Reconditioning Power-Generation Components with Thermal Spray

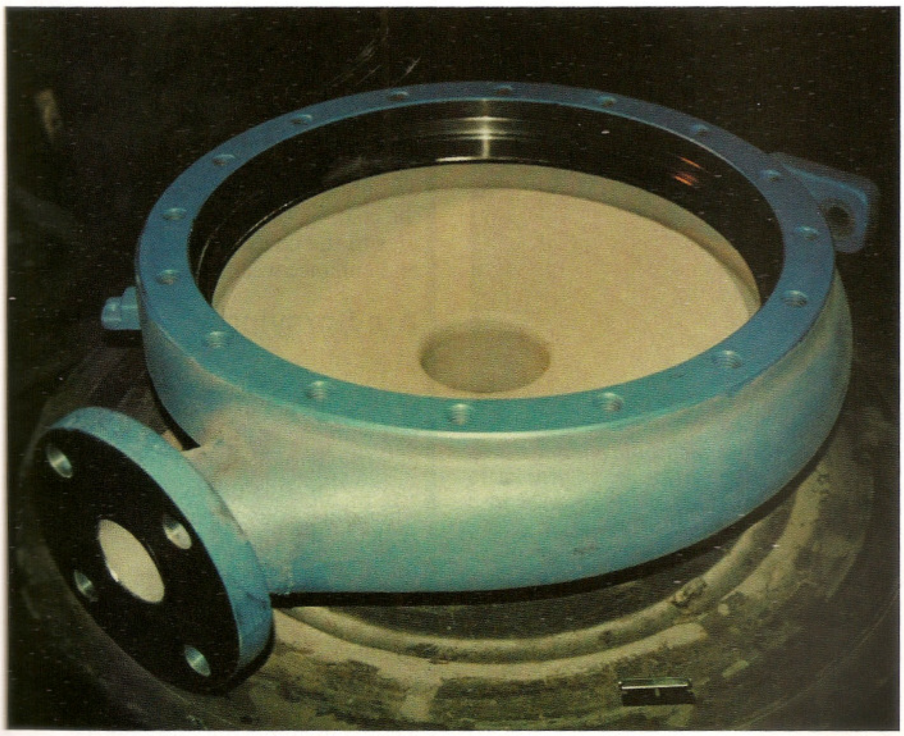

Fig. 1 — Applying a high-velocity oxyfuel (HVOF) sprayed carbide coating minimizes the wear and corrosion to the interior of this pump housing.

Thermal spraying offers versatility, economy, speed, and low heat input for restoring parts that normally would need to be replaced

BY KLAUS DOBLER

The growth of power-generation facilities throughout the world has been unprecedented. With this expansion, plant superintendents and maintenance supervisors will tell you that a tremendous amount of effort is expended behind the scenes to keep these power-generating facilities running smoothly. These facilities face numerous corrosion and/or wear issues, and maintenance must regularly be performed on various machines and systems. In an effort to reduce downtime, plant superintendents and maintenance supervisors have turned to and have come to depend upon thermal spray technology to extend the life of power-generating components and sys-

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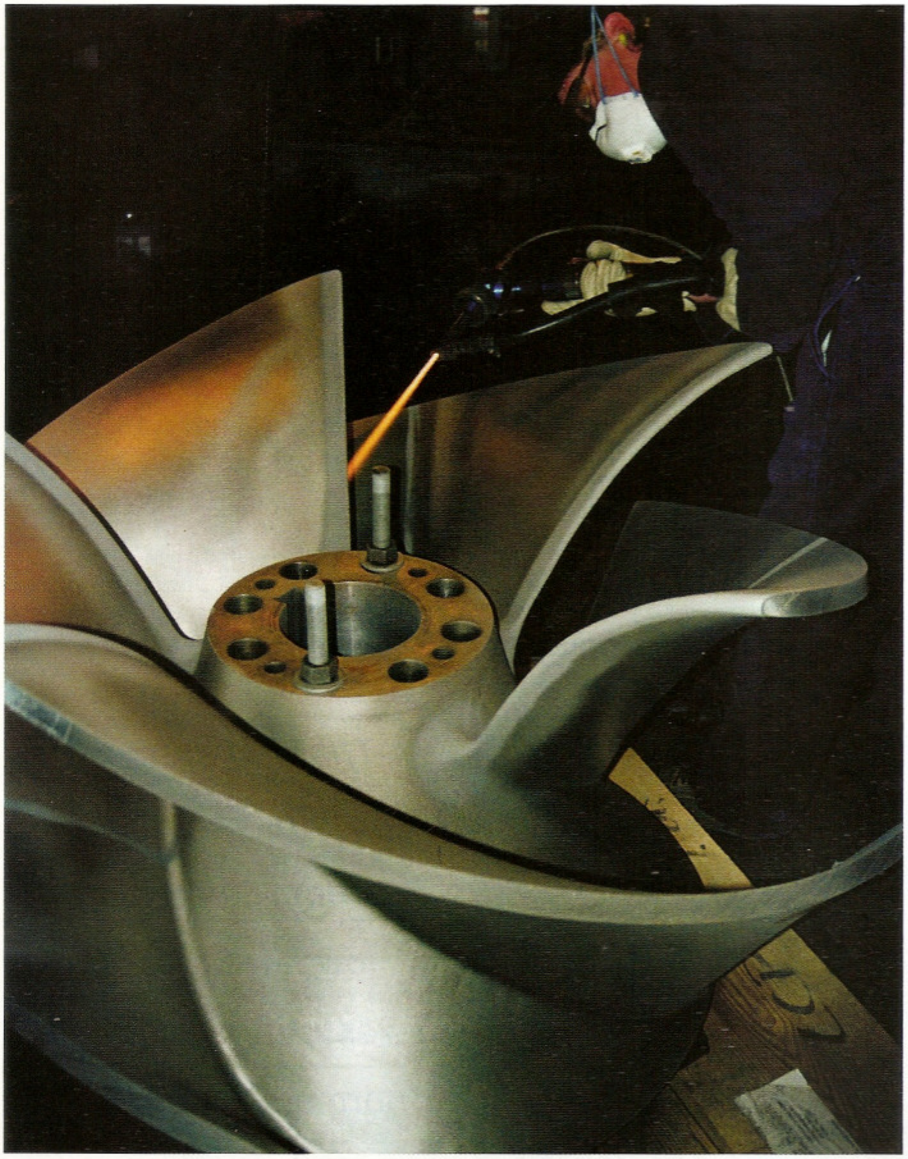

Fig. 2 — The leading edges of this impeller receive a wear-resistant carbide coating using the HVOF thermal spray process.

tems. Coatings manufactured by this technology are being used throughout the power-generating industry in applications such as water pumps, conveyor screws, boiler tubes, and coal crushers.

Pump Repair — Housings, Impeller Fins, Seal Sections, and Wear Rings

Pumps are used in almost every facet of a power-generating facility and must often endure abrasion as well as cavitation wear. The double suction pump is commonly used to move river water through a power plant. As river water commonly contains fine sand and even small stones, several sections of a pump can be attacked including the impeller fins, the pump housing, the impeller's seal section, and the wear ring.

The fins of the impeller are abrasively worn by the fine sand and the small stones and broken down by cavitation. Over time, pump efficiency will be reduced. Similarly, the housing of the pump also faces wear (Fig. 1) from the sand and/or rocks as water is pumped through it. If left unchecked, the housing will eventually wear away to the point where the pump may rupture. In both cases, the thermal spray solution is to apply a very hard and wear-resistant tungsten carbide coating onto the fins and leave it in the as-sprayed state — Figs. 1, 2. This HVOF sprayed coating contains about 1% porosity and has a very high hardness (1300–1400 HV 300 or ~ R_c 70).

The seal section of the impeller shaft undergoes abrasive wear when fine sand slips into the packing material and scores the journal. If the journal becomes too worn, water will eventually penetrate beyond the seal section and start corroding the bear-

Thermal Spray Processes

Flame Spraying

In the flame spraying process, oxygen and a fuel gas, such as acetylene or natural gas, are fed into a torch and ignited to create a flame. Either powder or wire is injected into the flame where it is melted and sprayed onto the workpiece.

Flame spraying can be readily performed in the shop or on-site and is generally low cost. Some of the materials that are typically applied are stainless steels, nickel aluminides, Hastelloy® alloys, tin, and babbitt. With relatively low particle velocities, the flame spray process provides thicker build-ups for a given material than the other thermal spray processes. The low particle velocities result in coatings that are more porous and oxidized as compared to other thermal spray coatings. Porosity can be advantageous in areas where oil is used as a lubricant, because a certain amount of oil is always retained within the coating, thus increasing its life. Oxides in the coating increase hardness and enhance wear resistance.

Arc Spraying

In the arc spray process, two wires are simultaneously brought into contact with each other at the nozzle. The electrical load placed on the wires causes the tips of the wires to melt when they touch. An atomizing gas such as air or nitrogen is used to strip the molten material off the wires and to transport it to the workpiece. Arc spraying is reasonably inexpensive and readily usable in the field. Low particle velocities enable high maximum coating thickness for a given material. Materials typically applied by arc spraying include stainless steels, Hastelloys®, nickel aluminides, zinc, aluminum, and bronze.

Recent advancements in nozzle and torch configurations provide greater control over coating quality and spray pattern. For example, the wires can be sprayed finely or coarsely. A 'fine' spray leads to smooth, very dense coatings whereas a 'coarse' spray enables greater coating thickness.

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Plasma Spraying

Plasma spraying is generally regarded as the most versatile of all the thermal spray processes. During operation, gases such as argon and hydrogen are passed through a torch. An electric arc dissociates and ionizes the gases. Beyond the nozzle, the atomic components recombine, giving off a tremendous amount of heat. In fact, the plasma core temperatures are typically greater than 10,000°C — well above the melting temperature of any material. Powder is injected into this flame, melted, and accelerated toward the workpiece.

Plasma spraying was initially developed and remains the preferred process for applying ceramic coatings such as chromia, zirconia, and alumina. However, metals can be readily sprayed with this method. The particle velocities for plasma are higher than for those of flame and arc spraying and result in coatings that are typically denser and have a finer as-sprayed surface roughness. The tradeoff is that the maximum coating thickness for a given material is usually reduced.

HVOF

The high-velocity oxyfuel (HVOF) process was invented only 20 years ago, yet it has thrust the thermal spray application range into areas that were once unattainable. In HVOF spraying, a combination of process gases such as hydrogen, oxygen, and air are injected into the combustion chamber of the torch at high pressure and ignited. The resultant gas velocities achieve supersonic speeds. The powder is injected into the flame and also accelerated to supersonic speeds. The results are the densest thermal spray coatings available.

The HVOF process is the preferred technique for spraying wear- and/or corrosion-resistant carbides as well as alloys of Hastelloy®, Triballoy®, and Inconel® alloys. Due to the high kinetic energy and low thermal energy that the HVOF process imparts on the spray materials, HVOF coatings are very dense, with less than 1% porosity, have very high bond strengths, fine as-sprayed surface finishes, and low oxide levels.

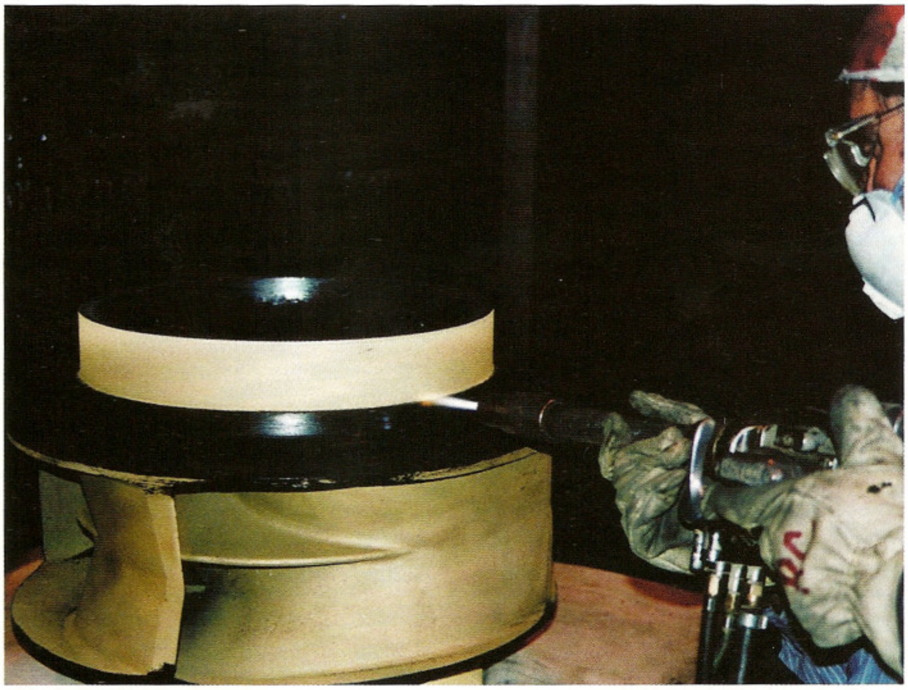

Fig. 3 — A craftsman rebuilds a ring section of an impeller by flame spraying it with a bronze coating, which will be machined to its final dimensions.

ings. An effective solution is to undercut the journal, plasma spray a chromium oxide coating, and finish the journal to size. Chromium oxide is characterized by a very high hardness (1300–1400 HV 300 or ~ R_c 70), a low coefficient of friction and excellent wear properties against abrasion in lubricated environments.

Lastly, the wear rings begin to erode as fine sand flows through the gap between the impeller and the housing. As it wears and widens, the efficiency of the pump is reduced. These wear rings can be efficiently reconditioned by applying bronze onto the rings and machining them to size — Fig. 3.

Coal Crusher Roll Repair — Journals and Seal Sections

In this case, a coal crusher (about 12 in. in diameter and 7 ft long) required repair on the seal section and the bearing section. A quick analysis of the seal section reveals that the coal dust generated during grinding penetrated the gap between the packing material and the journal, imbedding itself into the packing material and creating abrasion on the journal. The solution was to undercut the section, HVOF spray chromium carbide, then finish the journal to size. Chromium carbide has a hardness value of 950–1050 HV 300 (~R_c 65) and has good wear resistance properties against dry abrasion. With regard to the bearing section, the bearing scored the journal. Similar to the solution for the seal section, the journal was undercut, sprayed with stainless steel, then ground to size.

Reconditioning an Abrasively Worn Conveyor Screw

Conveyor screws are used in power plants to transport limestone into the boilers. One customer used a screw manufactured from carbon steel that needed to be replaced/repaired once a year due to the abrasion of the limestone. The thermal spray solution was to apply a thin layer of wear-resistant tungsten carbide on the shaft and both sides of the flights using the HVOF system. This repair procedure has extended the life of the screw significantly.

Outlook

Thermal spraying has established itself as a viable and cost-effective means for reconditioning worn components in the power-generating industry. The case histories presented in this article represent power-generating components that are currently being repaired with thermal spray technology. More importantly, they demonstrate that thermal spray coatings can increase component service life by 50 to 75%. By understanding the variety of successful applications, companies can duplicate and/or adapt these coating solutions to their own equipment. Moreover, a choice can be made that will save substantial downtime, increase profits, thereby resulting in an excellent return on the investment. ◆