Tech Article

Reduce Energy Costs with Vapor Degreasing

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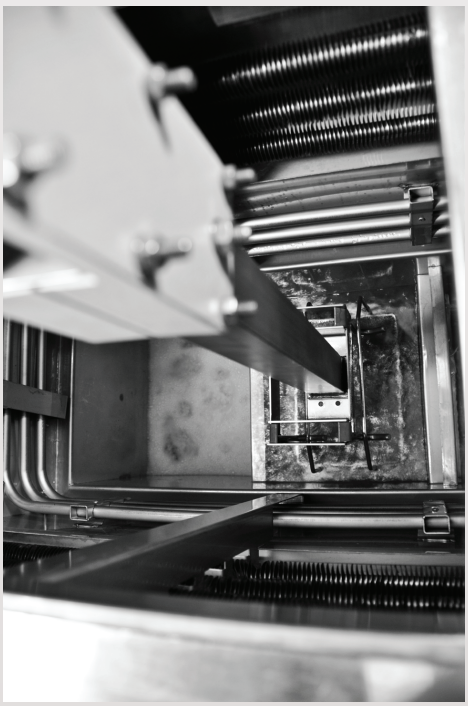

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In the world of precision cleaning, there are four common process choices for engineers. Hydrocarbon cleaning, aqueous cleaning, semi-aqueous cleaning, and solvent cleaning with vapor degreasers. Each method has its strengths and weaknesses, but one of the most environmentally acceptable choices for critical cleaning is vapor degreasing with modern specialty fluids. This is particularly true when energy consumption and costs are compared. The vast majority of atmospheric emissions in the world today come from the burning of fossil fuels, and much of that pollution is generated producing electricity. Using electricity conservatively helps decrease global warming protecting both the planet and your budget.

Energy Costs are Rising

The fact is, all energy costs are rising. However, electricity has been expensive historically and only getting more so. Another issue is capacity. Cold winters or geopolitical turmoil can generate energy crisis, and rolling black outs have been inflicted on companies during times of insufficient capacity.

Vapor degreasing is an option that can dramatically reduce a company's energy budget devoted to cleaning processes.

Vapor Degreasing Chemistries

Today, many companies sell modern, environmentally-acceptable cleaning solvents suitable for vapor degreasing. This means that the speed, convenience and energy savings of this proven technology is available to engineers everywhere.

Unlike aqueous or hydrocarbon cleaning, vapor degreasing requires special fluids with a unique combination of characteristics. Developing fluids with all of these characteristics was not easy.

Ideally, these cleaners should:

- be nonflammable
- be immiscible with water
- have an appropriate Kari-butanol (Kb) value
- have a high density
- feature a low surface tension
- be low viscosity
- have a low specific heat
- feature a low latent heat of vaporization

Impacting Cleaning Performance

Four of these characteristics affect cleaning performance. The high density, the low surface tension and low viscosity all ensure the solvent will wet every surface, getting into (and out of) tiny nooks and apertures. As the old adage goes: if you can't wet, you can't clean. The Kb value scales the strength of the fluid, and ensures it will have the power to dissolve any contamination. But it is the low specific heat and a low latent heat of vaporization that are the primary reasons a vapor degreaser is significantly more energy-efficient than other technologies.

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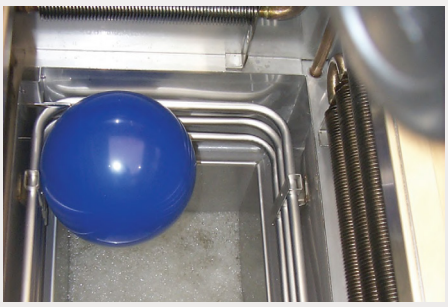
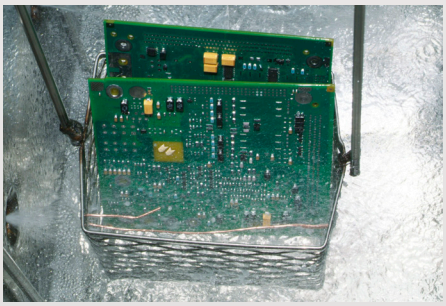


The invisible vapor of the cleaning fluid is heavier than air and is trapped inside the machine. Here, a balloon has been placed inside the system and is resting on top of the entrapped vapor. As the warm vapor touches the cooler balloon, the vapor condenses back into liquid form and drips off the bottom of the balloon. The faint line around the equator of the balloon is the air-vapor boundary



In a normal cleaning cycle, the boards are placed in a basket and lowered into the cleaning fluids. The boiling fluid churns and provides sufficient agitation for normal processes. In this system, solvent sprays and ultrasonic are used to deliver even higher levels of cleaning performance.

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Vapor Degreasing is More Energy Efficient

Vapor degreasing is more energy efficient than water for two reasons. They stem from the chemical properties of water itself. The inherent characteristics of water render it very difficult to use and to remove efficiently from complex surfaces.

The term “specific heat” defines the amount of heat required to raise the temperature of a unit mass by one degree Celsius (1°C, metric). The specific heat of water is very high. The specific heat for water is 4.186 joule/gram °C, which is four times higher than the popular MicroCare fluorinated fluids.

After cleaning, all systems need to remove the cleaning fluid from the surface of the parts. Once a liquid begins to change phase – that is, change from a liquid into vapor – specific heat is no longer used. The proper statistic to measure the energy required to evaporate a fluid is “the latent heat of vaporization.” Therein lies the issue: it takes a great deal of energy to evaporate water.

Water requires 970.4 BTU/pound of energy to vaporize one pound of liquid. In contrast, only 58.8 BTU for an equal weight, and the popular MicroCare cleaning fluids require 67.1 BTU/ pound. This means it will take roughly 14 times more electricity to evaporate a pound of water than to vaporize a pound of solvent.

Vapor Degreasing is Less Expensive Cleaning

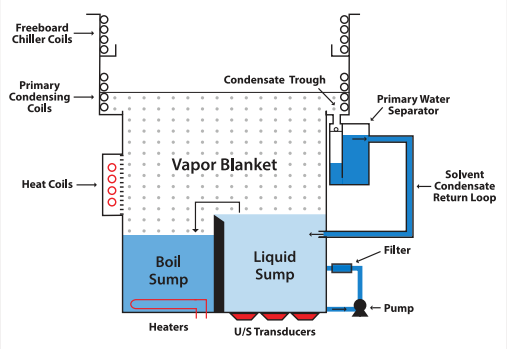
Most aqueous cleaner machines are horizontal designs which use hoists or conveyors to move the parts through a series of dip tanks. A typical aqueous batch system has one wash tank and between two to five reverse-flow, cascading rinse tanks that require 2-5 gallons/minute of deionized water. Aqueous cleaner machines are typically 50-150% larger than vapor degreasers of the same capacity, simply because of the need for more tanks, larger pumps, blowers, filters and so on. Normally, these machines consume about 8-10kWh of electricity. Most aqueous cleaning systems have three or more tanks with ultrasonic excitation, adding another 1-2kWh of consumption. Also, aqueous system cleaning cycles tend to last 20-40 minutes. Most vapor degreasers clean in 5-12 minute cycles, reducing energy costs and work-in-process inventory.

Removing Excess Water

Removing excess water from parts is challenging because of the chemical nature of water. Evaporating excess water with heat is relatively slow and expensive, so the most common drying option is the use of an “air knife.” A typical aqueous system can easily consume 5kWh at the drying stations, or twice that on a bigger machine simply because of the increased size of the motors, fans and compressors. Ultimately, for final drying, heated air knives are often necessary–compounding the energy consumption problem.

No Water Treatment Required with Vapor Degreasing

Water pre-treatment and post-treatment systems also use large quantities of electricity. Once the water is deionized, it is usually heated to 60-70°C for the cleaning process which requires at least 2-3kWh of power or more for the pumps and support equipment. On the back-end, assuming the system needs to process five gallons of waste water a minute, even the most frugal waste water system is going to need 3-5kWh.



Basic overview of vapor degreaser operations.

Stand-By Power Draw

One last consideration is the stand-by power draw. At many companies the aqueous cleaners are never shut down because of the cost of coming up to temperature and the delay in re-heating. These idle systems will use 2-5kWh of electricity at a minimum, hour after hour, even when no cleaning operations are being conducted.

A Real-World Example

A Branson 1620 aqueous system with modest cleaning capacity costs around $87,000. It has four sumps and is almost 5m long, twice as large as an equivalent vapor degreaser. It uses 17kW during start-up and 12kW/hour during use, plus ultrasonic stimulation, operating at 60°C. The total system will use approximately 25kWh/hour.

Aqueous cleaning machines also add heat to the surrounding environment which increases the load on the air conditioning system. The Branson 1620 will add nearly 300,000 BTU/ hour of heat to the room it is operating in plus approximately 15 pounds of water (roughly 7 liters) into the air every hour, which will need to be removed by the HVAC system. Vapor degreasers using common solvents make a minimal contribution to room heat.

Doing the Numbers

It's clear that the fundamental chemical characteristics of water make it inevitable that aqueous cleaning consumes far more kilowatt-hours to clean as the systems need to purify the water, clean the parts, dry the parts and then re-treat the water after cleaning. A general rule-of-thumb is that any aqueous cleaning system will use ten times the energy of a vapor degreaser of comparable capacity. Even a small facility will save a minimum of $300/month in direct energy costs by switching to vapor degreasing.

A general rule-of-thumb is that an aqueous cleaning system will use approximately ten times the energy of a vapor degreaser of comparable capacity. As substantial as those numbers are, many companies find the cost savings to be even greater. For example, a long-term US-based aqueous user, was able to document such massive savings by switching to vapor cleaning, the local electrical utility provided a grant that funded 100% of the purchase of the new cleaning hardware.

This is Just the Beginning

This is just the beginning. Other savings, from faster throughput to higher yields and fewer defects all contribute to ever greater profitability. In a nutshell: with energy costs rising and the availability of adequate water supplies becoming a global concern, it makes sense to make the move to energy-efficient solvent cleaning.

About the Author:
Mike Jones, retired Vice President of International Sales for MicroCare, has over 30 years of experience in the critical cleaning industry. He is a prolific writer and educator focusing on critical cleaning in general and vapor degreasing and benchtop cleaning in particular. For more information, visit www.microcare.com.

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