Apparatus and method for isolating a section of a pipe riser bore in the course of riser renewal

Field ~~of the Invention~~

The invention relates to a mechanical assembly or "isolation tool" for use in controlling fluid movement through a pipe bore during the course of replacing a section of the pipe. For example, the tool may be used in connection with the process of replacing the worn or damaged upper section of a vertical "riser" associated with an off-shore oil or gas production platform. The invention further relates to a method associated with the pipe section replacement procedure.

Background ~~of the Invention~~

The ~~invention~~ techniques disclosed herein were~~was~~ developed in connection with providing an isolation tool which could be used 'downhole' in connection with the process of replacing the upper section of an upwardly oriented riser associated with an off-shore oil or gas production platform. Such platforms are prevalent in the Gulf coast region of the U.S. It will be described herein in that connection. However, it is contemplated that the tool and method may find application in other fields of use as well and is not limited to downhole applications in upwardly oriented pipes.

The word "riser" is commonly used to identify a steel pipe extending up from the sea floor to a production platform. Oil or natural gas is produced through the bore of the riser from one or more wells connected to it.

Many of these risers have been in use for decades in the Gulf coast region. As a consequence, in many cases their upper sections have become weakened and worn by wave action, corrosion and other damaging actions. The well operators pay close attention to this deterioration and will initiate replacement of the upper section of the riser when appropriate.

Typically the prior art replacement operation has involved:

- closing the valves of the sea floor wellhead(s) to terminate production into the base of the riser;

- setting a packer at depth in the riser bore (for example, this might take place at a depth of up to 40' below the platform), so as to provide a barrier sealing off or isolating the upper section of the riser bore from its lower section;
- severing the riser wall at a point above the packer with a mechanical cutting tool;
- removing the severed upper section of the riser and lowering a replacement pipe section into its place; and
- welding the new riser section end to end to the old section.

It follows that one needs to isolate the pipe wall area, where welding is to occur, from the flammable gas which may still be present in the bore of the riser.

Heretofore there have been various downhole tools employed to so control the riser bore. In one case, a pig-type device or packer is displaced to the appropriate depth in the bore and then actuated from ground surface by means of an electronic signal. Upon actuation, the packer mechanically expands its seal element radially into sealing engagement with the pipe wall and anchors itself to the wall, thereby providing a barrier to gas movement along the inner surface of the upper pipe segment.

These prior art tools are closely held and are not publically disclosed in detail in the literature, to our knowledge. However, we understand that they are characterized by several shortcomings, including that:

- the tools are complex and their use entails lengthy set-up times;
- the tools are not adapted to monitor and provide a real time indication of the on-going competence or possible leakage of the packer seal element; and
- rental of the known tools is expensive.

~~It is t~~Therefore, ~~one object of the present invention to~~the techniques disclosed herein may provide an isolation tool for use downhole that can be comparatively quickly installed and deployed at the desired depth in a riser bore.

~~It is another object to~~The disclosed techniques may also provide a tool adapted to provide a real time indication of seal competency or leakage.

The disclosed techniques may further~~And it is another object to~~ provide a tool which, due to the simplicity of its structure and operation, can be supplied at less cost than has been common in the past.

If the tool is to be used at an off-shore platform, it is desirable that it be adapted to be insertable into the riser inlet within the space available. While these platforms are huge structures, the space available to feed an isolation tool into the open upper end of the riser bore is commonly very limited. Typically there might be only about 2 ½ - 6' of "head room" available at the riser inlet. ~~It t~~Therefore, ~~is a preferred object of the invention to~~the disclosed techniques may provide a tool which is adapted to be fed into the pipe bore in spite of the usual space limitations at the inlet.

If the tool is to be used in the context of an off-shore platform riser, it is desirable that it remain cohesive in use. Dropping a steel part down the riser bore is unacceptable to the well operator. ~~It t~~Therefore, the disclosed techniques may ~~is a preferred object to~~ provide a tool whose components are well tied together to maintain its cohesiveness while still allowing tool components to move to a limited extent in the course of 'setting' the tool.

If the tool is to be used in close proximity to a welding operation, it is desirable to avoid heat damage of the elastomer seals. ~~It t~~Therefore, the disclosed techniques may ~~is another preferred object to~~ provide a tool adapted to protect the seals against deterioration from heat.

Summary ~~of the Invention~~

In one aspect, the present ~~invention~~ techniques provide~~s~~ a primarily mechanical isolation tool adapted for use downhole. The tool is designed to work at depth within the bore of a pipe, such as an upwardly oriented riser associated with an off-shore production platform.

The tool provides a sealed pressurized barrier internally dividing the pipe bore into upper and lower sections. The barrier functions to block fluid movement along the inner surface of the pipe. But the tool also provides a conduit extending upwardly to the pipe's open end, for venting rising bore fluid at ground surface. The barrier is actuated or 'set' from ground surface by mechanical means extending down through the upper section of the bore.

In addition, the tool incorporates a system for monitoring, at ground surface, whether the downhole seal elements are leaking and it further preferably incorporates means for tieing tool components together so as to ensure cohesiveness.

One embodiment of the downhole isolation tool comprises, in combination:

segregated venting of pipe bore fluid from the pipe bore's lower section through the barrier to ground surface, said rod means may additionally function to actuate the isolation assembly, the housing assembly may provide a means for lowering, holding and recovering the isolation assembly and the monitoring means may function to provide an indication as to whether the seal elements are leaking.

In a preferred optional feature, the back plate is connected by floating locking pins with the back end of the body, said pins being positioned internally of the body in bores which permit limited axial movement of the pins and back plate but the body has shoulders which prevent separation of the back plate and body. In addition, the front plate is connected with the body by locking pins which permit limited axial movement of the body toward the front plate. As a consequence of this arrangement the vent rod means can pull the back plate and body toward the front plate and thereby squeeze the seal elements to actuate the isolation assembly, while the locking pins still ensure cohesiveness of the isolation assembly.

Brief Description of the Drawings

These and other features of the ~~invention~~ disclosed techniques will become more apparent in the following detailed description in which reference is made to the appended drawings wherein:

Figure 1 is a cross-sectional view of the isolation tool~~invention~~ according to embodiments herein;

Figure 2 is a partial cut-away side view of the isolation assembly;

Figure 3 is an exploded perspective view of the components of the isolation assembly of Figure 1;

Figure 4 is a perspective view of the back plate of the isolation assembly;

Figure 5 is a partial cut-away side view of the back plate shown in Figure 4;

Figure 6 is a perspective view of the vent rod of the isolation assembly;

Figure 7 is a perspective view of the body of the isolation assembly;

Figure 8 is a front view of the body shown in Figure 7;

Figure 9 is a cross-sectional view of the body taken at line I-I in Figure 8;

What is claimed:

1. A downhole isolation tool for use in providing a sealing barrier extending transversely across the bore of a pipe for isolating an upper section of the bore from fluid originating from a connected lower section of the bore, said pipe having a bore inlet at ground surface, said tool, when used in the pipe, comprising, in combination:

support means, connectable with the pipe at the bore inlet, for supporting and anchoring a plurality of downwardly extending segments of the tool;

an isolation assembly for positioning lengthwise in the pipe bore at depth, said assembly comprising a linear assemblage of components including a front plate, a front seal element, a central body, a back seal element and a back plate, said seal elements being axially spaced apart, resilient, deformable and annular, ~~each said~~the front seal element being positioned between one end of the body and the front plate, the back seal element being positioned between the other end of the body and the back~~a~~ plate, whereby~~,~~ the isolation assembly is arranged so that, when the plates and body are compressed together, the seal elements ~~may be~~ are squeezed and deformed outwardly into sealing engagement with the pipe and ~~may~~ thereby combine with the outer surface of the body and the inner surface of the pipe to form a sealed annular space;

a housing assembly for lowering the isolation assembly into the pipe bore and positioning it at the desired operational depth, said housing assembly being operative to be anchored at its upper end to the support means and connected at its lower end with the front plate, ~~whereby~~ the housing assembly being arranged to hold the front plate ~~may be held~~ stationary and fixed in place ~~by said housing assembly~~;

a tubular vent rod means for connection with the back plate and extension through the isolation assembly and upper section of the pipe bore to ground surface;

means, supportable by the support means, for tensioning the rod means to compress the plates and body together and deform the seal elements so that they sealably engage the pipe;

monitoring means, extendable down through the upper pipe section bore and connectable with the isolation assembly, for circulating pressurized fluid from ground

surface through the sealed space and back to ground surface, for providing an indication of seal leakage;

whereby the isolation assembly ~~may~~ is arranged to provide a sealing barrier wherein the front and back~~having a pair of annular~~ seal elements seal~~ing~~ against the pipe's inner surface at axially spaced apart intervals, and for the rod means ~~may~~ simultaneously to provide a passageway for segregated venting of pipebore fluid from the pipe's lower section through the barrier to ground surface, and wherein the housing assembly is arranged to~~may~~ provide a means for lowering, holding and recovering the isolation assembly and the monitoring means is arranged ~~may function~~ to provide an indication as to whether a seal element is leaking.~~.~~

2. The isolation tool as set forth in claim 1 wherein:

the pipe is an upwardly extending riser.

3. The isolation tool as set forth in claim 1 comprising:

a first set of floating locking pins, connecting the back plate with the body, for limiting the maximum separation distance between them while enabling the back plate and the body to be displaced toward and away from each other; and

a second set of floating locking pins, connecting the front plate with the body, for limiting the maximum separation distance between them while enabling the front plate and the body to be displaced toward and away from each other.

4. The isolation tool as set forth in claim 1, 2 or 3 wherein:

the body and plates have opposed annular bevels arranged to squeeze and deform the annular seal elements into sealing engagement with the pipe.

5. The isolation tool as set forth in claim 1, 2 or 3 wherein:

the back plate and body are slideable along the rod means; and

the rod means is operative to pull the back plate, back seal element and body toward the front plate to thereby compress the plates, body and seal elements together.

6. The isolation tool as set forth in claim 1, 2 or 3 wherein:

the housing assembly comprises a string of tubular joints joined end to end; and

the rod means comprises a string of tubular rods joined end to end and extending through the string of tubular joints;

the back plate and body are slideable along the rod means; and

the rod means is operative to pull the back plate, back seal element and body toward the front plate to thereby compress the plates, body and seal elements together.

~~7. A method for isolating an open end section of the bore of a pipe from the remainder of the bore, said pipe extending upwardly to ground surface, comprising:~~

~~positioning a pair of axially spaced apart annular seal elements, mounted on a body, at depth in the bore of the pipe, using a string of joints joined to end;~~

~~deforming the seal elements from ground surface, using a string of tubular rods, so that they seal against the pipe and combine with the body and the pipe to define a sealed space; and~~

~~circulating pressurized liquid through the sealed space from ground surface and back through conduit means to provide an indication of seal competence.~~