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[54] **METHOD OF PROTECTING WELL APPARATUS AGAINST CONTAMINATION DURING HANDLING**

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[51] **Int. Cl.**[2] **E21B 43/10**

[58] **Field of Search** 166/296, 295, 294, 280

[56] **References Cited**

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[57] **ABSTRACT**

A method of protecting downhole well apparatus having openings therein or movable parts during handling of such apparatus, particularly during positioning thereof in a wellbore, comprising; filling the openings or coating the movable parts with a blend of a wax and a polymer, handling the so-treated apparatus such as positioning the same in a wellbore, and removing the filling or coating blend from the openings or movable parts.

5 Claims, No Drawings

METHOD OF PROTECTING WELL APPARATUS AGAINST CONTAMINATION DURING HANDLING

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to apparatus and methods for completing wells. More particularly, it relates to such apparatus and methods wherein an apparatus having openings, holes, apertures or perforations therethrough to provide fluid flow channels through the apparatus or an apparatus having moving parts is positioned downhole in a well.

2. Description of the Prior Art

In completing wells it is often desirable to position downhole some type of apparatus through which fluids are passed between the wellbore and the surrounding formation. Such apparatus include perforated liners, screens, packers and the like. One characteristic of such apparatus is that they have cavities or recesses such as an opening or openings therethrough through which the fluid passes. The size of the openings may vary considerably depending on the exact nature and intended use of the apparatus. Other apparatus have movable parts which must be activated once the apparatus has been positioned downhole. Such apparatus include packers which have jaws which, once the packer is positioned downhole, must be moved out to contact and bite into the surrounding casing or borehole wall. Such apparatus are handled repeatedly from the time they are manufactured until they are in position downhole in a well ready for use. Such handling includes packaging, shipping, unpackaging, storing and positioning in a well. The apparatus are positioned downhole in a well by lowering the same through a borehole, such as via a wireline or as a part of the tubing string, to the desired position downhole. The borehole through which the apparatus is lowered may be an open hole or may be cased. During its passage through the borehole the apparatus necessarily contacts and passes through any fluid or detritus which may be in the wellbore and can scrape against the sides of the cased or open borehole, especially if the borehole deviates from the vertical. Throughout the handling and positioning operations there are many opportunities for extraneous solid materials, such as packaging materials, dirt, sand, detritus, drilling fluid solids, pieces of the borehole sidewall rock and the like, to contact and become lodged in the openings or movable parts of the apparatus. The presence of these extraneous solid materials cuts down or can even shut off flow through the apparatus or bind and prevent movable parts from moving thus decreasing or destroying the efficiency of the apparatus.

In order to protect the openings and movable parts in such apparatus it is known to fill the openings and coat the movable parts in the apparatus with a plugging material prior to positioning the apparatus downhole. After the apparatus is positioned, the plugging material melts away or is othewise removed to clear the openings or leave the movable parts free of extraneous materials. Previously known plugging or coating materials include inorganic solids such as hydrated nitrates of chromium, iron, mercury and nickel; pure organic compounds such as various acids, and crude organic materials such as paraffin, gilsonite, beeswax, metals and metallic alloys.

It is an object of this invention to provide an improved apparatus and method for positioning downhole in a well an apparatus having openings therethrough or movable parts. It is a further object to provide such an apparatus and method wherein the openings are plugged or movable parts coated with a removable plugging material during the handling and positioning of the apparatus.

It is a still further object to provide such a removable plugging material having improved bonding to the apparatus.

It is another object to provide an organic removable plugging material which is harder than previously used organic materials.

It is still another object to provide such an organic removable plugging material which melts at a temperature lower than that of the borehole in which it is positioned or can be removed from the openings or movable parts by contacting the same with a solvent.

Other objects, advantages and features of the invention will become apparent from a consideration of the following specification and appended claims.

BRIEF SUMMARY OF THE INVENTION

A method of protecting and maintaining open cavities or recesses such as openings in or movable parts of apparatus during placement of such apparatus downhole in a well comprising: (a) filling the cavities of the apparatus with a blend of a wax and a polymer, and (b) positioning the apparatus downhole in a well. If the temperature of the borehole at the downhole location is higher than the melting point of the wax-polymer blend, the well is shut in until the blend melts. Alternatively or if the temperature of the borehole is lower than the melting point of the blend, hot oil or other solvent for the blend is flowed through the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Many types of liners and screens have been used for years to control production of unconsolidated formation sand in oil, gas and water wells. Common types of liners consist of tubing in which slots or other holes of various sizes and configurations are cut. Well fluids can pass from the formation through the slots into the tubing and up the tubing out of the well, but sand or other formation particles bridge in the slots and are prevented from passing through the liner. Modifications of these liners can be made, as by wrapping the exterior of the liner with wire or a similar material which is spaced at regular intervals. Another modification is a liner having the openings in it coated on the exterior thereof by a permeable solid material such as plastic coated sand or concrete. Such permeable coating acts as the filter media and the liner itself acts as a base or form to support the permeable coating. The process of this invention can be carried out using any of these liners and screens.

Similarly the invention may be carried out using any downhole apparatus which contains a part or element which must be moved in relation to other parts or elements once the apparatus is positioned downhole. Typical are packers which contain jaw members which are in a contracted position during passage of the packer through the borehole but which are moved out into contact with the borehole sidewall once the packer has been lowered to its desired location. Such apparatus

have cavities or recesses between the moving parts and the stationary parts.

The temporary plugging or blocking material of this invention is a blend of a wax and a polymer. It has been found that wax alone does not adhere well to the metal surfaces of the cavities which are to be plugged. Also wax alone has too low a softening point compared to its melting point. This means that with an apparatus being positioned, which apparatus contains cavities filled with wax, the wax softens before the apparatus reaches its final location. This premature softening may result in the wax acutally attracting and picking up undesired solid plugging material and holding the same in the cavity area. Addition of a polymer to the wax forms a blend having a softening point which is desirably close to the melting point and which bonds better to metal than wax alone. Approximately equal weights of wax and polymer are preferred. As little as 20 percent by weight polymer imparts a substantial increase in softening point. More than about 75 percent by weight polymer results in a blend with a softening point and melting point which are too high for most applications.

The wax is preferably a synthetic paraffin wax having a softening point not substantially below its melting point. The polymer may be a solid polyvinyl acetate, a polyolefin such as a polyethylene, a polyamide, a rosin-type polymer such as a rosin ester, for example a glycerol ester of rosin or a synthetic polyterpene.

The softening point of the blend should preferably be within 10° to 15° of its melting point. The melting point of the blend should be a temperature above ambient temperature and equal to or slightly less than the temperature at which the apparatus which is coated with the blend can be heated during use. In well operations the melting point should be greater than the surface temperature but equal to or less than the temperature of the borehole in which a coated apparatus is positioned.

A series of tests were made to determine the strength with which wax and wax-polymer blends adhered to metal. The metal used was two rectangular mild steel specimens 3/16 inch by 1 inch by 2 ¼ inch. Each specimen weighed approximately 24 grams. Various waxes and wax-polymer blends were heated to above their melting point and while still hot painted with a paint brush onto a 1 square inch surface area on one side at the end of each specimen. The coated areas of the two strips were then pressed together and held until the coating cooled and solidified. The joined strips were then vertically suspended by one end in an oven. The temperature was slowly raised and the temperature at which one strip fell away from the other strip was noted. This was taken as the softening point.

Example	Wax (1 part by weight)	Polymer (1 part by weight)	Melting Point* (°F.)	Steel Specimens Separated (Softening Point°F)
1	Paraffin Wax A	none	146 – 153	129
2	Paraffin Wax A	Synthetic polyterpene	135 – 150	134
3	Paraffin Wax B	none	160 – 165	147
4	Paraffin Wax B	Synthetic polyterpene	165 – 170	163
5	Paraffin Wax C	none	200	158
6	Paraffin Wax C	Synthetic polyterpene	200 – 210	210

*ASTM D127

The foregoing tests show that addition of a polymer to the wax raised the softening point close to the melting point.

A test was made using a 2 foot long section of a 5 ½ inch outside "FEATHER" slotted liner having an inside diameter of 5 inches. The section contained 18slots uniformly positioned around its lateral sidewall. Each slot was 2 inches long, ⅛ inch wide at the interior of the liner and feathering to ½ inch wide at the outside of the liner. The liner was typical of those used in producing wells in California which produce sand along with the well fluids. A blend of 50 parts by weight paraffin wax D and 50 parts by weight synthetic polyterpene was mixed together at a temperature of 220°F and applied while hot by a paint brush to the slots of the liner until all the slots were filled. The coated liner was allowed to come to room temperature. The wax-polymer blend hardened and adhered strongly to the slot sidewalls. The coated liner was placed in an oven and observed as the temperature was slowly increased. The blend began to melt at 215°F. After 1.5 hours additional heating, the wax-polymer blend had all melted and completely run out of the slots leaving them open. The temperature of the oven had risen to 220°F.

This test proved that the wax-polymer blend could be satisfactorily placed in the slots of a liner and harden so that no extraneous solid material could enter the slot. When the liner was heated to above the melting point of the blend, the blend completely ran out of the slots freeing the liner for use in passing fluids.

A sample of the above wax-polymer blend was mixed with a typical California crude oil. The blend was completely soluble in the oil at a temperature of 180°F. Similar results were obtained with diesel fuel, kerosene and xylene in place of crude oil. These tests indicate that wax-polymer blend can be removed at a temperature lower than the melting point of the blend by the use of a solvent such as crude oil, diesel fuel, kerosene or xylene.

WELL EXAMPLE

A well in the San Miguelito Field of California was drilled through an oil and gas pay zone extending from 12,780 feet to 13,265 feet. Since other wells in the field were known to have sand problems, a slotted liner was positioned opposite the pay zone and the well placed on production. After six months on production the well casing collapsed. This was believed due to sand being produced through the liner along with the gas and oil causing the formation sand to shift and exert sufficient pressure against the casing to collapse it. The liner was pulled from the hole and examined. Some of the slots were eroded. It was postulated that most of the slots had become plugged while the liner was originally being placed in the hole. Thus all production had occured through the few remaining unplugged holes. The high flow rate through these few holes caused the holes to be eroded by the loose formation sand which was produced along with the oil. The bottom of the well was then redrilled through the producing interval. The esti-

mated bottom hole circulating temperature of this well was 210°F.

Seventeen 30 foot long sections of 2 ⅞ inch diameter pipe was perforated with twenty ¼ inch diameter holes per foot. A wax-polymer blend was prepared by mixing together 50 pounds of paraffin wax having a melting point of 200°F and a softening point of 158°F and 50 pounds of a synthetic polyterpene polymer and heating to 210°F. The blend softened and melted at 201°F. The melt was applied to the liner sections by brushing a sufficient quantity into the holes to fill the holes. The blend hardened when it cooled below 201°F. The liner was made up by coupling the seventeen sections together as the liner was run into the open hole at the bottom of the casing. The liner was positioned opposite the pay zone. The well was returned to production and produced at the same rate, 200 barrels oil per day, as before placement of the liner but at a decreased pressure drop. No sand was produced. Six months after placement of the liner the well was still producing satisfactorily with no sand problems. These results indicate that the wax-polymer blend stayed in the liner openings throughout the placement of the liner and kept sand from entering the openings during placement. The high production rate indicates that the wax-polymer blend melted and ran out of the liner openings when the liner reached the pay zone which had a temperature above the melting point of the blend. The decreased pressure drop indicates that a large number of liner openings were open and available for fluid production.

What is claimed is:

1. A method of placing a cavitycontaining well apparatus downhole in a wellbore comprising:
   a. blending together from 25 to 80 parts by weight of a paraffin wax heated to a temperature above its melting point and from 75 to 20 parts by weight of a polymer selected from the class consisting of polyterpenes, polyvinyl acetates, polyolefins, polyamides and rosin esters to form a melted wax-polymer blend having a softening point 10-15°F below its melting point,
   b. filling the cavity of the well apparatus with the melted wax-polymer blend,
   c. solidifying the wax-polymer blend,
   d. positioning the so-treated well apparatus downhole in a wellbore, and
   e. removing the wax-polymer blend from the cavity.

2. The method of claim 1 wherein the cavity is filled by brushing the melted blend into the cavity.

3. The method of claim 1 wherein the blend is solidified by allowing the blend to cool to ambient temperature.

4. The method of claim 1 wherein the apparatus is a screen, slotted liner or packer.

5. The method of claim 1 wherein the blend is removed from the cavity by contacting the blend with a solvent selected from the group consisting of crude oil, diesel fuel, kerosene or xylene.

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