

A Comparative Analysis of Perc Dry Cleaning and an Alternative Wet Cleaning Process

Executive Summary

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EXECUTIVE SUMMARY

Most people don't think about *how* their clothes are going to be cleaned when they drop them off at a neighborhood dry cleaner. They are only interested in receiving professionally cleaned and pressed clothing, at a reasonable price, within a short amount of time. But the cleaning method a professional cleaner chooses affects the environment, human health, the profitability of the business, the number of regulations with which the business must comply, and the cleanliness and appearance of the clothes.

As concern has increased over the manufacture, use, and disposal of halogenated solvents and chlorinated chemicals, the search for alternatives and pollution prevention strategies has become more urgent. Perchloroethylene, PCE or perc, is the chlorinated solvent used by the majority of dry cleaners today. In an effort to reduce perc use, stakeholders in the garment care industry and environmental community have been experimenting, analyzing, debating, and lobbying over an alternative wet cleaning method which would replace the need for perc.

This study is a comparative analysis of two professional clothes cleaning methods: traditional perc dry cleaning, and wet cleaning which uses water and biodegradable detergents in sophisticated washing machines (70 percent) in conjunction with a hand-washing method called multiprocess wet cleaning (30 percent). This study is not a risk assessment of perc. It is a comparison of two cleaning methods; one which relies on a toxic solvent and one which does not. The study uses evaluative techniques from Life Cycle Assessment and Life Cycle Design; it analyzes the use and disposal of cleaning agents, but does not include the manufacture and resource extraction impacts of these cleaning agents. Eliminating the manufacture and processing of perc understates the full environmental impacts, risks, and associated regulatory issues of perc and wet cleaning. The two cleaning methods are analyzed with respect to environmental and human health impacts, cleaning performance, economics, and regulatory requirements. The study does not score either cleaning method, but instead provides a framework so that policymakers, regulators, dry cleaners and consumers can assess the relative benefits and disadvantages of both cleaning methods.

FINDINGS

ENVIRONMENTAL IMPACTS

- Perc is a member of the chlorinated solvents family. There is increasing concern about the use of chlorinated compounds due to their persistence in the environment and their potential to bioaccumulate. There are no known, naturally occurring sources of perc in the environment.
- Perc is used by over 80 percent of the dry cleaners in the United States. In 1991, 122,700 metric tons (270 million pounds) of perc were consumed by the commercial dry cleaning sector, which consists of approximately 30,000 machines in operation nationwide.
- Of this amount, about two-thirds, or 180 million pounds, are released annually into the atmosphere. Some of the breakdown components of perc, such as vinyl chloride and phosgene, are toxic to humans. Another breakdown component, trichloroacetic acid, is a known herbicide which causes forest damage.
- Of the remaining 90 million pounds of perc not released to the atmosphere, most is captured in the form of a solid waste,

which is classified as hazardous under the Resource Conservation & Recovery Act (RCRA). Disposal of waste products containing perc must be handled by authorized facilities. Most cleaners pay to have perc-laden waste removed by an off-site disposal service which then reclaims some of the waste and sells the rest to cement kiln incinerators.

- Perc is also discharged into sewer systems each year in the form of wastewater. Perc can migrate through concrete sewer pipes and also escape through sewer systems which are designed to leak. Once in the soil, perc is mobile and can reach groundwater, where it remains fairly stable. Perc contamination of groundwater has been documented in many areas of the country.
- In California's Central Valley region, over 35 percent of 750 tested wells contained perc, many at levels higher than the permissible limit. Dry cleaning was found to be the likely source of contamination in 20 out of 21 wells that were extensively tested.
- A dry cleaning machine using the latest perc technology consumes more electricity to clean a garment than a high-tech wet cleaning machine, thus emitting more pollutants from energy generation into the atmosphere over time. This is primarily because the dry cleaning machine employs energy intensive emission control technology equipment, such as a refrigerated condenser.
- The wet cleaning machine consumes a great deal of water since the cleaning medium is water, rather than a chemical solvent. Thus, the environmental impacts of using and treating water are much higher for wet cleaning than they are for dry cleaning. Further study is being done on recycling water, which can reduce the negative environmental impacts of wet cleaning.

HUMAN HEALTH IMPACTS

- The National Institute for Occupational Safety and Health (NIOSH) and the State

of California have designated perc as a human carcinogen. The International Agency for Research on Cancer is planning to revise its classification from a possible to a probable carcinogen.

- Presently, the U.S. EPA's unofficial classification of perc falls on a continuum between possible (C classification category) and probable (B2 classification category) human carcinogen. Despite this classification, in 1991, the U.S. EPA Science Advisory Board (SAB) noted that due to existing levels of uncertainty and the widespread use of perc, it would be wise to reduce workers' exposure to perc.
- A 1994 NIOSH study found significant excesses of esophageal cancer and elevated "observed to expected" numbers of deaths of intestinal and pancreatic cancer in populations exposed to perc.
- A 1993 Boston University study found perc-contaminated drinking water supplies were associated with an elevated relative risk of leukemia, and increased relative risk of bladder cancer in residents drinking from the contaminated water supply.
- Results from both the 1993 and 1994 studies are significant since they isolate the health effects of human exposure to perc. Previous studies of human populations dealt with people exposed to a variety of solvents used in the dry cleaning industry and had been unable to isolate the contribution from perc.
- As recently as 1989, the Occupational Safety and Health Association (OSHA) lowered the Permissible Exposure Limits (PELs) for workers' exposure to perc from 100 ppm to 25 ppm. However, due to a procedural technicality, an industry-sponsored lawsuit overturned the new standard. Although dry cleaners are advised to limit exposure to 25 ppm, workers can still legally be exposed to levels OSHA has ruled are unsafe.
- Some perc can remain in garments after dry cleaning, resulting in human exposure. According to one study, after 100 days

only 40 percent of the perc which was held in the fiber pores diffused to the surface and evaporated.

- Since the adverse health impacts associated with dry cleaning result from exposure to perc and the spotting agents, wet cleaning, which uses nontoxic detergents, essentially eliminates the known health risks to cleaners and the public associated with perc use.

PERFORMANCE

- Perc is an effective clothes cleaning solvent. It dissolves lipophilic stains such as oils, greases, fats, and waxes; does not readily penetrate textile fibers; and evaporates quickly, reducing the potential for garment shrinkage. Perc is nonflammable and easily treated for reuse.
- Water can clean many garments, but it is not capable of dissolving lipophilic soils. For wet cleaning, nonchlorinated solvents are used to treat these stains. For the large majority of fabrics, water does not dissolve or weaken fibers or cause bleeding of dyes, and water is compatible with readily available detergents.
- Since garment shrinkage results in part from over-drying, a wet cleaner must pay special attention to the residual moisture content in a garment while drying. Wet cleaners eliminate shrinkage problems by using specially designed drying machines which are programmed for specific garments' needs or by drip drying.
- Environment Canada's Green Clean wet cleaning demonstration project received 177 survey responses for the months of June, July and August 1994. Of those customers that responded, 97 percent indicated the clothes were clean overall, and 98 percent responded that they would have their clothes wet cleaned again.

ECONOMICS

- Our model facility analysis found that wet cleaning can be an economically viable alternative to dry cleaning. The profitability

of wet cleaning depends on many variables, including the cost of labor, detergents, equipment, electricity and water. Wet cleaning facilities in operation today offer prices similar to those offered by dry cleaners.

- Uncertainties exist regarding the amount of labor required for wet cleaning. This raises problems in analyzing the profitability of wet cleaning because cost estimates are highly sensitive to assumptions about labor. To achieve the labor productivity required to compete with dry cleaning, the wet cleaner may need to invest in worker training.
- Wet cleaning involves significantly less up-front capital expenditures than does dry cleaning. For example, the cost of an Aqua Clean System washer and dryer is roughly \$30,000. In comparison, a similar sized dry cleaning machine costs roughly \$54,000.
- The cost of perc and charging detergents is significantly cheaper than the cost of wet cleaning detergents and sizing agents. However, dry cleaning entails additional costs associated with hazardous waste disposal of perc-contaminated wastes. When these disposal costs are included in the cost of perc usage, the cleaning agents for wet cleaning are less expensive than those for dry cleaning.
- Wet cleaning involves significantly lower electricity costs than dry cleaning, in large part because dry cleaning uses energy-intensive pollution control equipment. However, the savings from reduced energy use are fully offset by higher water-usage expenses associated with wet cleaning.

REGULATIONS

- Dry cleaners using perc must comply with several environmental statutes including the Occupational Safety & Health Act, which limits permissible exposure levels in the workplace; the 1990 Clean Air Act Amendments (CAAA), which regulate emissions to the atmosphere; the Resource Conservation & Recovery Act, which

- governs disposal of perc as a hazardous waste; the Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA), which establishes liability for groundwater and soil pollution; and various state regulations.
- The 1990 Clean Air Act Amendments require Maximum Available Control Technology (MACT) to reduce atmospheric emissions. However, the National Emission Standards for Hazardous Air Pollutants (NESHAP), which were promulgated by the U.S. EPA to meet the CAAA, allow certain cleaners to retrofit and maintain older technology such as vented or transfer machines. Therefore, not all cleaners are using the most effective technology to limit emissions; the closed-loop dry-to-dry machines.
 - The 1984 RCRA Amendments stipulate disposal methods for perc-contaminated waste. On average, a dry cleaner pays several thousand dollars per year to comply with RCRA and dispose of perc-contaminated waste.
 - Historically, dry cleaners have legally poured perc-laden wastewater into the sewer. Under CERCLA, dry cleaners are liable for these past wastewater disposal practices if they result in contaminated groundwater and/or soil. Certain state dry cleaning associations are establishing funds to pay for such liability-related claims.
 - Enforcement of dry cleaning regulations is based on self-reporting, inventory, and record keeping. Due to the fragmented nature of the industry, the small number of regulatory inspectors, and the abundance of facilities, not all dry cleaners are inspected
 - Wet cleaners are not affected by the above-mentioned regulations because the detergents they use are nontoxic, and biodegradable. A potential future regulatory concern for wet cleaners is their increased volumes of wastewater.
 - Because perc is used in dry cleaning, costly regulations are needed to reduce environmental burden and to protect human health. Wet cleaning is a pollution prevention approach to protecting the environment without costly regulations.

RECOMMENDATIONS

While our study emphasized the importance of five criteria (environment, human health, economics, performance, and regulations), the dry cleaning industry has expressed concern about the economic and performance criteria. The reason is that if wet cleaning cannot meet the base level of performance established by dry cleaning, it will not be acceptable to customers. If it is not economical for small commercial dry cleaners, then it will not be adopted voluntarily. These comparisons are difficult to conduct at this point, since wet cleaning technology and practices are still evolving. Most wet cleaners have been operating for less than one year, and their business is being compared to an industry with over 40 years of experience. Until wet cleaning operations have been operating long enough to collect empirical data on both cost and performance, dry cleaners will continue to maintain a level of skepticism about the practicality of wet cleaning. The following recommendations address these concerns.

DATA COLLECTION

Additional data are needed to resolve uncertainties with wet cleaning. To ensure acceptance and accuracy of the results, tests should be performed with input from all

involved stakeholders. Research efforts to resolve uncertainties might include following:

- Examining the long-term impacts of continued wet cleaning on garments and comparing these results to the long-term

impacts of continued dry cleaning on garments;

- Quantifying the labor requirements of wet and dry cleaning, and identifying how variations in volume and garment/fabric types affect the economic viability of wet cleaning;
- Analyzing the chemicals released into wastewater when previously dry cleaned and spotted clothes are wet cleaned, and the impact these chemicals could have on water quality;
- Developing a dose-response model to better predict the health effects of various levels of perc exposure;
- Experimenting and developing wastewater recycling technologies for wet cleaning;
- Surveying customers on expectations and attitudes toward professional clothes cleaning. Additional market research will help inform dry cleaners of the level of customer demand for wet cleaning.

INCENTIVES

Federal and state governments should help wet cleaners experiment with alternative technologies through incentives. Incentives would encourage cleaners to set up alternative cleaning systems by reducing the financial risk involved in such a conversion. A number of incentives might include the following:

- Providing subsidies, loan guarantees, low interest loans, and tax breaks to purchase wet cleaning equipment;
- Providing government-subsidized training programs for dry cleaning workers to learn the more complex wet cleaning techniques;
- Changing the Federal Trade Commission's garment care labeling regulation to say professional cleaning instead of dry cleaning.

IMPLEMENTATION

Dry cleaners need to begin looking critically at their garment stream and experimenting with wet cleaning on appropriate items in order to become more familiar with the potential of wet cleaning. In order to facilitate the on-site implementation of wet cleaning, dry cleaners could do the following:

- Consider buying a wet cleaning machine if they are expanding capacity. This would provide the cleaners and their customers with greater flexibility in choosing how to clean garments;
- Attend workshops and training programs on wet cleaning;
- Consider buying a wet machine and capitalizing on the investment by cleaning leathers and suedes on site, in the wet cleaning machine. This will allow the cleaner to expand the use of the wet cleaning machine while learning how to increase the amount and types of garments that can be wet cleaned.

INFORMATION DISSEMINATION

There needs to be an educational campaign to inform the public and dry cleaners about wet cleaning in order to facilitate its adoption. Elements of this effort include the following:

- Providing useful information on wet cleaning to a variety of interested stakeholders. Federal and state governments should act as information clearinghouses, referring dry cleaners to technical assistance, reference guides, manufacturers of wet cleaning equipment and sources of funding;
- Creating a guidebook designed to provide practical information about wet cleaning technologies and processes to cleaners who are considering adopting wet systems. It should include contact information for wet cleaning trainers, manufacturers, sales representatives, suppliers, and stores;
- Launching a consumer education campaign to provide the public with information about wet cleaning. This could help customers make more informed choices

about how their clothes are cleaned and develop a market for wet cleaning;

- Continuing and expanding workshops on wet cleaning. Dry cleaning associations, such as the Neighborhood Cleaners

Association, are already providing information and training workshops to their members on wet cleaning. Research and development should focus on improving the existing wet cleaning technology base because of its immediate benefits.

Summary of Findings of a Multicriteria Comparison of Perc Dry Cleaning and a Wet Cleaning System

Criteria	Perc Dry Cleaning	Wet Cleaning
Human Health	<ul style="list-style-type: none"> • Strong evidence suggests the human carcinogenicity and neurotoxicity of perc. 	<ul style="list-style-type: none"> • Little or no toxicity is associated with inputs to the cleaning process.
Environmental	<ul style="list-style-type: none"> • Perc is a chlorinated compound. Over 269 million pounds of perc were used by commercial U.S. dry cleaners in 1991. • Numerous problems are documented with respect to perc releases into air, land, and water. • Emission control technology is energy intensive. 	<ul style="list-style-type: none"> • There are minimal adverse impacts since principal inputs are water and nontoxic cleaning agents. • The process uses significantly more water. This could be partially mitigated through use of water recycling. • Machines require less energy to operate.
Performance (i.e. cleanliness and appearance of cleaned garments)	<ul style="list-style-type: none"> • Based on the limited testing of wet cleaning, both systems show advantages and disadvantages. Specific performance results are dependent upon fiber type, garment construction, machine technology, and process. • Both cleaning systems produce results which appear satisfactory to customers. 	
Economic	<ul style="list-style-type: none"> • Additional wet cleaning cost data is needed. • Preliminary analysis indicates that the two methods have roughly comparable costs and profits. • Estimates of the profitability of wet cleaning hinge on assumptions regarding wet cleaning's labor requirements. 	
Regulatory	<ul style="list-style-type: none"> • Many federal, state, and local regulations govern perc use and releases to air, land, and water. 	<ul style="list-style-type: none"> • Minimum regulatory burdens on professional cleaners exist.