New solutions may ease hardbanding controversy

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WHEN MOST WELLS were straight and relatively shallow, the sole purpose of hardbanding was to reduce abrasive wear and the resulting OD reduction of tool joints and bottom hole assembly components.

Drilling contractors, rental tool companies and pipe owners who wanted to preserve and extend the life of a sizeable capital asset applied tungsten hardbanding to the majority of the pipe, collars, and heavyweight they purchased.

Periodically they also reapplied hardbanding as needed when the previous application or component experienced wear.

Research and field experience demonstrated repeatedly that tungsten carbide hardbanding applied to drill pipe tool joints and BHA components reduced wear better than any other readily available, cost-effective material.

For this reason, tungsten carbide was for many years the only hardbanding applied to drilling tubulars on a widespread basis.

Operators now drill wells much deeper on a routine basis. Wellbore trajectories now often follow highly-deviated, S-shaped, horizontal, short radius, multi-lateral, and extended reach paths.

The number of rotating hours required to drill these wells has risen as measured depths increased and well paths became more complicated.

The use of top drive systems and the ability to backream while rotating is now common practice. And the search for oil and gas has moved into ever-deeper waters.

INDUSTRY STUDY

As all these conditions became more common, operators began to notice unacceptable levels of wear on casing and riser strings.

Instances of drastic wall reduction or a hole worn through casing or riser increased.

Operators, recognizing the operational threat to the integrity of their wells and associated economic and environmental impact started funding research to study the casing and riser wear problem.

An industry study formed under the auspices of the Drilling Engineers Association and given the working title of DEA-42 Casing-Riser Wear Study was initiated and administered by **Maurer Engineering Inc**, Houston.

The initial phase of the study concluded that tungsten-carbide-based hardbanding contributes significantly to the increased wear problem.

"Both operators and pipe owners have legitimate concerns about hardbanding.

"Pipe owners need to protect pipe from wear in order to meet performance standards and provide a fair return on their investment.

"Operators have more than tool joint wear and pipe service life to consider. The potential cost of repair, well control and cleanup if failure occurs can be very large."

A surprising discovery was that un-hardbanded bare steel tool joints were not too far behind tungsten carbide in adding to the problem.

Subsequent phases of the study further investigated the overall effect of tungsten and bare tool joints on casing and riser wear, as well as other contributing factors.

These later stages were also directed at finding alternatives to the existing hardbanding metals technology.

This research has shown that a number of other factors also affect the rate at which casing and risers will wear, including, but not necessarily limited to:

- Type of hardbanding and its wear factor;
- Wear factor of the tool joint;
- Tungsten carbide particle size, shape, and concentration;
- Well dogleg severity, well deviation;
- Riser/flex joint angle of misalignment;
- Weight of the drill string (side loads);
- Rotating hours in a casing or riser string;
- Rate of penetration;
- Location of kick off points;
- Use of top drives, back reaming;
- Poor cement jobs, areas of buckled casing;
- Type of mud and additives;
- Use of drill pipe protectors.

NEW EXPECTATIONS

Due in no small part to the study findings, operators have begun to question the overall economic and operational benefit of tungsten hardbanding applied to drillpipe and bottom hole assembly components. Hardbanding is now being subjected to a new set of standards and expectations of performance.

Why have conditions changed and what are these new expectations?

To put it briefly, although tungsten hardbanding reduces component wear, it also dramatically increases the wear rate on well heads, casing, risers, sub-sea stacks, wear bushings, and flex joints.

The very properties that make tungsten carbide an excellent wear reducing material for the component on which it is applied also cause it to wear the surface it comes into contact with while drilling.

Wear shortens service life of risers and flex joints and reduces burst and collapse strength of casing strings.

Devastating economic and environmental consequences may result if casing wall reduction or a hole worn through the casing causes a loss of well control.

The economic loss to the industry is difficult to calculate.

Costs might be calculated by adding together the industry-wide cost of early replacement of assets, lost rig time, patch-

ing casing, squeeze jobs relating to casing wear, running extra casing strings to seal a wear area, and environmental cleanup and well control costs.

The cost of a failure may run from a few hundred thousand dollars on a domestic land well or in the Gulf of Mexico to tens of millions of dollars on a remote deepwater project if a well blows out.

WHERE IS THE CONTROVERSY?

As a direct result of the study findings, new "casing friendly" hardbanding metals were developed and tested as an alternative to tungsten or bare steel tool joints.

These new materials lowered casing wear rates significantly compared with conventional tungsten when all other factors are equal.

Although DEA 42 testing proved that this new class of hardbanding metals lowered casing wear and drill string torque and drag effects when compared to bare steel or pipe hardbanded with tungsten, none protected drill pipe and BHA components from wear as well as the tungsten based systems.

Now operators are requesting that the new hardmetals be used in place of tungsten carbide, and many drilling contractors, rental tool companies and pipe owners are resisting the change.

They want a tungsten carbide application to better protect their tubulars from premature wear.

Cost has also become a major factor in the pipe owner's decision. Most pipe and BHA components in service already have tungsten carbide based hardbanding applied.

The operators often require the pipe owner to remove the existing tungsten application and replace it with the casing friendly material.

The majority of alloy hardbanding wire manufacturer's specifications also require this removal prior to the application of their product.

To accomplish this, the old hardbanding has to be removed from the tool joint using carbon-arc or plasma removal techniques.

The cost of the removal process and to prepare the area for a new welding application can run in excess of $100 per joint.

Add in roundtrip transportation costs from the rig, logistics and the cost of the new hardbanding material and application, and the total cost for a string of 500 joints of 5 in. drill pipe can very easily reach $1 million.

Costs will vary, based on the service area and the local pricing structure.

A typical casing friendly alloy hardband application can range from $75.00 to $150.00 per joint depending on the operating area, application type, hardband material, and applicator.

Damage to internal plastic coating and additional costs can also be incurred if reapplication of coating is necessary because the welding process used burns the coating due to high preheat and welding heat input levels.

OTHER CONSIDERATIONS

Higher cost and potential service life reduction alone have not been the only reasons pipe owners have been reluctant to wholeheartedly embrace the new materials.

Side effects have been noted in some instances where gouging has been used. Some of these side effects are uncontrolled localized heat input levels and increased concentrations of free carbon in the surface of the removal area.

These conditions can cause high localized hardness and cracking in the tool joint. Numerous joints of previously acceptable drill pipe have had to be scrapped as a direct result of the removal process.

Other detrimental side effects are stress cracks in the weld metal propagating into the base material and flaking and spalling of the weld material itself.

Operators in some instances have borne the full cost of replacing the existing tungsten hardbanding with casing friendly alloys but in many others the burden has been placed on the contractor or the rental tool company.

The pipe owner is then saddled with the problem of recouping his increased capital costs on a string, potential loss of pipe or a string that may need to be rebuilt or replaced earlier than normal if abrasive drilling conditions are encountered.

Both operators and pipe owners have legitimate concerns.

Pipe owners need to protect their pipe from wear and detrimental conditions if it is conform to the current requirements of T.H. Hill's DS-1, or with the API premium inspection and performance specifications.

It must also provide a fair return on investment, based on the reasonable service life of the drill string before being downgraded.

This can result in better drill string torsion and tensile limits over longer periods during the life of a string and reduced capital costs.

Operators on the other hand have more than tool joint wear and pipe service life to consider.

They have from hundreds of thousands to millions of dollars of repair, well control, and cleanup costs in potential liability on every well they drill if a serious failure occurs.

IS THERE A SOLUTION?

I believe that both operators and contractors can get what they need.

More casing friendly materials have been identified. The newest alloys in some cases reduce casing wear drastically below the first generation of materials tested.

Radial tool joint wear in a few new casing friendly material tests was comparable to, or even beat tungsten in open hole wear tests by as much as 80%.

Better understanding of the different compositions, application methods, and performance characteristics of tungsten and the different casing friendly alloy materials are needed.

New hardbanding materials and application methods can lower casing wear, reduce the total cost of eliminating the effects of tungsten carbide from the wear equation and provide drill pipe protection equivalent to or better than that of tungsten.

WATCH FOR CONCLUSION

This is the first of two articles on hardbanding. The concluding article in a future issue of Drilling Contractor *compares composition, application methods and performance characteristics of bare steel tool joints, tungsten carbide systems and the newer casing friendly alloys and outlines ways to evaluate the different methods of hardbanding.*