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Artificial Lift Technology

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Ian Landon
Chairman VOGA
"Hopefully, as more gas-fired generation comes on line and LNG exports hit their stride, prices will firm up."
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Solutions Extend Life Of Work Strings

By Michael Huber
and Bob Miller

CLEVELAND–Hardbanding to extend the service life of drill strings has become a near-universal best practice in oil and gas drilling operations. The same conditions that have been accelerating drill string hardbanding innovations and adoption in the past are today driving manufacturers to search for solutions to similarly extend the life of other critical and expensive drilling components.

With the resurgence in horizontal shale drilling activities, pent-up demand for oil and gas production is creating equipment and component shortages, including an inventory backlog for work string tubulars. Several factors are affecting oil and gas production worldwide, including:

- Enhanced drilling power and capabilities, enabling ever-deeper wellbores and longer horizontal laterals;
- Deviated well profiles;
- Aggressive new fluids that expedite the drilling process; and
- Demands for higher levels of productivity;

The resurgence of oil and gas field assets for shale drilling, combined with the pressures of drill site performance challenges and increasing market demands, are generating an industrywide search for solutions to extend component service life. A case in point is new innovations designed to extend the life of work string tubulars.

Although precise numbers vary depending on operational and geological conditions, it is commonly understood that work string rejection rates (due to outside diameter wear of the connections) are increasing because of the challenging operational demands in horizontal well architectures. Since 2015, a hardbanding process has been applied to work string tubulars, and early reports of its effectiveness are encouraging. The process essentially applies a sacrificial layer of a special wear resistance welding alloy to the outside tubular (upset) connections at the widest part of the tube–a process familiar to industry professionals because of its similarity to the widely accepted practice of tool joint hardbanding.

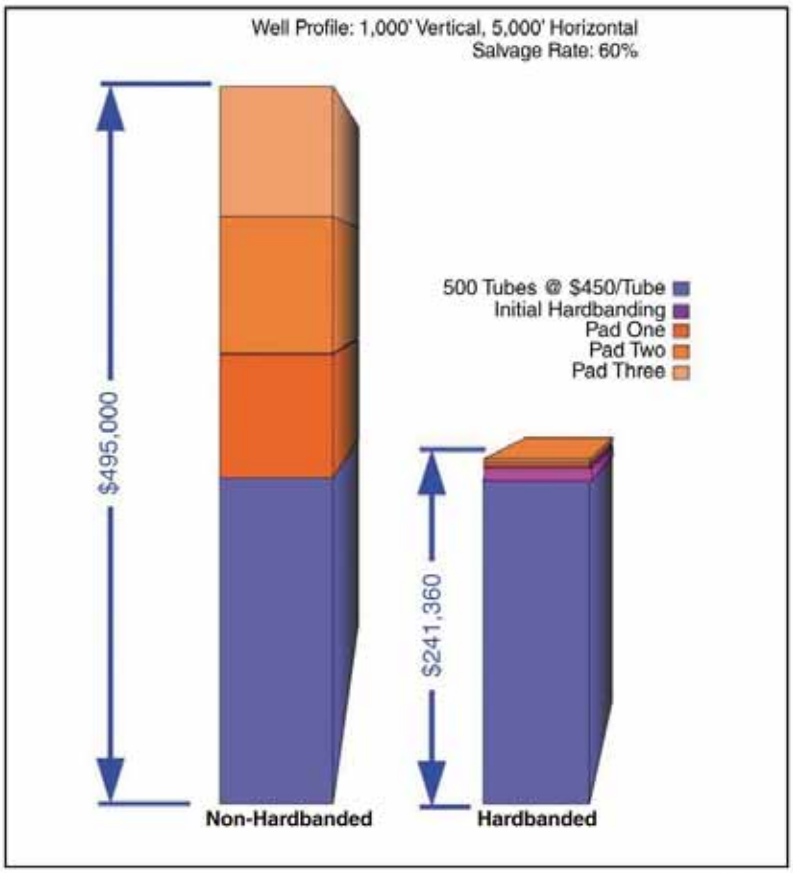
As with hardbanding, the process can be performed in the field, in a service

FIGURE 1

Hardband Applied to Pin End of Work String Tubular Connection

FIGURE 2

Work String Replacement Cost Savings
(Rental Company Operating in D-J Basin)



yard or at the work string tube manufacturer. Figure 1 shows work string tubing mounted in a hardbanding unit following the application of a one-inch wide hardband to the pin end of the connection. At least one work string tubular manufacturer already has begun offering the hardbanded work string tubular process during work string manufacturing as an upgrade.

The technology rapidly is gaining industry acceptance as a first line of defense against the costly downtime associated with work string tubing rejection. The casing friendly hardband alloy used is actually harder and more wear-resistant than the tubular's original steel, further extending work string service life in challenging well environments.

Reducing Tubular Rejections

This innovative process can reduce the rate at which work string tubulars are rejected due to outside diameter loss at the upset. Outside diameter loss is a major cause of work string rejection. When this new capability is combined with extended upset lengths enabling more threading recuts, two major causes of tubular rejections can be virtually eliminated.

Work string tubular hardbanding should use a welding alloy that is 100-percent crack free, and is not susceptible to spalling or separation from the base material. The process is capable of multiple rebuilds, ensuring that something other than wear of the outside diameter of the connection will be responsible for the eventual rejection of the tubing.

Initial field reports confirm that the hardbanded work string connections actually reduce torque and drag during their operation. This is particularly relevant in challenging applications such as extended-reach laterals and deviated well profiles. The procedure, if properly applied within proven parameters, does not affect the structural capabilities of the connection. In fact, independent third-party testing has been conducted on hardbanded work string connections to validate that the mechanical requirements of these connections have not been compromised.

As noted, reports from the field indicate an increasing rejection rate for work string tubulars and their connections. A typical work string may require more than 500 connections at an average cost in excess of $450 each, representing a sizeable investment of at least $225,000 per string.

The new hardbanding process represents a modest investment in the work string, but can provide substantial savings. Significantly, every work string hardbanding application that delays eventual replacement can increase operational productivity and reduce transportation costs for new tubing to the location.

As illustrated in Figure 2, by adopting this innovative technology, a work string rental company in the Denver-Julesburg Basin in Colorado saved more than $250,000 in replacement costs in 2017. The savings were based on a replacement cost of $450 per section of tubing and a cost of $20 per work string hardband application (one-inch wide hardband on the box end of the upset connection).

Restoring Connections

The even more difficult technological challenges inherent in restoring work string connections were overcome last year with the introduction of a tube welding restoration process commonly known as "buildup," which is capable of restoring undersized connections to their original outside diameter dimensions. Chief among the obstacles to overcome was the difficulty

FIGURE 3A

Out-of-Spec Box End before Buildup Procedure

FIGURE 3B

Restored Connections after Buildup Procedure

of welding over thin-walled sections.

The buildup welding product utilized in the restoration process is similar in chemistry to P-110-grade steel. Furthermore, the restored connections can accept the new work string hardbanding operations to enable further service life extension. Figure 3A shows an out-of-spec box end prepared for the buildup procedure (the "before" condition), while Figure 3B shows the restored upset connections after the tube welding buildup process.

The work string hardbanding application works hand-in-hand with the new patent-pending restoration process. These two complementary technologies enable revitalized connections to actually outperform the originals because of the improved wear resistance. The hardbanding process extends work string service life by reducing wear; the restoration returns work string tubulars to service when inevitable wear of the connection occurs.

The outside diameter of a worn connection must have at least 1/16-inch (0.0625 inches) of original metal thickness at the open end in order to accept the buildup application using a low-heat input welding process. The only additional limitation to using this restoration process is the remaining length of the connection. If the connections do not have enough remaining length for additional thread recuts, it might not make economic sense to invest in the outside diameter restoration process.

The welding process used to restore connections is designed for minimum heat input to prevent burning through the base material. A new buildup welding product was designed to provide specific metallurgical properties and weldability under unique conditions. The combination of carefully controlled heat and very tight welding parameters using a specified welding procedure significantly reduces the possibility of burning through the original metal.

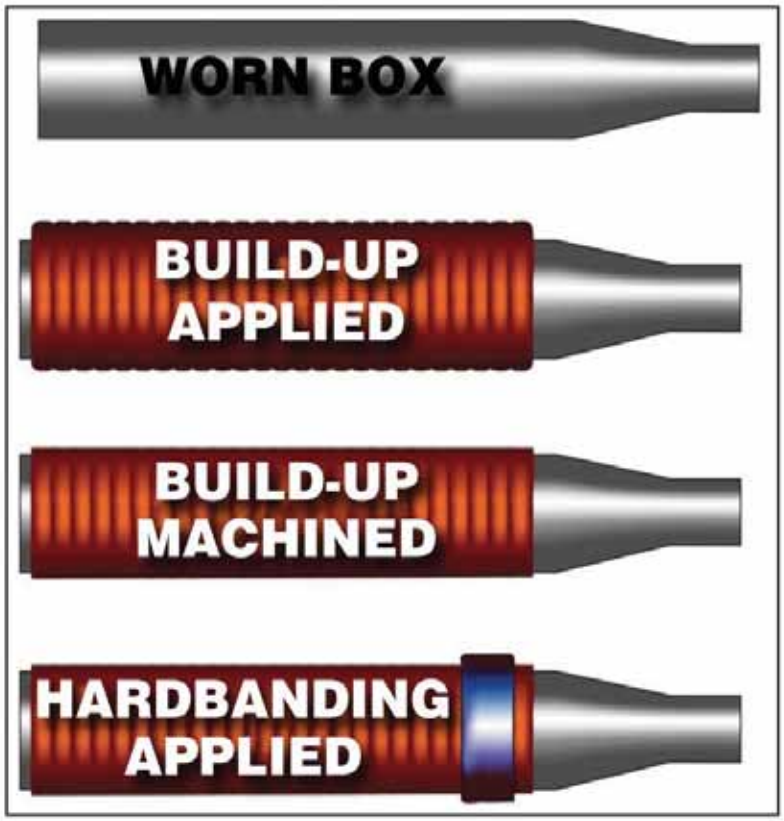
Once the weld has been applied properly, the weld material is milled to the connection's originally specified diameter and the threads are recut. Using the work string hardbanding process to restore connections is recommended to further protect rebuilt upset connections (Figure 4).

Blueprint Energy Partners provides tubular rental, inspection and hardbanding services in Wyoming and Colorado. Kent Stevens, general manager of the company, states, "Before applying hardbanding to our rental tubing, damage beyond repair due to wear of the upsets was depleting our inventory and putting our entire tubing rental business at risk. Since applying hardbanding to our tubing, we can count our upset downgrades on one hand.

"It has eliminated the issue of outside diameter wear entirely. Due to hardbanding, we have increased our market share and profitability. Now we are applying hardbanding to multiple customers' tubing, and the results are consistent," Stevens concludes. "It has entirely eliminated the issue of upset wear. It has been a game changer for us." ❐

FIGURE 4

Work String Restoration Procedure



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BOB MILLER *is a material engineer at Postle Industries Inc., which has developed Duraband® NC, TubeBanding™ work string tubular hardbanding technology, and the patent-pending buildup process using Postalloy TubeWeld 11™ to restore worn connections to original outside diameter dimensions. He has 45 years of experience in hardfacing metallurgy, tubular wire formulations and wear applications. Miller holds six U.S. patents, including patents for hardbanding products and procedures. Miller has also authored numerous technical articles in the hardbanding field and has hosted training webinars.*