Innovations from Venti Oelde

Wear Protection on Centrifugal and Axial-Flow Fans

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Material thickness is reduced by wear and, therefore, the useful life of fans shortened. This will often lead to the functionality of a larger production unit being impaired or shut down.

An air handling system is subject to material wear if solids are suspended in the air which is being transported. Erosion will be seen particularly on components where the air-stream is deflected. In a centrifugal fan with axially entering air-stream, the air-stream is deflected in the impeller by 90°. The velocity of the suspended solids is considerably increased in the impeller. The particles are pressed against the surface of the impeller and slide along until they are flung out of the impeller into the volute casing. In the fan casing, across the complete width of the impeller, there will be additional wear because the solids impact here in concentrated form, are deflected and exit from the fan with the air-stream.

The rate of wear is influenced by several factors:

- hardness of the solids
- particle shape
- amount of solids contained in the air-stream
- flow velocity

The material abrasion form is determined by the size of the particles.

Soft dust, such as, for example, flour from various types of grain, raw meal from limestone milling only cause a low rate of wear. These solids tend rather to caking in the air handling system. Wood meal, wood chips, cardboard, straw, hay and similar materials cause abrasion, whereby the amount of abrasive solids, sand and binder residue increase material abrasion. Iron oxides, such as escape into the workshop atmosphere in electric steel-works during smelting, metal and iron shavings, screening dust and suchlike cause excessive wear and make particular protection measures necessary. Cement and clinker dust, dust from calcining plants, coal, slag and mineral dusts, fly sand are all particularly hard and abrasive solids. Even if the air-stream contains less than 1 g/m³ of these solids, this can lead to increased abrasion and down-time. The flow velocity has a great influence on wear and the form of wear. At flow speeds of between 16 and 22 m/s the material abrasion is expected to be fairly small. However, if the shape of the air handling system, such as bends and baffles, causes the dusts to separate in the air stream, then, even at this relatively low speed, point wear is caused in and after these deflections, even in straight duct systems because the solids contained in the air-stream impact in concentrated form at these points. This effect is reinforced with increasing flow velocity, so that from 24 m/s the material thickness of fan parts subject to wear should be increased. At 28 to 30 m/s it is advisable to undertake specific countermeasures.

Modern technology offers a large number of wear protection procedures. With particular reference to wear protection for fans, some of the preferred measures are described:

a)
The use of commercially available hard metals, in the form of plate metal to manufacture wear liners, fan casings and fan impellers. Increased wear resistance is achieved by alloys and high carbon content or special tempering of the metal. Since the plate metal has to be machined by cutting, flame cutting, forming, removing material or welding so as to manufacture the required component, there are narrow limits on the maximum hardness. Materials, permitting the above processing and machining, have a wear resistance about 15 to 20 % higher than normal carbon steel. The extra costs for metal and machining are rarely considered to be a worthwhile investment by the plant operator because lengthening the useful life of a fan by 15 to 20 % seldom fulfils the customer's wishes, may not even be registered because there are no exact figures available for comparison.

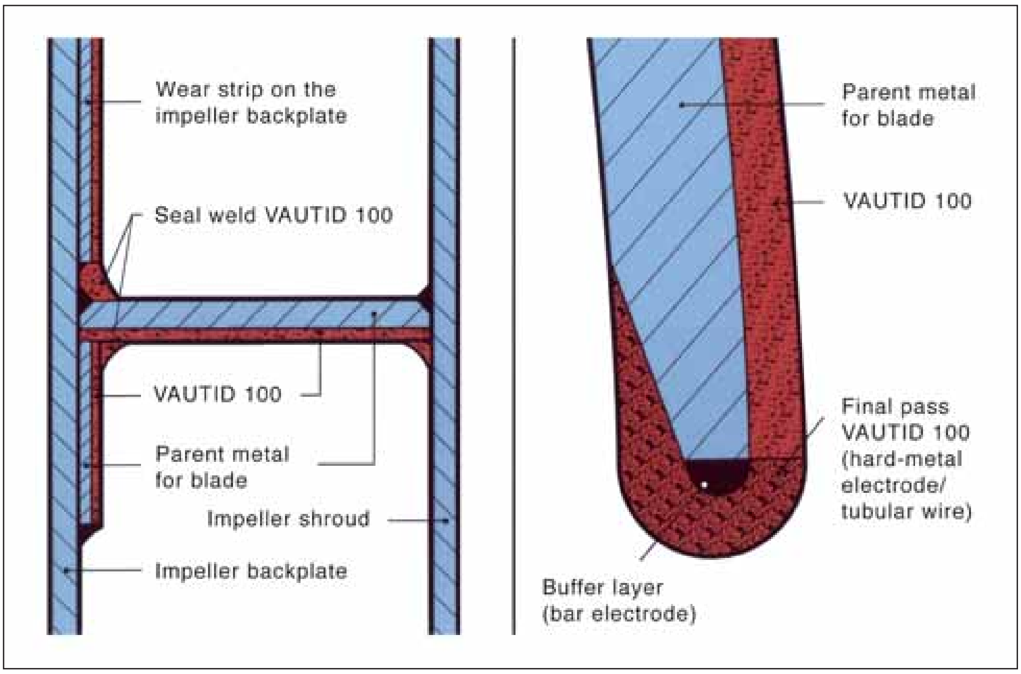

Diagram: Wear Protection on Impeller Backplate, Blade and Blade Inlet Edge

b)
A considerably longer useful life can be achieved by thermally coated parts. Extremely hard powdery metallic and non-metallic materials are applied by a thermal spray process to ready-prepared half-finished fan parts or finished components.

Ceramic oxide, aluminium oxide or titanium oxide are particularly wear-resistant against friction wear. The powdery spray material is melted in a nozzle system and applied at high pressure in powder form to the prepared component surface. Because the component is only warmed during this process to about 100 to 120 °C, there is only slight danger that the part may become deformed and, therefore, this coating procedure may be used with ready machined components. The spray layers are applied to a layer thickness of about 1 mm. Because the parent metal is not melted during this spray application and adherence is achieved by physical bonding, the coating can be loosened by impact. This coating can, therefore, be successfully used only where fine dust is entrained by the air stream.

Hard alloys, e.g. on chromium-cobalt-tungsten-boron basis are applied in powder form by special flame spraying guns onto the surface of the prepared component. The powder particles are brought close to their melting point and impact onto the component in the form of a paste. The layer thickness achieved is about 1 to 2 mm. So that there can be diffusion bonding between the layer being sprayed on and the part, the surface of the component must be heated to approximately the temperature of the plastic range of the spray layer (about 1000 °C). Because of the diffusion bonding, adherence of the spray layer to the component is very good.

c)
Hardfacing applied manually to wear exposed components, by means of electrodes or with tubular wire with inert gas, is a successfully adopted procedure (diagram). Metal plates are coated by means of automatic reciprocating welding machines. Since large amounts of the carbides are burned during welding, the necessary hardness of the protective layer is achieved with the help of a high carbon proportion. The carbon content is about 4 to 6 %; the hardness of the protective layer reaches about 60 to 65 HRC and the layer thickness about 4 mm. Hardfacing is welded onto a soft mild steel parent metal. While the welding consumable is being air cooled, no matter whether it has been manually applied or by welding machine, the welding consumable cracks diagonally to the weld in a lot of sections which may vary in size.

Initial objections to the use of high-carbon hardfacing layers, covered by cracks, which were raised particularly regarding their use on components subject to dynamic load, such as fan impeller blades, have been successfully countered in the last few years. Experience collected with impellers protected in this way, e.g. those used in cement works, has proved that the cracks in the hardfacing do not penetrate the parent metal and, therefore, do not detract from the function of the impeller.

Fig. 1

Hardfacing with a wear protection layer of about 4 mm adds considerably to the impeller weight and this must be taken into consideration; this also increases the moment of inertia, often meaning that it is necessary to increase the size of bearings, shaft and possibly motor output (with drive motors with a fixed rotating speed). When fans are being up-graded particular attention must be paid to this point.

Regarding the above listed procedures to protect components from wear, following must be remarked:

It is generally only possible to manually apply wear protection by means of rod electrodes or tubular wire on finished components, because the parts of the component where the application is required cannot be reached by automatic or semi-automatic welding machines. An inexpensive solution is the use of so-called wear-plates, that is wear-protection layers applied with the assistance of a reciprocating welding machine on mild steel (as described at the beginning). Fig. 1 shows an impeller with blades cut out from a wear plate. For example for larger impeller blades, the protective layer is applied to the finished cut-out plates or cut out of metal plates with plasma blow-torch cutting-off machines. Slight shapings, e.g. to obtain curved blade contours, can then be carried out on these components by rolling and bending.

Particular care must be taken with connecting welds between these wear plates and other constructional components. Since the wear-resistant layer is only applied to one side, the reverse side can be prepared for sunken fillet welds in “v” form, down as far as the wear-resistant layer. The root weld is laid with a chromium nickel electrode as a buffer layer; the other welds are laid with a mild steel electrode similar to the parent metal. On the lined side of the wear plate, the gap is covered by an electrode similar to the wear-protection layer.

Wear plates can be used for a great many applications. The plates or structural units made from them can be welded or bolted in place, for which purpose armoured countersunk bolts are available. Fig. 2 shows a finished centrifugal impeller using wear strips in front of the impeller blades, cut from wear plates.

Machine components are made inoperable often by only a few millimetres wear, causing losses of millions of €. These costs can be considerably reduced by taking preventive measures.

Fig. 2

Subject to alterations C 1/10/15/1.Stu

Ventilatorenfabrik Oelde GmbH
P.O. Box 37 09
D-59286 Oelde
Phone: +49 25 22 75 - 0
Fax: +49 25 22 75 - 2 50
info@venti-oelde.de
www.venti-oelde.de

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