while smaller gauges are more easily damaged in the processes of manufacture and installation or during production. Additionally, screens that use multiple filter layers are, by their nature, difficult or impossible to clean. Still further, the attachment of the wire wrap screen or wire mesh screen to the base pipe is an ongoing cause of concern. The sand screen filters are typically attached to the base pipe with conventional welding at both ends of the filter layer. A failure of any portion of the weld results in an uncontrolled opening and a loss of sand control. Therefore, a need has arisen for a sand screen that provides the desired sand control function, is robust, easy to clean and simple to manufacture.

SUMMARY OF THE INVENTION

[0010] The present invention disclosed herein comprises a sand control screen having a micro-perforated filter layer for filtering particles out of fluid produced from a wellbore and a method for manufacturing the same. The sand screen of the present invention allows for precise, reliably reproducible and infinitely variable opening size, shape, density and pattern in the micro-perforated filter layer, thereby providing the desired sand control function. In addition, the sand control screen of the present invention is robust, easy to clean and simple to manufacture.

[0011] The sand control screen having a micro-perforated filter layer of the present invention includes a base pipe having a plurality of openings that allow fluid flow therethrough and a filter layer having a plurality of micro-perforations. The filter layer wraps around the base pipe and is attached thereto. A drainage layer such as channels, wire wrap or wire mesh between the base pipe and filter layer allows production fluid to flow between the filter layer and the base pipe.

[0012] In one embodiment of the sand control screen having a micro-perforated filter layer, the filter layer is made of sheet metal that is wrapped around the base pipe. The sheet metal may be flat or corrugated. In the flat sheet metal embodiments of the sand control screen, channels may be formed in the outside surface of the base pipe or on the inside surface of the filter layer. In the corrugated sheet metal
embodiments of the sand control screen, the corrugations form the channels between the filter layer and the base pipe. [0013] The filter layer may be attached to the base pipe using a variety of techniques including fusion bonding, a friction fit, adhesives or the like. Alternatively or additionally, the filter layer may be attached to the base pipe using connectors, such as end caps, that seal the ends of the filter layer to the base pipe. The end caps may be attached to the base pipe using welded, threading or similar techniques.

[0014] In some embodiments of the sand control screen, the filter layer has a thickness between about 1/32 inch and about 1/4 inch. In other embodiments, the opening shape of the micro-perforations at the surface of the filter layer can be a circle, an ellipse, a slot or other similar shape having a radius. Alternatively, the opening shape of the micro-perforations at the surface of the filter layer may have sharp edges such as squares, rectangles, triangles or other multi sided polygon or shape. In certain embodiments, the micro-perforations may have a tapering cross-section through the filter layer wherein the smaller opening of this tapering cross-section may be oriented to either the exterior or the interior of the filter layer.

[0015] In one embodiment of the sand control screen having a micro-perforated filter layer, the opening size of the micro-perforations has a maximum width of 500 microns. In other embodiments, the maximum width of the micro-perforations is between about 50 microns and 500 microns. In another embodiment of the sand control screen having a micro-perforated filter layer, the opening density of the micro-perforations is between about 100 and 200 openings per unit area. In other embodiments, the opening density of the micro-perforations may be less than 100 openings per inch or more than 200 openings per inch.

[0016] In one embodiment of the sand control screen having a micro-perforated filter layer, the opening pattern of the micro-perforations has a uniform distribution. In other embodiments, the opening pattern may include a nonuniform or selected distribution. For example, in the corrugated sheet metal embodiment, the micro-perforations can be placed at the peaks and valleys of the corrugations, in the sides of the corrugations or in any other arrangement that is desired. The size, shape, density and pattern of the micro-perforations are determined by the desired flow area, the desired filtration capacity, the constituents being separated from one another and the like.

[0017] In another aspect, the present invention is directed to a method of making a sand control screen that includes fabricating a plurality of openings in the wall of a base pipe and creating a plurality of micro-perforations in a length of sheet metal having a first and a second edge opposite each other to form a filtration media. The method further includes forming a plurality of channels that allow fluid flow between the filter layer and the base pipe, shaping the filter layer to fit around the base pipe, bringing the first edge and the second edge of the filter layer substantially adjacent to each other, attaching the filter layer to the outer surface of the base pipe and coupling the first edge of the filter layer to the second edge.

[0018] In some embodiments, the step of creating a plurality of micro-perforations in a length of sheet metal may be accomplished using a water jet, a laser or similar technique. In certain installations, the steps of shaping the filter layer to fit around the base pipe, bringing the first edge and the second edge of the filter layer substantially adjacent to each other, attaching the filter layer to the outer surface of the base pipe and coupling the first edge of the filter layer to the second edge may be performed at the location where the sand screen will be used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] For a more complete understanding of the features and advantages of the present invention, references now made to the detailed description of the invention along with the accompanying figures in which corresponding numerals in the different figures refer to corresponding parts and in which:

[0020] FIG. 1 is a schematic illustration of an offshore oil and gas platform operating a sand control screen having a micro-perforated filter layer of the present invention;

[0021] FIG. 2 is a side elevation, partially cut away, of an embodiment of a sand control screen having a micro-perforated filter layer of the present invention;

[0022] FIGS. 3A and 3B each show a section of the base pipe from an embodiment of a sand control screen having a micro-perforated filter layer of the present invention, enlarged to display knurling on the surface;

[0023] FIG. 4 is a cross-section through one wall of the embodiment of FIG. 2;

[0024] FIG. 5A is a side elevation of an embodiment of a sand control screen having a micro-perforated filter layer of the present invention;

[0025] FIG. 5B is a cross-section through a portion of the sand control screen having a micro-perforated filter layer shown in FIG. 5A;

[0026] FIG. 6 is a side elevation of an embodiment of a sand control screen having a micro-perforated filter layer of the present invention;

[0027] FIGS. 7A and 7B respectively display a cross-section through a corrugated filter layer of a sand control screen having a micro-perforated filter layer and an associated pattern of micro-perforations in the filter layer;

[0028] FIGS. 8A and 8B respectively display a cross-section through a corrugated filter layer of a sand control screen having a micro-perforated filter layer and an associated pattern of micro-perforations in the filter layer;

[0029] FIGS. 9A and 9B respectively display a cross-section through a corrugated filter layer of a sand control screen having a micro-perforated filter layer and an associated pattern of micro-perforations in the filter layer;

[0030] FIGS. 10A and 10B display possible orientations of the micro-perforations in the filter layer of a sand control screen having a micro-perforated filter layer of the present invention; and

[0031] FIG. 11 is a flowchart showing the manufacture of the sand control screen having a micro-perforated filter layer of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0032] While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts which can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention, and do not delimit the scope of the invention.

[0033] Referring now to FIG. 1, a sand control screen having a micro-perforated filtration layer in use with an offshore oil and gas production platform is schematically illustrated
and generally designated 10. A semi-submersible platform 12 is centered over a submerged oil and gas formation 14 located below sea floor 16. Wellhead 18 is located on deck 20 of platform 12. Well 22 extends through the sea 24 and penetrates the various earth strata including formation 14 to form wellbore 26. Disposed within wellbore 26 is casing 28. Disposed within casing 28 and extending from wellhead 18 is production tubing 30. A pair of seal assemblies 32, 34 provide a seal between tubing 30 and casing 28 to prevent the flow of production fluids therebetween. During production, formation fluids enter wellbore 26 through perforations of casing 28 and travel into tubing 30 to wellhead 18. As part of the final bottom hole assembly, a sand control screen 38 having a micro-perforated filtration layer is included in tubing 30. Sand control screen 38 filters the particles out of the formation fluids as the formation fluids are produced.

Even though FIG. 1 depicts a cased vertical well, it should be noted by one skilled in the art that the sand control screen having a micro-perforated filtration layer of the present invention is equally well-suited for use in uncased wells, deviated wells or horizontal wells. In fact, in certain well configurations, the sand control screen having a micro-perforated filtration layer of the present invention may be used in conjunction with expandable tubing such that the tubing and the sand control screen are expandable downhole after installation. Also, even though FIG. 1 depicts an offshore operation, it should be noted by one skilled in the art that the sand control screen having a micro-perforated filtration layer of the present invention is equally well-suited for use in onshore operations. In addition, even though a single sand control screen is depicted, it should be noted by one skilled in the art that any number of sand control screens of the present invention may be coupled together to form one or more sand control screen strings.

Referring to FIGS. 2-4, one embodiment of a sand control screen having a micro-perforated filtration layer is depicted and generally designated 40. Sand control screen 40 includes a base pipe 42 that is depicted as having a plurality of openings 44 which allow the flow of production fluids into the production tubing. One skilled in the art will recognize that the number, size and shape of openings 44 are not critical to the present invention, so long as sufficient area is provided for fluid production and pipe integrity is maintained. For example, the base pipe could have a few as one opening. Alternatively, the base pipe could have a plurality of micro-perforations similar to those described below. Filter layer 50 is tightly attached to base pipe 42 and contains a plurality of micro-perforations 52. The size, shape, density and pattern of the micro-perforations 52 are determined by the desired flow area, the desired filtration capacity, the constituents being separated from one another and the like as well as the size of any packing sand used in association with an installation of sand control screen 40. In the illustrated embodiment, end caps 48 cover the ends of filter layer 50. In certain embodiments, however, these end caps 48 can optionally be omitted, as filter layer 50 may be tightly fused to base pipe 42.

The typical opening sizes in existing sand screens, e.g., 100-300 microns, can be reproduced in the micro-perforated filter layer 50. Additionally, both larger and smaller opening sizes can be provided in the disclosed micro-perforated filter layer 50 without the manufacturing difficulties encountered when these sizes are manufactured in either wire wrap or wire mesh sand control screens. A wide variety of intermediate size openings can also be easily produced.

Micro-perforated opening sizes for the disclosed micro-perforated filter layer can range between 50 and 500 microns, providing opening sizes that are not currently available from any manufacturer.

Due to the manufacturing processes used to create filter layer 50, the shape of micro-perforations 52 is precisely controllable and reliably reproducible. In the illustrated embodiment, micro-perforations 52 are depicted as circular, however, micro-perforations 52 may also be formed in the shape of an ellipse, a slot or other similar shape having a radius. Alternatively, micro-perforations 52 may have sharp edges such as squares, rectangles, triangles or other multi-sided polygon or shape.

Due to the tight tolerances available in the manufacturing process used to create filter layer 50, the density and pattern of micro-perforations 52 are precisely controllable and reliably reproducible. For example, the opening density of micro-perforations 52 may be between about 100 and 200 openings per square inch. Opening densities both less than 100 openings per inch and more than 200 openings per inch are also contemplated by the present invention. The opening pattern of micro-perforations 52 can have a uniform distribution or a nonuniform distribution. With the infinitely variable opening size, shape, density and pattern in the micro-perforated filter layer available with the present invention, certain embodiments of the micro-perforated filter layer not only allow for filtration of particles from production fluids but also allow for separation of fluid constituents from one another. For example, the micro-perforations may be configured to allow the production of hydrocarbon fluids therethrough and prevent the production of water therethrough. Likewise, the micro-perforations may be configured to allow the production of liquid hydrocarbons therethrough but prevent the production of hydrocarbon gases therethrough.

As best seen in FIGS. 3A, 3B and 4, the surface of base pipe 42 is knurled or machined to create channels 46 that form a drainage layer between base pipe 42 and filter layer 50 through which production fluid can flow. FIG. 3A depicts a helical channel pattern wherein channels 46 do not intersect. FIG. 3B depicts a helical channel pattern wherein channels 46 intersect one another. In FIG. 4, channels 46 are depicted as notches in the outer surface of base pipe 42. Alternatively, the drainage layer of sand control screen 40 could involve channels in the inner surface of filter layer 50. As another alternative, the drainage layer of sand control screen 40 could involve the use of a wire mesh or wire wrap between base pipe 42 and filter layer 50.

Filter layer 50 is a surface-type filter, which removes particles that are entrained in the production fluid at the surface of the filter. Because the particles remain on the surface, filter layer 50 is inherently easy to clean as particles can be washed away by a back-flow of fluid. This ability contrasts with depth filters, which trap the particles within the filter and are inherently difficult or impossible to clean.

Referring now to FIGS. 5A-5B, an alternate embodiment of a sand control screen having a micro-perforated filtration layer is depicted in elevation and in cross-section respectively and generally designated 140. Sand control screen 140 includes a base pipe 142 that has a plurality of openings 144 which allow the flow of production fluids into the production tubing. Filter layer 150 contains a plurality of micro-perforations 152. Filter layer 150 is corrugated prior to attachment to base pipe 142 and caps 146 prevent fluids from entering base pipe 142 without passing through filter layer.
150 and provide an additional means of attachment. The corrugations in filter layer 150 form large channels 146 between filter layer 150 and base pipe 142 through which production fluid flows to reach production tubing 30.

[0042] With reference now to FIG. 6, a further alternate embodiment of a sand control screen having a micro-perforated filtration layer is depicted in elevation and generally designated 240. Sand control screen 240 includes base pipe 242 with a plurality of openings (not shown) to allow the flow of production fluids into the production tubing. Filter layer 250 contains micro-perforations 252. Filter layer 250, like filter layer 150 of FIG. 5A, is corrugated prior to attachment to base pipe 242. However, the corrugations of filter layer 250 run circumferentially with respect to base pipe 242, rather than longitudinally, as in filter layer 150. End caps 248 protect and seal the ends of filter layer 250 to base pipe 242. The corrugations in filter layer 250 form large channels between filter layer 250 and base pipe 242 through which production fluid flows to reach production tubing 30.

[0043] When the micro-perforated filter layer is corrugated, the placement of the micro-perforations can be varied as necessary or desirable to prevent long term plugging of the filter and to maintain the desired flow area. With reference now to FIGS. 7A-9B, three embodiments of micro-perforations in a corrugated filter layer are displayed. In these illustrations, only the filter layer, such as filter layer 150 of FIG. 5, is shown. FIGS. 7A-7B contain filter layer 300 having micro-perforations 302 shaped to form slots. These slots 302 are created only in the peaks and valleys of the corrugations. In order to promote bridging of sand particles across slots 302, the widths of the slots as measured across their narrowest surface dimension is sized according to conditions in the producing formation and the desired filtering characteristics. In an alternate embodiment, shown in FIGS. 8A-8B, filter layer 310 contains micro-perforations 312 that form ellipses at the surface of the filter layer. The ellipses 312 are formed in the sides of the corrugations, but are eliminated from the peaks and valleys. Removing the micro-perforations from the peaks may prevent plugging while the sand control filter is installed. As in slots 302, the width of ellipses 312 as measured across their narrowest surface dimension is sized as dictated by the producing formation and the desired filtering characteristics. A further alternate embodiment is shown in FIGS. 9A-9B, which contain filter layer 320 having micro-perforations 322 that form circles at the surface of the filter layer. In this example, circles 322 are formed only on the sides of the corrugations, but not in the peaks or valleys. The diameter of the circle at the surface of the filter is sized appropriately for the producing formation and the desired filtering characteristics. One of ordinary skill in the art will understand that these arrangements are exemplary and do not limit the shape or distribution of the micro-perforations. In some embodiments, a shroud may be placed to the exterior of the corrugated filter layer to prevent damage during installation, but this is not necessary to the operation of the sand control screen.

[0044] The use of a corrugated filter layer with the sand control screen of the present invention provides certain advantages over the non-corrugated embodiments. For example, the addition of corrugations to the filter layer provides an increased flow area over the non-corrugated version. Additionally, the corrugated configuration reduces thermal effects relative to the bond between the filter layer and the base pipe.

[0045] With reference now to FIGS. 10A-10B, in at least some embodiments, the micro-perforations are formed using a water jet or laser cutting process. When these methods are used, the micro-perforations may have slightly tapering walls. For example, when the surface shape is a circle, the micro-perforation may have the shape of a truncated cone. Consequently, a slightly larger opening is found on one side of the filter layer than on the other side. If we consider the top of the figure to be the outside surface of the filter layer, FIG. 10A shows micro-perforations 332 containing a larger opening to the outside of filter layer 330. FIG. 10B shows micro-perforations 342 containing a smaller opening to the outside of filter layer 340.

[0046] Referring now to FIG. 11, a method of making the sand control screen of the present invention will now be discussed. In step 400, a section of base pipe is perforated to create openings. This step can be performed by the same methods used to create openings for wire wrap and wire mesh type sand control screens. In step 402, a length of sheet metal is micro-perforated using any available micro-perforation technique, such as water jetting or laser cutting. The thickness of the sheet metal is preferably in the range of 1/16 inch to 1/4th inch, and preferably 1/8th inch thick. The configuration of the micro-perforations for a given installation can be determined based upon formation condition and the desired filtering characteristics. In situations in which the desired sizes and/or shapes for the micro-perforations are not normally stocked, custom filter layers are feasible using the disclosed method. The specifications for the filter layer can be transmitted to a manufacturer of micro-perforated sheet metal for implementation. As will be shown, once the filter layer is micro-perforated, the actual assembly of the sand control screen is not technically difficult.

[0047] Micro-perforating results in more reliably shaped and sized openings than either wire wrapping or wire mesh screen methods, while tolerances for spacing of openings can be more easily controlled. Virtually infinitely variable screen ratings can be provided by varying the size, shape, density and pattern of the micro-perforations. Very small micron ratings can be produced by micro-perforation without loss of strength in the filter material. Similarly, large micron ratings formed by micro-perforation do not require the manipulations of large gauge wire and can be produced in sizes previously impossible to manufacture.

[0048] Once the sheet metal is micro-perforated to create the filter layer, channels are provided in step 404 to allow fluid flow between the filter layer and the base pipe. For corrugated embodiments of the micro-perforated filter layer, the corrugations of the filter layer are designed to form channels between the filter layer and the base pipe when the filter layer and base pipe are attached. For non-corrugated embodiments, channels are formed in either the outer surface of the base pipe or in the surface that will be the interior surface of the filter layer. In a preferred embodiment, the base pipe is placed in a knurling machine and knurls are created while the pipe is rotated, creating a spiral pattern of channels down the length of the base pipe that will lie under the filter layer. Cross-connections between adjacent channels can also be formed to increase available cross-flow. FIGS. 3A-3B show exemplary embodiments of knurling in the surface of the base pipe. In still another embodiment, the base pipe is treated to create an uneven, pebble-like surface. After the filter layer is
attached to the base pipe of this embodiment, the uneven surface creates interconnected channels between the base pipe and the filter layer.

[0049] The filter layer is shaped to fit around the base pipe in step 406 and the filter layer and base pipe are attached to each other in step 408. In one embodiment, the filter layer is fusion bonded to the base pipe to form a direct metal-to-metal attachment. In fusion bonding, the filter layer and the base pipe are placed in close contact with each other. A high current is run through the adjacent filter layer and base pipe, causing the two pieces to fuse. With this technique, the filter layer can be attached to the base pipe along the entire length of the filter layer, providing an extremely strong attachment. End caps, if necessary or desired, can be added as part of this step. Once the filter layer is attached to the base pipe, the edges of the filter layer are sealed to each other. In at least one embodiment, a seam weld is applied down the full length of the filter layer, sealing the edges of the filter layer together and forming a true one-piece, 360° filter.

[0050] In another embodiment of the attachment method, a friction fit is used to join the filter layer to the base pipe. The filter layer is first joined to itself to create an open-ended cylindrical shape that is sized to fit snugly over the base pipe. The cylindrical filter layer is then heated to increase the diameter across the filter and slipped over the base pipe. When sized properly, the cooled filter layer forms a tight fit to the base pipe.

[0051] One of ordinary skill in the art will realize that other methods of attachment can also be used without deviating from the scope of the invention. For example, a glue or other bond-inducing chemical means can be used. Additionally, a variety of connections, such as threads, screws or welds provide another means of attachment.

[0052] The disclosed method of manufacturing a sand control screen provides a number of advantages over current manufacturing methods for sand screens. The most critical step in the production of the present sand control screen is micro-perforating the sheet metal. This step can be performed under controlled conditions to produce reliable opening sizes and shapes with close tolerances in the spacing. The later steps of shaping the sheet metal and attaching the shaped filter layer to the base pipe can be performed in less controlled conditions without adversely affecting the quality of the sand control screen. Final assembly can be performed closer to the point of use, such as at the well site. Overhead can also be reduced by stocking only the micro-perforated sheet metal and assembling the sand control screens on user-provided base pipe. Specific configurations of micro-perforations can be produced quickly and shipped to the site to provide a custom-made filter that more closely meets the need of the user’s than the stock sizes currently available.

[0053] The disclosed sand control screen having a micro-perforated filter layer also provides additional advantages over existing sand control screens. The use of a micro-perforated filter layer can result in a sand control screen having a reduced outside diameter for a given base pipe size. The decreased outside diameter and strong attachment can make installation easier and may allow an increased base pipe size for a given hole diameter. Additionally, the attachment of the filter layer and base pipe along the entire length of the filter layer provides a strong attachment with a lower incidence of detachment. Manufacturing costs are decreased, while the quality and durability of the filter are increased.

[0054] While this invention has been described with a reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to the description. It is, therefore, intended that the appended claims encompass any such modifications or embodiments.

What is claimed is:
1. A sand control screen comprising:
a base pipe having at least one opening that allows fluid flow therethrough;
a filter layer attached to the base pipe, the filter layer having a plurality of micro-perforations; and
a drainage layer formed between the base pipe and the filter layer to allow fluid flow between the base pipe and the filter layer.
2. The sand control screen as recited in claim 1 wherein the filter layer has a thickness between about 1/2 and of an inch and about 1/4th of an inch.
3. The sand control screen as recited in claim 1 wherein the filter layer is a sheet metal filter layer.
4. The sand control screen as recited in claim 1 wherein the shape of the micro-perforations at the surface of the filter layer is chosen from the group consisting of a circle, an ellipse and a slot.
5. The sand control screen as recited in claim 1 wherein the shape of the micro-perforations at the surface of the filter layer is chosen from the group consisting of a square, a triangle and a multi-sided polygon.
6. The sand control screen as recited in claim 1 wherein the micro-perforations have a maximum width of 500 microns.
7. The sand control screen as recited in claim 1 wherein the micro-perforations have a tapering cross-section through the filter layer.
8. The sand control screen as recited in claim 1 wherein the filter layer is attached to the base pipe by one of adhesion, a friction fit and fusion bonding.
9. The sand control screen as recited in claim 1 wherein the drainage layer further comprises channels.
10. The sand control screen as recited in claim 9 wherein the channels are formed in one of the outside surface of the base pipe and the inside surface of the filter layer.
11. The sand control screen as recited in claim 1 wherein the drainage layer further comprises one of wire wrap and wire mesh.
12. A sand control screen comprising:
a base pipe having at least one opening that allows fluid flow therethrough;
a sheet metal filter layer wrapped around the base pipe, the filter layer having a plurality of micro-perforations, the filter layer being corrugated to form channels between the filter layer and the base pipe; and
at least one connector coupling the filter layer to the base pipe.
13. The sand control screen as recited in claim 12 wherein the filter layer has a thickness between about 1/2 and of an inch and about 1/4th of an inch.
14. The sand control screen as recited in claim 12 wherein the shape of the micro-perforations at the surface of the filter layer is chosen from the group consisting of a circle, an ellipse and a slot.
15. The sand control screen as recited in claim 12 wherein the shape of the micro-perforations at the surface of the filter...
layer is chosen from the group consisting of a square, a triangle and a multi-sided polygon.

16. The sand control screen as recited in claim 12 wherein the micro-perforations have a maximum width of 500 microns.

17. The sand control screen as recited in claim 12 wherein the micro-perforations are placed at the peaks and valleys of the corrugations.

18. The sand control screen as recited in claim 12 wherein the micro-perforations are spaced uniformly across the filter layer.

19. A method of making a sand control screen, the method comprising:
   - fabricating a plurality of openings in the wall of a base pipe, the plurality of openings allowing fluid flow therethrough;
   - creating a plurality of micro-perforations in a length of sheet metal having a first and a second edge opposite each other to form a filter layer;
   - forming a plurality of channels that allow fluid flow between the filter layer and the base pipe;
   - shaping the filter layer to fit around the base pipe wherein the first edge and the second edge of the filter layer are substantially adjacent each other;
   - attaching the filter layer to the outer surface of the base pipe; and
   - sealing the first edge of the filter layer to the second edge.

20. The method of making a sand control screen as recited in claim 19, wherein the filter layer is corrugated prior to the shaping step.

21. The method of making a sand control screen as recited in claim 19, wherein the shaping step and the attaching step are performed at the location where the sand screen is used.

22. The method of making a sand control screen as recited in claim 19, wherein the attaching step uses an attachment method chosen from the group of fusion bonding, friction fitting and adhesion.

23. The method of making a sand control screen as recited in claim 19, wherein the creating step creates micro-perforations having a tapering cross-section.

24. The method of making a sand control screen as recited in claim 23, wherein the shaping step orients a smaller opening of the tapering cross-section on the exterior of the filter layer.

25. The method of making a sand control screen as recited in claim 19, wherein the creating step uses one of a water jet and a laser to create the micro-perforations.

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