The Dynamics of Switching to Aqueous

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In the past cleaning with solvents such as mineral spirits has been an important component of many maintenance operations yet today a number of these operations are moving toward the use aqueous based cleaners. There was a time when companies with cleaning functions could use any product and process they wanted. Today many states and local governments have imposed regulations that effectively limit the options available. Additionally, numerous companies have implemented self-imposed restrictions that are pushing their cleaning processes toward aqueous based systems. This ongoing revolution in government and industry requirements will continue to force more and more companies to consider changing their cleaning operations.

This paper will discuss various aspects associated with switching from solvent to aqueous cleaners. It will explore the impact such a change can have on the manufacturing process including equipment, cleaner and waste handling. It will also examine the effect this change may have on employees. Case histories, relating to companies who have made this switch, also will be presented.

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Introduction

The art of cleaning for automotive rebuilders and industrial manufacturers has dramatically change during the last decades of the twentieth century. In many cases, cleaners, equipment and processes have undergone a slow but steady metamorphous from predominately solvent-based systems to alternative cleaners. The primary reasons for this change are new environmental issues, government regulations and changes in corporate policies.

Everyday more stringent regulations are being put into place by various government entities and Corporate America. These requirements are forcing firms to identify, test and implement alternative systems for their cleaning processes. This can be a complex and expensive procedure for most companies. In fact just recognizing the first steps in the replacement process is beyond the capabilities of many small and moderate size operations. These companies must rely upon outside resources to identify and implement any required changes.

The following paper reviews the dynamics of the process that takes place when a company decides to change from solvent to an alternative product such as an aqueous cleaner.

Why Clean?

In order to successfully accomplish the transformation from solvent to a more environmentally friendly product a company must first understand why they need to clean. Cleaning is performed to accomplish several tasks. This usually involves the removal of dirt, oils, metal chips, lubricants, oxide films and other contaminants from a part. In many cases it is also a necessity for subsequent operations such as plating, painting or machining. In other cases it may occur simply for aesthetic reasons. In today's high tech environment there is also an increasing demand and emphasis on cleaning for quality improvement and to increase the reliability of critical components.

How Does Cleaning Work?

In general cleaning is defined as the removal of soil or unwanted material from a substrate to which it clings. This can be done via several ways including:

- *Mechanical Action* (spraying, brushing, abrading, etc.)
- *Dissolution* (soil dissolves)
- *Chemical Reaction* (chelation, saponification, etc.)

and
- *Detergency* (lifting the soil from the substrate).

Often combinations of these mechanisms are employed. This is dependent on the substrate involved, the nature of the soil and the degree of cleanliness required.

There are four basic parameters that can influence the cleaning process: time, agitation, chemistry (type & amount) and temperature.

Time: In industry, where time is money, it is important to minimize this parameter. However, in certain cases, time is one of the major factors that can be adjusted to assure maximum cleaning. Simply put the longer a soil is subjected to a cleaning process the more complete the removal.

Agitation: Depending on the process this attribute can influence the level of part cleanliness the most or the least. A wide range of agitation, from very gentle immersion baths to aggressive spray systems, is available on today's cleaning equipment. In general the greater the mechanical agitation the better (faster, more complete) the cleaning.

Chemistry: This factor encompasses a wide variety of alternatives relative to cleaner type and their level of use (concentration). In general different types of cleaner chemistries will work more or less effectively on various types of soils. For instance, an acid based aqueous cleaner will remove rust stains much more effectively than an aliphatic solvent. The amount of a cleaning component in the system can also affect performance. Overall the more of a cleaner the better the cleaning. However some products can reach a level of concentration where redeposition, corrosion or other problematic issues surface.

Temperature: Adjusting a cleaning bath's temperature up or down can dramatically affect the efficiency of a cleaner. Certain soils are more easily removed by cleaning ingredients at specific temperature ranges. Other characteristics of a cleaner (foam, corrosion, evaporation, stability, etc.) are also affected by temperature and thereby challenge the perceived performance of the cleaning process. It should be noted that worker hazards and energy costs also increase with temperature.

By varying one or more of the above parameters a company can easily explore and optimize their cleaning process. Systematic evaluation of these parameters can also be used in the screening of new cleaners and equipment.

Switching From Traditional Solvents

Large portions of the companies converting from solvents today are going to aqueous based cleaners. The main reason for this change is that aqueous cleaning can be performed in almost any application that was once considered the domain of cold solvent cleaning or vapor degreasing. Due to the availability of a wide variety of aqueous cleaners, some investigation is required to find the right cleaner and process for a particular application.

To-date, much of the delay by the manufacturing community in moving to cleaning alternatives can be traced to a reluctance to accept the idea of a not perfect change. For many, especially those with relatively difficult cleaning tasks, there is no perfect replacement. A certain amount of compromise is unavoidable. Even with this in mind, the average application can be easily addressed with existing technologies. The true challenge being the selection of the best alternative.

For most companies, the best course of action for choosing a suitable alternative is to work with a large, well-known and technically capable supplier of cleaners and equipment. Such vendors can aid the small and moderate size companies in making the appropriate product and process selections. Leading suppliers of this type typically offer their knowledge and expertise to customers free of charge.

Cleaner, Equipment and Waste

There is a plethora of products that can be used in today's cleaning processes as alternatives for ozone depleting cleaning solvents. The main categories for these cleaners are:

- *Aqueous*
- *Semi-Aqueous*
- *VOC Exempt Solvents*
- *Ionic Salts*

and • *Blast Media*.

All of these products have their unique place. Each alternative has its own advantages and disadvantages. To determine the best choice for an application, it is necessary to consider many questions. These questions include:

What soils are being cleaned?
What type of substrate is being cleaned?
How is the soil distributed over the part?
What is the size, shape and number of parts being processed?
What type of existing equipment will the cleaner be used in or is new equipment required?
Is the use area well ventilated?
What post-cleaning applications occur on the part?
What is the maximum/minimum processing temperature?
Does the product need to be recycled?
What are the local regulations regarding VOC and waste discharges?

Answering these and other related questions is the only way to identify the needs and requirements a company has to meet in choosing an alternative cleaner and process.

Identifying the right cleaning equipment is another critical factor in making a successful conversion from solvents. In most instances, the equipment utilized for solvent cleaning is not acceptable for use with an aqueous solution. This primarily due to compatibility and corrosion concerns.

Additionally, the equipment processing parameters required for efficient aqueous cleaning are very different. As discussed earlier, mechanical energy is a prime ingredient to getting soil removal. For difficult to remove soils, high-pressure sprays and ultrasonic baths may be required. Access to heat energy is also needed to increase bath cleaning efficiency and dry parts. Availability of a rinse option is often needed to meet cleanliness requirements or apply additional protection to parts.

Differences in aqueous waste minimization and disposal is another area that can impact a company converting from solvent. Solvent waste typically has a value since it can be recycle for reuse. Traditionally this is not true for aqueous products and as a result waste disposal costs can be very high. Most companies do utilize an assortment of waste minimization efforts such as oil skimmer/separators and water evaporators to reduce disposal costs. Today, new aqueous recycling technologies involving membrane filtration are becoming available. Studies have shown that this technology can prolong a aqueous bath's life significantly. As these new techniques are refined the cost of handling aqueous waste should decrease dramatically.

Companies also need to bring the plant employees into the planning and implementing stages of a conversion from solvent. Many times this aspect is overlooked until very late in a program. These individuals need to be given a comfort factor relative to how the change will effect their jobs. Aqueous systems look, smell, feel and perform differently than solvents. In some cases aqueous cleaning can be more labor intensive due to increased processing parameters such rinses and drying stages. The employees also need to become familiar with the operating parameters that can be modified to increase cleaning efficacy and resolve processing issues (flash rusting, spotting, residues, etc.). Remember if the employees are made part of the process they will learn to handle and minimize problems.

Case Studies

Case 1: A Midwest manufacturer of metal screws and attachments for the automotive industry needed to convert from vapor degreasing system.

Case 2: An Ohio manufacturer of wood finishes and paint additives needed to clean his processing equipment frequently. The current process required soaking in methylene chloride and then scrubbing away the residue.

References

1. M.S. Lunski & M. Endres, *Parts Cleaning*, Volume 2, p. 16-21 (February 1998).
2. J.D. Durkee, *The Parts Cleaning Handbook Without CFCs,* Gardner Publications Inc., Cincinati, OH, 1994.
3. M. Endres & S. Bolkan, *Proc CleanTech'99*, p.129-135.