



Vapormatt

White paper

**Aerospace: Maintenance, Repair,
and Overhaul (MRO)**

Precision wet blasting has been used in the aerospace sector for many years, as a cost-effective and reliable method of surface cleaning and preparation. Since wet blasting first became widely used during the 1950s many hundreds of machines have been installed, in the facilities of major aerospace companies around the world. Many still choose to use Vapormatt for their surface finishing requirements.

Modern wet blast systems are radically different to their earlier counterparts, especially in their ability to provide precise finishes. With more accurate control of surface profiles, ability to monitor energy consumption and easily trace and log process data, modern systems are far more efficient. Perhaps as importantly, recent developments in technology have made it far simpler to upgrade existing machines, extending their operating life still further while improving levels of control and accuracy.

This paper will explain the benefits of adopting and adapting wet blasting technology for the use of surface finishing of aerospace components. More specifically, it will cover the relevant applications for turbine blades, propeller blades, landing gear, and aircraft toilets. In addition to an explanation of the science behind wet blasting, the aim of this paper is to be used as a source of information for those working in the maintenance, repair and overhaul (MRO) sector of the aerospace industry.



The wet blasting process

Originally pioneered by Norman Ashworth in the 1940s, wet or vapour blasting has grown to fit a wide range of applications with its main purpose to provide a highly precise surface finish as required by manufacturer's Standard Practices Manuals (SPM). As an alternative to dry blasting, the wet blasting process can offer MROs enhanced precision and reproducibility when it comes to the surface finishing of aerospace components.

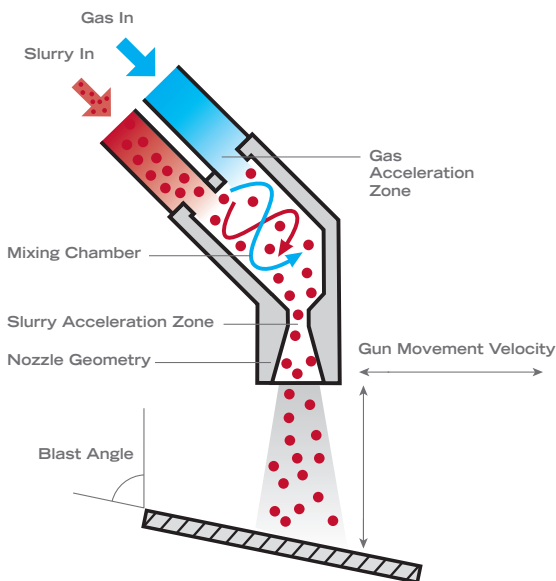
Wet blasting uses water and an abrasive medium to form slurry in the sump of the installed system. As the slurry is pumped through the system towards the gun, or multiple gun heads, compressed air is introduced; by allowing the slurry and air to synthesise within the mixing chamber of the gun body, a highly powerful blast stream is created which in turn accelerates through heavy duty, abrasion resistant nozzles. Having impacted upon the bearing surfaces the slurry is then recirculated through the same system for continuous use.

The wet blasting systems are versatile enough to work with a wide range of abrasive medias. Factors such as the form, hardness and mesh size of abrasive particles can be changed to suit the application. The recommended type of abrasive used for aerospace component applications has a great influence on the desired finish. For example, aluminium oxide is used to achieve a roughening effect and to create a matte and reactive finish on the surface that is ideal for dye penetration for non-destructive testing (NDT) and coating and bonding. Spherical particles, such as glass beads or ceramics, can also be used for: cosmetic improvement where a polished look is required, general cleaning when the surface should not be altered or for controlled shot peening, particularly on components that contain titanium and carry an explosion risk. For paint stripping and degreasing, softer plastic particles can be used for scrubbing and cleaning without risking damage to the substrate. Changing the blast media or granule size can change the process from relatively simple cleaning to a specific surface treatment.

When compared with other finishing processes like dry blasting, wet blasting offers a more uniform and consistent finish, thanks to the lubricating action of the water allowing a flow of slurry when processing complex shapes.

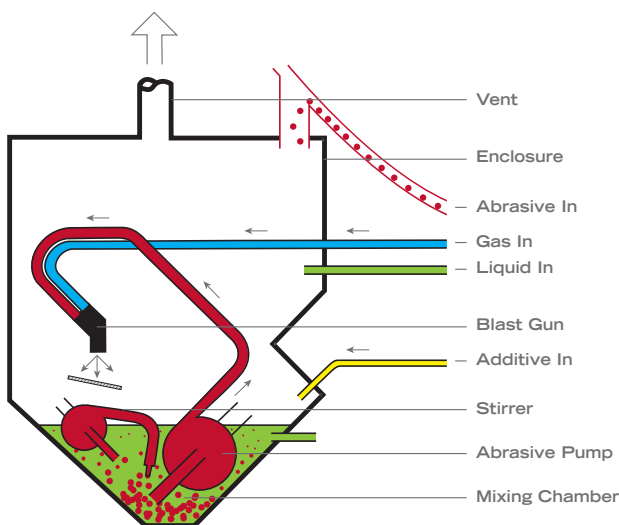
The variation and controllability of abrasive granules, nozzle and blast pressures, water temperature and a number of other factors make wet blasting a versatile process with clear advantages. With controls in place for slurry as well as air pressures, a finely tuned buffer can be configured to ensure a gentler action that will leave the substrate undamaged. In conjunction with the reliability of automation, you can ensure that every part will be treated in precisely the same way.

The mixing of compressed air and slurry in a blast gun.



Controllable factors

- Gas** - Type, Pressure, Flow Speed and Temperature
- Slurry** - Solid/Liquid Ratio
- Liquid** - Type, Pressure, Flow Speed and Temperature
- Solid** - Type, Size, Hardness and Shape
- Gun/part kinematics** - Velocity, Distance and Angle



Component cleaning and surface preparation

Low-pressure, high-volume water washing with appropriate cleaning chemicals is a recognised “solvent cleaning” method. Cleaning may involve anything from nuts and bolts to complete turbine components. Complexity can vary from a simple spindle to a sophisticated assembly such as blisks and fir trees, and materials can include any metal as well as composites and additive manufactured components.

With an effective wet blasting system, a variety of solvents from light oil to heavy grease can be removed. Rust, scale, carbon, paint, chemical deposits, general dirt and heat discolouration can also be removed.

Solvents such as water and mineral spirits can be used to remove foreign matter from the surface of ferrous metals. Finally, the acceptable finish of the part after cleaning can range from unchanged from the original finish, to lightly etched, or even in some cases, to the removal of the surface skin to a controlled degree.



A turbine engine blade being loaded into a Vapormatt Leopard Vertical machine via a holding jig

The characteristics of a wet blast process include:

- It will simultaneously degrease and remove solid contamination.
- It is a searching process that will treat complex surfaces and reach deep holes and the inside surfaces of pipes and tubes.
- It will clean and is compatible with all metals, and a wide range of composite materials.
- The system is environmentally friendly and does not use strong toxic chemicals or solvents.
- The process generates no dust and therefore creates no potential health hazards.
- The system is versatile in both size and degree of aggression (from delicate to very powerful).
- The system is economical, easy to maintain, and can be operated by unskilled labour.
- The ever-present water barrier prevents harsh impact and reduces surface damage.

Before



After



Utilising a fully enclosed wet blasting cabinet, an operator can process components without direct contact with the parts or contamination. Machines configured with gauntlet gloves enable the operator to use hand tools to perform disassembly within the cabinet if required; the brightly illuminated machine interior and large viewing window/door assist in this operation.

Cleaning before crack detection of turbine components and wheels

When aircraft tyres are changed, the wheels are inspected for cracks via NDT. Surface grime is removed using wet blasting – at a pressure low enough to remove dirt but not affect the paint layer. Wet blasting is also used for crack detection on turbine blades and ensuring that the surfaces of aircraft wings are perfectly prepared for the best possible adherence of deicing coatings.

Unlike dry or sandblasting that mask/hide surface cracks by peening over them, the wet blasting process exposes any cracks in the blade or wheel. The water element of wet blasting eliminates some of the dangers inherent in dry blasting. For example, there is no risk of dust clouds and charged particles, creating the potentially explosive mixture that you might experience with dry blasting. It also reduces localized heating (by friction), making the process particularly advantageous for the surface treatment of delicate substrates such as titanium components.

After inspection, it is imperative to remove any remaining chemicals as they may be detrimental to part life over time. Here again, you can use wet blasting to efficiently clean and prep the surface for any necessary repairs. Automatic wet blasting ensures consistent cleaning of the surface and guarantees the same bond quality every time.

With wet blasting technology, workshops can significantly reduce the time it takes to clean aircraft wheels and when compared to dry or sandblasting it produces no dust and eliminates explosion risk.

Creation of a reactive surface for coatings or bonding

In addition to surface finishing for coatings, wet blasting has been used for the preparation of composite components (typically, carbon fibre) for bonding to other composite or metal parts.



Prior to the introduction of wet blasting, most manufacturers used a combination of peel ply and hand flatting using wet and dry abrasive papers. The latter leaves a very uneven surface finish, and the part still needs to be chemically cleaned to remove any contamination left on the surface. Dry sandblasting has been tried but there is a risk of fibre damage that does not occur when wet blasting.

With composite materials being used more and more in the manufacture of critical components it is important they are compatible with existing materials and processes.

The advantage of using the wet blast process becomes apparent by the increased adhesion and shear strength of bonded components. By lightly wet blasting the top layer of the components the surface area for bonding is increased by 30% and any waxy coatings are removed.

As well as improving adhesion, users of wet blasting systems have found subsequent lacquering and painting processes become easier and more consistent. The introduction of water is an added benefit in that it reduces fibre damage by buffering the abrasive particles from the composite's surface.

Similar to coating preparation, our processes will improve the bonding success of your components. With a consistent finish that does not damage the substrate, components become easier to bond and allow for the even distribution of adhesives.

Advantages of using the Vapormatt wet blasting process for bond surface preparation

- Resinous material can be removed without damaging the fibres of the material.
- The lightly matted surface is very reactive and improves adhesion.
- The ever-present water buffer prevents abrasive media embedment and static build up on the composite surface.
- Wet blasting creates a very clean and reactive surface ideal for subsequent chemical bonding solutions.
- The same wet blasting machine can be used to treat all composites, metals, plastics and ceramics prior to bonding with equally acceptable results.
- There are no health or environmental side effects, and the process is completely dust free.



A composite propeller blade about to be processed in a Vapormatt Leopard Cub

Water-assisted stripping process

Water assisted stripping process (W.A.S.P) is the ideal process for washing and removing paint from undercarriage parts, brake components, control surfaces, wheels, landing gear and many other cleaning operations. There are two levels of pressure that can remove certain types of contaminants:

- **Low-pressure:** oil, grease, carbon, and brake dust without damaging the paint or substrate.
- **High-pressure:** concurrent paint stripping, oil, grease, carbon, and brake dust removal.

W.A.S.P. utilises a stream of hot water, soap and plastic particles to project a slurry at a surface that simulates hand scrubbing/cleaning without substrate damage. With automation, concurrent applications of degreasing and paint stripping are possible. W.A.S.P. is an operator and environmentally friendly application that requires no physical hand scrubbing, solvents, chemicals or dust. W.A.S.P., like other automated wet blasting applications, is highly controllable and can utilise unskilled labour.



Vapormatt Lion Rotary Machine designed to process tubular components



A stainless steel slip coupling that has been paint stripped by wet blasting



Aircraft toilet cleaning

The health and safety of maintenance staff are paramount, but this consideration has to be balanced with the need for an efficient method for the overhaul of toilet system parts. Any new method of overhaul and cleaning of toilet system assemblies and parts will be required to meet all current requirements and offer benefits in health and safety and also in time reduction of the overhaul process.

Improvements to the surface finish of the cleaned parts whilst eliminating bio-hazard exposure risk can be achieved by wet blasting. In addition to the blasting of the components taking place within the cabinet, the advantage of a wet blasting system is the ability to add biocide and degreasing additives to the wet blast slurry. Utilising spherical abrasive media for cleaning results in long media life with minimal breakdown through use.

Overflow and wastewater from the machine may be filtered by optional filtration specially designed for hazardous waste products, or alternatively, wastewater and overflow from the machine may be piped directly to the user's effluent treatment plant. Chemical dosing systems can also be offered as optional equipment, which enables frequent dosing of biocide or other chemical additives, whilst ensuring continued protection and operator safety.

Conclusion

With the longstanding history and consistent technological innovations of wet blasting in the aerospace industry, MRO companies can feel reassured that they are using a reliable, tried and tested and efficient finishing method. This technology is highly customisable with controllable parameters to suit even the strictest of procedures. This, in turn, makes cleaning and maintenance inspections safer for workers whilst improving operations.



Wet blasting a turbine blade in a Vapormatt Puma



Vapormatt Puma Manual wet blasting machine



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