Current hardbanding techniques protect pipe, casing

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HARDBANDING OF DRILL pipe tool joints and other drilling equipment has been around since the late 1930's. Originally, hardbanding was applied primarily to protect the drill pipe and other drilling tools from premature abrasive wear. Since that time there have been numerous changes in hardbanding and its application, but only within the last few years has new technology been introduced that allows hardbanding to protect the casing, the BOPs and the marine riser at the same time.

Hardbanding is one of the simplest, yet most misunderstood, product being used on a drilling rig today. Along with the new technology being utilized to drill the highly deviated wells such as horizontal, ERD or multi-directional comes the problem of creating excessive downhole drag and torque.

This drag and torque creates friction that, in turn, creates wear on the drill string, the BOPs, the marine riser and the casing. Today, there are several types of wear-resistant alloy hardbandings on the market and most of them are designed to protect either the casing, BOPs and marine riser or the drill string. However, of all the various types, only one or two of them are designed to protect all the components at the same time.

The original concept of hardbanding was arguably the most effective wear reduction method ever devised. The hardbanding was applied in a raised (proud) condition. Consequently, the hardbanding accomplished its goal: protect the drill pipe tool joint from rapid abrasive wear.

This photo illustrates the amount of casing damage that can occur from the drill pipe tool joint when older hardbanding techniques are used, such as tungsten carbide particles applied to the pipe in a raised condition.

The major problem was that, in this raised condition, it caused severe casing wear, therefore resulting in many casing failures. If there was a type of hardbanding that could be utilized in this same raised condition without causing the severe casing wear, then the industry would have solved one of their most pressing problems.

Unfortunately, it took many years to solve this problem and several different types and configurations of hardbanding were tried. Due to the unique problem of addressing both casing and tool joint wear with a single hardbanding material, most hardbandings have fallen short of their objective of being able to protect both the casing and the tool joint at the same time.

Over the past 70 years hardbanding has been responsible for many casing failures costing operators millions of dollars in repairs, sidetracks and even well abandonment. Additionally, it cost the drilling contractors equally as much in drill string and marine riser repair and/or replacement.

Along with the need to drill more critical wells such as directional, horizontal, ERD and deepwater came the need to develop products that would reduce the amount of wear caused by the drill strings being rotated or tripped inside the casing or riser and in long sections of open hole.

Extensive casing wear studies such as the **Maurer Engineering** DEA-42 have taught us the primary causes of casing failure and what products may be used to prevent them. The object that causes the most casing and riser wear is the drill pipe tool joint.

Because of the larger diameter of the tool joint compared to the drill pipe tube, whether in tension or compression, tripping or rotating, it is constantly in contact with either the open hole or the casing wall or both.

With this in mind, the constant contact is always creating some wear, either tool joint wear, casing or riser wear, or, most common, all of the above.

This tool joint has wear-resistant hardbanding applied to reduce wear to the drill pipe and joint as well as reducing wear and damage to casing.

In 1990, new wear-resistant hardbandings were introduced to the drilling industry. Now, after some 15 years of development, these hardbandings have been found to offer a viable solution to the problem of casing and riser wear caused by tool joint contact with the casing or riser wall.

Further developments have resulted in extended tool joint wear life while, at the same time, drastically reducing the casing and riser wear. Casing failures caused by drill string wear have practically been eliminated when using the proper wear-resistant alloy hardbanding.

HISTORY OF HARDBANDING

When hardbanding was developed in the late 1930's, it was primarily used to protect the drill pipe tool joints from rapid abrasive wear in open hole drilling. This hardbanding consisted of a mild steel matrix with sintered tungsten carbide particles dropped into the molten weld puddle during the hardbanding application process. It was applied in a raised (proud) condition to prevent the tool joint from contacting the side of the hole, either open or cased, and was a very suc-

cessful method of protecting the tool joints until the wells became more critical, deeper and more directional in nature. As a result, the industry began experiencing casing failures caused by the raised tungsten carbide hardbanding that was cutting away at the casing wall during drilling and tripping operations.

To combat this, drill pipe manufacturers tried different shapes of tungsten carbide particles, but to no avail. It was finally determined that, no matter what shape the tungsten particles were, as long as it was applied in a raised condition, it would still experience severe casing wear.

It was then that **Hughes Tool Company** developed and introduced Hughes SmoothX™ hardbanding. This entailed machining a groove into the tool joint body and applying the tungsten carbide hardbanding flush (even) with the tool joint OD.

Present hardbanding materials and techniques have eliminated damage to casing. Damage to marine risers like that in the above photo has also been virtually eliminated due to modern hardbanding techniques.

This improved the casing wear problem considerably and soon became the industry standard hardbanding for drill pipe. However, as the wells became even deeper and more directional in nature, the issue of casing failures became even more critical than before. Again, the tungsten carbide hardbanding was blamed for these failures.

SuperSmoothX hardbanding consisted of machining an even deeper groove into the tool joint body, applying one layer of tungsten carbide hardbanding at the bottom of the groove, and then applying a layer of mild steel on top of the tungsten carbide so that it was not exposed to the surface of the tool joint. This prevented the tungsten carbide particles from making direct contact with the casing wall until such time as a large portion of the tool joint OD was worn away and the tungsten carbide was finally exposed.

Grant Prideco purchased Hughes Tool and the SmoothX and Super SmoothX patents. While the company continues to utilize the SmoothX hardbanding method, the SuperSmoothX technique is rarely used today.

When operators continued to experience casing failures, they decided to discontinue the use of hardbanding altogether and use only drill pipe that had no hardbanding on the tool joints. It was then that the problems were compounded. To go along with casing wear, operators were required to repair or replace the drilling contractor's drill string since it was wearing out at an alarming rate.

Until this time drill pipe was considered to be an expendable item. Delivery time for new drill pipe was short and there was a considerable amount of used drill pipe available at very reasonable prices. Protecting the drill pipe tool joints had been a very low priority and much less expensive than casing failures.

What the industry did not realize at the time was that the milder tool joint steel caused almost as much casing wear as the tungsten carbide particles due to a galling action that occurs when two relatively soft steels, such as the tool joint and the casing, contact each other and cause friction. It was not until the industry began searching for some definitive answers to their continuing problems that they realized that plain steel tool joints caused almost as much wear as those hardbanded with tungsten carbide.

In 1989/1990, **Amorphous Technologies, Inc** developed a chromium alloy hardbanding, Armacor M™, that would substantially reduce casing wear. This was an amorphous (work hardened) type material that had a very low friction coefficient, therefore creating very little casing wear.

This hardbanding was developed primarily to protect the casing from wear caused by the drill string rotating in and tripping through the casing. Saving the casing was of utmost importance and the tool joint wear was of little or no priority in the development of this hardbanding. This was a big step forward for the operators, but not for the drilling contractors. Casing wear rates dropped drastically, but the tool joint wear rates were almost as high as unhardbanded tool joints.

When directional and horizontal drilling activity escalated in the mid-1990's, drill pipe became more expensive and delivery times became longer. Drilling contractors began voicing their concern about the added costs involved in maintaining an acceptable string of drill pipe for the operators. They began passing these costs to the operators and there soon became a need to address the tool joint wear problem associated with drilling these types of wells.

In late 1992, **Arnco Technology** developed and introduced a new breed of chromium carbide alloy hardbanding, Arnco 200XT™. This hardbanding was equally as effective against casing wear and much more durable in open hole in order to significantly reduce tool joint wear at the same time. This was the first "casing friendly" hardbanding developed to protect all components at the same time, rapidly became the industry leader in wear resistant alloy hardbanding.

More new hardbandings have been developed, but only one or two are capable of protecting all drilling components and the casing at the same time. Arnco Technology has recently developed another "casing friendly" hardbanding that is in this category, Arnco 300XT™.

This relatively new hardbanding is chrome-free, which is environmentally safe. It has an open hole wear life equal to that of tungsten carbide hardbanding and a low casing wear factor to protect the casing, BOPs and marine riser.

Laboratory and field tests have shown that there are several advantages to using the casing friendly hardbandings:

- 75%-95% less casing wear than with tungsten carbide;
- Elimination of casing failures caused by drill string;
- Use of lower weight and grade casing;
- Reduction of downhole drag and torque;
- Less likelihood of environmental incidents;
- Substantial increase in tool joint life.