PAINT STRIPPING AND REMOVAL METHODS

A review of the risks associated with different paint stripping technologies

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PAINT STRIPPING

The number and variety of components that require a painted coating to finish them is a commonly understood issue across industry and attracts many providers to offer different solutions in the field of paint application, curing, surface preparation and maintenance of paint related equipment.

By comparison the challenge posed by paint stripping and removal is often little more than an afterthought; and yet it stands to reason that if a paint coating is being applied at some point during the product lifecycle it may also need to be removed.

The difficulties faced in removing paint can often result in a heavily manual and labour intensive process that requires a physical method (such as blasting) to strip the paint.

The alternative to this for many is a set of hazardous chemicals that increase risks to operators and require a great deal of management time to ensure safe working practices are adhered to at all times.

This paper seeks to explore the alternative methods of paint removal available outlining their relative strengths and weaknesses and introducing potential opportunities to address the challenges faced when using the traditional methods of paint removal.

Traditional paint stripping technologies can be separated into two major subsets: mechanical or chemical. Both methods can be very effective, however with ever increasing awareness of the risks posed to operators by hazardous chemicals and the ever increasing control of substances from supply to waste disposal, what alternative technologies exist to enable companies to reduce their risk whilst maintaining productivity and quality on a consistent basis?
Chemical Methods

Caustic Strippers
These are amongst the most common immersion stripping techniques and typically are a water based solution, often containing sodium hydroxide or potassium hydroxide, operating at a pH of between 13 and 14. The high pH of the un-diluted chemistry can pose significant risks in to the safety of operators, not least in relation to potential chemical burns.

Alongside the health and safety issues there are a number of risks related to material compatibility that operators also need to be alert to.

To increase their effectiveness alkaline strippers are often heated to relatively high temperatures (80 to 90°C) which poses another risk in terms of potential scalding due to the presence of very hot liquid. In some applications, parts are dipped into a bath at approximately 150°C, which can remove certain coatings only; for example, this type of hot caustic stripping is not always effective on epoxies.

Furthermore, great care must be taken over which metals are placed in the bath; caustic paint stripping chemicals are only suitable for steel components. Paint stripping with alkali chemistry should generally only be used with steel components because these chemistries are incompatible for use on components containing metals such as aluminium, magnesium, copper, tin and zinc. For use with such components, solutions must be inhibited with sodium or potassium silicates, which in turn could leave white staining that can adversely affect repainting operations.

Alkali stripping usually leaves some residual paint and may need some additional manual abrasion afterwards meaning it can combine chemical and mechanical processes and their inherent risks to materials and operators.
Solvents

Historically paint stripping was carried out using methylene chloride (dichloromethane, DCM) but this process is now restricted in Europe through REACH due to the reclassification of methylene chloride and is now banned across the EU in relation to supply to the consumer market and professional users.\(^1\)

Whilst very effective, this chlorinated solvent chemistry has a number of severe health and safety related concerns. Exposure to high concentrations may result in unconsciousness, pulmonary oedema, respiratory failure and even death.\(^2\)

The ban distinguishes between three distinct classifications of use, the definition of each is given as follows:

- **Industrial Installation** - use in a facility undertaking paint stripping activities
- **Professional** - use by any persons including workers and self-employed where paint stripping activity takes place outside of an industrial installation
- **Consumer** - use by the general public

The use of methylene chloride has been banned through REACH in all of the above circumstances with the exception of Industrial Installations where in order for it to be used there are specific conditions that must be met including:

1. Effective ventilation in all process areas
2. Control measures to prevent and minimise the potential for evaporation from stripping tanks, and suitable loading and unloading arrangements
3. Implementation of safe handling methods to include preventing operator exposure in as far as is possible, such as pumps and pipework and removal of waste
4. Full PPE that is compliant to the European Directive
5. An appropriate level of training and instruction for operators prior to using equipment or the chemical so as to ensure correct operation and safety
6. Clear CLP identification of substances containing methylene chloride that the product is "Restricted to industrial use and to professionals approved in certain EU Member States — verify where use is allowed."

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\(^1\) [https://echa.europa.eu/documents/10162/0ea58491-bb76-4a47-b1d2-36faa1e0f290](https://echa.europa.eu/documents/10162/0ea58491-bb76-4a47-b1d2-36faa1e0f290)

\(^2\) [https://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_o_118.pdf](https://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_o_118.pdf)

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Physical Methods

Blasting
Multitudes of abrasive materials have been used to strip paint. These have included sand, glass bead media, and aluminium oxide to more exotic materials such as walnut shells. As harder materials are abrasive by nature, softer materials are also used for the removal of paint on more sensitive components, particularly in the aeronautical industry.

Plastic Media Blasting (PMB) uses small plastic balls or pellets, which can be recycled. There are concerns regarding the use of PMB because it can mask stress cracks in aircraft. It can be used to strip other items such as vehicles, ships, and motor engine parts. Similarly, sodium bicarbonate can be used as a paint stripper and has an advantage over PMB, as it will not mask stress cracks; however, its alkaline nature may cause some long term corrosion issues with aluminium.

Immersion Stripping with Abrasion
This is carried out in fluidised beds using compressed air, which is passed into the base of a tank containing quartz sand or aluminium oxide, making it fluid. Natural gas is mixed with the air and ignited creating bed temperatures of approximately 450 to 500°C.

Components or objects being stripped are lowered into the bed in a basket or on jigs and the paint is vaporised. The waste gases and any unburned natural gas are burnt in a post-combustion chamber sited above the tank. Wet scrubbers or similar devices are used to remove solids from the exhaust gases before it is vented to atmosphere.

This method is highly energy intensive and can only be used for steel components due to the high temperatures involved and is not suitable for other materials.

Molten salt baths operate at slightly lower temperatures (300 to 400°C) and are effective at stripping steel components, where the chances of distortion are greatly reduced. This technology can be used with aluminium components, but great care must be taken as exposure for more than 60 seconds can lead to unacceptable distortion.

As with fluidised bed stripping, objects being stripped are lowered into the bath and immersed into the molten salts before being removed and rinsed with water, dilute acid and then a final water rinse.

There are several disadvantages with this type of technology primarily related to energy consumption and the hazardous environment caused by the presence of the molten salts and the wastes created as a result of the process.
Manual Abrasion
On occasion, a simple method of removing paint is physically scrubbing and scraping to remove the coating, however this can be extremely labour intensive and requires a significant investment in time, and therefore this is rarely used by any business with a significant volume of work to complete.

Thermal Stripping
Significant changes in temperature can be used to facilitate paint removal either through the introduction of heat or via a cryogenic process. There are challenges faced by both methods that can mean neither is the best available technique for many applications.

Ovens can be used to simply burn paint off through the introduction of elevated temperatures, known as pyrolysis. This can only be used for steel and it can generate toxic gases and is energy inefficient.

Cryogenic stripping requires objects to be either immersed in or sprayed with liquid nitrogen causing a rapid decrease in temperature that leads to the paint contracting more than the metal, causing it to crack and peel off.

Whilst this appears simple, the process does have its limitations; cryogenic stripping does not work with polyurethane or epoxy coatings and cryogenic techniques can distort lighter or thinner metals and alloys due the rapid change in temperature.

In some sectors, temperature control is a critical process metric to ensure that the component is not deformed or altered in any way.

HOW CAN I AVOID HIGH LABOUR COSTS AND H&S CONCERNS IN PAINT STRIPPING?

For some companies the current solution has been to outsource the paint stripping activity to a local sub-contractor. Whilst this may prevent the need for hazardous chemicals to be present on their own site, it does not help remove them from the supply chain altogether and with customers requiring increasing visibility and transparency in the entire supply chain, subcontracting does not provide a solution, it merely passes the problems and difficulties on.

Sub-contracting does have some logistical challenges too, as often there will be a minimum order quantity or process volume to be met before goods are stripped. This can lead to inventory increasing and lead times to final customers being exaggerated as components will be stored until the critical mass is achieved for them to be transported off site to a 3rd party.

Even in transport, there are additional risks of damage to the components or objects which can cause customer satisfaction and/or quality issues too.
Waterborne chemical paint stripping

There is an effective method of removing paint whilst also avoiding the hazards of more traditional methods and retaining the ability to complete the work in house; to the required timescales and quality to ensure customer satisfaction is reliant purely on in house capability and capacity.

One potential solution is a blend of alcohol, water and an alkalinity booster. It may appear surprising that benzyl alcohol and water combine to create such an effective stripper. Benzyl alcohol on its own is only partially effective, so a common assumption may be that by diluting it with water the performance would at best remain consistent; however, the opposite is true if an appropriate method of application is selected too.

The chemistry is not a universal paint stripper and there are some coatings that it cannot remove. However it is ideal for removal of many types of common paints, including polyurethane, acrylic, lacquers, epoxy based paints and electro-coated paints.

The role of the alkalinity booster is to give some corrosion protection on some metal substrates such as mild steel or aluminium components; this means that it is compatible with most common metals if used at the correct concentration and applied appropriately.

Dilution rates of the mixture thresholds impact on the potential hazardous classification of the solution; for example if working solution is used at a dilution of 12.5%, then it is not classified as hazardous under CLP. For this reason alone, a consistent preparation of the working solution is a must; and ongoing top up can be done with premixed fluid to ensure continued compliance and optimised performance allowing the maximum benefit to be realised in terms of productivity gains.

It is more than just the right chemistry that is needed for waterborne paint strippers to work effectively, the appropriate equipment or machine will also be needed to apply the paint stripping technology to the component. To be at its most effective the equipment should be heated; a fully insulated tank will also minimise energy consumption. Moving parts should be kept to a minimum in order to avoid them becoming clogged by paint removed from components.

To ensure paint stripping reliability, the heating method should also be considered; heating elements are prone to clog up and will become less effective and fail sooner than anticipated due to the build of loose paint on the element itself.

In use, the fluid should be agitated to ensure that the solution remains homogeneous to retain the cleaning performance. Additionally the equipment should be closable to help reduce evaporation and to maintain the effective fluid lifetime.
SUMMARY

Paint stripping is a complex task that requires some technical awareness to ensure that compatibility of the chosen solution and the substrate material are addressed, to mitigate the risks of damage during the removal process.

Whilst it is a challenge it is one that does not need to involve overly labour intensive processes, or require the need for hazardous materials to be used exposing operators to unnecessary risks.

With the correct combination of equipment and chemical the paint removal process can become self-contained, virtually operator free and utilise a non-hazardous chemistry. In conclusion, it is possible to deliver outstanding productivity, consistent quality and compliance with health and safety responsibilities without it costing the earth; it just needs familiarity with the options available.

CONTACT US

For more information on our services and solutions please feel free to visit www.safetykleen.eu, call +44 (0) 1909 519300 or email skuk@safetykleen.eu

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