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LAYING HEAD PIPE MATERIAL FOR PRODUCTION OF WIRE ROADS IN LONG ROLLING MILLS*

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Abstract
Rolling small-diameter hot wire rods at high speeds with conventional laying head pipes can wear the pipe out frequently and affect quality and consistency in the final product. Laying head upgrades using Sandvik SAF2507LHP™ (UNS S32750) tubes make possible to achieve optimal metallurgical properties, smooth coil formation and easier coil handling. Operators can also avoid unwelcome shutdowns due to frequent worn pipe changes and turndowns. Sandvik have been developing different customers and understand their process needs. The suitable selection materials that are able to withstand high levels of wear better than low alloy and carbon steel grades that are commonly used in industry is very important to improve the quality and increase productivity. UNS S32750 tubes were demonstrably superior to low alloy and carbon steels when used in Laying Head Pipe system regarding tubes lifetime, reducing replacement, production interruptions and increasing reliability.
Keywords: Laying head pipe; Wire rod; Carbon steel; Duplex stainless steel.

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1 INTRODUCTION

Wire rods are used in a wide range of critical components. These include high tensile bridge and deepwater cables, chains and springs for automotive or industrial applications, agricultural machinery, industrial fasteners and more. Such applications require wire rod of optimized and consistent quality with an enhanced strength-to-weight ratio to reduce maintenance and avoid equipment downtime or failures. In order to achieve these properties, high expectations are placed on the equipment used to manufacture wire rods [1]. Figure 1 shows a schematic diagram of a laying head pipe.

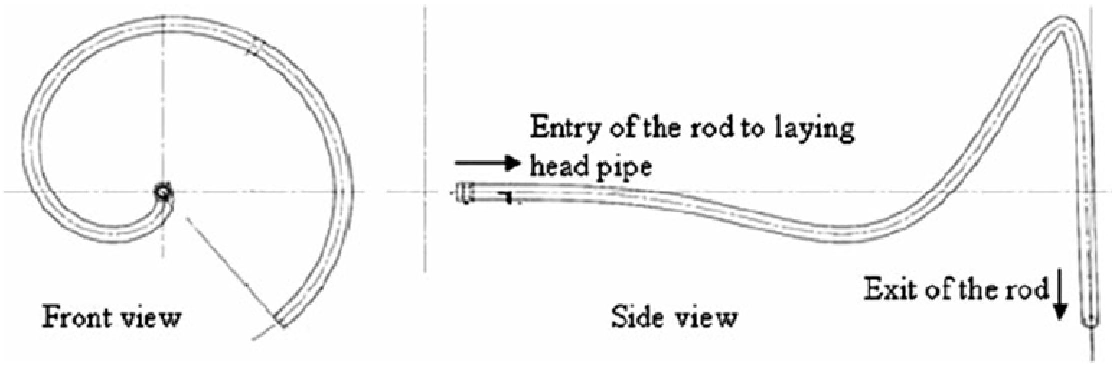

Figure 1. A schematic diagram of a laying head pipe [1].

In the production of a wire rod, one of the most critical part of the process is when the finished hot-rolled wire rod passes through the pipe with a rotating curve-shape inside the laying head to form a coil, shown in Figure 2a. This process heats the pipe surface to a high temperature (800-900°C) [1].
The Laying Head Pipe (LHP) rotates at high speeds and, in doing so, forms the wire rods into their new coil shape while laying them onto the conveyor. In a typical wire rod mill, a custom-designed pinch roll and LHP deposits the hot rod in convoluted form onto a roller-type Stelmor conveyor for air cooling [1].
The coil is then collected in bundle with the help of a reform tube and then is ready for delivery, see Figure 2b.

Figure 2. Linear hot-rolled product into a helix (a) and wire word coils ready to deliver (b) [1].

Effective use of the LHP at the coil formation state is also important to the effectiveness of the subsequent air cooling stage in order to ensure that the desired final properties of the wire are achieved [1].
Important parameters to consider are: Wire rod material; Inlet speed of the rolled rod (straight shape); Rotation speed of the laying head pipe; Dimensions of the rolled rod and of the laying head pipe; Temperature of the wire rod; Temperature inside the laying head; Temperature of the wall of the laying head pipe [1].

1.1 Severe wear in laying head pipes

LHPs can fail frequently against such high performance demands. This is primarily due to severe wear at the inner surface of the LHP caused by abrasion from the hot rolled wire rod as it passes through the pipe at high speeds [1].
Therefore new materials are needed that can better withstand the high wear from the friction between the hot wire and the internal pipe surface at high temperatures. This is increasing in the case of LHP applications since they are required to handle product at elevated temperatures in the range of 900 °C (1600°F), above the traditional temperatures of 600 to 700 °C [1].
The higher temperatures are combined with rising production outputs per day. These targets entail faster laying speeds increased up to 100 meters per second (m/sec) or 20000 feet per minute (fpm) from the traditional laying speeds of between 50 m/s (10000 fpm) and 70 m/sec (13780 fpm) [1]. The more severe wear has effects on LHPs, and so they necessitate frequent replacements.

1.2 Wear on the tube inner diameter

The form and accuracy of LHPs is critical. Pipes that are formed incorrectly, or have become malformed through age relieving or abuse, can cause serious problems in operation. A change in profile at the pipe's inner surface created by wear will likely disturb coiling and proper ring formation of the long products, and also affect the subsequent air cooling [1].
A visual indicator of wear, that is common in most critical working conditions, is the formation of a deep groove on the pipe's inner diameter (ID) after just a few days' production (i.e. a few thousand tons of wire rod). Grooves on the laying pipe ID can create irregular coiling or deposition in the wire rod when it reaches the cooling conveyor [1].
Such effects may result in additional needs for maintenance or replacement parts, and will also likely cause low surface quality and imprecise tolerances.
Figure 3 illustrates modes of failure in the form of deep longitudinal grooves at the inner surface of the bent portion of the pipe. When there is a size change on the wire and the LHP is grooved, the chance of cobble is higher.
When a collision of the wire with the pipe walls occurs and causes rapid uneven wear of the pipe and after only a few days of operation, this wear may lead to the wire breaking through the pipe. This is called a "cobble" [1].

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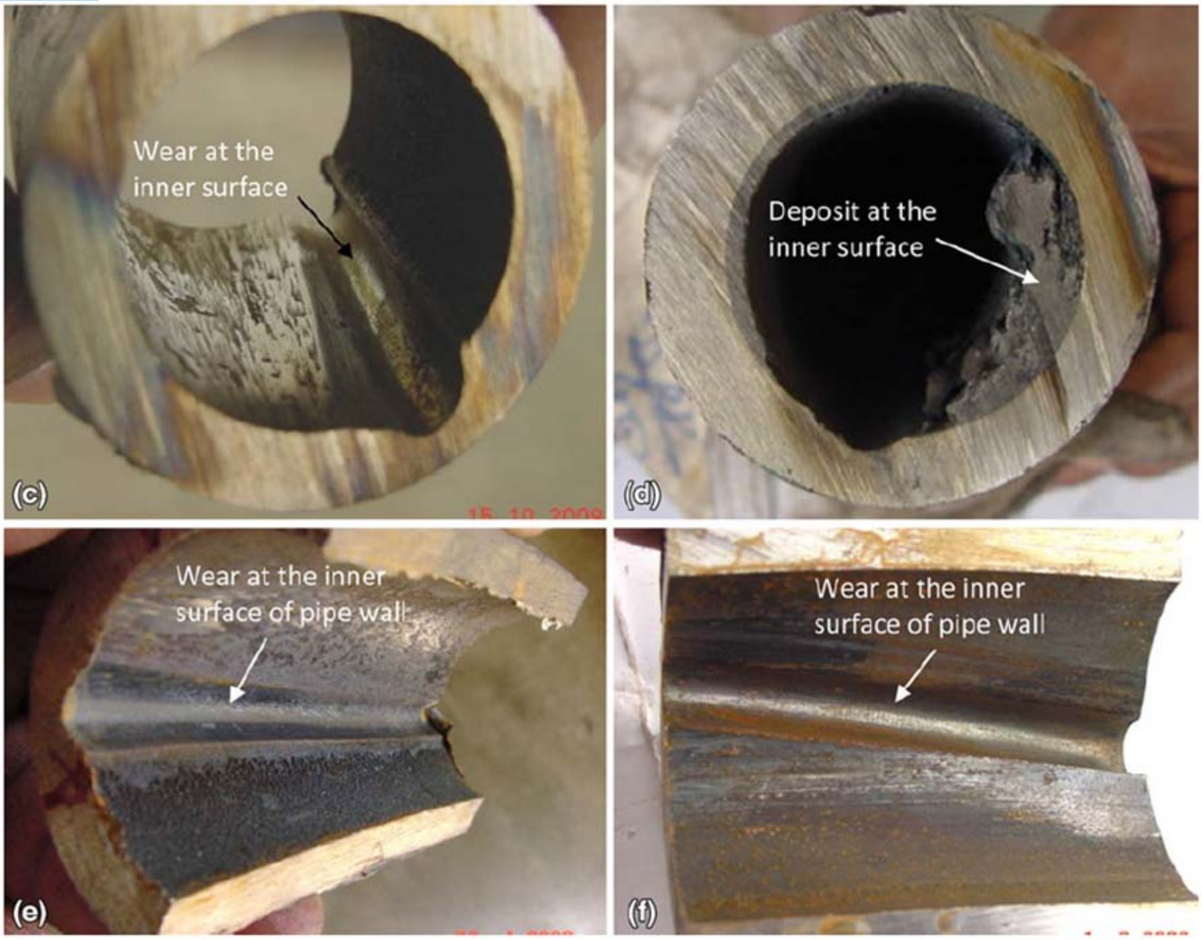

Figure 3. Failed laying head pipe (LHP) [1].

1.3 Use of Duplex Stainless Steels

The Duplex Stainless Steel can provide better performance for Laying Head Pipe production, since its higher mechanical properties and intermetallic formation are beneficial to the application. This investigation studied customers' needs for Laying Head Pipe production and compared the performance of SAF2507LHP™ (UNS S32750) and different low alloy and carbon steel grades.

2 CASE STUDY

In response to customers' needs for higher LHP production output and speeds, engineers at Sandvik investigated replacement materials that are able to better withstand high levels of wear from the friction between the hot wire and the pipe surface than existing low alloy and carbon steel grades.
Based on its findings, Sandvik identified SAF2507LHP™ [2] as an alternative material for tougher LHPs.

3 RESULTS AND DISCUSSION

SAF2507LHP™ (UNS S32750) [2] has already an established track record in improving the wear properties of wire rod mill LHPs during operations at high temperatures, thereby extending the operational lifetimes – see Figure 4.

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Figure 4. The wear profile of Sandvik SAF 2507 laying head pipe alongside pipe in low alloy and carbon steel.

Sandvik SAF2507LHP™ (UNS S32750) [2] is demonstrably superior to carbon steels when used in LHPs, through the positive experiences of customers. While the carbon stell is hard at room temperature and the heat makes it softer, UNS S32750 is very ductile at room temperature allowing a good starting point for the hot bending anf then becomes pretty hard during operation inside the laying head.
Sandvik is continuing to investigate on this grade in order to improve even more his behaviour in this application through a good bending and, together with some customers, optimize the working variables.

3.1 Case study

Laying head technology using high alloy stainless steels has delivered record-setting performances when tested at several other rolling mills. A wire rod mill in Italy was experiencing failures in its standard LHP made from P9, P22 and other carbon steel. The existing standard pipe was only able to process 15,000-20,000 tonnes of 5.5 mm diameter wire rod prior to failure, working at 75 m/sec. The safe configuration processed 5,000 tonnes of T22 wire rod, also of 5.5 mm diameter, working at 100 m/sec.
The mill chose to replace its existing pipe with UNS S32750, and thereafter experienced a production capacity increase from 5,000 tonnes to 35.000 at 75 m/sec and to 65.000 tonnes at 100 m/sec – thereby increasing the lifetime by a minimum of five times.
A relevant improving of the lifetimes were also achieved at a wire rod mill in Turkey after they installed 51LHPs in Sandvik SAF2507LHP™ (UNS S32750). The new LHP provides the plant with a 6-10 times longer pipe lifecycle when producing 6.3 mm diameter wire rod, and also helped to eliminate vibration problems.
An other Turkish mill installed 33 pipes in the mill for the production of wire rods up to 5,5 mm extending their extrusion capacity approximately 3 times more.

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4 CONCLUSION

The superior performance of Sandvik SAF2507LHP™ has enabled unmatched production levels in wire rod mills and helped to reduce incredibly the pipe replacings during normal small product rolling campaigns.
In addition, the technology allows to have a higher and more stable quality of the final wire rod produced. Thanks to this operators are able to predict and achieve more consistent results with improved and more reliably formed head and tail ends, and excellent ring patterns with even ring spacing for improved ring patterns and rod coil quality. This is achieved with reductions in maintenance, production interruptions and plant spares.

REFERENCES

1 Goutam Mukhopadhyay • Sandip Bhattacharyya, Wear of Laying Head Pipes in a Wire Rod Mill, Submitted: 7 December 2012 / in revised form: 1 April 2013 / Published online: 29 May 2013 © ASM International 2013

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