SPECIAL SERIES: Parts Cleaning

Why Is Drying So Hard with Aqueous Cleaning Technology?

It's only water, so why does it take so long? . . .

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There are good reasons why aqueous cleaning technology does not provide fast, high-quality parts drying. The reasons relate to the differences in physical properties between water and other materials that do dry better.

Aqueous technology has become the most popular replacement technology for parts cleaning since the manufacture of ozone-depleting compounds (ODCs) was banned. My independent surveys suggest that in mid-1995 around three-fourths of those surveyed are converting to aqueous technology compared to two-thirds at this time in 1994.

Suppliers tout (correctly, in many cases) that the proper aqueous cleaning agent and process can improve cleaning beyond that obtained from ODCs. End users like it because of familiarity and perceived environmental security. Regulators like it for the latter reason. So users must love it after they have converted to it, right? Well, not necessarily so.

End users' most common concern is that parts drying is seen as poor. That perception is generally correct, however, parts drying can be improved with aqueous cleaning technology.

A Misconception. It is not that drying water from parts is slow, inefficient or of poor quality; it is that drying is perceived to be slow, inefficient or poorly done compared to drying done with ODCs. If we did not have the benchmark of parts drying with CFC-113 or methyl chloroform (1,1,1 trichloroethane), we would not be disappointed.

Drying water from parts works as it always has worked. It has always been difficult to dry water from intricate sections, and evaporating water

from metal surfaces has always left mineral deposits as cosmetic defects. It is not that aqueous cleaning technology has been oversold by its proponents; it is just that drying parts has not been mentioned because it was not an advantage of the technology.

The Perfect Drying Fluid. First decide how you want to dry parts. If you look in many dictionaries for synonyms for drying, the word evaporation is often given. So, parts drying is evaporating water from part surfaces. The perfect fluid for evaporative drying would have the characteristics shown in Table I. The table suggests the type of problems that occur when trying to dry water from parts, relative to production or maintenance lines designed for use with methyl chloroform. Some problems are as follows:

- Water will not evaporate quickly.
- Parts will have to be heated to the boiling point of water to transfer enough heat to provide the evaporation.
- Water will collect in complex sections. It will only be removed if parts are heated to the boiling point of water to vaporize the water.
- Drying loads will not be reduced as much because there will not be much liquid drainage from the parts.
- Parts may have mineral deposits as residue after the water evaporates.

How to deal with an imperfect fluid. Table II shows some actions that will enhance the drying of water. The actions are organized around the disadvantages shown in Table I.

Those who dry parts without taking these (or similar) actions will seek to improve parts drying by using what I call the "bigger hammer" theory. This means that they compensate for the natural problems of drying parts by increasing air flow and temperature. This adds energy costs, and means the parts will be quite hot at the completion of the process.

The question you have to ask about aqueous cleaning technology (or any technology) is whether or not its advantages outweigh the disadvantages. For many, the advantages do outweigh the disadvantages. But for others, who value both high-quality cleaning and high-quality drying, other processes should be considered (co-solvent, chlorinated solvent, CO2).

When you choose a parts cleaning process, you must learn to live with its virtues and faults. Some processes are better for those who value parts drying; some are better for those who highly value parts cleaning. Drying is the flaw of aqueous technology. This article has pointed out the reasons for this situation, and offered some suggestions that have been proven to improve the quality and timing of drying of parts. **PF**

TABLE I—The Perfect Drying Fluid

Characteristic of Prefect Drying Fluid	Physical Property Requirement	Value for Methyl Chloroform	Value for Water
Evaporate quickly	High vapor pressure at any temperatures	340 mm Hg @ 122F	95 mm Hg @ 122F
	High relative evaporation rate	3	0.21
Take little energy to evaporate	Low heat of evaporation	102 Btu/lb	970 Btu/lb
Films of it won't cling to complex surfaces	Low surface tension	28 dynes/cm	72 dynes/cm
It drains easily from surfaces	Lower viscosity for low frictional drag	0.79 cps	1.0 cps
	Higher density to enhance gravity force	1.33 g/cc	1.0 g/cc
It has no non-volatile residue	No dissolved salts	None	Does the phrase "hard water" have any meaning?

TABLE II—How to Enhance Drying of Water

Drying Problem	Methods of Overcoming Drying Problem	Reason for Use of Method
Doesn't evaporate quickly	Consider use of another wash fluid to remove the aqueous cleaning agent, possibility a combustible organic liquid.	This liquid will evaporate more rapid than water, but will add a VOC emission to the unit.
Takes lots of energy to evaporate	Decide what areas of the parts will be difficult to dry. Use second heater to overheat some of the air, and focus this air at the problem areas.	Only heat selected part areas as necessary to evaporate water on those areas.
Films of water cling to complex surfaces	Use focused high-velocity air jets to knock off films of water from the complex surfaces. Can be done by hand or automated.	Air velocity around 1,000 fps dislodges films of water, whereas a velocity of 100 fps evaporates some of the water.
Water doesn't drain easily from surfaces	Delay drying step for 30 to 90 sec. Use time to vibrate parts basket at 1-10 cycles/sec over rinse bath to maximize drainage.	It is much faster to "waste" 90 sec to drain the basket well, than to wait 5 min to vaporize the water of 10-15 min to heat the parts hot enough to vaporize the water.
Water has non-volatile residue	Rinse with mineral-free (deionized) water. This can add significant cost.	The evaporated water has no mineral residue.
	Use centrifugal dryer which doesn't dry parts by evaporation.	Water is "slung off" by centrifugal force, and the salts stay with the water.

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