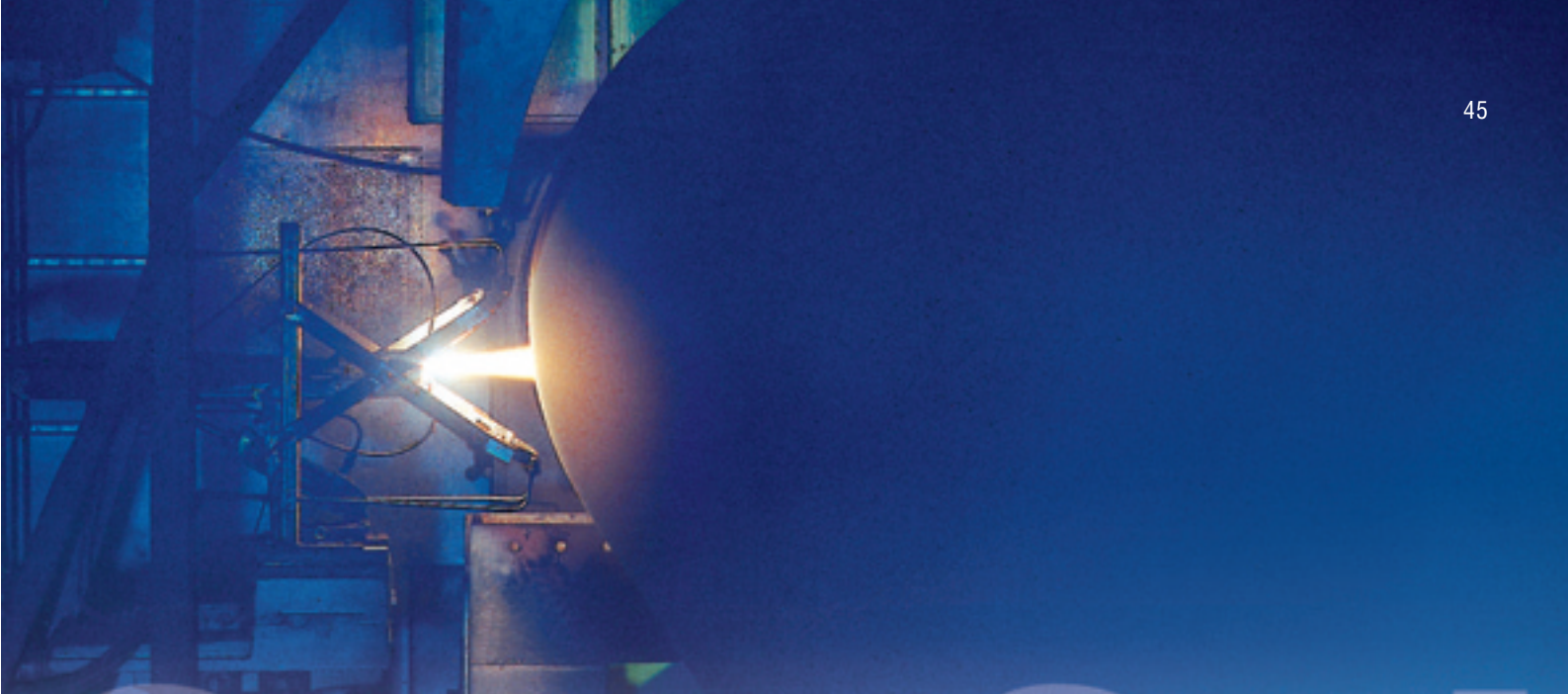

CeraCal™ – Optimized high-performance coating for hard calender rolls

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The ongoing trend toward faster calenders, increasingly online, is bringing extreme demands on hot calender rolls. For high quality paper production, they have to ensure for months at time a high degree of smoothness without any appreciable contour deviations. As mentioned in an other article there are efforts under way to meet these requirements by perfecting electrolytic chromium plating methods. Due to the vulnerability of chromium to scratching, however, this approach is not very promising. That is why Voith Paper Service is focusing instead on the development of suitable spray coating.

Tailored thermal spray coatings for hot rolls

Thermal surface coating by plasma spray has been coming into greater use for some time now. Powdered composite materials are sprayed thereby onto the component with high kinetic and thermal energy, as shown in Fig. 1.

The hard carbide and boride materials used are embedded in various kinds of metallic matrix.

Depending on the materials used and the respective spray process, surface hardnesses of 1,500 HV or more can be attained. However, hardness is not necessarily a measure of wear resistance.

Fig. 1: *CeraCal™ spray-coating application.*

Fig. 2: *Microsection through a CeraCal™ coating layer, scale 1,000 : 1.*

Fig. 3: *CeraCal™ carbide particles in the µm range.*

Fig. 4: *Another type of coating, showing white oxidation seams around the carbide grains due to overheating.*

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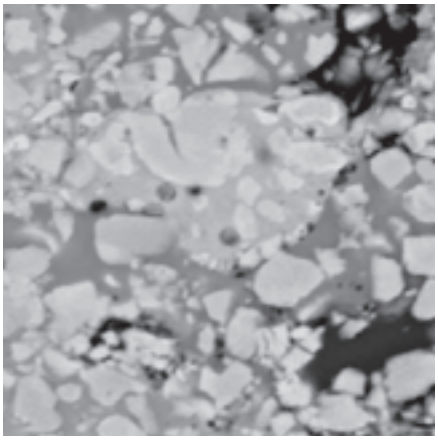

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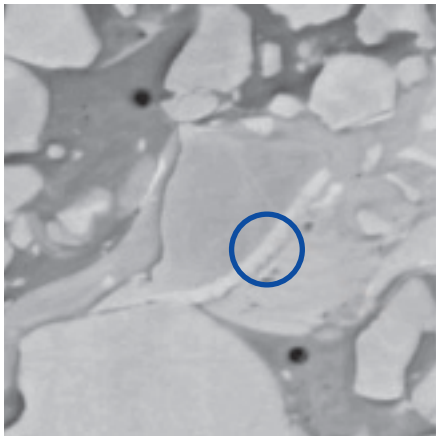

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More important for long service life is a coherent and well-bonded surface layer which is not too brittle.

The question has arisen as to whether multiphase surface coatings automatically roughen faster than chromium plated surfaces due to lack of homogeneity, thus causing a faster decline in paper quality. As proved by the latest developments in this field – for example the CeraCal™ system – the opposite is true. The main goal in developing this optimized coating system for hard calender rolls was to identify a materials and process combination perfectly matching requirements.

CeraCal™ – for the toughest demands

CeraCal™ hard-metal thermal spray coatings are applied by the High Velocity Oxygen Fuel (HVOF) method, using an encapsulated combustion chamber. This enables pressures of 12 bar or more for adding the necessary kinetic energy component to the thermal input. Moreover, by selecting an appropriate combustion medium, overheating of the carbide surfacing material is prevented by keeping the temperature below 500°C. Another advantage by comparison with the detonation method is that the HVOF process works continuously rather than intermittently, thus building up an extremely homogeneous surface layer **(Fig. 2)**.

The spray coating powder comprises spheroidal carbide pressed into a metallic carrier matrix. These spherical carbide particles ideally bond into the metal, while at the same time the matrix metal component is reduced. Surface roughening due to breakaway or erosion of the hard coating material during operation is thus prevented. The low metallic content reduces the risk of chemical corrosion separating out the carbide, which would also lead to premature roughening. This well-flowing powder material is sprayed by the HVOF nozzle on to the roll surface in layers. The particles reach velocities of 700 m/s or more and form a coating with a bond strength of more than 100 MPa and a hardness around 1,250 HV.

The roll surface can then be superfinished to Ra-roughness values of less than 0.03 µm, with negligible contour deviations (<8 µm over a working width of 9 m).

The effectiveness of this method is shown by electron scan microscope view comparisons of a CeraCal™ coating **(Fig. 3)** with another type of coating on the market **(Fig. 4)**. The carbide particles in the CeraCal™ coating are firmly embedded in the matrix, while the much larger carbide particles of the other coating show white seams. These white eta-phase seams are

caused by peripheral carbon deficiency due to overheating. They weaken bonding and resistance to chemical corrosion. The CeraCal™ coating system avoids this problem by limiting the heat input.

Performance in practice

The CeraCal™ hard roll coating system is suitable for all types of calender, both with hard-soft and hard-hard nips. Good results have been obtained in hard-soft nips at line loads up to 550 kN/m and oil feed temperatures up to 270 °C, with roll heating by steamboxes or external Cal-Coils. Doctor blades can be used without problem, but metal blades must be avoided. We recommend doctor blades made of carbon fibre composite with heat resistant bonding resin.

Users report very positive results with CeraCal™ coatings, as shown by the following examples:

- A producer of coated grades with high basis weights uses this type of coating in both calender stacks at 360 kN/m and 240 °C roll surface temperature. After operating for 2.5 years, the first CeraCal™ coating still shows the original surface roughness of Ra 0.04 µm.

- After more than 4,500 operating hours at 390 kN/m and about 1,160 m/min web speed, the producer of online-calendered SC-B grades measured an Ra-roughness of 0.12 µm on the CeraCal™ coating. Rolls in similar usage, but surfaced with another type of coating, had to be replaced after reaching the maximum roughness limit of Ra > 0.3 µm in less than 2,000 hours.

- LWC paper causes step-wise wear on hard supercalender rolls due to high pressure at the web edges. Based on good experience with HVOF coatings, this customer wanted to reduce surface wear to less than 40 µm in diameter per year. After two years of operation with CeraCal™ coating, annual wear is less than 30 µm.

- After installing a CeraCal™-surfaced thermo roll, a manufacturer of 50-70 g/m^2 coated paper for food packaging has been able to reduce line load by 7% and roll temperature by 10%. Product smoothness is, nevertheless, 1.5 times higher, with a gloss increase of 2 points.

- An SC-A producer coated his No. 3 water-heated supercalender roll with CeraCal™ process, and after six months of undoctored operation found, that with unchanged surface roughness of Ra 0.12 µm, product quality was identical to that with a chromium coating. He therefore decided to equip his new Janus MK 2 calender entirely with CeraCal™-coated thermo rolls.

As shown by these five examples, considerable progress has now been made in optimizing the surface coating of heated rolls. Results are no longer limited by the multiphase characteristics of thermal spray coatings. If the respective parameters are correctly adjusted, thermal spray coatings not only meet all specific requirements for hard calender rolls, but deteriorate far less than chromium plated rolls while producing quality results as least as good. Furthermore, the vulnerability of chromium surfaces to doctoring does not apply at all to CeraCal™ coatings.

Prospects

Further development work to optimize the various parameters influencing this process will also take into account the cost-benefit aspect. Field trials are currently underway with CeraCal™ coatings incorporating even finer carbide particles. If these trials with extremely demanding applications confirm the significantly longer service life expected, a favourable cost/benefit ratio will result despite the additional costs involved.