BRANSON CLEANING NEWS #4

Technical Brief

CHOOSING THE RIGHT CLEANING CHEMISTRY

Factors to Consider

Selecting the best cleaning process is like putting a puzzle together with pieces that differ for each player. Several basic factors must be considered in deriving the best process, but differing weight is given to each factor according to what is most important for your production.

This technical brief will discuss factors that should be evaluated before the cleaning process is selected, and why. In some cases the decision already has been made to use aqueous or solvent cleaning equipment; then it is a matter of tailoring the chemistry to best meet the production requirements.

All precision cleaning is achieved with either aqueous or solvent-based chemistries. Although some adjustments to the process can be made, the two types of cleaning are not necessarily interchangeable. The cleaning operation will be completed with maximum efficiency only if the chemistry has a specific affinity for the soil. If it does not, even the addition of ultrasonics which usually enhances cleaning effectiveness while reducing chemical concentration, temperature, and process time, will not achieve sufficient cleaning.

The optimum process will balance technical, economical, and environmental needs.

Factors to consider include:

- Identification and characterization of soil.
- Identification of the substrate and importance of its surface condition to ultimate use of the part.
- Degree of cleanliness required.
- Facility capabilities.
- Environmental impact.
- Overall cost.

Selecting a Process: Aqueous, Semi-aqueous, or Solvent

Selection of a cleaning process is influenced mainly by the type of soil to be removed, the substrate, the required degree of cleanliness, the manufacturing process, and the cost. The size and shape of the workpieces seldom influence the type of cleaning chemistry used, but may determine the method of cleaning, such as ultrasonic cleaning, and the handling techniques employed.

Proper selection of the chemistry – aqueous, semi-aqueous, or solvent – is crucial to obtaining a clean part. Although the basic principles of chemistry provide a guide for determining the right cleaner, there are certainly many problems where the answer is of a more subtle nature. There is no absolute rule that can be used to select the right chemistry. But as a general rule of thumb, aqueous cleaners are best for inorganic soils, such as oxides, salts, and shop dust; and solvents are best for organic soils, such as grease, wax, and oils, with semi-aqueous transitions between the two types.

The **type of soils** to be removed obviously influences the choice of chemistry. Soil types may be broadly classified into several groups: (a) drawing compounds, (b) oil and grease, (c) chips and cutting fluids, (d) polishing and buffing compounds, (e) rust and scale, (f) soldering flux, or (g) miscellaneous surface contaminants, such as atmospheric soils and residues from mechanical inspection techniques. Desired cleaning is achieved when the chemistry has a specific affinity for the soil.

The **substrate** must also be considered because, for example, metals such as aluminum and magnesium are sensitive to attack by some chemicals. Corrosion-resistant steels, also referred to as stainless steels, have a high resistance to both acids and alkalies, but the degree of resistance depends on the alloying elements.

The **overall manufacturing process** also must be factored into the choice of cleaning process. Consider the step immediately before and after the cleaning. If the part is introduced to the cleaning station wet, then an aqueous solution probably will have to be used. Either alkaline solutions or solvents will take off buffing compounds and probably be compatible with the metal piece. However, if plating follows cleaning, then solvents should not be used due to solvent out-gassing during the plating procedure. Parts to be packaged following cleaning obviously will have to be dried first.

Precautions must be considered when cleaning steel parts which may rust. Chances are they won't rust in an ultrasonic bath because the degassing action of ultrasonics removes oxygen, but rusting may occur in the subsequent water rinse and drying. A small amount of rust inhibitor added to the rinse water or static immersion will leave a slight film on the part to prevent rusting.

Solvent Properties

Solvent cleaning is the dissolution of the contaminant by a liquid, such as organic solvents and chlorinated hydrocarbons. Solvents generally are grouped according to chemical composition and are non-ionizing liquids. They do not have the ability to form ions and their solutions will not conduct electricity. Solvents offer the advantage of high solubility for waxes, oils, greases, and many other organic materials. It is important that solvents contain stabilizers which will then provide the advantage of chemical neutrality and will not attack active metals such as aluminum and magnesium. Some solvents will corrode certain electronic plastic components at elevated temperatures and should be avoided in favor of low-boiling point solvents.

Semi-aqueous

Semi-aqueous cleaners are specialty mixtures composed of water-in-solvent emulsions. They are posed as alternatives to chlorinated solvents, particularly in the electronics and metal working industries. These types of cleaners are effective on rosin flux, adhesives, oils and grease, and water or solvent-soluble soils.

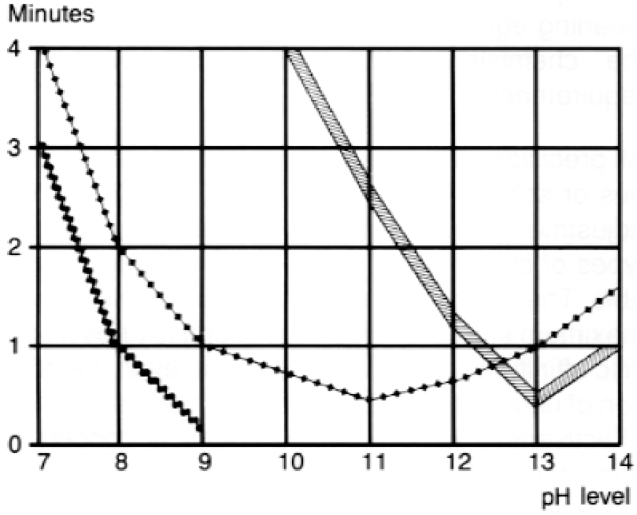
Aqueous Properties

The distinguishing feature of aqueous solutions is that they have the capacity to split the dissolving molecule into particles called ions. Each molecule will divide into an ion carrying a positive charge and an ion carrying a negative charge, so that the solution will conduct electricity.

Aqueous cleaners are classified according to pH or the degree of acidity or alkalinity of the cleaner. On a scale of zero to 14 with seven as neutral, less than seven denotes increasing acidity; numbers higher than seven designate increasing alkalinity (see Figure 1).

PH VS TIME

Effect on Cleaning



Three different detergents represented. Each cleaner exhibits max detergency in a certain pH range.

Figure 1

Aqueous cleaners contain combinations of ingredients such as surfactants, sequestering agents, saponifiers, emulsifiers, and chelators, as well as various forms of stabilizers and extenders. These ingredients are physically active and operate by reducing surface or interfacial tension, by formation of emulsions, and by suspension or flotation of insoluble particles.

AQUEOUS CHEMISTRY

	Typical Acidic Solution		Typical Alkaline Solution
Formula:	Citric acid, ammonia, nonylphenol ethoxylate, thiourea	Formula:	Sodium hydroxide, soda ash, alkaline salts & wetting agents
pH:	4.5	pH:	13.5
Uses:	Remove oxides from all metals, reactive compound from copper & copper alloy component	Uses:	Removal of carbonaceous soils, heat scale, rust, oils & grease *attacks reactive metals

If there are salts or inorganic residues on the parts, then aqueous chemistry is best. For scale, only acids will work. Whereas water will dissolve many inorganic soils not soluble in the non-ionizing solvents, it will not dissolve most greases and organic materials. However, water serves as a medium for carrying detergent compounds which will act on such soils because of their properties of wetting, emulsification, saponification, or deflocculation. Water also acts as the dispersal medium for oils and particles which it cannot dissolve, but will carry in suspension.

Advantages with using aqueous, or water-based, solutions are that they are excellent for inorganic soils, are readily available, and are excellent where drying is not a factor.

Summary

Analyzing the chemistry component of the cleaning puzzle helps us understand that a decision cannot be reached based on one factor alone. A complexity of interrelated factors must be considered to derive the most efficient, effective, and environmentally sound cleaning method. A logical and thorough study of the particular cleaning problem with consideration of all consequences should be performed before choosing between solvent, semiaqueous, or aqueous-based systems.

EXAMPLES

Here are examples of typical applications encountered in industry. Considerations for choosing solvent or aqueous chemistry are explored.

Removal of Pigmented Drawing Compounds

All pigmented drawing lubricants are difficult to remove from metal parts. Certain variables may further complicate the removal, such as higher temperatures resulting from increased drawing pressures which increase the adherence of some compounds. Elapsed time between the drawing and cleaning operations is also a significant factor; the longer the compound is allowed to dry, the more difficult it becomes to remove.

Acidic aqueous cleaners composed of detergents and phosphoric acid prove effective in removing pigmented compounds. A consistent, high degree of cleanliness can be attained.

Vapor degreasing with solvents is of limited value in removing these compounds. The initial solvent vapor will usually remove soluble portions of the soil, leaving a residue of dry pigment that may be even more difficult to remove by other cleaning processes.

Removal of Oil and Grease

Vapor degreasing using 1,1,1 trichloroethane is an effective and widely-used method for removing a wider variety of oils and grease. Repeatable and consistent results are attained because the solvent is constantly distilled and filtered. Vapor degreasing is particularly well adapted to cleaning oil-impregnated parts, such as bearings, and for removing solvent-soluble soils from their interiors.

Alkaline solutions are efficient and economical for removing oil and grease by saponification or emulsification, or both. Alkaline solutions will etch aluminum and other nonferrous metal parts unless inhibitors are used. Presence of alkaline solution in crevices may result in galvanic corrosion, and even traces of alkali will contaminate paint and phosphate coating systems; therefore, water rinsing must be extremely thorough.

Removal of Polishing and Buffing Compounds

Polishing and buffing compounds are difficult to remove because the soil they deposit is composed of burned-on grease, metallic soaps, waxes, and other vehicles that are contaminated with fine particles of metal and abrasive.

Aqueous emulsion cleaners are effective for removing all types of buffing and polishing compounds. Solution temperatures and emulsion concentrations must be closely selected for optimum soil removal. All emulsion cleaners must be followed by a thorough water rinse.

Vapor degreasing with solvent alcohol azeotropes is effective for most polishing compound removal. Cleaning with solvents will quickly remove most of the gross soil directly after buffing or polishing, and will easily remove tripoli and rouge. But solvents will not remove all types of polishing compounds. Effectiveness still will depend largely on the composition of the polishing compound and the selection of an appropriate polar solvent.

	AQUEOUS		***SEMI-AQUEOUS***
	Acidic*	***Alkaline****	
Pigmented Drawing Compounds	Excellent	Fair	Fair
Oil & Grease	Poor	Good (may etch aluminum)	Good
Chips & Cutting Fluids	Fair	Excellent	Good
Polishing & Buffing Compounds	Fair	Excellent	Good
Rust & Scale	Excellent	Good	Poor
Rosin Flux	Poor	Fair	Excellent

*Inhibited solutions for base metal protection.

For application assistance, contact your nearest Branson office or Branson's Cleaning Applications Laboratory at (203) 796-0522.

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