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Working With Silicones

How to Clean Floors and Process Equipment Containing Silicon-based Materials

Introduction

This bulletin details methods for removing silicon-based materials such as emulsions, fluids, antifoam compounds and resins from floors and process equipment.

Silicon-based materials can be difficult to remove from various surfaces such as floors and process equipment. There are several physical and chemical properties of silicon-based materials that can contribute to increased difficulty in removing these materials from surfaces, including: their natural affinity for many materials; their excellent chemical, water and heat resistance; and their marked incompatibility with most organic materials.

There are different methods that can be utilized to effectively remove silicon-based materials (i.e. emulsions, fluids, antifoam compounds, cured resins) from floors and equipment. These methods can either be aqueous-based or solvent-based. There are many factors that should be considered when choosing a cleaning procedure, including:

- The type of silicon-based material to be removed
- If removing an emulsion, knowing the type of emulsion (silicone-in-water versus water-in-silicone) is important. For example, water-in-silicone emulsions, where silicone is unemulsified in the external phase, tend to behave similarly to silicone fluids. These emulsions are generally more difficult to remove from systems which previously contained silicone-in-water emulsions (where the silicone is already emulsified in the internal phase)
- Materials of construction of equipment to be cleaned
- Waste material handling capabilities
- Local, state, and federal regulations for water, land, and air
- Safety

Pre-Treatment of Floors and Process Equipment

Prior to introducing cleaning agents to floors or process equipment, extract as much of the silicon-based material as possible. For example, when cleaning floors, use shovels and/or absorbent materials to remove the bulk of the material. Examples of absorbent materials can include: treated cellulose, vermiculite (kitty litter), and expanded clay. When cleaning process equipment such as vessels, make use of available pumps and/or drain taps to expel most of the material from the equipment.

Non-Solvent-Based Method

Aqueous solutions of various surfactants, detergents, or degreasers can be used to partly emulsify the silicon-based fluids to effectively clean floors and equipment. Some examples of products used are:

- Shocon¹ – Surface emulsifier and degreaser. Can be applied to concrete, steel, glass, and glazed surfaces
- Aqueous Reactivator^{®1} – Emulsion breaker and silicone cleaner. Used for cleaning process equipment and floors

- Power Purge¹ – Aggressive cleaner and degreaser. Used for removal of cured silicon-based materials such as resins
- Heated caustic solutions (i.e. KOH solution such as CIP-100^{®2}) to clean emulsions and cured silicon-based materials from manufacturing kettles
- Other citrus turpene-type products such as: Citrikleen XPC^{®3}, CSI Resolve^{™4}, and Zep[®]-EZ⁵

When cleaning process equipment, several items to consider are:

- The use of clean-in-place (CIP) devices, such as spray nozzles, to more effectively reach all areas of process vessels
- Draining “dead spots” within the process
- Flushing wash material through all sections of piping, control valves, filters, pumps, etc.
- Maintain a minimum flow velocity of approximately 2 m/s throughout piping

Once the silicon-based material has been removed, it may be desirable to sanitize floors and equipment using a disinfectant. The disinfectant could be a chlorine compound such as household bleach. Other examples of disinfectants are quaternary ammonium compounds, iodophors, acid-ionic surfactant germicides, phenols, and gluteraldehyde. Manufacturers of disinfectants include:

- Steris Corporation²
- The Dow Chemical Company⁶

The cleaning results attained by these cleaning agents and disinfectants will vary from situation to situation. The overall cleanliness of floors and equipment should be determined via thorough experimentation and testing. See the “Testing for Residual Material” section for some examples of test methods for determining the quantities of any remaining silicon-based material.

Always follow the manufacturer’s recommendations for their specific cleaning and disinfecting agents to determine:

- Any limitations that may exist
- Compatibility with materials of construction of equipment (in conjunction with recommendations from equipment suppliers)
- Suggested usage levels
- Necessary safety and environmental precautions

Solvent-Based Method

There are many different solvents that can effectively remove silicon-based materials from floors and process equipment. Generally, suitable solvents are (specific examples are shown in parentheses):

- Aliphatic hydrocarbons (hexane, heptane, mineral spirits, VM&P naphtha, Stoddard solvent, WD-40^{®7})
- Aromatic hydrocarbons (toluene, xylene)

- Higher alcohols (2-ethyl hexanol)
- Isoparaffins
- Higher ketones (methyl ethyl ketone, methyl isobutyl ketone)
- Ethers (ethyl ether, hexyl ether, methyl ether)
- Cyclomethicone (XIAMETER[®] PMX-0245 Cyclopentasiloxane, XIAMETER[®] PMX-0345 Cyclosiloxane Blend)
- Low molecular weight polydimethylsiloxanes (Dow Corning[®] OS fluids)

Most silicon-based materials are generally NOT soluble in:

- Water
- Methanol (partial solubility with some lower alcohols, such as isopropanol, ethanol)
- Glycols (propylene glycol, ethylene glycol, glycerin)
- Fats and oils (vegetable oils, petrolatum, fatty acids)

The solubility of silicon-based materials with various solvents depends on several factors. First, the viscosity of the silicon-based material can affect its solubility with solvents. Typically, the low-viscosity materials will exhibit greater solubility in solvents versus the higher-viscosity materials. Second, the type and degree of chemical functionality (dimethyl, amine, phenyl, etc.) on the siloxane backbone can vary the degree of solubility with solvents. There are some types of silicon-based materials (i.e. silicone polyethers) that can be compatible with polar materials such as water. Many of the product data sheets will list recommended solvents for the given materials. Thorough experimentation and testing should always be performed to determine the most effective solvent for a given application. See the “Testing for Residual Material” section for some examples of test methods for determining the quantities of any remaining silicon-based material.

Also, flammability and toxicity should be important considerations in the choice of a solvent. Always provide adequate ventilation, and follow precautions on the solvent container label.

Use the guidelines outlined in the “Non-Solvent-Based Method” section to ensure that all areas of a system are properly flushed with the cleaning solvent. Also, follow the solvent manufacturer’s recommendations to determine:

- Any limitations that may exist
- Compatibility with materials of construction of equipment (in conjunction with recommendations from equipment suppliers)
- Suggested usage levels
- Necessary safety and environmental precautions

Testing For Residual Material

It may be desirable to test the effectiveness of any given cleaning procedure by quantifying the level of silicon-based material remaining on the equipment or floor. This can be achieved by measuring the amount of elemental silicon contained in the final cleaning rinse. Two examples of test methods that can be used are: Atomic Absorption (ASTM method, D 3733) and Inductively Coupled Plasma – Atomic Emission Spectroscopy. If the molecular structure and molecular weight of the silicon-based material is known, the amount of elemental silicon can be converted to give an estimate of the total amount of silicon-based material remaining in the system (i.e. polydimethylsiloxane contains approximately 38% elemental silicon).

References

¹ReNewSystems, Inc.
P.O. Box 1072
Bay City, MI 48706
1-800-722-2641
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²Steris Corporation
5960 Heisley Road
Mentor, OH 44060-1834
1-800-JIT-4-USE
www.steris.com

³Spartan Oil Corporation
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Lansing, MI 48912
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www.spartanoilcorp.com

⁴Cleaning Systems, Inc.
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⁵Zep Manufacturing
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⁶The Dow Chemical Company
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⁷WD-40 Company
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Product Information

A complete list of XIAMETER[®] brand fluids is available at www.xiameter.com.



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Printed in USA

AGP9787

Form No. 95-712-01

