CLEANING AND SURFACE PROCESSING

CLEANING WITH NON-HALOGENATED HYDROCARBONS IN COMPARISON TO WATER BASED CLEANING

Sandro Siminovich, Product Line Manager

WHY WE CLEAN PARTS?

What is preferred?
Industrial cleaning is the removal of chips, lubricant (coolant and oil) and any other unwanted material from the part prior to further processing.
INTRODUCTION

Definition of a cleaning task

Process definition and selection of the machine technology according to the requirement and complete process chain (before and after).
INTRODUCTION

Washer types

Single chamber

Belt washers

Multi tank
Process definition and selection of the machine technology according to the requirement and complete process chain (before and after).
## CLEANING MEDIA

### Cleaning capacity & effects

<table>
<thead>
<tr>
<th>Substance</th>
<th>Chlorinated Hydrocarbons</th>
<th>Aqueous cleaners</th>
<th>Hydrocarbons</th>
<th>Modified alcohols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trichloroethylene Perchloroethylene</td>
<td>Alkaline, neutral and acidic cleaners</td>
<td>C9-C13 Isoparaffins</td>
<td>Modified alcohols</td>
<td></td>
</tr>
<tr>
<td>Polarity</td>
<td>Non-polar</td>
<td>Polar</td>
<td>Non-polar</td>
<td>Slightly polar</td>
</tr>
<tr>
<td>Organic contamination: oil, grease</td>
<td>Very good</td>
<td>Moderate</td>
<td>Very good</td>
<td>Good</td>
</tr>
<tr>
<td>Inorganic contamination: salts, coolant</td>
<td>Moderate</td>
<td>Very good</td>
<td>Moderate</td>
<td>Moderate – good</td>
</tr>
<tr>
<td>Organic + inorganic contamination</td>
<td>Moderate – good</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Very good</td>
</tr>
<tr>
<td>Solid contamination: chips, particles, dust...</td>
<td>Depends on machine configuration</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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CLEANING FLUIDS

Polarity: “Like dissolves like”

Water

\[ \delta^+ \text{H} - \text{O} - \text{H}^+ \]

Polar

⇒ Removal of polar contamination (water based)

Hydrocarbons

\[ \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{CH}^+ - \text{CH}_3 \]

Non-polar

⇒ Removal of non-polar contamination (oil based)
CONTAMINATION CLASSIFICATION

What is what?

- Cooling lubricants (emulsions, oil)
  - Mineral oil
  - Metal soaps
  - Graphite
  - Molybdenum sulfide
  - Pigments

- Polishing/Lapping paste
  - Waxes
  - Metal oxides

- Corrosion protection
  - Sulfonates
  - Carboxylates
  - Inhibitors
  - Mineral oil

- Rust, oxides, scales
  - Metal oxides
  - Metal salts
  - Metal abrasion

- Flux material
  - Inorganic salts

- Others
  - Dust
  - Crack products
  - Old coating
  - Polar
  - Non-polar
  - Both
Choice of cleaning media in terms of quality efficiency

SELECTION OF CLEANING MEDIA

Contamination > Oil & Chips

Contamination > Coolant & Chips

Filter patch after aqueous cleaning

Filter patch after solvent cleaning

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Open top cleaning and degreasing systems

Open top solvent systems, maybe with air suction, without emission control

“Semi-closed” systems, maybe with condensation trap (cooling coils) as emission reduction
HYDROCARBON MACHINE TECHNOLOGY

Closed loop vacuum degreasing systems

- Full closed, double-safe vacuum technology, no additional chemical or analytic tests required
- Cleaning, degreasing and corrosion protection possible in ONE system
- 100% Drying
- Low consumption of hydrocarbon due to continuous distillation and solvent treatment and automatic oil discharge
- Energy efficient → Reduced running costs, no waste of used cleaning media
- No surface attack and corrosion
- No operator contact with the cleaning media
Hydrocarbon washers

- Work chamber
- Tank 1 (cleaning)
- Distillation (vapor degreasing)
- Tank 2 (fine cleaning or rust protection)
PROCESS FUNCTIONS

Water based washers

- Tank 1 (cleaning)
- Tank 2 (fine cleaning)
- Tank 3 (rinsing or rust protection)
- Oil separator
- Work chamber
## HYDROCARBONS

### Advantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>To be noted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery via distillation</td>
<td>Higher temperature of parts after cleaning</td>
</tr>
<tr>
<td>Good degreasing efficiency</td>
<td>(cooling unit might be necessary)</td>
</tr>
<tr>
<td>Continuously good cleaning result also for high oil input</td>
<td>No chemical surface attack possible (e.g. etching)</td>
</tr>
<tr>
<td>Almost no need to control solvent quality</td>
<td>Inorganic contamination (e.g. salts) leads</td>
</tr>
<tr>
<td>Compatible with different materials</td>
<td>to “white” spots on parts surface</td>
</tr>
<tr>
<td>100% drying possible</td>
<td>Input of chlorinated oils can lead to machine</td>
</tr>
<tr>
<td>Low energy consumption &amp; running costs</td>
<td>corrosion</td>
</tr>
<tr>
<td>Long-term corrosion protection possible (no activation of surface with</td>
<td>Limited water input</td>
</tr>
<tr>
<td>water)</td>
<td></td>
</tr>
</tbody>
</table>
## WATER BASED

### Advantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>To be noted</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Good cleaning of inorganic contamination  (coolants)</td>
<td>➤ Degreasing is possible but with limited oil input</td>
</tr>
<tr>
<td>➤ Surface attack is possible  (etching)</td>
<td>➤ Constant control of bath quality is needed</td>
</tr>
<tr>
<td>➤ More flexibility in choices for cleaners</td>
<td>➤ Long term corrosion protection is not possible</td>
</tr>
<tr>
<td>➤ Cleaners can be dosed in different concentrations</td>
<td>➤ Minimum of two step process is necessary (cleaning and rinsing)</td>
</tr>
<tr>
<td>➤ Short term corrosion protection is possible</td>
<td>➤ Difficult to dry without leaving residue in part surface</td>
</tr>
<tr>
<td>➤ Not flammable</td>
<td>➤ Higher energy consumption (evaporation, drying)</td>
</tr>
<tr>
<td>➤ Lower initial investment</td>
<td></td>
</tr>
</tbody>
</table>
Comparison with similar process in single chamber machines.
### COST COMPARISON

<table>
<thead>
<tr>
<th>Costs</th>
<th>Hydrocarbon</th>
<th>Water based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine (initial investment)</td>
<td>$ 300,000</td>
<td>$ 220,000</td>
</tr>
<tr>
<td>Initial fill (chemical + water)</td>
<td>$ 4,480</td>
<td>$ 1,160</td>
</tr>
<tr>
<td><strong>Investment total</strong></td>
<td>$ 304,480</td>
<td>$ 221,160</td>
</tr>
<tr>
<td>Utilities (per year)</td>
<td>$ 21,330</td>
<td>$ 30,110</td>
</tr>
<tr>
<td>Operator (per year)</td>
<td>$ 65,000</td>
<td>$ 65,000</td>
</tr>
<tr>
<td>Maintenance (per year)</td>
<td>$ 6,720</td>
<td>$ 5,570</td>
</tr>
<tr>
<td><strong>Running total (per year)</strong></td>
<td>$ 93,050</td>
<td>$ 100,680</td>
</tr>
<tr>
<td><strong>Running cost per load</strong></td>
<td>$ 3.08 / load</td>
<td>$ 3.33 / load</td>
</tr>
</tbody>
</table>

- Considering single chamber washer machines running 21 hours per day, 240 days per year.
- Cost per load considered based on 6 loads per hour.
## COST COMPARISON

A real case: Replacing water based by hydrocarbon

<table>
<thead>
<tr>
<th>Cost per year *</th>
<th>Water based (before)</th>
<th>Hydrocarbon (after)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>$26,400</td>
<td>$8,400</td>
</tr>
<tr>
<td>Natural gas</td>
<td>$10,200</td>
<td>N/A</td>
</tr>
<tr>
<td>Water</td>
<td>$1,560</td>
<td>N/A</td>
</tr>
<tr>
<td>Waste disposal</td>
<td>$11,400</td>
<td>$5,400</td>
</tr>
<tr>
<td>Chemicals</td>
<td>$24,408</td>
<td>$11,880</td>
</tr>
<tr>
<td>Consumables</td>
<td>$1,800</td>
<td>$3,600</td>
</tr>
<tr>
<td>Operation</td>
<td>$181,440</td>
<td>$98,040</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$59,340</td>
<td>$14,400</td>
</tr>
<tr>
<td>Total</td>
<td>$316,548</td>
<td>$141,720</td>
</tr>
</tbody>
</table>

* Data from customer who replaced multi tank water based machine with single tank hydrocarbon.

- Payback approximately 28 months.
- Reject levels reduced.
- Automated machined allowed operator to do other activities.
- Pre-wash operation eliminated.
- Parts did not require RP application.
Cleaning with Hydrocarbon

Contamination: Oil and chips
Goal: Free of particles and oil
WATER BASED CLEANING

Aluminum control valve block

Contamination: Coolant and salts
Goal: Clean surface

Before

Water based

After

Hydrocarbon
Cleaning of used bearings

Contamination: Grease and particles
Goal: Free of grease
WATER BASED CLEANING

Retooling application for turbine parts

Contamination: Oxidation
Target: Free of oxidation
Like cleans alike: the contamination to be removed from the part is the most important factor in selecting the cleaning media to be used.

Hydrocarbon solvent washers have similar cleaning properties as old vapor degreaser machines, but modern technology makes them environmental and operator friendly.

Hydrocarbon washers have a higher initial cost when compared to water based machines, but lower operating costs and more consistent results.

Total investment and running costs are important decision factors, but it is necessary to consider the entire manufacturing process chain when selecting the correct cleaning equipment for each application.
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