Viable drill pipe hardbanding strategies are outlined

Joe Haberer, ICO Worldwide Inc

THE CONTROVERSY surrounding use of the new casing/riser friendly hardbanding materials was discussed in a previous article.

The main objection by many contractors and rental tool companies is that the new hardbanding materials do not protect the tool joints as well as tungsten carbide based hardbanding.

This article outlines methods to compare the performance characteristics of the various systems and suggests application methods and application vendor selection criteria.

First, it is necessary to define the basic performance characteristics of hardbanding and bare tool joints.

These basic characteristics can be defined as:

• Casing wear percent—The casing wall percentage removed by a hardbanding material or a bare tool joint during the wear test;

• Casing wear factor of the hardbanding material or tool joint—The wear potential of the hardbanding material or a tool joint in the casing;

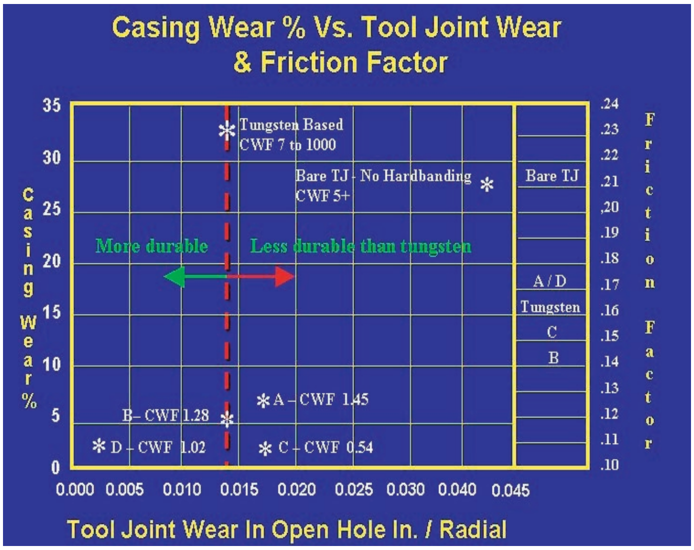
• Hardbanding/tool joint wear rate in casing—The reduction of the HB material or tool joint OD during the wear test in casing (IC);

• Hardbanding/tool joint wear rate in open hole—The reduction of the HB material OD or tool joint in in./radial during the open-hole (OH) wear test;

• Friction factor—The friction force between the HB material or tool joint and the casing as measured during the casing wear test (potential increase or decrease in torque and drag while drilling).

When performance is defined for each material, a spreadsheet can be constructed with the appropriate test numbers as in Figure 1.

Using the spreadsheet to plot a graph of the values shows that the alloy hardbanding materials listed have acceptable casing wear % properties ranging from 3.39% to 6.36%.



One, though, has a drastically lower casing wear factor of 0.54, with the others grouped in a narrow range of 1.02 to 1.45.

Typically, casing friendly hardbandings are acceptable if the material has a wear factor of 1.5 or less.

Any one of these alloy materials, therefore, is a candidate for use based on low casing wear properties and should also be acceptable to most operators from that standpoint.

From the perspective of the contractor, though, the OH and IC material loss numbers are not so tightly grouped.

An operator specifying Alloy A gets acceptable casing wear characteristics, but the material itself wears somewhat faster in casing and open hole than a standard tungsten based application.

This increased wear rate decreases tool joint life and increases the frequency of hardbanding reapplication.

Conversely, Alloys B and D, respectively, have OH wear comparable to—or better than—tungsten and IC wear only slightly higher.

If an operator or end user specifies no hardbanding at all, or an alloy with higher tool joint wear numbers than tungsten, the following question can then be raised:

Should compensation be offered or requested for the expected shorter tool joint / hardbanding life, or is an alloy that meets those client needs acceptable?

OTHER FACTORS

Although the performance of a particular hardbanding material may be a primary reason for selecting or rejecting a material, there are secondary considerations that should also be considered, including:

• Excessive cracking in the material;

• Field experience;

• Flaking and spalling of the material;

• Availability of application and reapplication;

• Ability to be applied over existing tungsten carbide, other alloys or itself;

• Ability to be field-applied in a consistent manner;

• Ease and consistency of application;

• Ability to be applied without damaging existing plastic coating;

• Cost, including removal of old hardbanding, trucking to a facility for existing hardbanding removal and new application preparation.

Figure 1: Test data for hardbanding materials

Material	Casing wear %	Casing wear factor	Material wear in casing, in./dia	Material wear in OH, in./rad	Friction factor
Tungsten	22-100	7-1,000	.000-.003	.014	.015-.020
Bare TJ	18-43	5+	.002-.003	.034-.043	.020-.022
Alloy A	6.36	1.45	.006	0.17	0.17
Alloy B	5.9	1.28	.004	.014	0.14
Alloy C	3.39	0.54	.005	.017	0.15
Alloy D	3.69	1.02	.0004	.003	0.17

APPLICATION

When the material is selected, the best way to apply it must then be selected.

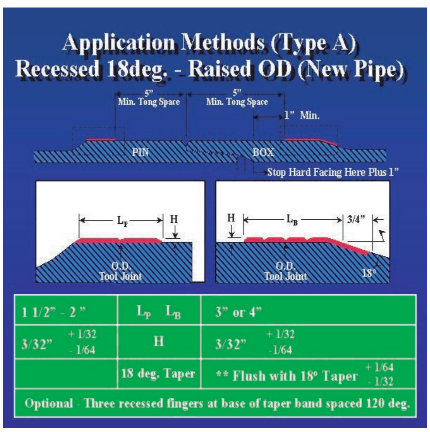
There are many basic application configurations. New pipe hardbanding can be applied with or without hardbanding on the 18 degree taper and with or without fingers.

The application can be raised ("proud") or flush ("recessed"). Hardbanding can be applied to the box only, or to both box and pin.

Used pipe with no previous hardbanding can be hardbanded like new pipe. Used pipe with existing hardbanding must have the old hardbanding removed to have a recessed application, or the new material must be capable of being applied on top of existing hardbanding to be welded in a raised configuration.

Although there are many possible hardbanding application configurations, a raised OD application will prolong the life of the pipe and protect the casing better than will a recessed one.

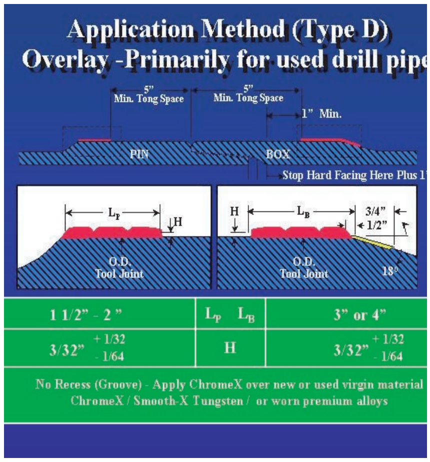
For new pipe, hardband both box and pin. Apply a $^{3}/_{32}$-in. thickness (+0/-$^{1}/_{64}$ in.) by ¾-in. recessed band to the 18 degree taper and apply 3 recessed "fingers" spaced 120 degrees apart, below and tied in to the taper HB.



Apply a $^{3}/_{32}$-in. thickness (+$^{1}/_{32}$ in./-$^{1}/_{64}$ in.) by 3-in. long raised hardbanding on the tool joint box OD, tied in to the 18 degree band.

Also apply a $^{3}/_{32}$-in. thickness (+$^{1}/_{32}$ in./-$^{1}/_{64}$ in.) by 1$^{1}/_{2}$-in. to 2-in. long raised application to the tool joint pin. Start the first band approximately $^{1}/_{8}$ in. from the pin 35 degree taper.

If the string may be run in a pin-up application apply recessed hardbanding to the 35 degree pin taper. For used pipe, select a material that can be applied on top of the existing hardbanding if applicable.



Apply a $^{3}/_{32}$-in. thickness (+/- $^{1}/_{32}$ in.) by 3-in. long raised hardbanding on the tool joint box OD. Start the hardbanding ¼ in. from the taper to allow elevator clearance. Apply a $^{3}/_{32}$-in. thickness (+/- $^{1}/_{32}$ in.) by 1$^{1}/_{2}$-in. to 2-in. long raised application to the tool joint pin.

Both testing and field experience have indicated that pipe with the above applications will cause less casing wear and better protect the tool joints from wear than a recessed alloy.

In all of the above application types, the hardbanding must be reapplied on a periodic basis when the existing application wears down to get the maximum casing and tool joint wear benefit.

It is important to note that a raised tungsten carbide application protects the tool joint better than a recessed one but drastically increases casing wear above that of a recessed application.

THE APPLICATOR

Finally, someone must apply the material. Inexperienced and untrained personnel improperly apply hardbanding or sacrifice quality for quantity.

They do not follow the manufactures application parameters or even adhere to simple, proper welding techniques.

Any hardbanding material is only as good as the applicator that applies it.

It is important to remember that welding is being done on high strength steels with alloys that are in most cases dissimilar from the parent material.

Proper application techniques are critical to the weld bead profile, appearance, fusion bond, and performance.

Every hardbanding applicator needs to have at a minimum the following:

- A quality assurance program based on ISO or API;
- A Weld Procedure Specification (WPS) for each material they apply;
- A Procedure Qualification Record (PQR) for each material;
- A Welder Performance Qualification (WPQ) for each welder applying hardbanding;
- A copy of each material manufacturer's suggested welding parameters and their inspection and acceptance/reject criteria;
- A copy of the purchaser's or end user's application standards if applicable;
- Properly trained welding operators;
- Properly maintained welding equipment;
- Preheat devices capable of preheating to proper recommended temperature (the importance of proper preheating and cool-down rates cannot be overemphasized);
- Accurate temperature measuring devices for measuring preheat and post weld cool-down rates.

ASME Section IX contains the procedures for developing weld and operator specifications and qualifications.

It is critical that welding operators understand the need for proper parent material cleaning, preheat, welding, and post-weld cool down requirements.

Lack of attention to any of these areas can seriously affect the adhesion, appearance, and performance of the weld material, as well as the tool joint on which the material is applied.

Following the principles outlined here for material selection and application strategy—and by utilizing knowledgeable, quality oriented application vendors—the operators requirement for reduced casing wear can be achieved.

And the contractor's need for increased tool joint and hardbanding life can be met. ■