Method and apparatus are provided for preventing damage to the surface of metal tubulars or work pieces when force to turn or support the tubulars is applied by the serrated surface of a die or insert. A woven fabric made from a polymer and having a selected thickness and structure is maintained between the die and the surface to be protected.
BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to installation of tubulars using supporting or torqueing devices and to machining of work pieces. More particularly, a layer of woven polymer fiber is disclosed to serve as a protective layer on dies, inserts or other gripping devices to avoid or minimize deformation of the surface of tubulars or work pieces.

2. Description of Related Art

Tubulars of various diameters are installed in wells constructed for the production of hydrocarbon liquid or gas. The larger diameter tubulars are called “casing.” Smaller diameter “tubing” is placed inside the casing to provide a flow channel inside the casing. “Joints” of casing or tubing, often 30-45 feet in length, are picked up by hoisting apparatus to a vertical position and joined to previously joined joints, normally by male threads on the tubular and female threads in a connector. Torque is applied to make-up the threads by a device called “pipe tongs,” which includes inserts or dies having hardened metal teeth to grasp the tubular (similar to the familiar “pipe wrench.”) The surface of the tubular is normally indented by the hardened metal teeth on the dies, forming “die marks.” While an additional joint of casing is being installed at the surface, the previously joined casing joints in the well are supported at the drill floor by a device called “slips,” which also includes hardened metal teeth (dies) that are forced against the outside surface of the tubular as the slips are pulled downward into a bowl. The surface of the tubular is normally indented by the hardened metal teeth on such devices, forming “die marks.” Various other devices used in pipe handling, such as slip-type casing and tubing elevators and automated equipment (e.g., an “iron rough-neck”) contain dies that are designed to indent the surface of a tubular when a force is applied to grasp, turn or support a piece of tubular. “Chucks,” also having teeth that indent the surface of metal, are commonly used to grip work pieces in lathes or other machining devices.

Damage to the surface of tubulars made of soft iron by die marks is generally not considered detrimental to performance of the tubulars, but when tubulars in a well are made of corrosion-resistant alloys (CRAs) (designed to be used when a well contains highly corrosive well fluids) or the tubulars have protective coatings, damage to the surface by pipe-handling equipment can be very detrimental to service life of the tubular.

Various methods have been proposed to avoid or ameliorate surface damage to tubulars. U.S. Pat. No. 4,712,284 discloses the use of smooth-faced jaws made of soft material such as aluminum and control of frictional force on the tubular by control of hydraulic linear motors. U.S. Pat. Nos. 4,989,909 and 6,488,323 disclose friction grips for tubulars designed to avoid damage when gripping to apply torque to the tubular. To activate the gripping function, fluid pressure is applied into a bladder-like structure, which expands a material that develops frictional force when forced against the surface of the tubular. A die insert having a grit coating for tong dies and handling tool inserts is sold by McCoy Global for use with Corrosion Resistant Alloy tubulars.

What is needed is method and material to allow applying a force to grip tubulars or work pieces for rotation, support or other handling operations that avoid surface damage to the tubular or work piece, that are easy and low-cost to apply and that can be used along with standard industry equipment without replacement of parts of the standard equipment.

BRIEF SUMMARY OF THE INVENTION

A webbing or woven fabric made from a polymer, preferably a synthetic polymer such as NYLON, is provided for placement over dies such as used in supporting, gripping or torqueing apparatus. The webbing allows tools that normally function by causing die marks on the surface of tubulars or work pieces to function by frictional force on the surface without surface damage. If more friction force is needed, the webbing may contain small particles. The webbing may be in the form of flat pieces, sleeves, cylinders or other structures adapted to place the webbing between dies and a tubular or work piece surface when apparatus is operated to grip a tubular or work piece.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

FIG. 1(a) shows side and top views of a die for vertical support such as in slips and FIG. 1(b) shows a top view of dies for applying force in a horizontal plane such as in power tongs. FIG. 1(c) shows teeth of the die oriented vertically.

FIG. 2 shows a perspective view of slips for supporting a tubular in a well with dies that deform the surface of the tubular by die marks.

FIG. 3(a) shows a sketch of a simple woven fabric and FIG. 3(b) shows a sketch of a three-dimensional woven fabric.

FIG. 4 shows a perspective view of slips for supporting a tubular in a well with dies covered by a woven fabric.

DETAILED DESCRIPTION OF THE INVENTION

The method and materials disclosed herein may be used in a variety of equipment that supports, torques, guides or otherwise handles tubulars, which include casing and tubing for wells, pipes for transmission of materials and other cylindrical objects that may be gripped for processing, such as in a lathe or other equipment for machining of metal goods. The force required in these processes to move or hold stationary a tubular or work piece is often applied by a serrated surface on a die, such as shown at 10 in FIGS. 1a and 1b. Teeth 12 of the die are designed to deform the surface of the body to which a force is applied. In FIG. 1a, teeth are oriented horizontally so as to exert an upward force to balance the weight of a tubular, as in a slip. In FIG. 1c, teeth 14 are oriented vertically, so as to exert a torque on a tubular in a pipe tong, which is designed to rotate vertical pipe as joints of the pipe are added or removed from a string of pipe in a well. FIG. 2 shows a sketch of slips 20 to support pipe as it hangs in a well. Segments 22 of slip 20 each contain die 24 and handle 26. Segments 22 are joined to form a slip and sized to collapse around a tubular. The outside surface of each segment 22 is supported by a matching bowl or insert bushing (not shown), using standard industry practices. As the slips move into the bowl, the radial force on the slips causes teeth 12 (FIG. 1) to deform the surface of a tubular and leave die marks on the surface. The die marks may cause stress corrosion cracks in
the tubular, may destroy a coating on the tubular or may cause other effects deleterious to the service life of the tubular.

[0014] I have discovered that placement of a woven fabric between a die and a tubular can prevent the formation of die marks on the surface of a tubular and provide a high friction force along the axis of the tubular. A woven NYLON fabric (webbing) (about 2-inch by 5-inch) was placed on the dies in a pipe tong used to make-up casing. The fabric was 0.25 inch thick. The fabric prevented die marks and provided high friction force to support the casing. Because some threads of the fabric embedded in the dies, the fabric stayed in place over the ties after the tong was removed. Alternatively, the fabric may be made of KEVLAR, polypropylene, polyester or other synthetic polymers, or natural polymers may be used. Polymers having higher friction coefficients are preferred. Alternatively, small, (preferably less that 0.010 inch maximum dimension) high-hardness or abrasive particles (such as tungsten carbide) may be added to the fabric to provide a higher friction coefficient of the woven fabric on tubulars. The particles may be added to the melt of synthetic thermoplastic polymer before fibers are formed or may be added to the fabric as or after it is woven. This material having small particles may be used in applications where higher friction coefficient is needed, such as when conditions make a tubular slippery.

[0015] There are several variables in making a woven fabric that should be considered in optimizing results using the method and materials disclosed herein. A composite of woven and non-woven fibers may be used. The open-source book Advances in Modern Woven Fabrics Technology, pub. by In Tech, ed. S. Vassiliadis, July 2011, contains information regarding design and manufacture of such materials. FIG. 3, from Ch. 5 of this book, illustrates two forms of woven fabrics. FIG. 3(a) shows one layer of a simple triaxial loose woven fabric. Multiple layers or larger fibers of such fabric may be used to increase thickness. FIG. 3(b) shows a schematic part of the unit cell of a 3-D orthogonal woven fabric, a much more complex fabric.

[0016] The structure and complexity of the fabric for use disclosed herein can be selected by simple experiments in which: (a) a sample of the fabric is placed on a die, (b) the die is pressed against a surface of a tubular or work piece for which it is to be used with a known force, usually comparable to the force applied in the apparatus in which the fabric will be used, and (c) the frictional force required to move the tubular is measured, determining the static coefficient of friction. Fabrics having a maximum coefficient of friction will be selected. Alternatively, dies in equipment where die marks are to be prevented may be covered with a woven fabric and the equipment operated to determine if results are satisfactory. The composition and size of the fibers in the fabric, the pattern used to weave the fibers and the thickness of the fabric may be varied to arrive at the optimum material. Patterns of the fabric may be selected based on patterns of the dies with which they are to be used. Fiber size may be optimized depending on the spacing and height of teeth in the die for which it is to be applied, for example. Preferably, the woven fiber will have sufficient strength after use over a die to be removed intact or to be left for successive uses of the die and then removed intact. Excessive thickness of the woven fiber should be avoided in some applications, such as in slips, to allow the slips to fit to a sufficient depth in the bowl. In slips and other applications, such as tongs, spiders and elevators, adjustments may be made, if necessary, to the dies or to the bowls or other apparatus to allow for thickness of the woven fabric. The minimum thickness needed is that sufficient to prevent die marks on the tubulars or work pieces in the application of the dies.

[0017] Woven fabric may be placed between a die and a tubular in a variety of methods. The simplest is simply to insert the fabric by hand. A band of woven fabric may be placed on a tubular at the position where a die will be applied. Most fabrics are inexpensive enough to allow for actual use on a die of only a small fraction of the material supplied to the process. The fabric may be held on the tubular by an adhesive or by bands around the tubular.

[0018] Alternatively, the fabric may be placed on or in proximity to the dies of apparatus. The woven fabric may be held in place by embedment in the dies, by an adhesive or by a variety of mechanical means. If the synthetic polymer is thermoplastic, the adhesive may be the polymer melted on the back side of the fabric when the fabric is placed in contact with a heated die. The apparatus containing dies may be designed for easy placement and maintenance of woven fabric between the die and the surface to be protected. In a slip or pipe tong, for example, the segments of the slip or tong may contain mechanical fasteners around the die area that are adapted to retain strips of woven fabric. Examples of conventional fasteners, such as snaps, pins and clips, are provided, for example, at en.wikipedia.org/wiki/Fastener, searched Jan. 11, 2013. FIG. 4 illustrates standard slip 40, having segments 42 and handles 48. Strips of woven fabric 44 have been placed over dies 24, shown in FIG. 2. Strip 44 may contain a mechanical fastener (not shown) or it may be attached to straps 46, which contain mechanical fasteners 47 adapted to attach to a matching part of the fastener on segment 42. Strips 44 can be easily removed and replaced as needed. In some applications, strip 44 may enclose a die and may be simply rotated to place new fabric over the die. A sock or bag of woven fabric may be placed so as to cover a die in some applications. Adhesive or mechanical means may be used in a variety of apparatus using dies in order to avoid damage to tubulars or work pieces. Mechanical fasteners may be disposed to avoid interference with functions of the apparatus.

[0019] Although the present invention has been described with respect to specific details, it is not intended that such details should be regarded as limitations on the scope of the invention, except to the extent that they are included in the accompanying claims.

1 claim:

1. A method for preventing die marks on a metal tubular or a work piece when applying a force to the tubular or work piece by use of a die, comprising:
   selecting a material comprising a woven fabric;
   placing the material over the die; and
   maintaining the material between the tubular or work piece and the die while the force is applied.

2. The method of claim 1 wherein the material is selected to have a maximum value of static coefficient of friction with a selected metal surface.

3. The method of claim 1 wherein the material further comprises particles to increase the coefficient of friction with a selected metal surface.

4. The method of claim 1 wherein the material is maintained between the tubular or work piece and the die by an adhesive or a melt of the material.
5. The method of claim 1 wherein the material is maintained between the tubular or work piece by embedment of fibers of the material in the teeth of the die.

6. The method of claim 1 wherein the material is maintained between the tubular or work piece and the die by mechanical fasteners in the material.

7. The method of claim 1 wherein the material is maintained between the tubular or work piece and the die by mechanical fasteners in straps that are attached to the material.

8. The method of claim 1 wherein the woven fabric is made from a synthetic polymer.

9. The method of claim 6 wherein the synthetic polymer is selected from synthetic polymers consisting of NYLON, KEVLAR, polypropylene and a polyester.

10. Apparatus for turning or supporting a tubular or work piece, comprising:
    apparatus comprising a die; and
    a woven fabric disposed over the die.

11. The apparatus of claim 10 wherein the apparatus is slips.

12. The apparatus of claim 10 wherein the apparatus is tongs.

13. The apparatus of claim 10 wherein the apparatus is used for machining a work piece.

14. The apparatus of claim 10 further comprising a mechanical fastener adapted for maintaining the woven fabric disposed over the die when the apparatus is operated.

15. The apparatus of claim 14 further comprising a strap containing the mechanical fastener, the strap being attached to the woven fabric.