ADVANCED ANTI-ABRASIVE FANS

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Introduction

TLT-Turbo's advanced coatings for fans are applied to the aerodynamically critical internal fan components that are exposed to strongly-abrasive particle flows. These anti-abrasive tungsten carbide composite (TCC) coatings are designed to conserve the aerodynamic geometry of, for example, the fan blades for longer than possible to date. This means, the fan efficiency and consequently the drive power can be kept close to the as-planned level.

In addition, these coatings are thinner and aerodynamically much smoother than the welded coatings typically available on the market. Finally, the TCC-coatings generally allow the structural strength of, for example, the fan blades, to be preserved for a comparably longer operational time while reducing the facility stand-still time for maintenance and reducing the associated service cost.

Fan abrasion in cement

Cement plant gases are typically loaded with hard and sharp-edged dust and/or ashes (see Fig. 1), which erodes key parts of fans, for example eroding impellers of centrifugal fans

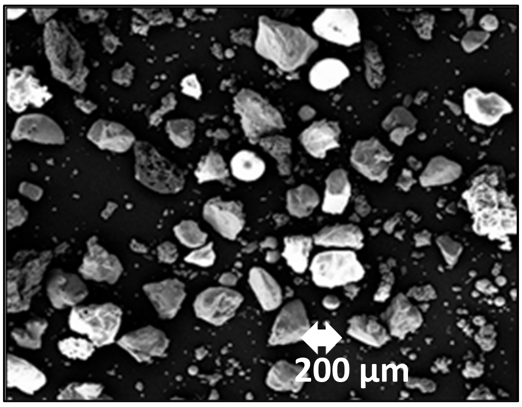

Fig. 1: Scanning electronic microscopy image of typical industrial abrasive ash particles

The geometry alterations generated by advancing wear of the aerodynamically and statically critical fan components can result in severe reduction in fan efficiency, which in turn leads to an increasing drive power requirement of the fan drive motor.

Furthermore, sometimes even short after facility commissioning, the structural strength of fan components falls under permitted limits, due to excessive particle flow erosion of critical components and the resulting decrease in wall thicknesses (see Fig. 2 and 3).

Fig. 2: Destruction of a centrifugal fan impeller blade close to a welding seam by particle flow erosion

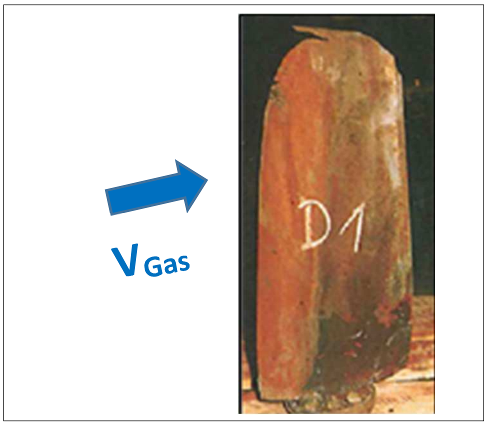

Fig. 3: Strong erosion of the blade of a coal fired power plant axial fan as a result of impact wear at the blade face and outlet edge

As a result, a premature, unplanned standstill of the industrial facility takes place. Time-consuming and costly repair work on-site or in the workshop, to overhaul or replace the component(s) is highly understandable.

To realise a limited extension of fan operational time under such abrasive process conditions some standard anti-erosion measures are applied. Previously, the wall thickness of critical fan components were increased or thick hard-facing coating were welded on the affected fan component(s) (see Fig. 4). Alternatively, heavy, thick and armoured protection plates can be screwed to the affected area.

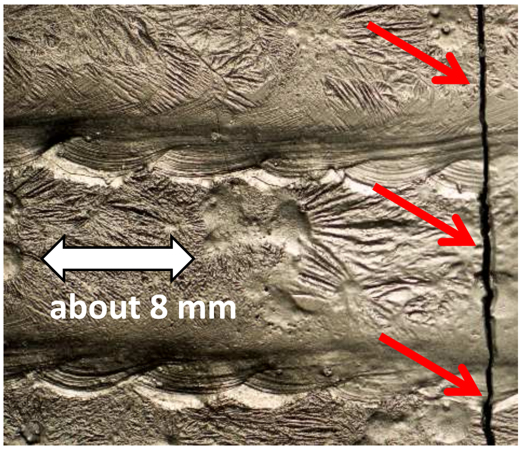

Fig. 4: Welded hard-facing coating with crack

In addition, these standard coating measures result in a significant increase in the fan components' weight. This is up to about 30 % for centrifugal fan impellers. As a consequence, bearings and shafts need to become larger and heavier, increasing running costs.

Rough surfaces damage fans and efficiency

Welded hard-facing coatings typically have very rough surfaces with numerous cracks that partially reach the surface of the fan component or the protection plate substrate material. The rough coating surface constricts the aerodynamic efficiency. Cracks provoke excessive local particle flow erosion and allow direct access of corrosive media to the protection plate material. This generates local but propagating corrosion of the substrate as well as flaking of the coating. (See fig. 4).

Flaking and blistering of coating can open a window to the unprotected surface of the fan component material, causing local strong erosion and possibly corrosion as well as accelerated flaking of the coating. Beyond that, the rough coating surface augments the risk of caking on fan components, again adversely affecting aerodynamic efficiency. Cleaning of these components will also be impeded.

In addition, these standard coating measures result in a significant increase in the fan components' weight. This is up to 30% for centrifugal fan impeller. As a consequence, bearings and shafts need to be become larger and heavier, increasing running costs.

TLT-Turbo's new coatings

To reduce the weight increase, TLT-Turbo has undertaken research and development efforts to protect fan component surfaces of different materials with innovative, thin anti-abrasive coatings (see Fig. 5) and significantly decrease the specific volumetric erosion rates.

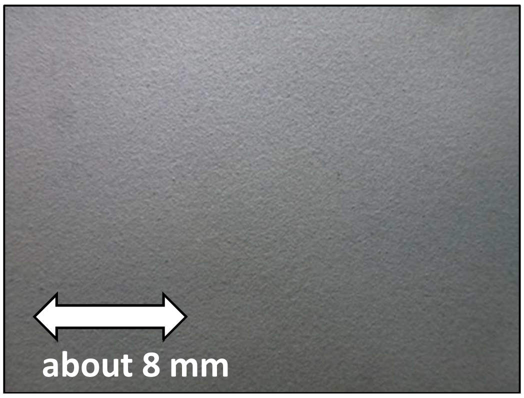

Fig. 5: Aerodynamically smooth, thin HVOF sprayed tungsten carbide coating on centrifugal fan impeller blade

Besides weight reduction, TLT's new coating, TLT-101, features a hydraulic smooth surface for superior aerodynamic efficiency as well as extremely low porosity to protect the coating from being corrosively undermined. Furthermore, its low, small scale porosity avoids early blistering or flaking of coating. Finally, it can be assumed that the hydraulic smooth coating surface diminishes the risk of caking on fan components adversely affecting the aerodynamic efficiency. The cleaning of these components will be facilitated.

TCC-101

TCC-101 is essentially a tungsten carbide powder with some special additives. It is sprayed onto fan components using high velocity oxy-fuel (HVOF) coating. The obvious improvement in particle flow erosion resistance (see Fig. 6) does not only result from the special composition of materials within the coating but also from high supersonic spray velocity (significantly beyond Match = 4.0).

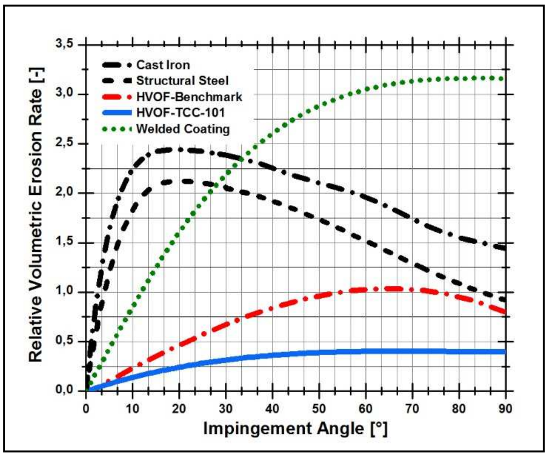

Fig. 6: Relative erosion rate ERR of the TLT WKB, TLT-H-101 (TCC-101), as a function of the impigment angle, as compared to standard protections and other fan materials

The results shown in Fig. 6 have been derived from TLT-Turbo's measurements in its own particle flow test stand whereby standard abrasive particles are used. The diameters of these particles are statistically distributed and range from about 50 µm up to 300 µm. The flow velocity of the tests amounts to 160 m/s a typical velocities at an impeller blade.

The relative volumetric erosion rates in Fig. 6 have been normalized with the maximum volumetric erosion rate of the commercially available HVOF-benchmark coating, a HVOF-sprayed tungsten carbide composite (TCC) coating. The relative erosion rate has been plotted against the impingement angle of the particle jet flow.

Analysing the measurement results in Fig. 6 for an impingement angle range of 0° to 60°, TCC-101 shows less than half the erosion rate of the benchmark coating and only about one-eighth of a typical welded hard-facing coating. The erosion process of fan components is, in this range, dominated by particles producing micro grooves and cuttings on the component surface.

Within the impingement angle range of about 60° to 90° (see Fig. 6) where the erosion process is dominated by particle impacts shattering the component surface, the TLT-101 coating shows less than half the erosion rate of the benchmark coating and only about one-eighth of a typical welded hard-facing coating.

For the sake of completeness, the relative volumetric erosion rates of TCC-101 coating is also compared to a rolled standard fine grain steel and a typical fan blade cast aluminium alloy (see Fig. 6).

Conclusion

TLT-Turbo has developed the advanced anti-abrasive coating TLT-101to increase the operational life-span of heavy fans (see Fig. 7) that work in highly loaded particle flow processes in the cement or other industries.

Being compared to the market standard of welded coatings and even to a HVOF-tungsten carbide benchmark coating, the HVOF-sprayed tungsten carbide composite (TCC) coating of TLT-Turbo shows a significantly lower erosion rate. The TCC-coating is thin, will be directly sprayed on the critical fan components and can be designed to be repairable by exchangeable components according to customer demands. Furthermore, its surface is aerodynamically very smooth.

These features allow the design of more advanced anti-abrasive fans compared to previously. TLT-Turbo's anti-abrasive fans are built to operate longer with less standstill time for abrasion caused maintenance, consume less drive power and to have less weight.

Fig. 7: Typical axial - and radial fan of TLT Turbo GmbH for "strong" industrial operating

The development of the advanced TCC-coating TLT-101 is more than just a starting point; it is the basis for a family of customer-tailored anti-abrasive TLT-Turbo coatings in the future.