ABSTRACT

Box-end rotary sucker rod shear couplings including a substantially cylindrical housing having an interior surface defining a passage from an upper end to a lower end along a longitudinal axis and an exterior surface. The shear coupling also includes a set of threads around an inner circumference of the upper end for receiving a rotary sucker rod coupled directly into the upper end of the passage without an intervening adaptor; a set of threads around an inner circumference of the lower end for receiving a pump pin coupled directly into the lower end of the passage without an intervening adaptor; and one or more circumferential grooves machined into the cylindrical housing between the threads for causing rod shear failure at a predetermined axial load. In some embodiments, the shear couplings are conventional box-end sucker rod couplings. Also disclosed are rotary sucker rod assemblies including such rod shear couplings.
Fig. 2B
(Prior Art)
BOX END SUCKER ROD SHEAR COUPLING

BACKGROUND

[0001] Rotary sucker rod shears have long been used downhole for preventing damage to rod strings. These rod shears fail at a predesignated load. This controlled rupture prevents the sucker rod string from exposure to excessive force from the service rig driving the string.

[0002] A traditional rod shear 100 is shown in FIGS. 1A, 1B, and 1C. FIG. 1A shows a cross-sectional view of the rod shear 100. FIG. 1B shows the rod shear 100 from the box end 102. FIG. 1B shows the rod shear 100 from the pin end 104. The traditional rod shears' components include a box component 101 having a box (female) end 102 and a pin component 103 having a pin (male) end 104. The box end 102 has threads 106 on an interior circumference 108 and the pin end 104 has threads 110 on exterior circumference 112. The pin component 101 is inserted within the box component 103, so that the box end 102 and the pin end 104 are at opposing ends of the assembled rod shear. The components 101, 103 of the assembled rod shear 100 are coupled together by one or more transverse shear pins 120, which function as a failure element.

[0003] The traditional rod shear 100 is used in a traditional rotary sucker rod assembly 200, shown in FIG. 2A. The rotary sucker rod assembly 200 includes a rig 202 which drives the sucker rod string 204, which is typically a series of several single rods 220, 222, 224, 226 coupled together. The sucker rod string 204 serves as a mechanical link from the rig 202 to the surface on the sucker rod pump 230 near the bottom of the well. FIG. 2B shows an upper sucker rod 224 coupled to a lower sucker rod 226. Sucker rod 224 is a single unit having a box (female) end 250 and a pin (male) end 260. Sucker rod 226 is a single unit having a box (female) end 251 and a pin (male) end 261. Generally, the individual sucker rods 220, 222, 224, 226 in the rod string 204 are oriented with the pin end 260, 261 down. The box end 250 has threads 252 on an interior circumference 254 for engaging the pin end of the sucker rod above, and the pin end 260 has threads 262 on an exterior circumference 264 for engaging the box end 251 of the sucker rod below 226. The pin end 261 of the lowest sucker rod 226 in the rod string 204 is coupled to the rod shears 100, as shown in FIG. 2C, by engaging the threads 263 on the exterior circumference 265 of the lowest sucker rod's pin end 261 with the threads 106 on the interior of the box end 102 of the rod shears 100. The sucker rod pump 240, shown alone in FIG. 2D, has a pump pin 242 that connects the sucker rod pump 240 to the remainder of the rotary sucker rod assembly 200. In a traditional rotary sucker rod assembly 200, the pump pin 242 and the rod shears 100 are connected by a coupling 244 having two opposing box ends 246, 248, shown in FIG. 2E. The upper box end 246 is coupled to the pin end 104 of the rod shears 100, while the lower box end 248 is coupled to the pump pin 242.

[0004] During operation, rotational force from the rig is transmitted through the rod string 204 to the box component 101 of the rod shears 100. If the shear pins have not failed, the box component 101 of the rod shear 100 transmits rotational force to the pin component 103 of the rod shears 100, and, eventually, to the pump pin, thereby operating the pump. If the axial load exceeds the predetermined limit for which the shear pin is designed, the shear pin fails, and the box component 101 of the rod shears 100 spins harmlessly around the pin component 103 of the rod shears 100. Failure of the shear pin severs the mechanical link, thereby eliminating the load and preserving the other components of the assembly.

[0005] The traditional rotary sucker rod shear design has several shortcomings. Often, the pump attached to the rod string is a progressive cavity pump (PCP). The length of the traditional rod shear, being a stiff member, exacerbates the eccentric motion of the pump's rotor, which leads to premature sucker rod fatigue failures. Further, the length of the traditional rod shear requires more material than a shorter length, which increases costs. A current solution is a shorter rod shear using the same general design. However, the traditional rod shear design requires a certain length in order to accommodate the shearing pin elements and the box-pin thread combination. Thus, even the shorter rod shear is longer than desirable.

[0006] Historically, rotary sucker rod shears have been specially manufactured by fabricating the individual components of the rod shear, assembling them, and then testing the assembled rod shear. This complex, multi-step manufacturing process is relatively expensive. Thus, another shortcoming of the traditional rod shear is the high cost associated with its manufacture.

[0007] Another of the traditional design's shortcomings is its pin end-box end design. This design necessitates an additional component, the coupling, in order to connect the shear to the pump pin. The additional component further increases the cost of the sucker rod assembly and the complexity of the sucker rod assembly's installation. Further, the pin end threads of the pin-end box end design are easily damaged by mishandling, which can lead to seized threads upon field installation.

[0008] Disclosed herein are rotary sucker rod shears which address one or more of the shortcomings of the current rotary sucker rod shear design.

SUMMARY

[0009] Disclosed herein are box-end rotary sucker rod shear couplings including a substantially cylindrical housing having an upper end; a lower end; an interior surface defining a passage from the upper end to the lower end along a longitudinal axis of the cylindrical housing; and an exterior surface. The shear coupling typically includes a first set of threads around an inner circumference of the upper end for receiving a rotary sucker rod coupled directly into the upper end of the passage without an intervening adaptor; a second set of threads around an inner circumference of the lower end for receiving a pump pin coupled directly into the lower end of the passage without an intervening adaptor; and one or more circumferential grooves machined into the cylindrical housing between the threads for causing rod shear failure at a predetermined axial load. Typically, the rotary sucker rod has complementary threads on an outer circumference for engaging the rod shear coupling, and the pump pin has complementary threads on an outer circumference for engaging the rod shear coupling. In some embodiments, the shear couplings are a conventional box-end sucker rod coupling. Also disclosed are rotary sucker rod assemblies including such rod shear couplings.
BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIGS. 1A-C illustrate a prior art rod shear.


[0012] FIGS. 3A-C show a rotary sucker rod shear coupling.

[0013] FIG. 4 shows a rod shear coupling in a rotary sucker rod assembly.

[0014] FIGS. 5A-C illustrate the rod shear coupling coupled to a lowest sucker rod in the rod string and to a pump.

DETAILED DESCRIPTION

[0015] Disclosed herein are box-end rotary sucker rod shear couplings. Specific design details have been provided for illustration but should not be considered limiting. Readers of skill in the art will recognize that many variations of sucker rod shear couplings may be implemented consistent with the scope of the invention as described by the appended claims.

[0016] FIGS. 3A-D show a rotary sucker rod shear coupling 300 for use with a rotary sucker rod string in a rotary sucker rod assembly. FIG. 3A shows the rod shear coupling 300 from a perspective view. FIG. 3B shows the rod shear coupling 300 from a cross sectional view along its longitudinal axis. FIG. 3C shows the rod shear coupling 300 from a cross sectional view across its longitudinal axis. FIG. 3D shows the rod shear coupling 300 from an end view. The rotary sucker rod shear coupling 300 includes a substantially cylindrical housing 302 having an interior surface 306 defining a passage 310 along the longitudinal axis of the housing 308 and an exterior surface 304. Although the housing 302 is typically cylindrical, in various embodiments the housing 302 may be implemented as one of a multitude of various oblong shapes adapted for downward insertion within a well and having cross sections that may be circular or polygonal (e.g., hexagonal, octagonal), and which may change along the longitudinal axis. Substantially cylindrical is defined here to encompass all such housing designs.

[0017] The passage 310 extends from the upper end 312 of the rod shear coupling 300 to the lower end 314 of the rod shear coupling 300, so that the passage 310 is in fluid communication with the area above the rod shear coupling 316 and the area below the rod shear coupling 318. Although other configurations may be used, in a preferred embodiment, the interior surface includes a first set of threads 320 around an inner circumference 322 of the upper end 312 adapted for receiving a rotary sucker rod coupled directly into the upper end 312 of the rod shear coupling 300 without an intervening adaptor, and a second set of threads 324 around an inner circumference 328 of the lower end 314 for receiving a pump pin coupled directly into the lower end of the rod shear coupling 300 without an intervening adaptor. The housing 302 of the rod shear coupling 300 may be a conventional box-end sucker rod coupling. The conventional box-end sucker rod coupling is produced using standard manufacturing processes, resulting in a much lower cost than the traditional shear rod 100.

[0018] The rod shear coupling 300 of FIG. 3A has one or more circumferential grooves 330 machined into the interior surface 306 of the housing 302 between the threads 320, 324. In other embodiments, illustrated in FIGS. 3E and 3F, the circumferential grooves 330 are located in the exterior surface 304 (FIG. 3E) or the interior surface 304 and the exterior surface 306 (FIG. 3F). In the embodiment of FIG. 3F, grooves 330 in the interior and exterior surface 304, 306 are aligned. By aligned, it is meant that a portion of an interior groove circumnavigates a portion of an exterior groove within a plane. The one or more circumferential grooves 330 weaken the rod shear coupling 300, causing failure of the rod shear coupling 300 at a predetermined axial load, which is lower by a margin of safety than the axial load estimated to damage the sucker rod string.

[0019] The rod shear coupling 300 is used in a rotary sucker rod assembly 400, shown in FIG. 4. Similarly to the traditional rotary sucker rod assembly 200, the rotary sucker rod assembly 400 includes a rig 202 which drives the sucker rod string 204 composed of several single rods 220, 222, 224, 226 oriented with the pin end 260 down and screwed together.

[0020] Upon installation, shown in FIG. 5A, the pin end 261 of the lowest sucker rod 226 in the rod string 204 is coupled to the rod shear coupling 300 with the first set of threads 320 of the rod shear coupling 300 being engaged with the threads 262 on the exterior circumference 264 of the lowest sucker rod’s pin end 261. The second set of threads 324 around the inner circumference 326 of the rod shear coupling’s 300 lower end 314 engages threads 241 on the exterior of the pump pin 242 to couple the rod shear coupling 300 to the pump pin 242.

[0021] It should be understood that the invention concepts disclosed herein are capable of many modifications. Such modifications may include, but are not limited to the number, shape, and configuration of the grooves machined into the rod shear coupling, modifications in the threads, the method of machining grooves, the materials from which the rod shear coupling is made, and the method for manufacturing the rod shear coupling. To the extent such modifications fall within the scope of the appended claims and their equivalents, they are intended to be covered by this patent.

What is claimed is:

1. A box-end rotary sucker rod shear coupling comprising:
   a substantially cylindrical housing having
   an upper end;
   an interior surface defining a passage from the upper
   end to the lower end along a longitudinal axis of the
   substantially cylindrical housing;
   an exterior surface;
   a first set of threads around an inner circumference of
   the upper end adapted to directly receive a rotary
   sucker rod without an intervening adaptor, the rotary
   sucker rod having complementary threads on an
   outer circumference for engaging the rod shear coupl-
   ing;
   a second set of threads around an inner circumference of
   the lower end adapted to directly receive a pump pin
   without an intervening adaptor, the pump pin
   having complementary threads on an outer circum-
   ference for engaging the rod shear coupling; and
   one or more circumferential grooves machined into the
   cylindrical housing between the threads so as to
   cause rod shear failure at a predetermined load.

2. The rod shear coupling of claim 1 wherein the one or
   more circumferential grooves in the cylindrical housing
   between the threads comprise at least one circumferential
groove in the interior surface.
3. The rod shear coupling of claim 1 wherein the one or more circumferential grooves in the cylindrical housing between the threads comprise at least one circumferential groove in the exterior surface.

4. The rod shear coupling of claim 1 wherein the one or more circumferential grooves comprise at least one circumferential groove in the exterior surface and at least one circumferential groove in the interior surface.

5. The rod shear coupling of claim 4 wherein at least one circumferential groove in the interior surface is aligned with at least one circumferential groove in the interior surface.

6. The box-end rotary sucker rod shear coupling of claims 1-5 wherein the cylindrical housing comprises a conventional box-end sucker rod coupling.

7. A rotary sucker rod assembly comprising a box-end rotary sucker rod shear coupling according to any of claims 1-5.

8. A method for manufacturing a box-end sucker rod shear coupling, the method comprising:

providing a conventional box-end sucker rod coupling having an elongated body having
an upper end;

a lower end;
an interior surface defining a passage from the upper end to the lower end along a longitudinal axis of the body;
an exterior surface;
a first set of threads at the upper end adapted to directly receive a sucker rod; and
a second set of threads at the lower end adapted to directly receive a pump pin; and
machining one or more circumferential grooves in the box-end sucker rod coupling between the first set of threads and the second set of threads.

9. The method of claim 8 wherein the one or more circumferential grooves are machined in the interior surface of the box-end sucker rod coupling.

10. The method of claim 9 wherein the one or more circumferential grooves are machined in the exterior surface of the box-end sucker rod coupling.

11. The method of claim 8 wherein the one or more circumferential grooves are machined in the exterior surface of the box-end sucker rod coupling.