ABSTRACT: A well screen including a spearhead or similar device for engagement with a wireline tool and a self-supporting helical body formed from a metallic rod that can be unwound and straightened for removal from the wellbore by pulling on the screen from the earth's surface.
RETRIEVABLE WELL SCREEN

BACKGROUND OF THE INVENTION

Field of the Invention
This invention relates to screens and liners for use in wells completed in poorly consolidated formations.

Prior Art
Screens and liners have been widely used for preventing the entrainment of sand in fluids produced from oil wells, gas wells, and similar boreholes. Typical devices include slotted pipe, wire wrapped pipe containing slots or perforations, and perforated pipe provided with slotted buttons mounted in the perforations. One problem with such devices is that they are often difficult to remove from the wellbore in the event that replacement or workover of the well becomes necessary. Sand accumulating in the space surrounding the device may "freeze" it in place. In some cases this sand can be dislodged by washover techniques, swabbing, injecting oil under high pressure, or using chemicals but in other instances it may be necessary to drill or mill the screen or liner out. This is a time consuming and expensive operation, particularly in wells with long producing zones. The problems thus encountered are more severe in deviated wells and in tubingless completions and other small diameter wellbores. In many such cases the use of screens and liners is wholly impractical.

SUMMARY OF THE INVENTION

This invention provides an improved well screen that alleviates many of the difficulties referred to above. The screen of the invention includes a spearhead or other device that can be engaged with a wireline tool or similar grappling device lowered into the well from the earth's surface and an elongated body formed from helical coils of metal or similar material between which the produced fluids pass into the interior of the body. The coils are closely spaced so that sand grains and other solids entrained in the fluids are screened out in the wellbore. Adjacent coils are interconnected to maintain the required spacing and lend rigidity to the body. When it is desired to remove the screen from the well, the spearhead is engaged and an upward force is applied by means of the wireline. As the line is pulled, the helical coils unwind and straighten out. This collapses the body incrementally and permits removal of the entire apparatus from the wellbore, even though the device may be surrounded by closely packed sand.

The apparatus of the invention has numerous advantages over screens and liners available in the past. It is inexpensive and simple to fabricate, can be installed in deviated wells of small diameter, offers relatively little obstruction to the entry of fluids into the wellbore, effectively screens sand and other debris, and can be removed from the well without difficulty. As a result of these and other advantages, the improved screen has wide application in wells where sand control has been a problem in the past.

DESCRIPTION OF THE DRAWING

FIG. 1 in the drawing is a vertical elevation, partially in section, of a sand screen constructed in accordance with the invention. FIG. 2 is a cross section of the apparatus of FIG. 1 taken about the line 2–2; FIG. 3 is a vertical elevation of an alternate embodiment of the invention; and FIG. 4 is a cross section of the apparatus of FIG. 3 taken about the line 4–4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiment of the invention shown in FIG. 1 of the drawing includes a spearhead 11 for engaging the screen with a conventional wireline tool or other device which is lowered in the wellbore from the earth's surface. The configuration of the spearhead will depend in part on the particular wireline apparatus with which it is to be used and may be varied as necessary. The base of the spearhead will normally extend outwardly beyond the upper part as shown and will have a transverse cross section such that it will offer relatively little impedance to the flow of fluids upwardly past it into the tubing string above. An elongated screen body 12 of generally circular cross section is attached to the spearhead base and extends downwardly beneath it. The body of the device of FIG. 1 is composed of two elongated members 13 and 14 which are secured to the base of the spearhead and wound together to form a long hollow spiral having closely spaced turns or coils. The tapered configuration aids in lowering the device through the tubing or casing and facilitates seating it at the bottom of the borehole. Members 13 and 14 will normally be rods or bars of iron, steel, copper, brass, or a similar metal but synthetic plastics and other materials can also be used, particularly in water wells and other shallow installations where the forces acting on the screen will normally be relatively low.

The members may be of circular cross section as shown in FIG. 1 or may have square, wedge-shaped, or other cross-sectional configuration. Adjacent turns are soldered, bonded, or otherwise fastened together at spaced points about the spiral as indicated by reference numerals 15 and 16 in order to maintain the desired spacing between adjacent turns and lend rigidity to the structure. The spacing employed will depend in part upon the size of the sand grains in the formation and the manner in which the device is to be used but will normally be between about 10 and about 60 thousandths of an inch. It is generally preferred to surround the screen with coarse sand or gravel injected from the surface and hence larger openings might otherwise be tolerated can often be used. The two members 13 and 14 are twisted together and soldered, brazed, or otherwise held in place at their lower ends to form a closure at the bottom of the screen as indicated in FIG. 2 of the drawing. In lieu of two elongated members as shown in FIGS. 1 and 2, three or more members may be coiled together to form the helix if desired.

FIG. 3 in the drawing depicts an alternate embodiment of the invention in which a single elongated rod 20 of wedge-shaped cross section is attached to a spearhead 21 at its upper end. The spearhead shown includes a supporting ring 22 which is designed to seat in a landing nipple or similar device in the lower end of the tubing string. This is shown more clearly in FIG. 4. The rod forms an elongated helical coil 23 of substantially uniform diameter over its entire length. Adjacent turns in the rod are tied together by wires or similar strands 24, 25, and 26 which make the structure more rigid and help maintain the necessary spacing. The strads employed should not be larger than the spacing between adjacent coils. This particular embodiment of the screen is open at its lower end but may be manufactured in closed form if desired. Methods for spacing the coils and holding them together in addition to those depicted in the drawing will suggest themselves to those skilled in the art and may be employed if desired.

In using a tapered screen of the type shown in FIGS. 1 and 2, coarse sand or gravel will normally first be placed in the wellbore opposite the producing formation. As a general rule, the material selected will be about six times the size of the formation sand itself. The screen assembly is then lowered into place in the wellbore so that it rests on the sand or gravel and the upper end of the assembly remains in the lower end of the tubing string through which fluids are to be produced. The diameter of the upper end of the body should be sufficiently large to prevent the passage of sand or gravel between the screen and the inner wall of the tubing. After the unit has thus been placed, hydraulic pressure can be applied at the surface to force the screen downwardly into the sand or gravel and seat it.

If a device of the type shown in FIGS. 3 and 4 is used, it may if desired be employed in conjunction with a conventional wireline tool or other device which is lowered in the wellbore from the earth's surface. Such a device can be fabricated in any length necessary and used to screen off very long producing sections. The coiled body is sufficiently flexible that it can be lowered through deviated wells and installed in small diameter wellbores where conventional screens cannot be used.
Methods for the installation of screens and liners by reverse circulation have been described at length in the literature and will be familiar to those skilled in the art.

Fluids entering the wellbore after the screen has been installed will flow through the surrounding bed of coarse sand or gravel and pass between adjacent turns in the screen. The screen holds the sand or gravel in place. Any formation sand contained in the incoming fluids will bridge across openings in the bed of coarse sand or gravel until an outer bed of formation sand has been formed. The pressure drop through the screen is relatively low because the openings extend around the circumference of the device with few interruptions.

In the event that it becomes necessary to remove the screen from the wellbore, a wireline provided with a conventional overshot or similar device at its lower end is lowered into the wellbore until the overshot or other device engages the spearhead. The line is then pulled from the surface to remove the screen. The force exerted on the line causes rods 13 and 14 in the apparatus of FIG. 1 or rod 20 in the device of FIG. 2 to unwind and straighten out. As this occurs, the connections between adjacent turns or coils are ruptured. Unwinding of the coils proceeds even though sand, gravel, and other solids are packed tightly around the screen. The entire screen assembly can thus be pulled out of the wellbore without danger of its being “frozen” in place. Although this destroys the screen the units are relatively inexpensive and can be replaced as necessary. Replacement at reasonable intervals has advantages in that it tends to minimize difficulties that might otherwise be encountered due to erosion and plugging.

I claim:

1. A well screen for controlling the production of sand from a well which comprises a plurality of elongated members coiled into a helix having closely spaced turns and a spearhead attached to the upper end of each of said members for pulling on the members with a wireline, at least part of the turns in said helix being connected to one another to maintain the desired spacing between adjacent coils and lend rigidity to the structure.

2. A screen as defined by claim 1 wherein said helix is tapered and closed at the lower end.

3. A screen as defined by claim 1 wherein at least part of the turns in said helix are brazed to one another.

4. A screen as defined by claim 1 wherein at least part of the turns in said helix are tied to one another with strands of smaller diameter than said elongated members.

5. A screen as defined by claim 1 wherein said helix is of substantially uniform diameter over its entire length and is open at the lower end.

6. A screen as defined by claim 1 wherein said elongated members are of wedge-shaped cross section.

7. A screen as defined by claim 1 wherein said spearhead includes a seating ring.

8. A screen as defined by claim 1 wherein said elongated members are metallic rods.