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NEW TOUCH-UP CONVERSION COATING

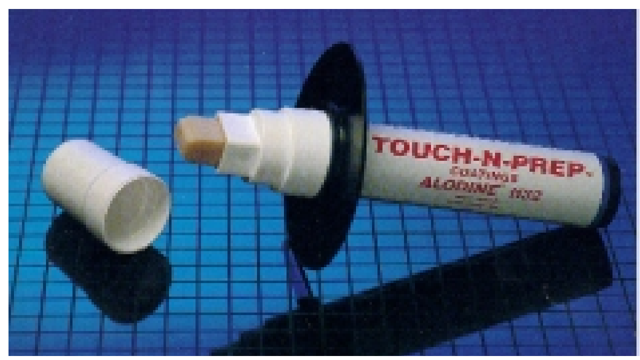
A conversion coating is applied to aluminum alloys to increase their corrosion resistance, improve paint adhesion, and reduce electrical contact resistance. The conversion coating solution contains chromic acid, which is a hazardous material, and proprietary additives. When this solution is applied to aluminum, it converts the oxide on aluminum to a chromium/aluminum oxide with the enhanced properties mentioned above. There are two important military specifications that are used for specifying conversion coatings. MIL-C-81706 controls the conversion coating material and MIL-C-5541 controls the process to apply conversion coatings on aluminum.

During manufacture of aircraft parts, conversion coating is applied to aluminum parts by dipping them in large tanks containing the conversion coating solution. The conversion coating can also be sprayed onto the aluminum. After one to three minutes the parts are rinsed and dried and the conversion coated aluminum is now ready for painting or other surface treatments.

This is acceptable for bare detail parts that can fit in tanks and spray cabinets, but what happens when the aluminum part is on the aircraft and needs a conversion coating touch-up application? There are numerous situations during aircraft manufacturing, maintenance or deployment that would require the use of a touch-up conversion coating. Some of these situations include: establishing an electrical ground on the aircraft during assembly, repairing minor damage received during flight, or maybe repairing minor corrosion on older aircraft. In all of these situations, the aluminum needs to have the recommended level of corrosion resistance restored by re-applying the conversion coating. This is accomplished by applying a touch-up conversion coating which requires the conversion coating solution to be brushed onto the surface of the aluminum that is being repaired.

The brush process is tedious and hazardous because it requires the person doing the repair to keep the aluminum surface wet with conversion coating solution for two to three minutes (which is even more difficult if the area is located overhead). Care must be taken to prevent the chromic-acid-containing conversion coating solution from dripping onto other areas and the worker. Excess conversion coating solution must be rinsed off and the rinse water blotted up. The brushes and cloths used must be disposed of in special hazardous material containers because they now contain a chromium compound.

Boeing commercial and military aircraft programs are working together to improve this process by implementing a new pen application touch-up method. The Touch-N-Prep pen is manufactured by the Henkel Corporation (formerly Parker-Amchem) of Madison Heights, MI; and consists of a special felt tip marker that contains the Alodine 1132 conversion coating solution.



Alodine Touch-up Pen

Application of touch-up conversion coating with the Touch-N-Prep pen is very easy. After the aluminum is cleaned and deoxidized (which was also required for the brush method) the conversion coating is applied with the Touch-N-Prep felt tip pen. The coating is thinly applied (drips and puddles are not permitted). It's allowed to dry in place (no rinsing) and a second coat may be applied for enhanced corrosion resistance if desired. That's it – no brushes to dispose of, no rinse water to blot, and no dripping conversion coating problem. This new touch-up process definitely saves time and money. Even though the Alodine 1132 in the Touch-N-Prep pen still contains a chromic acid solution, the pen application method significantly limits worker exposure and reduces hazardous waste.

Preparation for Paint Touch-up

Boeing Commercial Aircraft currently allows the use of Touch-N-Prep pens (see BAC 5719, PSD 6-120). The US Air Force has just recently changed their Tech Manual for corrosion repair (TO 1-1-8) to allow Touch-N-Prep, and the US Navy is in the process of doing the same for their Tech Manual on corrosion repair (NAVAIR 01-1A-509). The F/A-18E/F program is also planning to change their finish specification to allow the use of Touch-N-Prep pens during assembly operations. In addition, work is underway to add Touch-N-Prep (Alodine 1132) to MIL-C-81706. However, until this is done, Touch-N-Prep can only be used on military programs that specifically permit its use.

The Touch-N-Prep pen is a good alternative to reduce chromium exposure and waste, but this is only an interim solution. The final solution is a non-chrome conversion coating method. There is a lot of research going on at The Boeing Company and other aerospace companies to look for non-chrome conversion coatings, but that's another story.

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EMERGING PAINT STRIPPING TECHNOLOGIES

Removing paint, whether on a detail part or on an assembly, is a process required during both the manufacture and maintenance of aircraft structures. Regardless of the type of structure being stripped, the methods used can generate undesirable side effects that may be hazardous to worker health and the environment. For example, two of the most frequently used methods can be hazardous in different ways. Chemical paint strippers containing methylene chloride (MeCl) have traditionally been used to strip paint from a variety of surfaces. It is fast, effective, and an exempted Volatile Organic Compound (VOC), but it remains a Hazardous Air Pollutant (HAP) and its Permissible Exposure Limit (PEL) is regulated by a OSHA standard. In addition, waste streams generated from the use of MeCl are difficult to handle and expensive to remove. Mechanical sanding is also a common method of removing paint from surfaces. However, the dust plume emitted from sanding operations on many aircraft coatings can produce hazardous chromium and crystalline silica dust.

Emerging paint stripping alternatives are addressing the current limitations of traditional methods. The ongoing research and development at The Boeing Company is looking at improving the current technology from both evolutionary as well as revolutionary approaches. Evolutionary approaches include replacing MeCl strippers with non-hazardous (non-HAP) chemical strippers, capturing emissions inherent in mechanical sanding, and improving media blasting technology. Revolutionary paint stripping techniques include the FLASHJET® Process, the hand-held laser and a hot liquid nitrogen blasting process.

Non-HAP paint strippers such as benzyl alcohol have replaced MeCl strippers in recent years. Although these non-HAP strippers are better for the environment and the worker than MeCl strippers, there are performance disadvantages. These strippers tend to be much slower, requiring dwell times ranging from two to 16 hours (in some cases they never work) versus the 15-20 minutes required for traditional MeCl strippers. New research is looking to improve the effectiveness by evaluating chemical strippers containing N-methylpyrrolidone (NMP), hydrogen peroxide, or formic acid.

Vacuum-Assisted Sanding Operation

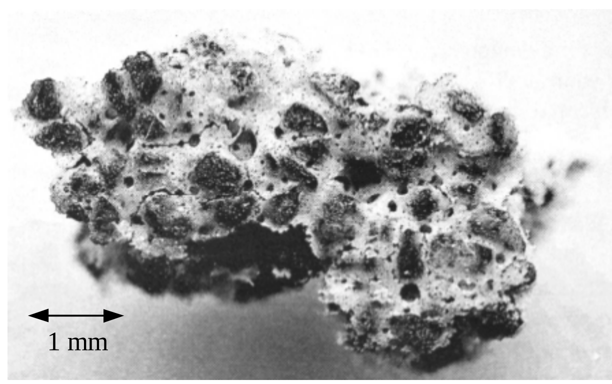
Vacuum-assisted mechanical sanding is one of the most economical and practical methods to control hazardous waste emissions and attain efficient paint removal. Mechanical sanders fitted with vacuum ports collect most of the dust in a HEPA type vacuum filter and worker exposure to sanding dust is significantly reduced. In addition, surface clean-up time is reduced. Boeing St. Louis Process Specifications that require mechanical sanding are starting to transition to vacuum-assisted sanding. This is not to say that vacuum sanding is a cure-all to paint removal problems, PPE is still required. Mechanical sanders have the potential to damage surfaces through abrasion and cannot necessarily be used in every instance. Tight corners can prevent sander access and the addition of more hoses and vacuums can require a rethinking of logistics on large areas. However, overall, vacuum sanding is a viable alternative for reducing hazardous waste exposure over previous methods.

Dry Media Blasting Process

Dry media blasting processes are constantly evolving, as newer blast media materials become available for paint stripping. Plastic media blasting (PMB) and wheat starch blasting methods have been in use for years to remove paint and the emerging improvements are in the details of the blasting media materials used. The principal media materials under evaluation and development include cornstarch, engineered media such as nano-composites, and, the newest of the group, Sponge-Jet. The stripping mechanism of each dry media blasting process is the same - paint is removed by the abrasive action and impact energy of the media projected under direct pressure. Depending on the type of media and blasting parameters used, paint is removed aggressively or slowly. Dry media blasting processes produce a waste stream of spent media and paint debris that may contain chromium and crystalline silica that must be contained and disposed of as hazardous waste.

Cornstarch blasting media is an improvement over the widely used wheat starch media. The cornstarch media is more durable, allows for faster stripping rates with only minimal additional risk to the underlying substrate, and is also biodegradable. In addition it is not as susceptible to moisture absorption as the wheat starch. However, it too produces dust and requires that the removed paint and spent media be contained and disposed of properly.

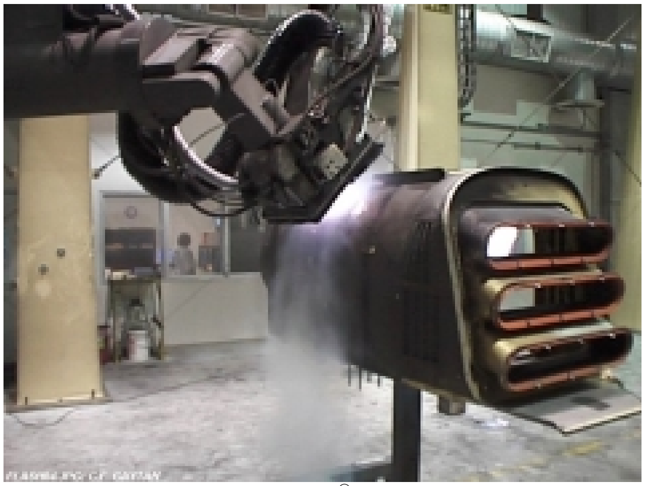
Engineered media such as nano-composites are presently being developed as alternatives to starch media. Depending on the media chosen, strip rates can increase with little risk to substrates. The media is more durable and can be recycled for other purposes including plastic hard goods. However, it is not biodegradable. Although these engineered media generate substantially less dust than the existing starch media, they still must be disposed of with care knowing that the plastic material will not decay.



Photomicrograph of Sponge Media

Sponge-Jet borders on a revolutionary change in thought in the paint removal industry. In the Sponge-Jet process, grit such as aluminum oxide or plastic media is embedded and cured into a polyurethane sponge material and subsequently chopped into a range of "blowable" sizes. Sponge-Jet blasting can utilize the same mechanical systems as traditional media blasting technologies with only minor alterations and can be tailored to the application needed. Sponges can be chosen that selectively strip different types of paints, remove sealants and even clean surfaces in hard to reach areas such as fuel tanks and cargo bays. Unlike other blasting media processes, the Sponge-Jet process is nearly dust-less. This is due to a difference in the impact energy of the media as it contacts the surface. Rather than impacting the paint and bouncing off to produce airborne dust, the sponge material distributes the energy of the impact over a wider area and abrades the surface. A high degree of control can be maintained to selectively remove only targeted layers, with less airborne contaminates. Material can be collected and reused as in other systems but clean-up is easier since there is virtually no dust and media tends to stay locally around the area being worked. This system does suffer from the same material disposal difficulties as other blasting systems, but represents a level of improvement previously not attainable.

There has also been developments within paint stripping technology that could only be considered revolutionary. They represent the efforts of thinking outside traditional lines and have resulted in some processes with potentially large savings in time and cost as well as an increase in worker safety. Such revolutionary processes include the FLASHJET Process, laser stripping and hot liquid nitrogen blasting.



FLASHJET® Process

The FLASHJET Process combines two previously marginal processes into an automated paint stripping system. The Boeing-developed FLASHJET System utilizes a xenon flashlamp simultaneously with a low-pressure carbon dioxide pellet stream to remove thin layers of paint from aircraft surfaces. The flashlamp chars a thin layer of paint and the frozen carbon dioxide pellets keeps the substrate cool and sweeps the ash away into an effluent capture system, where the residue is captured by HEPA filters. This system has been sold internationally for military use and is currently being evaluated for commercial airline use.

Improvements in the field of lasers have carried over into the paint stripping world with the development of hand held lasers that specialize in removing paint in extremely difficult locations, such as on landing gear or in bays that the FLASHJET Process or mechanical sanding cannot reach. Lasers do not leave an extraneous debris trail of media that processes such a media blasting produce. Lasers ablate the outer paint surface producing ash that can be easily removed to allow for repainting. They can remove paint from fasteners and around odd shapes relatively well. With a variety of laser types to choose from such as NdYAG and pulsed lasers, there are a variety of solutions possible that can be tailored to a particular application.

Hot liquid nitrogen is being evaluated and has been shown to remove paint without some of the byproducts associated with media blasting and MeCl paint strippers. The nitrogen process uses liquid nitrogen that is passed through an intensifier and then warmed slightly before passing through a nozzle to the coating and substrate. The nitrogen impinges the coating surface as a liquid and then turns to a gas (change in volume of 1:750). This process explodes the coatings or sealant from the substrate. The process adds no additional media wastes because the nitrogen is returned to the atmosphere. However, this process is not compatible with composite substrates because it will explode the composites just like the coatings or sealants.

Human exposure factors, regulations, and disposal costs have all contributed to changes in paint stripping technology. Attention is now being focused on developing improved and completely new methods that address these concerns. Economic factors have played a role to lower stripping costs that reap benefits in production as well as life cycle costs. The direction of development at The Boeing Company has taken multiple paths but can generally be put into two basic categories - evolutionary change and revolutionary change. Regardless of the method of paint stripping used there are many emerging alternatives that represent an improvement in existing technology. Although no method completely eliminates all the hazardous elements it is clear that substantial progress has been, and continues to be made.

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