Improving Mill Productivity with Advanced Wear Protection Solutions

Port Alberni mill extends boiler ID fan life, outage cycles with advanced wear protection.

By Jennifer Broadwater, Chad Juliot, and Andreas Weckesser

NorskeCanada's Port Alberni mill in British Columbia recently conducted erosion studies on its power boiler induced draft (ID) fan to determine the most effective way to reduce severe wear, increase fan productivity, and prolong intervals between planned outage cycles.

Based on results of these studies, the mill replaced chrome carbide weld overlays on the fan's blades with brazed tungsten carbide protection, successfully extending the unit's effective run time from eight to twelve months, and ultimately plans to lengthen its scheduled power boiler outage cycle from once a year to once every two years. As a result, it anticipates an immediate annual savings of $150,000 in fuel costs and an additional $150,000 biannually in maintenance costs.

Positioned on the west coast of Vancouver Island, the Port Alberni Division is one of the largest producers of telephone directory and LWC papers in North America, with a capacity of 432,000 metric tpy. The mill's 480 metric tpd of integrated CTMP furnish for these grades requires a significant energy supply, a portion of which is produced onsite.

Power Boiler

The mill's steam plant has a 1978 Combustion Engineering power boiler with a 1997 converted Kvaerner fluidized sand bed. The boiler is fired with hog fuel produced by local logging operations and sawmills. It has a steam capacity of 400,000 lb/hr and burns an average of 900 metric tons of hog fuel/day

By-products generated from the power boiler include highly erosive fly ash and flue gases. The boiler's ID fan pulls flue gases from the boiler and forces them through to the precipitator. The mill uses one operating ID fan and has one spare fan rotor.

The ID fans, manufactured by Baron Industries, have 10 forward facing curved fan blades. They have a 10-ft-dia fan wheel with inlets on both sides, and are propelled by a 1,750-hp drive fixed to a Liquid Flo fluid coupling (used to control the 800-rpm fan speed).

Figure 1. Port Alberni's power boiler ID fan.

Maintenance is performed on boiler equipment during the required annual boiler outage. The ID fan wheel is replaced with a spare wheel every year, and extensive repairs are performed on the fan housing, inlet dampers, and multiclone sections upstream from the fan. The boiler shutdown duration is dictated by the amount of time required to overhaul the fan.

Severe Wear

Port Alberni began experiencing severe wear on the ID fan in 1997 when the boiler was converted from a stoker grate to a fluidized-bed system. The wear problems were first detected when the plant was forced to increase fan speeds to achieve optimum capacity. Outer portions of the blades were wearing excessively due to highly erosive components in the fly ash, and, eventually, sections of the blades wore completely through, dramatically reducing capacity.

Prior to 2001, the mill experimented with chrome car-

Figure 2. Fan blades protected by chrome carbide weld overlays after 12 months in operation.

bide weld overlays to protect the ID fans from abrasive wear. During typical fan operation, however, fine particles eroded through the hairline cracks inherent to hardface weld overlay materials. These cracks provided a less resistive path for erosive materials to wear through the overlay. Portions of the chrome carbide were undercut and began to detach from the fan, as shown in Figure 2.

The Port Alberni ID fan is typically operated at 75%-80% of capacity. Operators began detecting a decrease in fan capacity approximately eight months after installing the chrome carbide weld overlays, and fan speed was steadily increased to maintain desired capacity. After 10 months of operation, wear and productivity losses exceeded the ability to compensate with increased speed.

The fan was unable to achieve required boiler loading for the remaining two months until the planned outage period. As a result, the plant was forced to burn more costly natural gas in its second boiler to achieve the required mill steam load, resulting in estimated additional fuel costs of $150,000.

Severe erosive wear of ID fan components can also create unbalanced vibrations, causing the fan to trip. Fan failure would result in incremental boiler fuel costs of approximately $80,000/24-hr period (based on June 2004 gas prices) and could impact daily paper production, resulting in lost revenue. To prevent this from happening, the mill's maintenance engineers began investigating alternative wear protection.

In June 2001, they attached three sample coupons to the scroll of the ID fan housing and monitored erosion performance for six months. The 4-in. x 10-in. coupons (bent with a radius of 80 in.) were made of brazed tungsten carbide cladding, chrome carbide weld overlay, and hard alloy steel.

Chrome Carbide

A chrome carbide weld overlay plate is comprised of a mild steel base with a chromium carbide weld layer. The combination creates a wear resistant plate with a moderately formable backing that can be welded directly onto existing components. The overlay can be applied and repaired in the field fairly inexpensively. Its thickness can be increased by applying multiple weld layers. However, multiple layers create a fragile surface, leading to check cracking. Thicker applications are not practical on ID fans due to weight concerns and the instability and extra motor pull that is created.

When applied unevenly, cracks can occur between weld overlays, severely altering their wear resistant characteristics. The welding process produces intense heating and cooling, often causing overlay distortion and severe cracking. In high impact environments, these flaws can create plate spalling and breaking.

Check cracking is inherent with chrome carbide weld overlays, and material pre-heating, post-heating, slow cooling, and stress relieving may be needed. Extreme localized heating, combined with the difficulty in controlling cooling rates, typically results in material check cracking. Channeling will occur as surface check cracks create a path for erosive materials to undermine the base material, jeopardizing structural integrity and possibly leading to a catastrophic failure.

Wear Resistant Alloy Steel

A variety of hard alloy steels can be used as wear protection. The alloy steel tested by Port Alberni was a heat-treatable, low alloy steel with a low sulfur content. This material is inexpensive, readily available, and, similar to weld overlays, is formable and can be welded directly onto existing components in the field. However, protection offered by low alloy steels in extreme wear environments is inherently limited.

Field-applied steel plates are also susceptible to check cracking, which can propagate into the base material and the attachment weld, causing a potentially catastrophic fan failure.

Brazed Tungsten Carbide

The infiltration brazing method constitutes filling (by capillary action) a porous coating or structure with molten filler metal. While there are many methods for applying the carbide and braze in preparation for infiltration braze coating, the principle technique used to manufacture the cladding involves a nonwoven preformed cloth. The particles used in this process are sized and mixed to provide a homogeneous, stable, dense coating.

Superior wear protection provided by brazed tungsten carbide cladding can be attributed to the brazing process, which metallurgically bonds the hard particles and matrix metal to the substrate. The cladding is virtually crack-free due to the controlled application and cooling during the brazing process. Hard particle densities of more than 70% by volume can also be achieved during the brazing process. The method does not generate significant carbon dilution into the protective layer, ensuring a uniform wear rate.

The brazed tungsten carbide cladding cannot be field applied or repaired due to the nature of the brazing method. The process also places size limitations on the pieces that can be directly clad. To enable field installation on large equipment such as ID fans, liners with brazed tungsten carbide cladding applied to a thin substrate are fabricated and then weld-attached onsite. Brazed tungsten carbide cladding has a higher initial installation cost than traditional protection methods. However, profitability analysis often demonstrates that this protection can generate overall cash savings and higher internal rate of returns (IRR) by extending capital equipment life.

Test Results

The tested wear protective materials were compared in December 2001, after six months of ID fan operation (see Figure 3). The brazed tungsten carbide cladding outperformed both the low alloy steel and the chrome carbide overlays. Only the tungsten carbide cladding retained its original length, as shown in Figure 4. Due to the success of the sample brazed tungsten carbide cladding, the mill covered portions of the ID fan blades with clad liners during its next annual shutdown.

Brazed Tungsten Carbide Cladding Application

In July 2002, the mill installed ten 33-in. x 17.5-in. fan blade liners protected with 0.060 in. of infiltration brazed tungsten carbide cladding on the operating ID fan (Fan A), which maintained optimal capacity through 12 months of continuous operation. In July 2003, a routine inspection of Fan A revealed a wear zone in the middle of the liner's leading edge.

Also in July 2003, the mill expanded the brazed tungsten carbide application to its auxiliary fan (Fan B), cladding blades and areas on the center of the support web, which had historically experienced extensive wear. The Fan B application involved cladding ten 33-in. x 17.5-in. fan blade liners, ten 42-in x 9.5-in. fan blade liners, ten 19.8125-in. x 23-in. fan rib plates, and twenty 11.3125-in. x 17.75-in fan side plates. The cladding thickness of all fan components remained 0.060 in. Fan B also maintained full capacity through 12 months of operation.

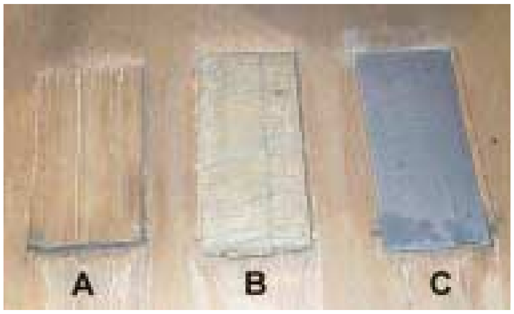

Figure 3. Comparison of wear results after six months: (A) alloy steel, (B) chrome carbide weld overlay, (C) brazed tungsten carbide cladding.

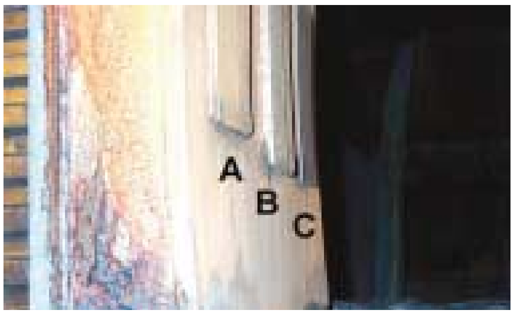

Figure 4. Comparison of material lengths after six months: (A) alloy steel, (B) chrome carbide weld overlay, (C) brazed tungsten carbide cladding.

The mill expanded its use of the cladding again in June 2004, by cladding Fan A with ten 42-in. x 9.5-in. fan blade liners, ten 19.8125-in. x 23-in. fan rib plates, and twenty 11.3125-in. x 17.75-in. fan side plates. To extend the useful life of the fan even further, next-generation liners for the 33-in. x 17.5-in. blades were developed and installed on Fan A. The entire liner was clad with a 0.040-in.-thick application of brazed tungsten carbide, with the high wear portion of the fan receiving an additional 0.040-in.-thick application.

Due to the predictable wear rate associated with the dense, uniformly applied tungsten carbide cladding, the double-clad fan liner should perform at ideal efficiency for at least two years. As a result, the mill anticipates it will begin replacing the power boiler ID fan once every other year instead of annually, resulting in a $150,000 biannual savings in maintenance costs. ■

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