Tech Article

Vapor Degreasing: A Triple Threat to Contaminant

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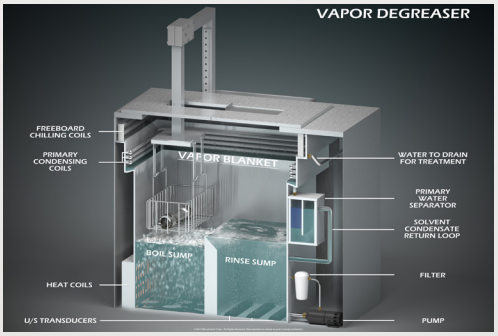

Vapor degreasing uses solvent immersion, combined with vapor rinsing and drying to remove all types of contaminant.

In the world of vapor degreasing, there are three types of solvent degreasing systems. Mono-solvent cleaning, azeotrope cleaning and co-solvent /bi-solvent cleaning. Of them all, bi-solvent cleaning is perhaps the most complex but also the most powerful. We'll explain what each method is and how to use them. We will also look at how to make the right choice when it comes to your critical cleaning.

Vapor Degreasing – The Ins and Outs

Let us first understand exactly what vapor degreasing is. Vapor degreasing is an industrial cleaning process for precision parts. It uses solvent immersion, combined with vapor rinsing and drying to remove all types of contaminant. This includes oil, grease, wax, flux and particulate.

The concept is very simple. A vapor degreaser is a closed-loop system consisting of a top-loading steel vessel composed of two chambers, both filled with solvent. In one chamber, the solvent heats to a boil, which then generates a vapor cloud that rises to meet two sets of cooling coils. These cooling coils cause the vapors to condense and return to their liquid state. This liquid then channels back to the rinse chamber.

A hoist lowers a basket containing the contaminated parts through the vapors and into the boil sump first. The basket lowers into the rinse sump containing the clean solvent that has been condensed from the vapors. This process is easily programmable and allows for excellent process control and repeat-ability. The parts come out clean, dry, and immediately ready for packaging or further processing.

It has only been in the past decade or so that leading companies have commercialized new, environmentally-acceptable cleaning chemicals suitable for vapor degreasing. This means that the speed, convenience and energy savings of this proven technology is easily available to engineers everywhere.

Know Your Cleaning Type

So now we understand the basics behind the vapor degreasing system, how do we know what cleaning chemistry to use? Vapor or solvent degreasing fluids fall into three main types; mono-solvent, azeotrope and co-solvent /bi-solvent cleaning.

Mono-solvent

As its name suggests, a mono-solvent cleaning contains only one component and is usually the most cost-effective option because it is easier to manufacture. Its 'one component' composition can be beneficial as the operator does not need to monitor solvent concentrations or worry about what solution to add into their vapor degreaser.

Notably, because the composition remains consistent it can clean in both liquid and vapor phase making it a practical option. However, its cleaning abilities are limited and some of the most common mono-solvents today can have flammability or toxicity issues. N-Propyl bromide (nPB), trichloroethylene and perchloroethylene (PERC) are some of the most popular mono-solvents and they can all contribute to safety and environmental issues.

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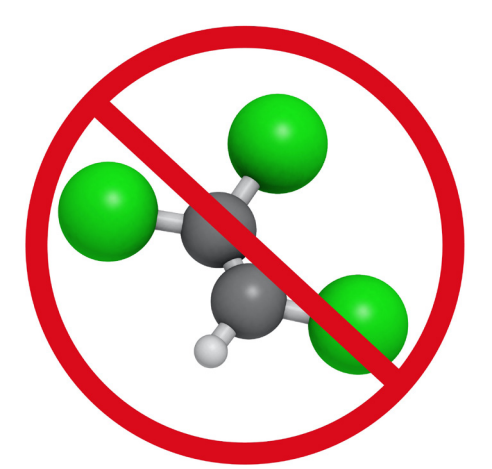

Trichloroethylene (TCE) is one of the most popular mono-solvents that can negatively impact air quality.

Although mono-solvents can be relatively aggressive in cleaning strength, they are best used for machining oils and lubricants consisting of hydrocarbon components. Higher boiling mono-solvents melt waxes and other high-boiling contaminants. Monosolvents work well on metals; however, it is important to monitor the process for acid acceptance if using one of the less stable (chlorinated) mono-solvents.

Azeotrope

Azeotropes are blends of two or more components, when mixed together behave as if they were one chemical. Azeotropes deliver the benefits of a mixture of different elements with the convenient handling and storage of a single compound. They form a very stable mixture which remains together in the liquid and vapor phase so that the structure stays the same throughout a vapor degreasing system.

Azeotropes use distillation rather than trapping contamination using filters and membranes and so can be re-purified while the contamination is ‘locked’ into the liquid at the bottom of the vapor degreasing machine.

They also have the advantage of incorporating ingredients, which when paired together, clean well and embrace all the ‘appropriate’ benefits required for cleaning. For example, flammable and non-flammable ingredients can be combined to produce a stable non-flammable mixture, an important feature when it comes to safety. This makes cleaning processes simpler, safer and more reliable.

Azeotropes can be modified to obtain bespoke physical properties making the blends useful across a broad range of applications and on a wide variety, or combination, of organic, inorganic and particulate contaminants. This means it works well on most substrates and fluorinated azeotropes, with the added benefit of not requiring acid monitoring.

Because they are tailored to the contamination, azeotropic mixes clean much faster than some mono-solvents. This can reduce the cleaning cycle time by as much as 75% increasing productivity.

Environmental Benefits

With many organizations like the U.S. Environmental Protection Agency considering measures to reduce and restrict the uses of substances containing nPB, PERC and trichloroethylene due to safety concerns, azeotropic cleaners are coming into their own as a replacement. Because they are custom blended, chemicals like nPB are eliminated giving them much better toxicity profiles.

Although azeotropes cost more per pound than mono-solvents, they are still extremely competitive and have the advantage of comprising safer, more stable chemistries which outweigh any cost implications. Additionally, training and process optimization can make cleaning with azeotropes more efficient and cost-effective than mono-solvent cleaning.

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Contaminants vary from machining oils, metal fines, fluxes and inks to greases, fingerprints and waxes.

Co-solvent/Bi-solvent

These are the most complex, but also the most powerful cleaners used within a vapor degreaser. These systems use a non-volatile cleaner in combination with a volatile rinsing solution. Most of the cleaning happens in the non-volatile cleaner. It is then rinsed off by the volatile fluid. The benefit of these systems is that the non-volatile cleaner is adjusted and modified to fit the specific cleaning needs. Occasionally a contamination cannot be managed by a mono-solvent or azeotrope due to material compatibility issues, throughput problems or environmental regulations. To be able to find a substance with the required cleaning power and without the use of ingredients under regulatory restriction or with solvent-sensitivity issues, a co-solvent may be the answer. It is formulated to meet specific safety needs, for example, making it non-chlorinated or VOC-free.

There are a few downsides to co-solvent cleaning, however. The most obvious being the requirement for a separate cleaning tank. It cannot be used in a one-sump vapor degreaser, or with vapor-only cleaning. This means a reduction in throughput from an extra cleaning cycle.

It also requires monitoring to ensure concentrations of each component are correct. This necessitates extra training to guarantee that the correct additions happen to the system when necessary.

What a co-solvent system can give you in return is the ability to remove difficult soils, which often require high temperatures. It delivers almost the same convenience and speed of traditional solvent cleaning but increases this cleaning with a second chemical providing the additional cleaning ‘horsepower’ that the application may require.

Which Method is Best?

Production Machining is a diverse manufacturing sector requiring a wide variety of cleaning needs. The contaminant will also vary from machining oils, metal fines and marking inks to greases, fingerprints and waxes. To successfully remove the contaminant, use specific cleaning fluids to displace soils and leave parts clean and dry.

The cleaning method will always depend on an individual problem. A properly designed, operated and maintained vapor degreaser is the very best and least-expensive cleaning choice for most industrial applications. However, there are a lot of factors that need to be considered to achieve the best result.

Understanding the specific contamination and the part and time limitations will help in deciding the best process to use. To ensure a method will work correctly, it is essential to test first. Experience and expertise are helpful in optimizing and developing cleaning cycles that will best suit a specific job, so it is important to consult with a vendor who can test and provide cleaning solutions to meet requirements.

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About the Author:
Venesia Hurtubise is a Technical Chemist at MicroCare which offers precision cleaning solutions. She has been in the industry more than 6 years and holds a MS in Green Chemistry from Imperial College. Hurtubise researches, develops and tests cleaning-related products that are used on a daily basis in precision cleaning and medical applications.
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