



**HAZARD**

**CONTROLS**

HC 17

## *Control of Exposure to Perchloroethylene in Commercial Drycleaning (Substitution)*

**HAZARD**

Perchloroethylene (PERC) is the most commonly used drycleaning solvent. PERC can enter the body through respiratory and dermal exposure. Symptoms associated with exposure include: depression of the central nervous system; damage to the liver and kidneys; impaired memory; confusion; dizziness; headache; drowsiness; and eye, nose, and throat irritation. Repeated dermal exposure may result in dermatitis. NIOSH considers PERC a potential human carcinogen.

**CONTROLS**

To reduce exposure to drycleaning solvents, a comprehensive control approach should be followed involving engineering measures, work practices, and personal protection. Engineering measures are the most effective means of control and should generally be considered first. If a substance is hazardous to health or to the environment, sound industrial hygiene practice dictates that a less hazardous material or process be considered as a substitute.

### ■ **POTENTIAL ALTERNATIVES TO DRYCLEANING WITH PERCHLOROETHYLENE**

- ◆ In recent years, extensive research and development have been conducted to bring an acceptable PERC alternative to the market. Two potential alternatives to PERC are now on the market: Wetcleaning and Petroleum-Based Drycleaning. Modern wet cleaning is a new method to clean by water immersion garments normally cleaned in solvent. Petroleum-based drycleaning has been used in garment cleaning for many years. Liquid carbon dioxide is a recently developed technology that is not yet on the market. Each of these potential alternatives has different physical properties from PERC that affect their cleaning performance as well as their health and safety hazards.



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## ■ WETCLEANING

- ◆ At least 30%, and potentially a much higher percentage, of garments drycleaned using PERC can be wet cleaned satisfactorily while controlling fabric deterioration and shrinkage. Water tends to expand natural and hydrophilic fibers, but solvents have minimal effect on the properties of fibers. When natural and hydrophilic fibers expand, they also wrinkle, shrink, and lose their shape and strength. In general, the higher the synthetic content of the garment, the lower the risk of shrinkage. Machine wet cleaning can have minor variations, but most techniques are similar in that they all use
  - specially formulated wet cleaning soaps and spotting agents,
  - increased extraction of water before drying,
  - close monitoring of heat and moisture content during the drying process, and
  - lower level of mechanical action during washing.

Garments are washed with varying levels of mechanical action based on garment type and amount of soilage. The greatest risk to the garment occurs during drying. Many fibers can be fully dried with little or no difficulty. However, delicate garments or those susceptible to high shrinkage must be dried for only a few minutes before being hung to air dry in the shop. Because of these problems, most wet-cleaned garments require more finishing work than garments cleaned with solvent. Long drying times and more finishing work substantially add to the required processing time.

### **Advantages of Wetcleaning**

- Fewer health and safety hazards
- Soil contamination and large emissions of air pollutants eliminated
- More pleasant smell than solvent
- Some soils are more easily removed (i.e. sugars, salts, drinks, body fluids, starch, and milk)
- Comparable cost to cleaning with PERC
- Burden of strict health, safety, and environmental regulations reduced

### **Disadvantages of Wetcleaning**

- Not currently a complete replacement for cleaning with PERC
- Slight fabric deterioration, structural surface changes, felting, loss of luster and shape, dye transfer or color change
- Wools, silks, and rayons are subject to fiber shrinkage or bleeding of dyes
- Greases, oils, waxes, and resins are more difficult to remove
- Large quantities of contaminated wastewater
- Labor-intensive, requires highly skilled workers
- Presents additional ergonomic risks to workers because it is more labor intensive

## ■ PETROLEUM-BASED DRYCLEANING

- ◆ Petroleum-based solvents are flammable; PERC is not. Petroleum-based solvent vapors are fuels that can burn if they are present in concentrations between the lower explosive limit (LEL) and the upper explosive limit (UEL) with sufficient oxygen. If the concentration of petroleum-based solvents in air falls below approximately 8 percent, flames will extinguish. When sufficient petroleum-based solvent vapors and oxygen are present, a fire can begin in the presence of an ignition source such as a spark or static electricity.
- ◆ Petroleum-based solvents with higher flashpoints and inherently safer machines are now on the market. These solvents have flashpoints higher than 55°C/131°F and are thermally stable

at operating conditions. Petroleum-based drycleaning machines have had several technical advances to improve machine safety and reduce the risk of fire and explosion. These advances include vacuum technology, inerting with nitrogen, and better control of machine operating parameters. The following measures can be taken either in combination or separately:

- Use of an inert gas such as nitrogen or argon to displace oxygen and ensure that the oxygen concentration is sufficiently low to prevent combustion (approximately 8 percent).
- Operation under a vacuum to remove oxygen and lower its concentration (<8 percent).
- Ensuring that the LEL is not exceeded, or if the LEL is not known, ensuring that the operating temperature remains 15°C below the flash point.
- Ensuring that the vapor concentration remains below 50 percent of the LEL by controlling operating temperatures or providing sufficiently high airflow.

#### **Advantages of Petroleum-Based Drycleaning**

- Generally considered less toxic than PERC based upon exposure limits. Toxicological properties not as well documented as PERC.
- Because the vapor pressures are lower than PERC, exposures due to inhalation are generally lower
- Established cleaning solvent that is effective at cleaning all types of garments
- Generally less expensive than PERC

#### **Disadvantages of Petroleum-Based Drycleaning**

- Presents fire hazards; PERC does not. Fire codes may limit where some shops using these solvents may be located.
- Better living condition for bacteria to grow because of solvent additives. Bacteria cause the garments to retain unpleasant odors.
- Lower vapor pressures result in a longer drying process than PERC.
- Less effective at removing oil and grease stains than PERC
- Higher insurance premiums than with PERC

### **■ LIQUID CARBON DIOXIDE**

- ◆ Liquid Carbon Dioxide (CO<sub>2</sub>) is a recently developed technology that may become commercially available in 1998. Many of the details concerning this technology are not available. Liquid carbon dioxide has been used for cleaning in other processes for several years. CO<sub>2</sub> would be processed by a gas manufacturer and delivered to drycleaners in pressurized canisters.
- ◆ During the process, clothes are immersed in liquid CO<sub>2</sub> in an enclosed cylindrical basket (inside a pressure vessel that is under pressures of 700 to 1,000 psig). The load is then agitated inside the basket by high velocity fluid jets or mechanical action to remove soils. Once the cleaning process is finished, the garments are removed and need no drying.
- ◆ Manufacturers indicate that because liquid CO<sub>2</sub> has a low viscosity, better cleaning is possible because smaller particles can be removed from the surface with less redeposition. Liquid carbon dioxide is a nonpolar solvent that is most effective at removing nonpolar soils such as

oil and grease. Since water soluble soils are polar, they have a relatively low solubility in liquid carbon dioxide (as well as PERC). To remove common polar soils such as salt and glucose, liquid CO<sub>2</sub>-compatible additives must be used, or the stains can be removed during pre-spotting.

### Advantages of Liquid CO<sub>2</sub>

- Environmental concerns such as soil contamination, air pollution, etc. eliminated.
- Shorter expected cycle time than PERC machines, reduced garment pressing time
- Capable of cleaning suede, leather, and fur that PERC cannot
- Relatively high PEL of 5,000 ppm

### Disadvantages of Liquid CO<sub>2</sub>

- Potential safety hazards—high pressure system, asphyxiation
- Questions regarding garment redeposition of stains that have been removed
- Possible problems removing protein stains such as grass, lipstick, or chocolate
- Possibly more expensive than PERC machines
- Very new technology for garment cleaning applications that has not stood the test of time

## For More Information

To obtain more information about controlling this hazard or for information about other occupational health and safety issues:

— call NIOSH\* at **1-800-35-NIOSH (1-800-356-4674)** or  
— visit the NIOSH Home Page on the World Wide Web at  
**<http://www.cdc.gov/niosh/homepage.html>**

A NIOSH technical report, *Control of Health and Safety Hazards in Commercial Drycleaners: Chemical Exposures, Fire Hazards, and Ergonomic Risk Factors*, has been published on this subject. This document is one in a series of seven *HAZARD CONTROLS* concerning control of hazards in the drycleaning industry that are available free upon request.

\*NIOSH is the Federal agency responsible for conducting research and making recommendations for preventing work-related illnesses and injuries. All *HAZARD CONTROLS* are based on research studies that show how worker exposures to hazardous agents or activities can be significantly reduced.

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