Carbinite METAL COATINGS

Case Study

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CARBINITE METAL COATINGS – TEXTURED CARBIDE PROCESS IMPROVEMENT

-Carbinite Metal Coatings Works with Major Aluminum Manufacturer on Flat Rolling Processes-

Stub Mandrel Inserts:

Shortly after new grades of aluminum were specified at one branch plant of a major US aluminum manufacturer, a problem was identified relating to material hardness and gauge thickness. The equipment and process for rolling stock at this location had been developed to accommodate a wide grade range of roll stock. However, the thicker clad stocks pushed the limits of the equipment. Softer and thinner stock does not require the extreme levels of tension and force needed to reduce harder and thicker stock.

The Problem:

This higher tension proved too much of a challenge for the stub mandrels that were gripping the inside (I.D.) of the spools used for the thicker stock. When the torque that was needed to keep proper tension exceeded the friction load generated by the stub mandrels, the spool would slip, causing a temporary slack in the system. Any loss or inconsistency in tension resulted in a scrapped coil, or what the mill engineers referred to as a “coil dump.” The scrapped aluminum had to be cycled back to the melt, resulting in a loss of mill availability. With the increase in aluminum demand for automotive and aerospace applications, these production losses were unacceptable. With any flat rolled process, strip tension is one of the most crucial factors that must be controlled.

Four Possible Alternatives:

1. **Cut Keyways into Spools:**

Pros:
Mechanical engagement allows no potential for the spool to slip on the mandrel.

Cons:
Modification of over 1000 pieces per plant to ensure compatibility (Not cost effective).
Other modifications required to mill equipment for keyed spools to function.

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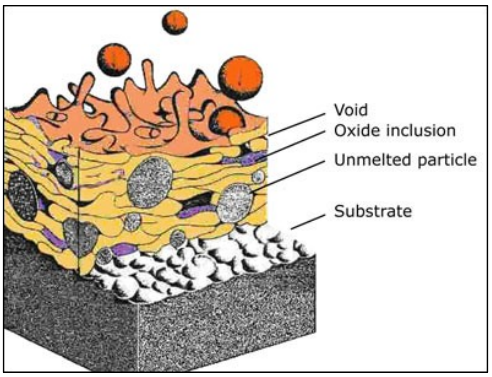
Four Possible Alternatives, continued:

2. **Blast and Nitride:**

Pros:
Easy and inexpensive option to add texture to the face of the segments.

Cons:
Cannot be maintained once nitride has been completed.
Segments only achieve a minimal roughness

3. **Thermal Spray:**



Pros:
Pure and hard textured surface.
Readily available technology, common solution in steel and aluminum mills for wear.

Cons:
Potential for cracking.
Minimal texture achieved.
Must be stripped and machined for resurfacing.

4. **Electro-Spark Deposition (ESD) Surface Alloying:**

Pros:
Metallurgically bonded and hardened rough surface.
No cracking, chipping, or peeling.
Can be reapplied without stripping or machining.

Cons:
Potential for coating to brinell back into mandrel face due to soft 4140 substrates.

Solving the Problem:

Phase 1:

Carbinite Metal Coatings was asked to develop a cost-effective solution to the quality problems caused by tension loss. Working in conjunction with two plant engineers, the decision was made to simply coat the O.D. of the expanding stub mandrel with Carbinite's #3 (60 grit) textured carbide coating. This was the lowest risk option with the greatest potential for an easy win. Since the segments would not be heat treated, the coating could be easily removed by machining. The range of textures offered by Carbinite's ESD process proved to offer the highest increase in COF by far compared to all options shown.

Carbinite's textured carbide coating seemed to eliminate the issue with scrapped coils initially. However, as is often the case, other challenges presented themselves. Since the coating was applied to segments made of fairly soft 4140 steel, the coating wanted to brinell back into the substrate, resulting in a loss of friction. Overall coating life was found to be inadequate (Initial service lives were less than 3 months), as was functionality due to the extreme loads imposed by the new campaign of thicker and harder material.

This image shows a welded and machined segment prepared for coating (left) and then a coated segment (right).

Phase 2:

The new problem that presented itself was how to improve the surface of the stub mandrels. Using a harder base for the Carbinite coatings was the basis for phase 2 of this trial. It appeared this would extend the life of the coating and improve maintainability. A proprietary hard face weld application was selected, followed by a machining and truing of the outer diameter of the segments in preparation for coating.

Phase 2, continued:

The welded and machined segments were then coated and prepared for installation. While the weld overlay claimed to be nearly 60Rc, the results were still unacceptable. Service life remained below 3 months. Both the engineers at the plant and the Carbinite in-house team were beginning to think this was a problem that a coating simply could not solve. However, both parties were willing to persevere despite the disappointing results up to this point.

Carbinite's Senior Application Engineer possessed a background in machining and tooling coatings, and understood that air hardened tool steels like A2 seemed to coat very well. These steels also have long lives in high sheer load applications like bend dies and clamps for tube and pipe applications. This knowledge led to a successful end product for the aluminum mill.

Phase 3 (Success):

The solution came in the form of custom A2 tool steel inserts. These custom inserts were designed by Carbinite's Application Engineering Department and required modification of the stub mandrel segments to include pockets that would accept the inserts. In conjunction with The Mull Group, Inc. (Wheeling, WV), the pockets were machined to accept coated tool steel inserts.

These mandrel inserts provided the substrate needed for the textured Carbinite coating to survive, and led to unexpected advantages.

<u>Unexpected Advantages:</u>

1. **Shipping:**
   The inserts were significantly smaller than the stub mandrels, reducing the time and cost of shipping between Carbinite and the aluminum mill.

2. **Maintenance:**
   Two sets of inserts were machined and coated by Carbinite so the mill Maintenance Department would always have a spare set available. If traction was ever in question, there would be no need to schedule a full 8-hour outage to change the segments. The inserts can be quickly swapped, saving a great deal of time and money.

Unexpected Advantages, continued:

3. **Life:**
   The inserts showed a service life of over 6 months making it through full campaigns as needed.

4. **Outage Time:**
   Previously, about 8 hours of outage time was consumed by changing segments that needed resurfaced. The new coated inserts are now changed quickly by one person, freeing up valuable time and manpower during a short outage.

Outcome:

This experimental stub mandrel insert project was so successful that Carbinite now offers engineering and coating of custom inserts, including mandrel modification, to a variety of applications. The end user has seen a total elimination of scrapped coils due to tension loss during campaigns. Significant time and cost savings are also seen at each and every scheduled outage with the modular insert design. Problem Solved!

For more information about this and other problem solving applications contact:

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