BALL ACTUATED DOWNHOLE TOOL

BACKGROUND

Wellbore tools are known that are actuated by actuator balls. A downhole actuator ball is conveyed downhole to actuate one or more wellbore tools, as by landing in the tool and creating a seal therewith. While commonly called a ball, some devices are indeed in the form of an actual spherical ball but some are alternately shaped as darts, are oblong, have tails, etc.

In some operations, it is desirable to use a dissolvable ball that can be conveyed downhole to actuate a wellbore tool, but which will dissolve over time when in contact with liquid. In some cases, the ball has a body formed of a dissolvable material and a coating that protects the ball against dissolving until the coating is opened to expose the body to the dissolving liquid.

SUMMARY

In accordance with another broad aspect of the present invention, there is provided a ball-actuated tool comprising: a tool mechanism including a ball landing area; and a ball coating opener in the ball landing area.

It is to be understood that other aspects of the present invention will become readily apparent to those skilled in the art from the following detailed description, wherein various embodiments of the invention are shown and described by way of illustration. As will be realized, the invention is capable for other and different embodiments and its several details are capable of modification in various other respects, all without departing from the spirit and scope of the present invention. Accordingly the drawings and detailed description are to be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

Several aspects of the present invention are illustrated by way of example, and not by way of limitation, in detail in the drawings.

The drawings include:

Figures 1, 2 and 3 are schematic sectional views through one embodiment of a ball-actuated tool where Figure 1 shows the tool in a pre-actuated position, Figure 2 shows the tool being actuated by a ball and Figure 3 shows the ball coating opener opening the ball coating.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

The description that follows and the embodiments described therein are provided by way of illustration of an example, or examples, of particular embodiments of the principles of various aspects of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention in its various aspects. In the description, similar parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings are not necessarily to scale and in some instances proportions may have been exaggerated in order more clearly to depict certain features.

A ball-actuated tool includes a ball coating opener for opening the coating of a dissolvable ball, when the ball lands on the tool.

The ball-actuaed tool is installable in a wellbore. In one embodiment, for example, the tool is configured for securing in a wellbore string and the string is run into a well bore. The tool has a ball-actuated tool mechanism on which a ball acts to operated the tool.

The ball-actuated tool and tool mechamism may take many forms but in each embodiment, the tool mechanism includes a ball landing area in which the actuating ball lands to actuate the mechanism. The ball landing area may include a seat, a ball stop, a channel, etc. that the ball may land on. Once on in the seat, the ball stop or the channel,

the ball creates an effect, such as by diversion of fluid, creation of a pressure differential, etc. to operate the tool.

The ball-actuated tool also includes a ball coating opener in the ball landing area. The ball coating opener acts on the ball, when it arrives in the ball landing area to open the ball's coating such that the dissoluction process can begin for the ball, only after it arrives at the tool. As such, the ball does not begin to break down until it arrives at the tool and its active form can be maintained until then.

The tool is configured to be actuated by a dissolvable ball with a protective coating. In particular, in some applications, the ball to be employed is dissolvable, having a main body that includes dissolvable material but in which the main body is coated with an external protective coating. The protective coating is intended to protect the ball's dissolvable components against exposure to the liquid that causes them to dissolve. Only when the protective coating is opened will the dissolvable material be exposed to liquid and begin to dissolve. As such, keeping the protective coating intact until a selected time can extend the useful life of the ball.

The ball's protective coating may be opened as the ball moves into the ball landing area, when the ball stops in the ball landing area or after the ball has actuated the tool. The opener may include a protrusion positioned to act against the ball in the ball landing area. The proturions is configured to open the protective coating on the ball in the ball landing area. The protusion can protrude from the main body, from the seat or from the sleeve. The protrusion protrudes into a space through which the ball must pass such as the main bore or on which the ball must land such as the seat.

The protrusion can take many forms such as including one or more sharpened surfaces such as an edge or tip. The protrusion may be fixed in place and the ball moves to contact it such as to push past it. Alternately, the protrusion may be moveable such that it moves to contact the ball and/or moves out of the way after contacting the ball. The protrusion can be one structure or a plurality of structures.

The protrusion may act to open the protective coating in various ways as by cracking, cutting, scraping, etc. the coating.

If the protrusion is selected to act on the ball (to open the ball's coating) before the ball acts to actuate the tool, the protrusion may be selected to open the protective coating but not destroy the ability of the ball to actuate the tool, such as by landing on and sealing against a seat or a sealing surface if, in fact, the ball is intended to act in that way to fulfill its actuation purpose.

In the illustrated embodiment, a ball-actuated tool 110 includes: a body 112 having ends 112a, 112b for connection into a wellbore string 114, a main bore 118 extending between ends 112a, 112b through the body. The tool includes a tool mechanism including a ball landing area formed as a seat 120. A ball 122 is launchable from above tool 110 and intended to pass through string 114 to arrive in main bore 118. Ball 120 is formed to land on seat 120 to actuate the tool as by stopping fluid flow through seat to create an axial force. The axial force may, for example, shift a sleeve or other piston. Alternately, the ball may land on seat 120 and divert fluid around the seat.

While other balls may be employed, tool 110 is particularly suited to handling coated balls such as ball 122. Such balls each include a main body 122a that includes a dissolvable material and an external protective coating 122b.

In the illustrated tool the seat is positioned on a sleeve 124 that is axially moveable to open ports 126 to main bore 118 and ball 122, when landing on seat 120, creats a seal against seat 120 to generate a pressure differential that produces an axial force to move sleeve 124 and to divert fluid to ports 126.

The ball-actuated tool further includes a protrusion 140 adjacent the seat. The protrusion is adjacent the seat such that the ball comes into contact with the protrusion when in the ball landing area.

In the illustrated embodiment, protrusion 140 is positioned alongside the sleeve and with a sharpened tip 140a adjacent seat 120. Sharpened tip 120a is normally recessed below

120, for example is positioned, between seat 120 and lower end 112b of the tool body. Sharpened tip 140a is exposed to protrude into the area of seat 120 when the sleeve is moved axially arrow A by the ball landing thereon.

In use, therefore, protrusion 140, being normally recessed below seat 120 (Figure 1), does not interfere with the landing of ball 122 on seat 120. Ball 122 can land and seal against seat 120 without contacting protrusion 140. The protrusion is spaced from seat 120 and therefore ball 122. However, the ball's landing on seat 120 (Figure 2) generates a pressure differential that causes the sleeve to shift axially down (arrow A Figure 3). When this occurs, the sleeve shifts and ball 122 is driven into contact with tip 140a of the protrusion. The force generated by the pressure differential forces ball 122 against the tip such that tip 140a punctures coating 122b to provide an access point 130 to core 122a. Thus, only after the ball's actuating work is substantially complete, is the ball's coating opened by the protrusion. The ball can then begin to dissolve and distintegrate.

The ball launching apparatus of the invention is useful, therefore, with a coated disintegrating ball, which is a ball formed at least in part of a disintegrating material that breaks down in wellbore liquids but which has a coating to prevent contact between the disintegrating material and the liquid until the coating is opened. The tool opens the coating after the ball has arrived at the tool and, for example, after the ball has entered the ball landing area. In the illustrated embodiment, the ball coating is opened by the opener after the ball has seated on the seat and actuated the tool.

The previous description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to those embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments. Thus, the present invention is not intended to be limited to the embodiments shown herein, but is to be accorded the full scope consistent with the claims, wherein reference to an element in the singular, such as by use of the article "a" or "an" is not intended to mean "one and only one" unless specifically so stated, but rather "one or more". All structural and functional equivalents to the elements of the various embodiments described throughout the

disclosure that are known or later come to be known to those of ordinary skill in the art are intended to be encompassed by the elements of the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 USC 112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or "step for".

Claims:

1. A ball-actuated tool comprising: a tool mechanism including a ball landing area; and a ball coating opener in the ball landing area.