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GRACE METALWORKING FLUIDS
CLEANING HANDBOOK

CLEANING METHODS

Cleaning is defined as the removal of soil or unwanted matter from a surface to which it clings. The cleaning process can be accomplished by one or more of the following cleaning mechanisms:

**WETTING**
Through the use of surface active agents, the cleaning penetrates and loosens the substrate-soil bond by lowering surface and interfacial tension.

**EMULSIFICATION**
Once wetting occurs, two mutually-immiscible liquids are dispersed. Oil droplets are coated with a thin film of surfactant, therefore prevented from recombining and floating to the surface.

**SOLUBILIZATION**
The process by which the solubility of a substance is increased in a certain medium.

**SAPONIFICATION**
The reaction between any organic oil containing reactive fatty acids with free alkalies to form soaps.

\[
\text{Insoluble Fatty Acid + Alkali} = \text{Water Soluble}
\]

**DEFLOCCULATION**
The process of breaking the soil into very fine particles and dispersing them in the cleaning media. The soil is then maintained as a dispersion and prevented from agglomerating.

**DISPLACEMENT**
Soil is displaced by mechanical action. Movement of the workpiece or fluid enhances the speed and efficiency of soil removal.

**SEQUESTRATION**
Undesirable ions such as calcium, magnesium, or heavy metals are deactivated, thus preventing them from reacting with material that would form insoluble products, (i.e., hard water soap scum).
SELECTING A CLEANING METHOD

The nature of the soil, the substrate involved, and the degree of cleanliness required are all factors to consider when selecting the cleaning process to use.

When selecting a cleaning method, one must consider the size, shape, and surface of the part to be cleaned, the soils involved, and the rate of production needed to ensure that the end results desired are obtained. As a general rule:

\[ \text{Concentration} \times \text{Temperature} \times \text{Time} \times \text{Mechanics} = \text{Clean} \]

Types of cleaning methods include: manual (hand wipe, brush, mop, etc.), Immersion (soak, agitation, electrolytic, ultrasonic), vibratory/tumbling, spray, and vapor degreasing.
CLEANER CHEMISTRY

Cleaners generally fall into three categories: organic solvents, emulsion cleaners, or aqueous alkaline cleaners.

ORGANIC SOLVENTS

Can be used in manual, immersion, spray, or vapor applications. They can be made from the following solvents:

Aliphatic: Naptha, Stoddard solvent, kerosene, mineral spirits
Aromatic: Toluene, xylene, hi-flash naptha
Chlorinated: Perchloroethylene, trichloroethylene, 1,1,1-trichloroethane, dichlorodifluoromethane, methylene chloride
Glycol Ether Solvents: Butyl Cellosolve, Butyl Carbitol, Cellosolve Acetate, hexylene glycol
Oxygenated: Methanol, ethanol, isopropyl alcohol

All solvent cleaners have high Volatile Organic Content (VOC). The United States Environmental Protection Agency (EPA) regulates the amount of VOCs which can be released into the atmosphere.

Virtually all solvents also have worker vapor exposure limits defined by the Occupational Safety and Health Administration (OSHA). In addition, solvent-based cleaners are virtually all hazardous wastes as defined by the U.S. EPA.

Although solvents can be reclaimed, it is expensive and the sludge and/or used solvent must still be treated as a hazardous waste.

EMULSION CLEANERS

Some water-based cleaners use non-chlorinated solvents as part of their package. A typical composition might include an organic solvent, a metallic or amine soap, and surface active agents.

These emulsion cleaners function by emulsifying the soils and keeping them dispersed throughout the fluid. As the emulsion cleaner is used, the entire bath becomes contaminated. The spent bath, including the water, must then be treated as a hydrocarbon waste.
ALKALINE CLEANERS

These cleaners are generally composed of water, an alkali source, sequestrant, a surfactant package, and corrosion inhibitors.

Daraclean cleaners are designed to be self-cleaning. Since the cleaner has a greater affinity for the part surface than the soil does, it undercuts the soil and pops it from the part surface. Light oils float to the bath surface where they can be skimmed or filtered off. Heavy soils settle to the bottom where they can be filtered off or collected as sludge.

Only the contaminants need be hauled away as waste. The liquid can be recycled indefinitely. Concentration is replenished and cleaning continues.

Soils readily removed with alkaline cleaners include:

- cutting oils
- shop dirt
- low melt waxes
- rust preventatives
- finger prints
- grease
- mill markings
- carbon
- road soils
- coolants
- some water-based paints

Alkaline cleaners are successfully used:

- prior to painting
- prior to plating
- prior to anodizing
- in-process cleaning
- sump cleaning
- as the finish process prior to packaging

Unlike solvent cleaning, emulsion and alkaline cleaners may require rinsing.
**RINSING AND DRYING**

Although not always required, rinsing can be an important step in the aqueous cleaning process. Hints to remember concerning rinsing include:

| Rinse Water | Keep it clean! Hard water salts can cause spots. Chlorinated water can promote rust. Dirty water can recontaminate parts. |
| Rinse Tank | Clean thoroughly and often. This stage should be constructed of 304 or 316 stainless steel. If a mild steel tank is used, it should be coated with a two-part epoxy paint or an inhibitor should be put into the rinse water to retard corrosion of the tank. |
| Rinse Soap or Silicates | Rinse immediately. Use a warm overflowing rinse for soaps. Use an abundant rinse for silicates. |
| Rinse Copper | Rinse cold. Not all alkalies rinse the same. Soda ash and liquid silicate are generally easier to rinse than are other silicates, phosphates, or sodium hydroxide. |

Unlike vapor degreased parts which come out dry, aqueous cleaned parts are wet. Drying can be facilitated by a number of methods depending on part configuration and the speed required.

These methods include:

- air evaporation
- compressed air blow off
- warm air circulating fan
- drying oven
- infrared lamp bank
- solvent displacement
- sawdust tumble
- cloth wipe
- centrifuge

Cleaner chemistry can also affect drying characteristics. Cleaners with low surface tension tend to have reduced drag-off and subsequently dry faster.
TESTS FOR CLEANLINESS

One question which must be asked is “How clean is clean?” The degree of cleanliness varies depending on subsequent processes. It is reasonable to expect that a printed circuit board must be cleaner than a rebuilt carburetor. Cleanliness can be measured by any number of different methods such as:

- **Visual**
  - Does the part look clean?

- **Water-break-free**
  - Will water sheet off the part rather than bead?

- **White tissue**
  - Will a white cloth stay white after being rubbed on a cleaned, dried surface?

- **Scotch transparent tape**
  - Will a piece of tape lift soils from the part surface?

- **Black light/fluorescence**
  - Can you see dye sticking to soils using a black light?

- **Solvent extraction**
  - This is used primarily for organically soiled parts which must be ultra clean.

- **Scanning Electron Microscopy (SEM)**
  - Visually examine a magnified surface for cleanliness.

- **Auger/ESCA**
  - Identify and quantify surface contaminants.

- **Conductivity**
  - Measure the residual electricity-conducting components.
SUGGESTED ALKALINE CLEANING PROCESSES

In-process cleaning:

1 Stage:
- CLEAN 3-25% 60-160°F
- RINSE 60-160°F

2 Stage:
- CLEAN 3-25% 60-160°F
- RINSE 60-160°F
- PLATE ANODIZE

Cleaning prior to plating or anodizing:

- CLEAN 3-25% 60-160°F
- RINSE 60-160°F
- PLATE ANODIZE

or:

- CLEAN 3-25% 60-160°F
- CLEAN 3-25% 60-160°F
- RINSE 60-160°F
- PLATE ANODIZE

or:

- CLEAN 3-25% 60-160°F
- RINSE 60-160°F
- RINSE 60-160°F
- PLATE ANODIZE

Cleaning prior to painting:

- CLEAN 3-25% 60-160°F
- DRY
- PAINT

or:

- CLEAN 3-25% 60-160°F
- RINSE 60-160°F
- DRY
- PAINT

or:

- CLEAN 3-25% 60-160°F
- RINSE 60-160°F
- PHOSPHATIZE
- RINSE 60-160°F
- DRY
- PAINT

or:

- CLEAN 3-25% 60-160°F
- RINSE 60-160°F
- PHOSPHATIZE
- RINSE 60-160°F
- SEAL
- DRY
- PAINT
The properties of commonly used vapor cleaners are compared to commercially available aqueous alkaline cleaners.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Vapor Cleaners</th>
<th>Aqueous Cleaners</th>
</tr>
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<tbody>
<tr>
<td><strong>Specific gravity</strong></td>
<td>1.322</td>
<td>1.305</td>
</tr>
<tr>
<td><strong>Flash point (TOC)</strong></td>
<td>none</td>
<td>none</td>
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<tr>
<td><strong>Boiling point, °C</strong></td>
<td>74.1</td>
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<tr>
<td><strong>VOC, pounds/gallon</strong></td>
<td>10.9</td>
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<tr>
<td><strong>Surface tension, dynes/cm</strong></td>
<td>28</td>
<td>19</td>
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<tr>
<td><strong>pH 100%</strong></td>
<td>—</td>
<td>11.5</td>
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<tr>
<td><strong>pH 10%</strong></td>
<td>—</td>
<td>10.5</td>
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<tr>
<td><strong>BOD, 10% (ppm)</strong></td>
<td>—</td>
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<td><strong>COD, 10% (ppm)</strong></td>
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<tr>
<td><strong>Freon extractibles</strong></td>
<td>—</td>
<td>1,124</td>
</tr>
<tr>
<td>(<strong>ppm</strong></td>
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</tbody>
</table>
DARACLEAN METALWORKING FLUIDS

Grace Metalworking Fluids has commercially available alkaline cleaners under the Daraclean label.

The Daraclean cleaners are safe on ferrous, cuprous, and most aluminum substrates as well as on plastic and glass. They are all-temperature cleaners designed to be low foaming (at temperature above 100°F) so they can be used in foam, tank, or spray applications.

Special features of Daraclean cleaners include:
- Self-cleaning
- Recyclable
- Hard water stable
- In-process rust protection

Formulated with people and the environment in mind.

Custom formulations and cooperative customer relationships are also part of the Daraclean Metalworking Fluids program.

STEPS FOR SUCCESSFUL CLEANING

Whether you are setting up a trial, a new production cleaning line, or are modifying an existing cleaning system, several steps should be followed to ensure success.

1. Determine tank volume. Allowing for several inches of free-board, multiply Length x Width x Height in feet x 7.5 x 0.66 = Gallons
2. Select the proper product. Your Grace sales engineer can help you.
3. Charge the tank at the recommended product concentration. For trials, use the highest concentration practical; it’s easier to reduce concentration after successful results are achieved. A starting range of 3-6% is suggested for spraywash applications while a 10-20% starting range is suggested for immersion applications.
4. Operate at the prescribed temperature. Trials should be run at 120-140°F when possible. Temperature can be reduced gradually once desired cleaning results are obtained.
5. Allow the work to remain in the cleaning bath the proper length of time, as required for cleaning or as the process will allow.
6. Provide adequate rinsing when needed.
7. Check and replenish the bath on a regular basis to maintain the proper concentration. Your Grace Metalworking Fluids sales engineer can provide you with a Titration Test Kit to measure product concentration in your tank. Laboratory burette test methods are also available upon request.
8. Skim and filter contaminants from the bath on a routine basis for extended tank life. If skimming and filtration is unavailable then dump spent solutions when chemical makeup equals or exceeds the initial charge.
9. Before filling the tank with a fresh solution, clean the tank, check the heating coils to ensure they are free of scale and debris, and make sure the drain valve is closed.
EQUIPMENT

Daraclean Metalworking cleaners can be used to replace chlorinated vapor degreasers without major capital equipment expenditures. Shown below are standard vapor degreasers before and after modification for use with aqueous cleaners. To modify an existing vapor degreaser, disconnect the chiller coils and raise the liquid level. To facilitate agitation, a PVC tube with drilled holes can be inserted and attached to an air source.

Daraclean cleaners are formulated to reject soils. For maximum sump life, filtration is recommended. Oils should be skimmed or overflowed off the top of the bath surface. Heavy soils and particulates should be filtered via media, cyclone, centrifuge, or diatomaceous earth.

Your Grace Metalworking Fluids sales engineer will assist you with your chemical and equipment needs.

- Refrigerated Condensing Coils
- Freeboard Zone
- Spray
- Refrigerated Water Separator
- Refrigerated Cooling Coils
- Solvent Filter
- Pump

Vapor Degreaser Without Modification

- Refrigerated Condensing Coils
- Air Source
- Spray
- Refrigerated Water Separator
- Refrigerated Cooling Coils
- Solvent Filter
- Pump

Modified Vapor Degreaser For Immersion Cleaning