

HARNESSING HARDBANDING APPLICATIONS

BOB MILLER, POSTLE INDUSTRIES, EVALUATES WHETHER HARDBANDING PRACTICES CAN SAVE PIPE OWNERS MONEY.

Before dissecting the economics of hardbanding, a short review of drill pipe components is probably in order. A single drill pipe is made up of three major components: 1) tube, 2) box tool joint, 3) pin tool joint (Figure 1).

Because the tool joint is required to maintain the same forged inside diameters as the tube, and provide for a threaded connection, an expansion of the tool joint OD is necessary. This expansion causes a bulge at either end of the drill pipe which subjects the tool joint to accelerated wear during drilling operations (Figure 2). Deviated holes cause considerably more wear than straight holes. To protect the tool joints from excessive wear, they are frequently hardfaced with a wear resistant welding alloy known as a hardband. These weld deposits are typically three 1 in. bands on the box and two 1 in. bands on the pin. The alloys used are designed to not only protect the tool joint, but are also designed to protect the casing from excessive wear. The hardbanding products are sometimes referred to as 'designer alloys' because each is specifically designed for the oilfield application. Two such products manufactured by Postle Industries, Inc. are Tuffband® NC and Duraband® NC (Figure 3), the latter being the premium alloy.

Most hardbandings will protect the tool joint and the casing, some better than others. For example, Duraband NC provides 7-to-1 better protection of the tool joint and 4-to-1 better protection of the casing.

Logically speaking, using a judicious selection of hardband products and proper hardbanding procedures would certainly save money from a tool joint and casing protection viewpoint. Then why are the economics of the hardbanding products and procedures

in question? Someone once said, "it's not the talent that wins, it's how you play the game." Saving money is winning the game, and judicious decision-making early on and throughout the life of the drill string can save thousands of dollars, but there is no guarantee that it will. Tool joints are one of the most expensive and critical components of the drill pipe and possibly the whole drill string.

Given their extreme importance it only makes sense to treat them with the utmost care and respect. And in doing so, money will be saved. However, there are a number of factors that come into play that could cost a drill pipe owner a great deal of added expense and delays. The three critical areas that will be discussed are; 1) the initial application, 2) re-applications and 3) a sound and thorough applicator monitoring system or certification.

Initial applications

The very first hardbanding application, called the 'initial application' usually occurs at the drill pipe manufacturer's facility. Hardbandings are further re-applied in the field because of wear throughout the life of the drill string. These subsequent hardbandings are called re-applications. It is not uncommon for re-applicators to apply different hardband types, chemistries or trade names over top of the initial hardbands, providing they have been independently tested and certified for compatibility. While this practice of applying compatible hardband products interchangeably appears to be convenient and cost-effective, it is far from being a prudent decision. Most field re-applications using compatible products, develop hardbanding defects that may dictate complete removal and a subsequent repair procedure.

The compatibility issue strongly affects the initial application. Unfortunately, decisions for the first or initial application are made knowing that the re-application products will probably be different than the initial application product, and this practice can seriously jeopardise the life and functionality of the drill string. Pipe owners would do themselves a great service when specifying initial hardbanding to keep in mind that re-applications should use the same hardbanding product.

All hardbandings and procedures undergo a great deal of testing, retesting, and procedural upgrades. Many are certified to be applied over other types of hardbandings and even themselves. For example, Duraband NC is certified for application over Tuffband NC and itself, as well as other major competitors. This is considered 'compatible.' All initial hardbands (except tungsten carbide), are considered 'casing friendly'



Figure 1. Drill pipe components.

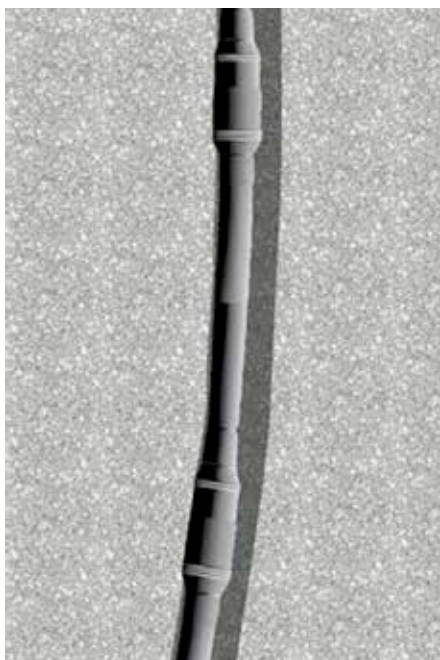


Figure 2. Wear on tool joint in a deviated hole.



Figure 3. Tuffband (left) and Duraband (right).

a term that no longer is relevant, since past data in the Maurer casing wear test proved to be non-repeatable and inconsistent. The current API casing wear test is considered to be satisfactory. All certified products appear to be viable choices for the first or initial application on tool joints. Price, availability and the usual procurement requirements are considered when choosing the initial application. And so, one product is chosen for the initial application over another for various reasons, and unfortunately not much thought goes into the repercussions that might be incurred further in the life of the drill string.

Re-applications

By far, the re-applications of hardbanding over worn hardbanding in the field are more numerous than the initial application by perhaps four to one, depending upon formation, drilling depth, deviations and general operating rig properties. As the hardbanding wears, imperfections may be revealed that occurred during the previous hardbanding application including porosity, cracking, spalling and slag inclusions. Poor welding conditions, inadequately trained personnel and faulty equipment are just some of the contributors to these defects. If the previous hardbanding was improperly applied and contained defects, the resulting re-application with the same hardbanding product, may magnify these defects. In fact, the resulting hardband may be rejected and require complete removal followed by a buildup of mild steel and final application of a suitable hardbanding. As illustrated by the pie chart in Figure 4, hardbanding removal and repair can be quite costly. In addition to the labour and materials that are required by this cleanup, valuable rig time may be incurred while these procedures are employed. Also, the intense removal and welding arcs will have a negative effect on the internal plastic coating (IPC), which may cause the drill string to be completely stripped of all IPC and recoated.

Faced with this unfortunate situation, a product such as Duraband might be chosen as an alternative over the worn hardbanding. Duraband is guaranteed not to crack, so it should be an excellent choice. Or is it? Duraband is only guaranteed not to crack when it is applied properly over itself or over Tuffband. All re-applications over alternative products are subject to final inspection criteria and may be rejected. Only when this initial strategy is in place can initial hardbanding and re-applications be considered a money saving endeavour.

So, if the correct hardbanding product is chosen for the initial application and followed by re-applications of the same material, then money can be consistently saved by the pipe owner, correct? Not necessarily. Because of new restrictions on the IPC integrity, the IPC will be burned during the previous hardbanding re-application procedures. And although the actual tool joint does not require IPC, it is typically coated and subjected to the same scrutiny as the drill pipe IPC. If it is damaged, then the complete removal and re-application of the IPC may be required.

To keep the IPC from burning, some have approached the problem by injecting water into the tool joint while hardbanding, but this practice compromises the heat affected zones' hardness, rendering it too high to be fail-safe. Obviously this procedure is not tolerable, which is why Postle has developed a hardbanding procedure called Coolbanding®. To be most effective, the procedure should be conducted as the very first re-application. In this way, the IPC will be spared during the procedure. Note that this is not a healing procedure. If the IPC has been damaged by wire lines or prior conventional hardbanding procedures, the procedure will not salvage the IPC. Coolbanding is not an initial hardbanding procedure and should never be used as such. It is strictly a re-application procedure and confined to be used 'only' over previously worn Duraband.

So what is this procedure? Coolbanding is a Duraband arc welding procedure that focuses on keeping the local heating caused by the

welding arc to a minimum and keeping the inside diameter of the tool joint below 400 °F (204 °C), the temperature at which common IPC materials start to deteriorate. This is accomplished by changing the welding DC polarity from electrode positive to electrode negative together with applying the hardbands with absolutely no oscillation.

These two parameters ensure that the heat affected zone (HAZ) does not encroach into the base metal and keeps the base metal HAZ hardness to less than 40 Rc, an accepted value imposed by some third party inspectors. Figure 5 compares conventional hardbanding and Coolbanding. Duraband is one of the few hardbanding wires that performs without undue spatter and a defect free weld deposit when the electrode is negative. Some hardbanding facilities apply water or a spray in addition to the Coolbanding procedure to ensure IPC integrity. It can be applied easily to either the pin or box tool joint. Applicators and welding operators require a special certification to conduct Coolbanding procedures.



Figure 4. A pie chart illustrating the added costs incurred when hardbanding requires removal.



Figure 5. Comparison of conventional hardband to Coolband.



Figure 6. RDT wear knot with Coolbanding.

Some formations, coupled with deviated or horizontal directional wells, wear out the pipe bodies themselves. To combat this, RDT-USA has developed a drill pipe called a Wear Knot™. Figure 6 illustrates this configuration.

Because of the thinner walls compared to tool joints, the IPC is particularly vulnerable to burning during conventional hardbanding. Without hardbanding, the Wear Knot would wear quickly. But by employing Duraband in a conventional procedure on the initial hardbanding followed by Coolbanding on re-applications, the IPC is not burned and field deployment is quickly realised.

Certification

Up until now two of the three critical factors in money-saving hardbands, have been addressed. The final factor is a certification programme that ensures that all of the welding operators are tested and qualified to apply hardbanding products. Postle Industries has improved welding operator's quality and integrity by implementing a rigorous certification programme. It consists of three distinct levels of competence, Level I, Level II, and Level III. Level I has been designated for those applicators that are new to the company's hardbanding products. Only after sufficient experience with the products is the next level considered. Level II requires the witnessing of the applicator's hardbanding procedure on a designated tool joint. This tool joint is then submitted to the company's metallurgical lab for dissection, dimensional analysis, magnetic particle inspection (MPI), and microhardness examination. Only after rigorous scrutiny and well defined criteria have been completed satisfactorily, are the applicators awarded a Level II and re-application of Duraband NC welded over worn Duraband NC hardbanding. As in Level II, a sample tool joint is submitted to the lab for analysis and the Level III Certification is awarded accordingly. The certifications are considered temporary and are revisited every five years for evaluation.

While the certification process requires that all hardbanding equipment be calibrated and in proper working order, this alone does not insure a quality hardbanding. Particularly during very busy seasons, equipment becomes stressed and worn to the point where malfunctions can occur. Defect-free hardbandings are highly dependent upon optimum operating conditions.

Electrical ground connections, power supply systems, welding wire delivery systems, and mechanical systems require routine inspection and repair when necessary. A log of any changes to a specific piece of equipment will go a long way in preventing equipment malfunctions and hardbanding defects, which cost everyone money and time. For pipe owners, routine auditing of their hardbanding vendor or facility will also pay huge dividends. In addition to equipment logs, the subject of hardbanding logs – or the lack of them – has serious implications to saving money with hardbanding. Even in the best of conditions hardbanding defects do occur. In many instances records of the hardbanding type (trade name), date, and hardbanding vendor will aid in analysing the defect root cause and repair procedures.

Without these logs the repair procedures, which often call for complete removal of the hardbanding with subsequent applications of mild steel build, can be quite costly.

Summary

So does hardbanding save money? Clearly from the foregoing evidence it can be seen that yes, hardbanding does save money but only when a conscientious effort is made to understand and implement proper strategy in the ordering of the initial application and re-applications. Without proper planning, pipe owners will suffer from the costly effects of not planning hardbanding issues throughout the life of the drill pipe. ■