Maximize Profits and Productivity by Avoiding Inflexible Cleaning Processes

By Mike Jones, MicroCare Corporation, with Sally Stone

Critical cleaning processes are found in many industries from electronics to telecommunications to aerospace and medical devices, and they all require different degrees of 'clean'. But one common characteristic that defines "critical cleaning" is the recognition that if the cleaning is not done properly the product simply will not function reliably for the required life of the product. *If the cost of a cleaning failure is high, then it's a mission-critical application.*

But the landscape for cleaning processes has become more challenging. As a general trend across many industries, components are getting smaller, capabilities are getting greater, and tolerances are getting tighter. To pick just one example: the first disk drives on IBM personal computers held 10 megabytes of data. Today, terabyte capabilities are the norm. That's a *one million percent* increase in capacity in just thirty years. And as anybody in the hard disk drive industry will tell you, today's cleaning processes are ever-more critical.

Aqueous cleaning is defined by the inherent limitations of the water molecule. In most cases, the most common answer to get better cleaning is to add more power: lots of heat and bigger pumps. This is a fundamental limitation of the water molecule, and makes it challenging to clean complex shapes or fragile devices.

Users of modern cleaning systems need to constantly improve their cleaning processes while juggling product upgrades, cost reductions and aggressive competition. If that's not tricky enough, there are further restrictions due to environmental concerns, new regulatory requirements and pressures for a healthy workplace. So it becomes clear that these three conflicting trends — the continued miniaturisation of components with the concomitant increase in performance; the unflagging need to protect people and the environment; and

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the economic drivers of reducing costs while boosting quality — combined make any cleaning decision difficult.

Which brings us to the key question: how do you adapt critical cleaning processes when some outside force — a technology change, a regulatory change, a competitive threat or whatever — mandates a change from your current techniques?

Be Ready to Adapt

Like open-heart surgery, implementing change in a living, breathing factory is never easy. Regardless of the cause, it is never going to be simple. But change is coming. Today most companies use water-based processes for the bulk of their cleaning applications but a number of factors suggest water cleaning is looking like an increasingly troubled proposition and solvent cleaning seems to be the future-forward choice.

Why? Because in an increasingly dynamic and complicated market the “prime directive” must be to select the most flexible, versatile option. Life isn’t going to get easier; change is not going away. Versatility should be prized above all else, and flexible technologies embraced. Rigid manufacturing processes, however smart they may have been at the time of purchase, lock a factory into fixed answers. A factory may be the leader with today’s products for today’s customers, but when change hits it will be the small and nimble competitors that will survive. So vapour degreasing is a choice you should consider because it is the “small and nimble” critical cleaning option.

Photo, left: Complex shapes are a challenge for aqueous cleaners. If the water is applied to the parts with sufficient energy to get into the tight spaces, it often becomes trapped and difficult to remove. In contrast, vapour degreasing (left) easily cleans complex shapes and assembled parts, even inside blind vias. The solvent evaporates from the parts inside the machine before they are removed from the cleaning system. The parts come out clean, dry, and near room temperature.

Many companies have renewed their interest in the benefits of vapour degreasing. In the electronics industry, cleaning ever-denser chip configurations make cleaning very difficult. In medical and pharmaceutical applications there is strong pressure to greatly minimize bioburden issues. In the hard disk drive industry, hydrocarbon contamination is being driven down to levels considered impossible a decade ago. Every player in these advanced industries knows that better cleaning makes for better, faster and more reliable products.

Vapour degreasing is a simple process that uses sophisticated, “low-boiling” chemistry to remove contamination. These are closed-loop systems and recycling is inherent in the process. Vapour degreasers are small, fast, highly cost-effective and — most importantly — extremely flexible.

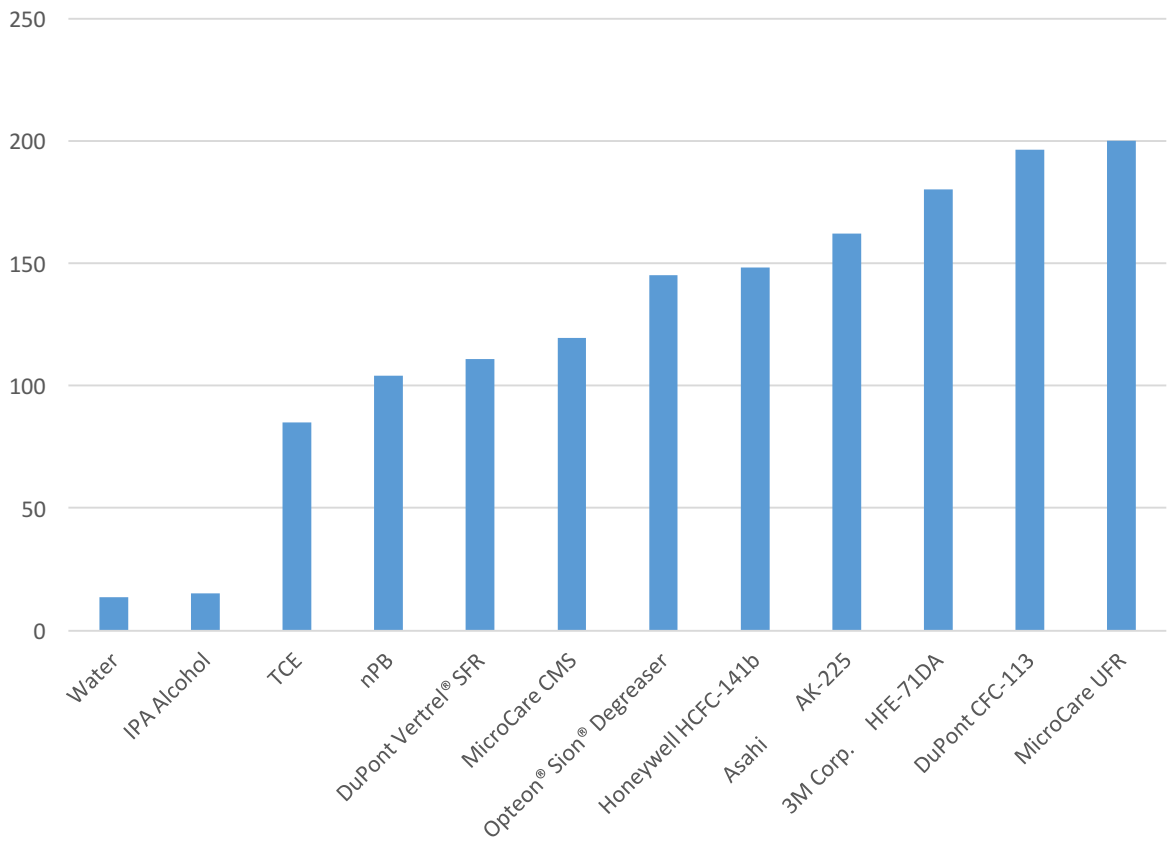
The concept behind vapour degreasing is simple. The system boils a cleaning liquid into a vapour, contains the vapours inside the system, cools the vapours back into a liquid, and collects this purified liquid for re-use. The cleaning fluid boils at a low temperature (usually slightly above room temperature) so it takes very little electricity.

Low-boiling solvents have multiple chemical properties that are advantageous to critical cleaning. For example, they usually have a very low surface tension and a very low viscosity, so the fluids easily clean even the tightest of spaces and under the smallest of parts. Most vapour degreasing fluids also are very heavy and dense, typically 20-40% heavier than water, which aids in dislodging particulate from the components. Because the solvent is engineered for the application delicate parts are easily cleaned and dried. It is possible to combine all these factors into a “wetting index” that permits apple-to-apple comparisons. (See Chart 1)

Vapour degreasing systems usually work vertically, with the rinsing and drying processes taking place above the cleaning tanks. This consumes very little floor space and cuts energy usage. This can be a substantial cost savings for the company leasing the space and paying the utility bills.

Chart 1: Wetting Indices Compared

A “wetting Index” is a measure of a fluid’s ability to clean complex shapes. Water has a very poor wetting index, which is a function of its inherent molecular structure. Modern solvents do a much better job cleaning small, delicate or intricate shapes. For details about the mathematics behind a wetting index, contact MicroCare.



Vapour degreasing systems can be extremely cost-effective because the solvent is re-used indefinitely. In effect, each vapour degreaser is a recycling system. Reusing the solvent is the heart and soul of how the machine works. This is in bright contrast with the “pump and dump” processes of many water-based cleaners.

There are more than a dozen manufacturers of vapour degreasers world-wide. Numerous equipment options make vapour degreasing even simpler and faster. The solvent tanks can be fitted with filtration systems to remove insoluble contamination (particulate). Another option is for the system to be fitted with ultrasonics to enhance cleaning. Automated hoists free technicians from the tedium of lifting parts in and out of the system. “Super heat” and external distillation are other money-saving, performance-enhancing choices. Depending on the application and process requirements, the technology exists to handle the largest parts and highest volumes. These machines, when properly designed, equipped and configured, out-perform the cleaning efficiency of any other cleaning technology.

Aqueous Allure

The most common alternative to solvent cleaning is to use water. Water cleaning is not, on the face of it, a bad idea. Even today for non-critical applications it can work quite nicely because water cleaning uses the kinetic energy of pumps and sprays to “power-wash” contamination from surfaces. Intuitively, water also seems like it would be an environmentally-friendly option. However, there are a number of reasons why the advantages do not always materialize as expected.

Every aqueous system needs heat to clean. While it takes 8,340 BTUs to boil a gallon of water it takes only 1,000 BTUs to boil a gallon of solvent. So, as a general rule, aqueous cleaners will consume eight times more energy than a vapour degreaser cleaning the same quantity of parts. Here’s the rub: the burning of fossil fuels to generate all that electricity is one of the primary sources of global warming.

Photo, left: Water has a very high surface tension. Here, a cactus plant capitalizes on this inherent characteristic of water to trap rain water. This same behaviour makes it difficult for water to clean in small parts or tight spaces

Another issue is the difficulty of miniature parts. Small, delicate parts can be a challenge to clean in a rough-and-tumble aqueous system. Plus, because of the nature of the water molecule, water often cannot get into the tightest spaces or smallest apertures. This mean those hard-to-reach locations are not wetted and so they are not cleaned; see Chart 1 to compare the wetting index of water to a grab-bag of popular solvents. Filtration is problematic with water-based

cleaning systems as well, because water does not easily traverse 2 or 3 micron filters. The only way to deliver micron-grade filtration is with big, energy-hungry pumps to force the water through the filter.

Drying is another complexity. After water cleaning, drying requires additional steps and additional energy (heaters, blowers and air knives). If bacterial growth is a problem, the process controls required to eliminate bioburden add significantly to the complexity and costs of an aqueous cleaner.

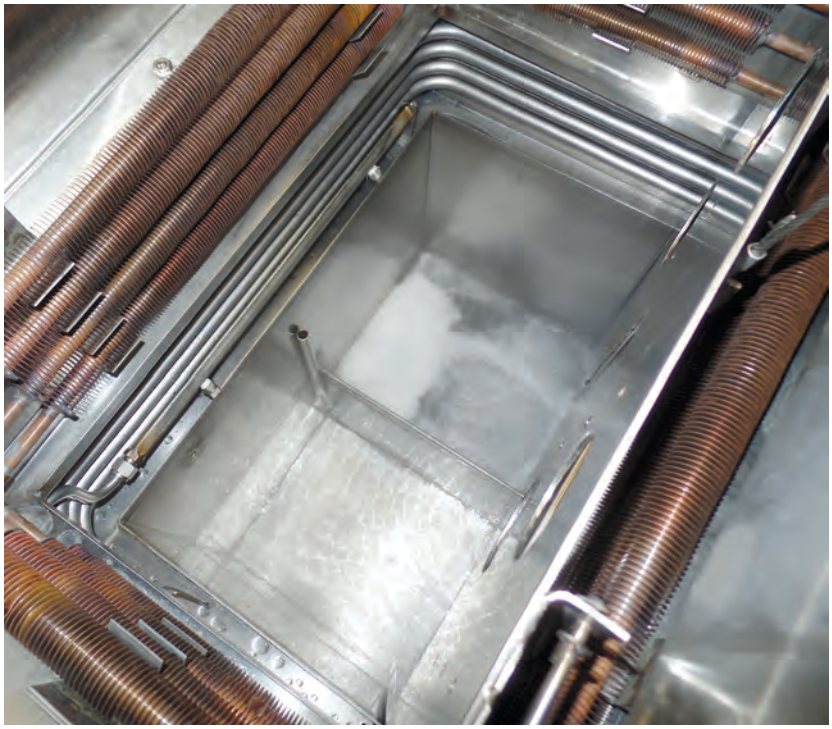
In terms of waste treatment, most aqueous systems require pre-treatment of their incoming water, which uses more electricity. Aqueous systems also produce a waste stream that requires treatment before discharge, further exacerbating the electrical issue. Lastly, aqueous systems add humidity and heat to the rooms in which they operate, placing a burden on the air conditioning system of the facility and increasing energy consumption.

Aqueous cleaning processes usually operate horizontally so the systems have a large footprint, require more overall space and using more electricity.

Selection Guidelines

Advances in solvent technology are pouring onto the market. Chemours (the new Dupont spin-off), 3M, Honeywell, MicroCare, Solvay and others all are commercializing environmentally innovative cleaning fluids that perform very well. In fact, many companies are rediscovering that a properly configured vapour degreaser using these new fluids can be very gentle on the planet and yet deliver consistent and reliable cleaning, often with the lowest overall costs.

Cleaning systems are a “bet your business” decision, or at least a “bet your career” decision. It is essential that the decision be based on a thorough understanding of the inputs and outputs. The first and most important input is the contamination.



Photo, left: Vapour degreasing capitalizes on the fascinating and unusual chemical characteristics of the cleaning solvent rather than fighting against them. This photo shows a small, two-tank degreaser; the primary cleaning “sump” is at the top of the photo and the rinse sump is towards the lower portion.

The fluid boils at about 40˚C — cool enough to touch — and after cleaning parts are moved into the rinse tank. Notice the two sets of condensing coils around the upper portion of the machine. The lower coils retain the solvent vapors in the machine while the upper coils keep humidity out.

Engineers need to completely understand source, characteristics and behaviour of the contamination they are trying to remove. For example, traditional rosin fluxes used on circuit boards require very different cleaning chemistries than today's new lead-free fluxes and pastes.

Companies today make it easy to test new cleaning fluids. These tests usually involve collecting a standardized sample of contaminated parts and sending them to the chemical company's lab. They will suggest the optimal cleaning process. Any quality vendor should be willing and able to perform a modest amount of testing. The vendor should provide a detailed written report and often will perform these services free of charge.

It goes without saying, but I'll say it anyway: decisions involving chemistry, equipment and processes all need to be made concurrently. *These decisions cannot be made separately*. Trying to fix a cleaning process after an inappropriate selection will be daunting, slow and expensive. The chemistry, equipment and processes must all be harmonized together like instruments in an orchestra.

Summary

Three significant trends are at work across most industries: the continued miniaturisation of components, the need to protect people and the environment, and the need to minimise production costs while boosting quality. To adapt to this changing world, the most versatile, flexible, low-risk option that meets all the critical cleaning requirements is solvent cleaning using a vapour degreasing process.

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About the Author—

Michael Jones, Vice President of MicroCare Corporation, has more than 25 years of experience in precision cleaning and technical applications. He is extensively involved in new product development and has directly supported customers within the Aerospace, Military, Electronics and Medical Industries using a wide variety of cleaning processes.

Sally Stone is a free-lance technical writer and public relations expert at Hart Marketing. She has enjoyed a lengthy career explaining complicated topics in easy-to-understand technical articles, across a wide variety of industries and technologies.

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About MicroCare Corporation—

MicroCare Corporation is the leading manufacturer of cost-effective, environmentally progressive chemical products for precision cleaning, coating and lubrication.

Since 1983, MicroCare has been helping customers to improve their products and processes. MicroCare supplies to a wide variety of industries as diverse as electronics, metal finishing, transportation, photonics, medical devices and aerospace, MicroCare is a catalyst for change, lowering costs and improving quality. MicroCare is continually expanding and developing its innovative range of products ensuring it is the favoured choice globally.

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