REMOVE COATINGS FROM TURBINE COMPONENTS WITHOUT DAMAGING THEM AND LOWER YOUR COSTS.

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The Clean & Green Solution

A Precision Abrasive Waterjet (AWJ) Process is higher quality and more cost effective than traditional acid stripping and grit blasting.

AWJ precision process cleans better, protects better and extends useful part life lowering total cost.

Superalloy components require coating systems to protect the base metals from the extraordinary operating environments of gas turbines. These tenacious coatings are designed to resist the oxidation and corrosion created by the combustion process in the turbine hot gas path. These coatings also resist removal when they become depleted during operation.

Most modern hot gas path coatings consist of a ceramic thermal barrier coating (TBC) on the outer surface and a “bond” coat between this TBC and the base metal. Typically, acid stripping and grit blasting of these bond coatings from superalloy components can cause both metallurgical and dimensional damage.

Acid stripping and grit blasting of MCrAlY bond coatings from vanes, blades, shrouds, liners and transition pieces are destructive processes. Exposure to acid can result in stress corrosion cracking, pitting, and alloy depletion. Grit blasting can result in uneven material removal and thinning of the base metal. And there are the environmental issues that are becoming increasingly important.

A Precision Abrasive Waterjet (AWJ) Process gently removes the coating without compromising the base metal integrity. There is no inter-granular attack or other issues with the AWJ process. The AWJ process is the cleanest, most efficient, most repeatable process for removing MCrAlY coatings from hot gas path components. An environmentally friendly process, it is gaining momentum as the preferred method for the factory of the future.

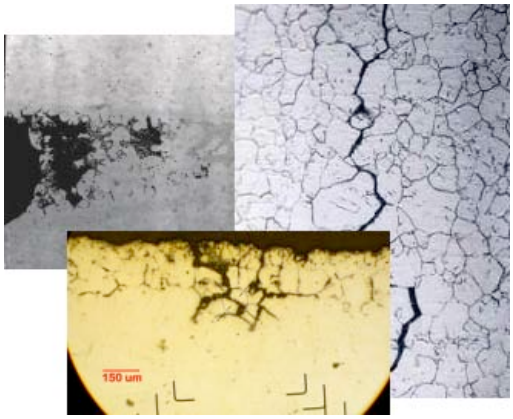
When you want to remove coatings from turbine components without damaging them and lower your costs, be sure to specify a Precision Abrasive Waterjet (AWJ) Process.

Compare stripping processes to see the difference.

ACID STRIPPING: A Solution with A Problem.

Typical problems from Acid Stripping include inter-granular attack (IGA). Many OEM's and users limit part repairs to one cycle because of IGA. In addition to the IGA, acid stripping leaves smut that contaminates the interface.

Acid requires masking to avoid removing the internal coatings, and subsequent unmasking. That is expensive and adds no value. A poor mask can destroy internals and scrap the part. The acid stripping process is a batch lot process and it is not unusual to find a group of Industrial Gas Turbine (IGT) parts being damaged due to acid variability.



One result of Acid Stripping is inter-granular attack (IGA). Acid Stripping is not environmentally friendly.

Acid attacks braze from previous repairs, reducing part life and the number of repair cycles adding to the total cost to your operation. Braze metal in brazed joints are often attacked due to the difference in material composition and porosity. Braze tends to absorb the acid and make it difficult to remove. Acid attack occurs.

And acid stripping does not evenly or uniformly remove the bond coat. Parts require subsequent hand processing to clean up adding more labor cost.

Internal cavities and areas such as the highly stressed blade root must be protected from strong acids. Also, control of the acid bath requires close monitoring. The process is "dynamic" and the chemistry of the bath is constantly changing due to the part/acid reactions and losses due to evaporation.

The intent of the acid bath is to strip coatings but the byproducts are both costly and damaging. And there are the environmental issues and costs to factor in.

Both aero and industrial applications are particularly vulnerable since their superalloys contain materials such as chromium and similar heavy elements. When these materials are put into solution they become toxic in nature. Personal Exposure Limits have recently been lowered by the EPA to lessen the probability of long-term health issues due to exposure to such materials.

Because of shortcomings in the acid stripping process, like incomplete removal and smut, a grit blast process follows.

GRIT BLASTING: A Problem Solution

Grit blasting with aluminum oxide also has its drawbacks. It is a hand-held operation and is done by the plant's least trained personnel, and is the least controlled of all repair processes, yet the most pervasively used.

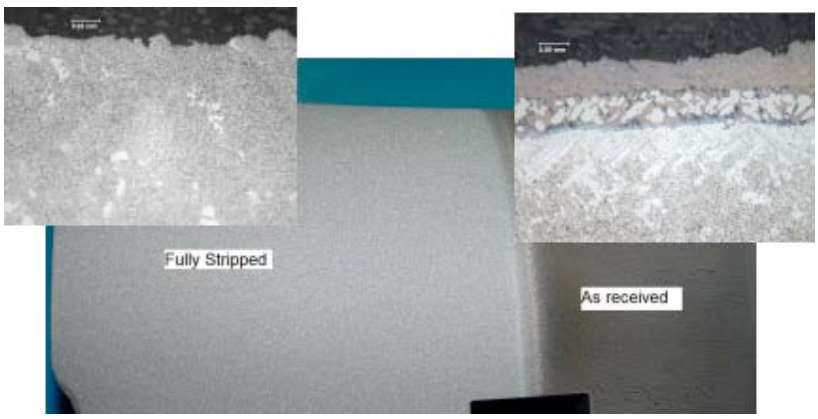
Grit blasting can result in uneven material removal and thinning of the base metal. The coating and the base metal are both gray metallic in coloring, which makes it hard to distinguish the coating to be removed from the base metal. With a hand-held grit blast operation uneven removal is the normal result. Grit blast guns use coarse grit that breaks to down to finer grit during a typical liner blasting leaving a dirty residue. The gun is difficult to insert by hand up into a liner, for example, and still be able to hold any consistent tolerance, especially when the color difference between the coating and the base metal is not apparent.

The results of grit blasting are uneven removal, and distortion of geometry, besides contaminating the surface interface with Aluminum Oxide (ALOX). Most turbine manufacturers control the amount of contamination in the interface between the coating and the substrate. Alumina contamination negatively impacts the tensile bond integrity. Because of incomplete bond coat removal, and contaminated surfaces, patches and even sheets of coatings are known to come off in initial service, or long before normal warranty outages. Sometimes coatings come off as they are applied causing as high as 40% rework. Worse, many repair processes call for additional grit blasting, if residual grit is found at Fluorescent Particle Inspection! More grit (dirt) perpetuates the problem!

Precision Abrasive Waterjet (AWJ) Processing: A Solution to the Problem

Precision Abrasive Waterjet processing (AWJ) is an environmentally friendly process that removes coatings without damaging the turbine component while lowering total costs.

A precision 5 axis Computer Numerically Controlled (CNC) Abrasive Waterjet (AWJ) removes the coating in iterative steps. The process behaves like a machine tool with material removal rates being controlled by speeds, feeds, pressures and material flow.



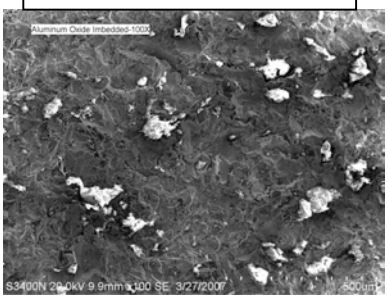
CNC control allows the AWJ process to deliver precise results at a lower total cost using an environmentally friendly (green) process.

Since coating thicknesses naturally vary, an X-ray Fluorescent device reports elements like Yttrium that decline in intensity as the base metal is approached. With this type of process control, it is sometimes possible to realize additional repair cycles in some components due to minimal damage to the substrate.

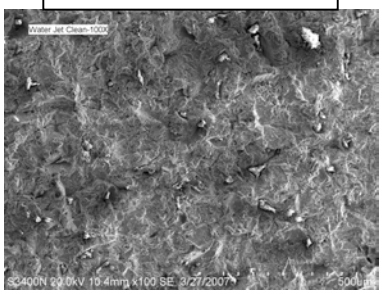
This CNC process has many advantages. First, it is a highly controlled mechanical removal process – sort of a surface milling process with tight tolerance control. It doesn't put Chrome into solution, like acid. It is a mechanical removal process. The machine is actually capable of holding positional tolerance to less than .0005 inch. The waterjet stream is controlled to a specific distance from the surface, with feed and speed controlled by software that keep the offset normal over the entire form of a blade for example. Coating thickness is measured before and after the AWJ to insure full removal of the bond coating and diffusion layer, as well as any contamination, corrosion, etc., under the bond coat. The process has the consequence of removing craze cracking, and deep cracks better than Fluoride Ion cleaning.

The remaining surface is also cleaned of all surface contamination and indeed in some cases shows Directionally Solidified (DS) grain structure and DS etching. Most companies using this method then bag the part and send directly to coating. Grit blasting re-contaminates the surface and destroys the bond interface. Process controls are in place to measure before and after conditions to verify removal over the surfaces where it is desired.

Surface Contamination after Grit Blast



Surface Cleanliness after Wateriet



Because of the CNC processing, single part flow occurs that beneficially reduces risk of batch lot errors. Actual part processing time is much less than acid and grit blast, at usually lower total costs. The AWJ process can remove the TBC and Bond coat in one process. Grit blasting of TBC and bond coating in some cases may be slightly lower cost but at the higher total expense of lower service life and reduced repair cycles.

- The system utilizes Six Sigma philosophy - eliminates the human variable found in hand grit blasting.
- Run charts can be generated.
- All process parameters are controlled by the CNC Control system.

- An X-ray Fluorescent device is used to measure the Yttrium "K-alpha" peak to determine the amount of MCrAlY and bond coat remaining. As one approaches the base metal, the peak diminishes, and thereby allows "sneaking up" on the base metal with iterative passes by the unit.
- The high-pressure water prevents entrapment of the abrasive in the material, so the part is much cleaner than grit blasted part.
- Parts can often be coated after waterjet without an aggressive grit blast process. This will speed the part through the repair process.
- The AWJ process can remove the TBC and Bond coat in one process.

There has been extensive scrutiny, qualifications and approvals by Users, Independent Service Providers and major OEMs over the last 5 years resulting in increasing utilization of the AWJ stripping process on almost every frame and application, from Blades (buckets), Vanes (nozzles), Liners, Transition Pieces, and Shrouds.

The results are predictable, repeatable, and environmentally friendly.

Huffman Corporation (www.huffmancorp.com) in conjunction with Springfield Manufacturing LLC (www.springfieldmfgllc.com) developed and patented the process, US 6,905,396. The AWJ process utilizes Huffman's multi axis machine tool technology, built on Huffman's superabrasive grinding machine platform used for tight tolerance gas turbine component machining. The AWJ machining service is available from Springfield Manufacturing. Springfield has seven machines available to service your requirements. Both Huffman Corporation and Springfield Manufacturing are located in Clover, SC - just 30 minutes from Charlotte and just over an hour from Greenville SC.

Aerospace and Industrial Gas Turbine original equipment manufacturers work with Springfield to seek out applications where cost, cycle time, and improved repairability can be realized with green manufacturing.

Specify Precision Abrasive Waterjet (AWJ) Process to remove coatings from turbine components without damaging them and lower your costs.

If you are looking for a way to significantly extend service life of the critical life-limited parts, ask for them to be AWJ cleaned before coating without grit blasting for new parts, or to be AWJ stripped before re-coating for your repairs. You will extend component life as a result, and reduce your maintenance cost considerably.