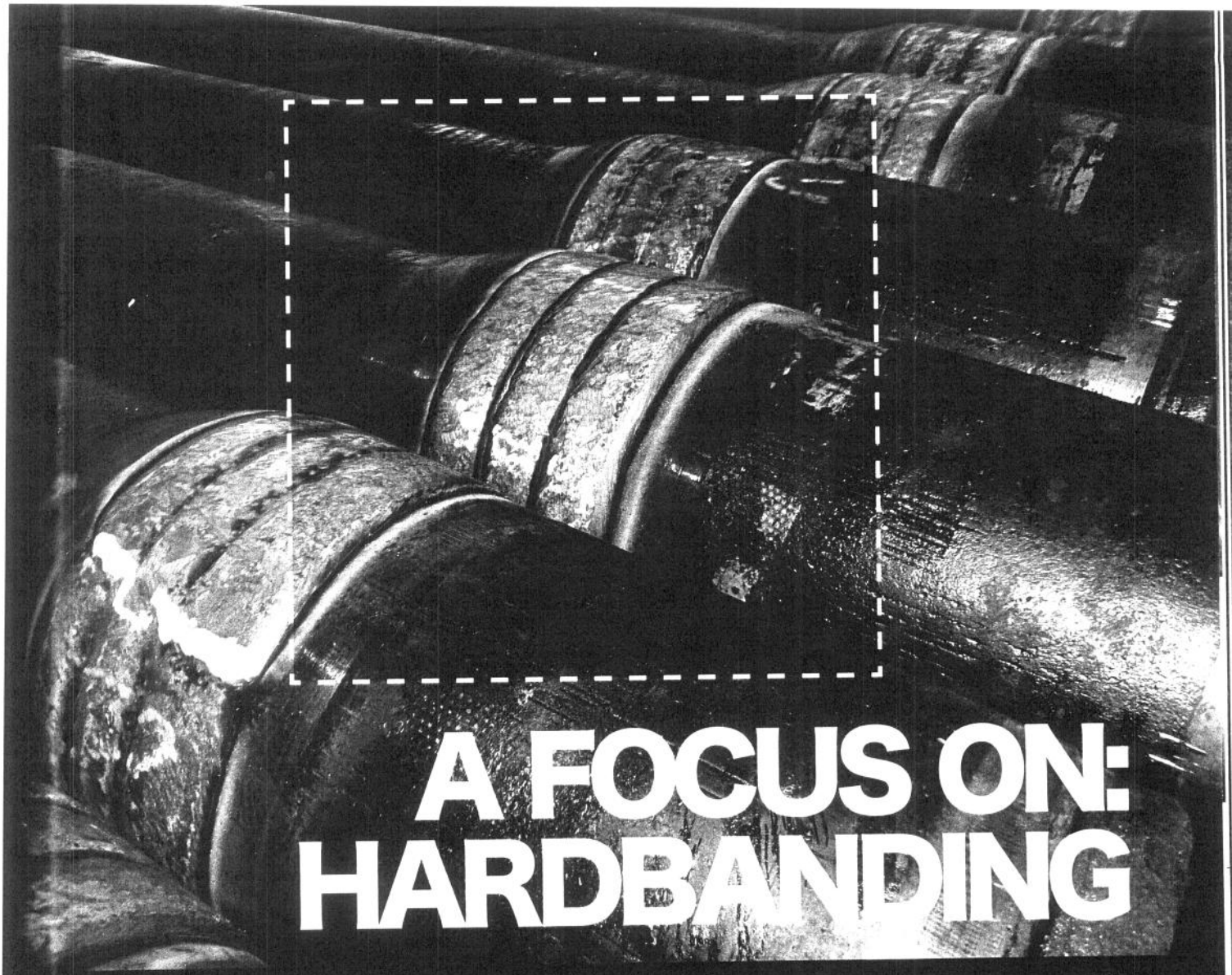

# A FOCUS ON: HARDBANDING

**Anthony Marrelli, Proband Hardbanding Services Ltd, Canada and Downhole Protection Services Inc., USA, points out the various misconceptions regarding the hardbanding industry and details its technical challenges.**

The aim of a hardbanding company is to provide a service to help drilling contractors protect their drill string, and oil companies alleviate casing wear. This equates to potential savings of millions of dollars to oil companies when using the proper application of each area.

There are several misconceptions regarding the hardbanding industry and the following information is provided to explain the industry, its challenges, technical issues and the understanding of hardbanding and its purpose.

## Tool joint protection

The technology of tool joint protection has evolved over the years to meet the ever-growing needs of the oil and gas drilling industry. Since the beginning of drilling, maximising the life of the drill pipe has been an ongoing goal. With the increasing sophistication of the drilling technology, drilling activities have gone to more challenging environments where more is being asked of the drill pipe. As drilling environments have become more challenging, protecting the pipe from wear has become an important issue for drilling operations. Wear can increase operational costs due to repair of components, rig time to change out worn down components and just shorter life span of drill pipe. The industry has turned to the use of coatings, often called hardbanding, on the tool joints to help address this challenge. As the industry has moved to use of hardbanding to address the problem of wear, the technology of hardbanding has progressed accordingly to meet the growing demands put upon it.

## Tungsten carbide

In the early days of development of hardbanding, tungsten carbide grains or a similar type of hard material applied via steel wire was the most commonly used option for minimising wear of tool joints. Tungsten carbide imbedded in the steel matrix worked well as the hardness of the tungsten carbide (Vickers hardness of 1700 - 2400), helped protect the pipe, which had a much lower hardness of 30 HRc. This worked well to protect the pipe, especially in the open hole environment. Not only did the use of hardbanding increase the time that a rig could be continually drilling, it was now extending the life of the drill pipe itself. Since the hardband became the primary

**Case study: casing wear in the North Sea and Colombia**

**Using Armacor for deep well offshore drilling**

The offshore exploration division of a major oil company had been experiencing rapid casing wear in the North Sea and Colombia. The cost of the casing wear, in some cases, had been as high as US$ 1.5 million - US$ 2 million per well, a significant and unacceptable figure without considering the additional safety implications of reduced casing integrity. The company also found that the life of drill string was being prolonged at the expense of the casing. It was this business-driven requirement for reliable casing integrity that forced this oil company to re-examine its hardbanding specifications.

After testing various hardbanding materials, Armacor was found to offer better performance than other conventional drill pipe hard facing materials. Encouraged that the testing indicated the potential for a significant reduction in wear over this oil company's previous hardbanding 'standard', the company began field trials on eight rigs in Colombia because of the severity of both the local drilling conditions and existing casing wear problems. As an added bonus, the application of Armacor proved simple because of the lack of tungsten carbide pellets. An extensive evaluation was made on the rigs that had used Armacor hardbanding material after the rigs had achieved in excess of 5000 cumulative rotating hours with no reported or measured incidents of casing wear. It was revealed that the combination of smooth, flush Armacor hardbanding and good drill pipe protector management had helped to eliminate this oil company's casing wear problems.

point of wear rather than the tool joint, the life of the drill pipe was extended by just rebanding the tool joint with the hardband material once it had worn down. As long as rebanding on the pipe was still possible, hardbanding basically solved the problem of tool joint wear causing the end of life of the drill pipe with the much lower cost of rebanding the tool joint. Tungsten carbide matrix is still one of the best and cheapest hardbanding materials available and used today in an open hole environment.

While the use of hard materials such as tungsten carbide helped to address the tool joint wear issue, the industry realised it was causing a new problem. Where casing is used, the use of carbides was causing excessive wear and eventual failure of the casings. The hardbanding materials, in general, were much harder than the casing (typically having a hardness of approximately 70 HRc). So while the use of these hard matrix materials worked well to protect the pipe, the roughness of the tungsten carbide grains became a problem where a casing was used. These hard grains like tungsten carbide would grind away at the casing, like sandpaper, causing the casing to fail especially at those critical junctures where significant pressure is put on the casing. This problem has created a need for a whole new category of hardbanding that would be smoother and thus not as rough on the casing. The tradeoff here was giving up some of the hardness, resulting in faster wear, but improved protection against casing failure. This is where the greatest technology focus has been for the last 20 years. As the industry has gone to more challenging drilling conditions, the goal has been to develop hardbanding material that has the best combination of hardness as well as surface smoothness to better protect the casing.

## Industry evolution

In this area, the technology has evolved tremendously as companies have developed complex alloys to try to meet the challenge of creating the best wear resistance with the lowest surface friction. At the current time, 'state-of-the-art' in this category are materials made out of amorphous metals. Amorphous metals is a category of materials that was developed from a NASA space programme where it was discovered that metals can be made much harder if all crystallisation was kept out of the material. By keeping the metal from crystallising, it was found that the material became essentially 50% to 100% harder due to much stronger bonds between the atoms in the material. Not only are amorphous metals harder, the lack of grain boundaries also created a much smoother surface. In fact, the surface of an amorphous metal can approach the coefficient of friction equivalent to Teflon. This combination of high hardness with the lowest coefficient of friction made amorphous metals an ideal choice for where the drilling conditions are tough and where casing wear is an issue.

## Introducing: hardbanding

In recent years, a new category of need has been developing. While a basic tough matrix such as tungsten carbide is cost-effective and works well in an open well and amorphous metals have helped solve the problem of combining protection for both the tool joint and the casing, the proliferation of different hardbanding materials was creating a logistics and quality problem out in the field. The fact is that because hardbanding worked so well addressing the tool joint protection issue over the years, the industry has evolved now to where industry best practice involves hardbanding the drill pipe; however, with so many different players involved in the drilling operation, often it is unclear which hardbanding material was used. The basic issue is that while most hardbanding materials can be rebanded over themselves, they usually cannot be banded over other hardband materials. This has created a challenge in the industry.

To help address this issue, a whole new class of hardbanding materials is coming to market now. This group of hardbanding materials has the ability to weld over other types of hardbanding material. While the hardness of these materials are approximately 15 - 20% lower than that of the amorphous hardbanding materials and 300% lower than tungsten carbide, it provides the applicator the ability to hardband over most other materials. In environments that are not too harsh, this tradeoff seems to be worthwhile for many operators. While the hardband will not last as long as the other two types of materials, these hardbanding materials appear to be an alternative where the rebandability and identity of the original hardbanding material is an issue.

## What next?

As a result of the evolution and technology advancements in the oil drilling industry and the subsequent developments in the area of tool joint protection, the oil and gas drilling industry has seen the development of a whole range of hardbanding material to meet the needs of differing drilling operations. In an environment where casing wear is not an issue, use of hardbanding that uses hard compounds such as tungsten carbide is most economical and efficient. Where the drilling conditions are tougher and casing wear is an issue, hardbanding material with the highest hardness but with the lowest coefficient of friction is the best. Where rebanding over any hardbanding material is the primary concern, the new group of hardbanding materials that allows rebandability is the best choice. Applicators of hardbanding material should have a good understanding of these factors to help their customers make the right choice of hardbanding material. OT

## Note

The technical information on hardbanding materials has been provided by Dr. Paul Kim Metallurgist of Liquid Metal Coatings LLC.