Tech Article

Cost Effective Cleaning with Vapor Degreasing

Author:
John Hoffman, Technical Consultant for MicroCare

Industries:
Electronics, Manufacturing, Medical Device, Aerospace & Defense, Automotive

Published:
Finishing Today Magazine

MicroCare™

In the finishing industry today, the most common cleaning system is based on water technology. Since the move away from the two most common vapor degreasing solvents (CFC113 and 1-1-1-trichloroethane) over the past decade due to suspected ozone depletion, aqueous cleaning has become a tried-and-true process. But aqueous cleaning systems tend to have large footprints, require a significant capital investment and guzzle electricity at a prodigious rate. Plus, they are maintenance intensive, and require processed water and wastewater treatment systems. Most young engineers feel these constraints are locked in stone, but there is another cleaning option. One from the history books. If you're willing to go "back to the future," it's time to revisit vapor degreasing.

Vapor Degreasing Concepts

To a certain degree, the term "vapor degreasing" is a misnomer. Certainly it is possible to clean in the solvent "blanket" of vapors, with the solvent vapors condensing to liquid on the part. But for faster, more reliable cleaning in the vapor degreaser, immerse the parts into the liquid solvent. There, liquid surrounds the part and enters all of the nooks and crannies to maximize solvent contact and cleanliness.

The Concept Behind Vapor Degreasing Is Simple

A vapor degreaser boils a liquid into a vapor, contains the vapors, and cools the vapors back into a liquid. It then collects this purified liquid for continuous use. The machine is not only a cleaner system than the conventional degreasers used in the past, it is also a continuously recycling system.

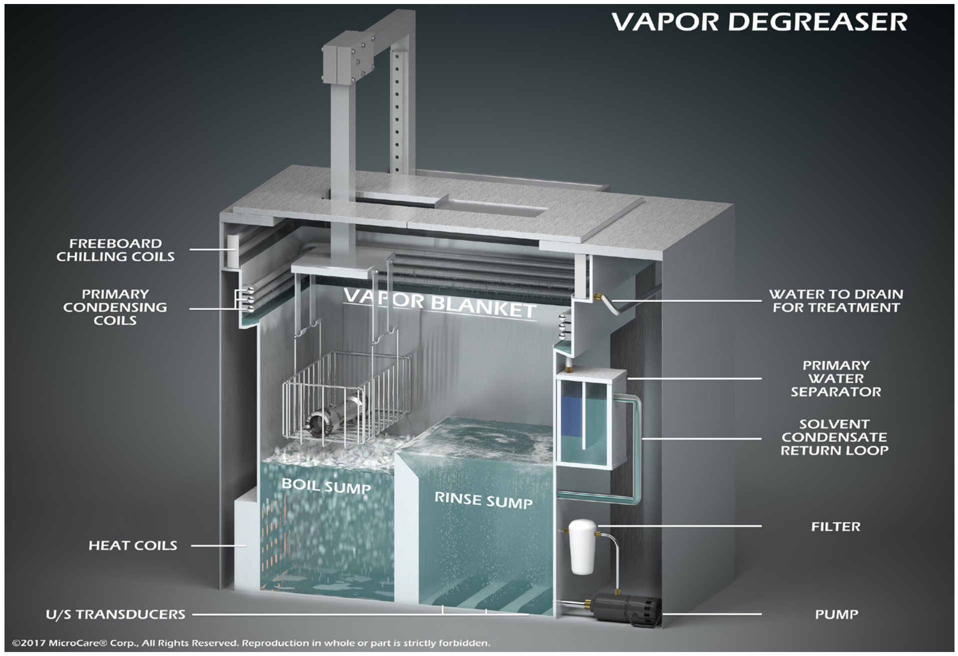
The solvent in the "boil" sump heats to its boiling point, usually 100-170°F (38-77°C). The heat can be provided with electric heating elements, hot water coils, steam coils or the heat from a "heat pump" refrigeration unit.

It's noteworthy that even a small water-cleaning system will consume considerably more energy in heating the cleaning solution than a vapor degreaser of comparable capacity. The higher energy consumption occurs because water has a much higher specific heat and a much higher latent heat of vaporization than vapor degreasing solvents. This fundamental characteristic of water also explains why it takes so many BTUs to dry the parts after they have been dried in an aqueous system. In contrast, some small vapor degreasing systems operate on 120 volt power supplies.

Vapor Cleaning

Once boiling, the solvent produces a clear, dense vapor that rises through the machine, displacing the air in the degreaser. Eventually the vapors rise up and reach the lower set of cold coils called the "primary condensing coils". These coils chill the solvent vapors and condense the solvent back into its liquid state. This liquid drips into a condensate trough that is under the primary condensing coils and around the interior circumference of the machine. There it routes through a water separator, decanting any water that may have condensed on the condensing coils and removing it from the solvent.

A two-sump vapor degreaser includes a boil and rinse chamber.



The inner workings of a vapor degreaser are simple, making them cost-effective.

At this point, the distilled solvent is directed back into the rinse sump from the water separator. Since the rinse sump is already filled with clean solvent, the addition of clean, newly distilled solvent will cause the sump to overflow into the boil sump, completing the distillation cycle. The addition of this fresh, pure solvent maintains a consistently clean rinse sump. It also allows contamination and particulate to be washed back into the boil sump and concentrated there.

Equipment Considerations

Numerous options are available that make the vapor degreasing process even simpler, cleaner and faster. The rinse sump is usually fitted with a circulating filtration system to remove insoluble contamination (particulate). Another common option is for the rinse sump to be fitted with ultrasonic transducers to enhance cleaning. Automated hoists can free up technicians from lifting parts in and out of the system while also ensuring that the proper cycle time and part movement takes place which can lead to reduced solvent use and more consistent cleaning.

Secondary Freeboard Chillers

Another important feature of modern vapor degreasers is a second set of cooling coils. They are located above the primary condensing coils. Called “freeboard chillers,” these coils are always colder than the primary condensers, usually around -20°F (-29°C). Their purpose is to lower the temperature and humidity of the air above the vapor blanket to minimize solvent diffusion from the saturated vapor blanket into the air, thereby minimizing solvent losses.

In addition, since the freeboard chillers dehumidify the area above the vapor blanket, minimal water will be condensed on the primary condensing coils, which helps maintain solvent integrity. Note that the freeboard chiller coils don’t contain the solvent blanket in the degreaser. That’s the job of the primary condensing coils. If the vapor blanket ever rises above the primary condensing coils into the area of the freeboard chiller coils, there is something wrong with the primary condensing coils and a refrigeration technician should be consulted.

Modern cleaning fluids help make vapor degreasing environmentally acceptable.

Superheated Coils

Lastly, another option in the degreaser is the installation of “superheated” coils. These coils superheat the vapor blanket above the “normal” boiling point of the solvent. This superheated vapor quickly heats the freshly cleaned parts and ensures that all the condensed solvent on the parts is vaporized and recovered under the vapor blanket. This process guarantees that the parts are dry before being removed from the system, which minimizes solvent dragout and solvent consumption.

Choosing a Degreaser

There are more than a dozen manufacturers of vapor degreasers in the U.S., and several dozen more worldwide. Depending on the cleaning application and process requirements, the technology exists to handle the largest parts and highest volumes. These large machines, when properly designed, operated and maintained, can be extremely efficient with minimal solvent consumption.

Cost Comparison

Despite the historically proven performance advantages of vapor degreasers, many engineers worry about the operating costs of these systems. After all, water is basically free, while ozone-safe solvents cost $1,500-$10,000 per drum. Can vapor degreasers truly be cheaper to run than water cleaning systems?

The best way to evaluate the operating costs of different types of cleaning systems is to compare them on a cost-per-part-cleaned basis. This approach provides an apples-to-apples comparison that can illuminate the hidden costs of water cleaning.

Acquisition and Installation

First, tabulate the acquisition and installation costs. Included among these are the direct capital costs of the cleaning system (the hardware itself, plus the support systems, wastewater treatment systems, and so on). Plus, the indirect capital costs (the floor space, upgrades to the facility’s electrical system, plumbing costs, etc.).

Operating Costs

The next step is to estimate the direct operating costs for both systems. This estimate includes the solvent and water costs and energy costs. Plus, labor costs, waste disposal costs and inventory costs that change due to faster or slower cleaning cycles. Engineers also will need to take into account the personnel time needed to operate and maintain the cleaning equipment. Vapor degreasers typically are almost maintenance-free; aqueous systems can be much more complex and time-consuming.

Solvent Cost

Then there is the solvent cost. While the solvent selection process is beyond the scope of this article, evaluating the cost of the solvent is simple. The proper way to estimate solvent costs is not to compare the cost per pound. But to compare the cost per part cleaned. For example, a modern vapor degreaser will use approximately 0.062 lb of solvent/hr/ft2 of solvent/air interface when in use. A typical 10-gallon degreaser has about 2.5 ft of solvent/air interface. So, it will lose about 1.25 lb of solvent (less than one cup) in an eight-hour work day. If the solvent price is roughly $3/lb, the solvent cost for a day of cleaning is under $4. And the cost-per-part, assuming 1,000 parts were cleaned that day, is $0.00372 per part.

MicroCare™

Tech Article

When these costs are tabulated and then divided by the total number of parts cleaned by the system, the true cost of cleaning becomes apparent.

Economical, Environmentally Acceptable Cleaning

For decades, the vapor degreasing process has proven to be the most consistent and "headache-free" cleaning process for manufacturing engineers. Vapor degreasing has come full cycle, and many engineers have realized that it is a safe, economical and environmentally acceptable cleaning method. Energy demands and new environmental concerns are generating an increased interest in the vapor degreasing process. If a current aqueous cleaning system is reaching the end of its life cycle, now is the time to explore vapor degreasing as an alternative in your manufacturing plant.

To obtain the desired results in the most economical and environmentally acceptable manner, it is imperative that the degreaser system be properly configured, operated and maintained. In addition to the hardware issues, the proper solvent selection requires careful analysis, and that selection depends on the contamination being removed. When analyzing the application, always define the impurities first, then select the chemistry that removes those impurities, as well as the equipment that uses the chosen solvent properly.

It is clear that the vapor degreasing concept is being revitalized. In today's world, where quality, reliability and energy efficiency are paramount, the old process of vapor degreasing deserves another look. It is a modern, planet-friendly and cost-effective cleaning process.

About the Author:

John Hoffman, Technical Consultant for MicroCare, has specialized in the field of critical cleaning for more than 50 years. He holds a BS in Chemistry from Rutgers, Philadelphia College of Textiles and Science (now Jefferson University). Hoffman helps companies update their critical cleaning processes to improve productivity and boost quality in a safe, and environmentally-acceptable manner. He is an expert on vapor degreasing, modern cleaning fluid technologies and thermodynamics. For more information, visit www.microcare.com.