Method and apparatus for retaining and protecting various components of well tools such as packers involves the use of a heat-shrinkable elastomeric sleeve placed over the well tool and heated to radially shrink it into relatively snug fitting relationship over the well tool parts.
RETENTION SLEEVE FOR WELL TOOLS AND
METHOD OF USE THEREOF

BACKGROUND OF THE INVENTION

When placing downhole well equipment in the desired location in the wellbore, many adverse environments are penetrated by the tools. Some of these environments include such adverse conditions as high temperatures, high fluid flow past the equipment, highly corrosive elements in the well fluids, and highly erosive suspensions of abrasives in flowing fluids.

As a result of passing through such environments, many undesirable effects are incurred by the well tools, often causing malfunction of the tools. For example, when the tool string has one or more well packers, these adverse conditions may soften and expand the packer elements resulting in premature setting and/or destruction thereof. Abrasive fluids accelerate the destruction of the resilient packer elements as well as ports and valves in the metal portions of the tools.

Furthermore, hydraulically actuated components of such tools may be prematurely activated or deactivated by pressure surges or fluid flowing past the well tools. Such hydraulic components include packer slips, anchor buttons, valves, and others. In addition, mechanically actuated expanding and rotating members can be accidentally actuated by fluid flow around the tool or can be jammed by sand and sediment deposits to prevent the desired actuation at the proper time.

Attempts to prevent the occurrence of such problems have included shear means such as screws, pins, and welds to prevent premature movement of movables. Metal springs of varying configurations and resiliency are used to retain movable components in a certain orientation.

The above attempts suffer the disadvantages of being unreliable and complicated. The present invention solves the problem by providing an elastomeric sleeve which slips over the tool to be protected or the components to be retained, which sleeve is then heated to shrink it down tightly over the tool, providing a resilient protective barrier and retaining means. The sleeve may be designed to fully encapsulate the tool providing a seal against pressure gauge, fluid flow, heat, and abrasion. A buffer zone is created between the tool and the wellbore.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a side view partly in cross section of the invention on a well packer before heating;

FIG. 2 illustrates the invention of FIG. 1 after shrinking;

FIG. 3 illustrates the invention with special cut-out areas.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates the invention being utilized on a hydraulically actuated well packer 11 having a tubular gripping member 12, anchor buttons 13, hydraulic actuating assembly 14, and resilient packer elements 15. Such a packer is typical of the apparatus disclosed in U.S. Pat. Nos. 3,548,936; 3,818,987; and 3,599,712.

Generally, operation of this type of packer in the wellbore occurs by the hydraulic actuation of assembly 14 which moves a ring 16 upward against a rotatable tubular slip 12. This rotates the slip 12 until the teeth thereon engage the casing wall. Simultaneously with rotation of slip 12, upward movement of the ring 16 and slip 12 causes compression of resilient packer elements 15 outward into sealing engagement with the casing wall. Radially expandable anchor buttons 13 having external teeth thereon may be slidably located in the packer body to be hydraulically expanded outward for further anchoring the packer in the casing.

All of the aforementioned anchoring, sealing, and actuation mechanisms are susceptible to corrosion, precipitation, jamming, and the other undesirable effects when in the aforementioned adverse environments.

These undesirable effects are prevented by the placement over the tool or tool string of a generally tubular elongated sleeve 17 of heat shrinkable elastomeric material. Sleeve 17 is of the type of man-made elastomer which shrinks radially upon heating above a certain temperature and thereafter exhibits a thermal and chemical stability while retaining at least a portion of its elasticity. Such materials are well known in the art and include for example, a polyolefin material used under the trademark “Fit-221” manufactured by Allied Electronics Division of the Tandy Corporation, Fort Worth, Texas. This material is listed as an example only as it is clear that other known heat-shrinkable elastomers such as polyvinyl chloride and specially treated neoprenes are available for use with this invention. The sleeve used on a standard 4 1/8 inch well packer having an actual outer diameter of 3.78 inches, in one embodiment of this invention was a cylindrical tube having an inner diameter of 4 inches and a wall thickness of 0.056 inches. The material was “Fit-221” which, when heated above 135° centigrade, contracted radially about the well packer until it was tightly and elastically shrunk about the packer as illustrated in FIG. 2. The polyolefin material used has a radial shrinkage which is a maximum of around 50 percent with a maximum axial shrinkage of only about 5 percent. The radially inward shrinkage of the sleeve about the packer serves to maintain the anchor buttons 13 recessed in the packer, covers and compresses inward the resilient packer elements 15, and retains the tubular gripping member 12 in its non-rotated, non-engaging position. When the shrinkage has been completed, the tool is then ready to be placed in the string and lowered into the well.

When it becomes desirable to activate the various mechanisms in the packer, the elasticity of sleeve 17 allows this to be accomplished. The gripping elements 12 and 13 have relative sharp gripping teeth which are moved against the casing wall with sufficient force to cut through the sleeve and even substantially extrude the entrapped area of the sleeve outward from between the toothed elements and the casing, thus allowing good gripping engagement between the teeth and the casing wall.

Likewise, the hydraulic actuating force on gripping member 12 is of much greater magnitude than the retention elasticity of sleeve 17 thereby insuring a positive actuation and engagement of member 12. The elasticity of sleeve 17 also allows radial expansion of packer elements 15 resulting from the axial compression thereon. Packer elements 15 move radially outward thereby effecting a fluid-tight annular seal between the casing, the sleeve 17, and the elements 15.
The elastomeric sleeve 17 maintains its tight contact with almost the entire packer assembly thereby continuously protecting it from erosion, corrosion, and pressure surges.

It should be appreciated that this apparatus can also be utilized solely as a protection shield for tools not needing the elastic retention. The sleeve in its contracted position provides a tough relatively fluid-tight cover over the well tools as they are lowered through the hostile environments and banged into obstructions and abrasive deposits in the well bore such as are located around casing joints. Upon reaching the desired location in the well bore, the tools can be removed of the cover if desired by pumping a solvent down the well bore which will dissolve the elastomeric sleeve.

FIG. 3 illustrates an external view of a shrinkable sleeve 17' on a tubular gripping member 12' similar to that of FIGS. 1 and 2. In this embodiment, the portion of the elastomeric sleeve which would normally cover the toothed gripping portion of member 12 has been cut-out to allow direct contact of the teeth with the casing wall. This embodiment is particularly advantageous in situations where the hydraulic actuation forces are limited and the operator wants to insure a good set of the packer in the casing. For instance, in an old well where it is believed that the casing may be weak from corrosion, actuation force on the gripping member may have to be moderated to prevent casing damage. This embodiment allows setting of the packer gripping member through openings in the elastomeric sleeve thereby reducing the level of actuating pressure required for the packer. This also allows a thicker sleeve to be used so as to obtain even better retention and protection of the other parts of the well tool.

Although a specific preferred embodiment of the present invention has been described in the detailed description above, the description is not intended to limit the invention to the particular forms or embodiments disclosed herein, since they are to be recognized as illustrative rather than restrictive and it will be obvious to those skilled in the art that the invention is not so limited. For example, whereas the invention is described with relation to well packers, it can also be utilized with most other downhole tools including conventional wedge-slip type packers, perforating equipment, drilling bits, multiple string packers, hydraulic anchors, bridge plugs, and many others. As a further example, rather than using a heat shrinkable elastomer it is clear that a chemically shrinkable material or one that is activated by electric current could be used. Thus, the invention is disclosed to cover all changes and modifications of the specific examples of the invention herein disclosed for purposes of illustration which do not constitute departures from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Retention apparatus for well tools having radially movable components, said retention apparatus comprising:
   an elongated tubular sleeve arranged to enclose the well tools and initially having a passage thereof larger than the well tool; and,
   said tubular sleeve being comprised of an elastomeric selectively shrinkable material which has been preselectively shrunk into a snug fitting resilient relationship on the well tool.

2. The retention apparatus of claim 1 wherein said shrinkable material is of the type having a relatively high radial contraction and a relatively low axial contraction.

3. The retention apparatus of claim 1 wherein said shrinkable material retains chemical and physical stability and elasticity at high temperatures after said shrinkage.

4. The retention apparatus of claim 1 wherein said shrinkable material is activated by chemical reaction.

5. A protective sleeve for use on downhole well tools, said sleeve comprising:
   an elongated tubular sleeve adapted to enclose a well tool and initially having a longitudinal passage therethrough larger than the well tool; and,
   said tubular sleeve being comprised of a shrinkable material which has been shrunk into fluid-tight encapsulating enclosure about the well tool.

6. The protective sleeve of claim 5 wherein said shrinkable material is shrunk by applying heat thereto and said material after shrinking is at least slightly elastic, and is thermally and chemically stable in a well bore.

7. A method of retaining expandable elements on a well tool; said method comprising:
   placing over the well tool in the area of the expandable elements a sleeve of shrinkable elastomeric material; and,
   activating said shrinkable material to shrink said sleeve into tight-fitting elastic relationship on said well tool.

8. The method of claim 7 wherein said shrinkable material is a heat-shrinkable elastomeric material and said activating step further comprises applying sufficient heat to said heat-shrinkable material to raise it above its activation temperature, and maintaining said material at or above the activation temperature until the desired shrinkage has occurred.

9. A method of applying a protective covering on a well tool; said method comprising:
   placing over the well tool a tubular sleeve of shrinkable material having a high chemical and thermal stability after shrinkage; and,
   shrinking said material radially to a relatively fluid-tight fit around said well tool.