Titanium-based hardbanding aims to balance protection for wear in casing, tool joints

By Stacy Eickhoff, Tuboscope NOV

OVER THE PREVIOUS decade, average well depths have increased, and directional and extended-reach drilling have become commonplace. These wellbore trajectories, with their highly tortuous paths and the associated increases in torque and drag, have placed stresses on drill pipe. They have also created conditions of accelerated wear on both the drill pipe and casing never encountered to the degree we see in the industry today, due to the higher side loads associated with these deep tortuous well bores.

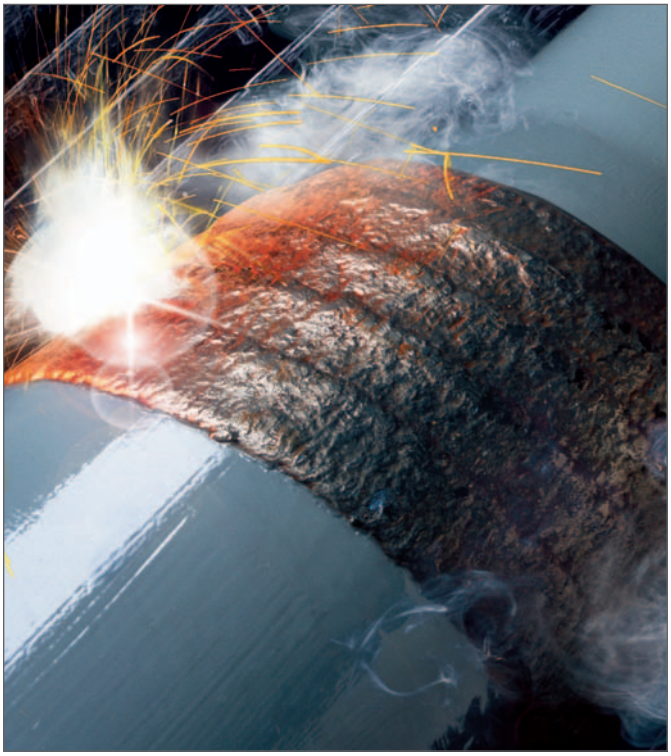
Lead times on new drill pipe orders of 12 months or more are not uncommon, and pipe costs have risen dramatically in recent years. Drill pipe strings with large tube OD or heavy wall thickness and premium connections run in excess of $1 million. These conditions have made it necessary to investigate means to prevent wear to the drill pipe and to increase the useful life of this critical, high capital cost asset.

Hardbanding in the oilfield has long been acknowledged as an effective means of preventing wear to the tool joints. However in the early 1990s, the DEA-42 study proved that the tungsten carbide-based hardbanding in widespread use at the time was the primary cause of wear to the casing. Furthermore, the study proved that the absence of hardbanding, while slowing casing wear to a very small degree, allowed the tool joints to wear at an extremely accelerated rate and thus rapidly lose torsional capacity.

The problem, then, is balancing the need to protect the casing from wear and simultaneously protecting the tool joints from the increased wear conditions present in high KOP (kick-off point), deviated, extended-each and horizontal wells. The first casing-friendly alloys introduced in the 1990s reduced the casing wear problem, but eventually field service history concluded that either they wore at an unacceptable rate or their metallurgy was so designed that they cracked excessively, causing catastrophic tool joint failure, or the hardbanding itself failed due to the material completely disbonding (spalling) from the tool joint, which left sharp ridges and edges that can cause casing wear. This condition can leave large quantities of hard metal in the well.

The problem to solve then includes:

- Low casing wear within industry limit determined by DEA-42 testing.
- Highly durable to resist wear and protect the tool joint.
- Crack-resistant to prevent cracking in the material and tool joint.
- Disbonding (Spall) resistant.
- Unlimited ability to resurface / reapply the material without special conditions.
- Ability to reapply in the field in remote and adverse conditions.



The TCS Titanium hardbanding has shown a 3 ½-time increase in wear resistance over chrome alloy and chrome carbide materials.

In 2004, **National Oilwell Varco**'s **Tuboscope** introduced the TCS Titanium. Titanium carbides on their own are approximately 40% harder than tungsten carbide while simultaneously exhibiting crack resistance and a slippery smooth microstructure, which prevents metal pick-up in metal-to-metal applications. The titanium carbides are uniformly distributed throughout a chrome-martensitic alloy matrix. This combination provides a balance among casing wear potential, high stress abrasion resistance, crack resistance and weldability.

This is a super-refined hardbanding alloy, manufactured as a self-shielding, flux cored, open arc wire. The open arc / self shielding type wire was chosen so the material could be applied in any field location in the world, even where shielding gases are not available or the quality is suspect. This means that the TCS Titanium can be applied in a plant, or the field / rig site if needed.

An ASTM G-65, Standard Test Method for Measuring Abrasion Using the Dry Sand / Rubber Wheel Apparatus test, was performed on the TCS Titanium. It showed a 3 ½-time increase in wear resistance over chrome alloy and chrome carbide materials. In addition, 14 separate laboratory metallurgical evaluations were performed on the material to determine cracking susceptibility, spalling resistance, overlay capability, determine welding parameters (WPS), SOP procedures, weldability, and generate Procedure Qualification Records.

To date, over a half-million joints have been hardbanded with TCS Titanium.

Tuboscope and TCS are registered trademarked terms.