Solvents used:

Glycol ethers (dipropylene glycol tertiary-butyl ether)

(Rynex, Solvair, Lyondell Impress) are in many cases more effective than perchloroethylene (perc) and in all cases more environmentally friendly. Dipropylene glycol tertiary butyl ether (DPTB) has a flashpoint far above current industry standards, yet at the same time possesses a degree of solvency for water-soluble stains that is at least equivalent to, and in most cases better than, perc and the other glycol ether dry cleaning solvents presently in commercial use. A particular advantage of the DPTB-water solutions of the Rynex product in dry cleaning is that they do not behave like a typical mixture, but, rather, the behavior is the same as a single substance. This permits a better-defined separation upon azeotropic distillation at a lower boiling point, facilitates reclamation more effectively (at a level of 99% or greater), and also enhances purification using conventional distillation techniques.

Hydrocarbon

is most like standard dry cleaning but the processes use hydrocarbon solvents such as Exxon-Mobil's DF-2000 or Chevron Phillips' EcoSolv. These petroleum-based solvents are less aggressive than perc and require a longer cleaning cycle. While flammable, these solvents do not present a high risk of fire or explosion when used properly. Hydrocarbon also contains volatile organic compounds (VOCs) that contribute to smog.[11]

Liquid silicone

(decamethylcyclopentasiloxane or D5) is gentler on garments than perc and does not cause color loss. Requires a license be obtained to utilize the property of GreenEarth Cleaning. Though considerably more environmentally friendly, the price of it is more than double that of perc and GreenEarth charges an annual affiliation fee.[12] Degrades within days in the environment to silica and trace amounts of water and CO_2. Produces nontoxic, nonhazardous waste. Toxicity tests by Dow Corning shows the solvent to increase the incidence of tumors in female rats (no effects were seen in male rats), but further research concluded that the effects observed in rats are not relevant to humans because the biological pathway that results in tumor formation is unique to rats.[13] (170.6 °F/77 °C flash point).

Modified hydrocarbon blends (Pure Dry)

Brominated Solvents n-Propyl Bromide (DrySolv).

Perchloroethylene

has been in use since the 1940s, perc is the most common solvent, the "standard" for cleaning performance, and most aggressive cleaner. It can cause color bleeding/loss, especially at higher temperatures, and may destroy special trims, buttons, and beads on some garments. Better for oil-based stains (which account for about 10% of stains) than more common water-soluble stains (coffee, wine, blood, etc.). Known for leaving a characteristic chemical smell on garments. Nonflammable. A recent study conducted at

Georgetown University shows perc, classified as carcinogenic to humans by the EPA, is retained in dry-cleaned clothes and that levels increase with repeat cleanings.[8]

Liquid CO_2 –

Consumer Reports rated this method superior to conventional methods, but the Drycleaning and Laundry Institute commented on its "fairly low cleaning ability" in a 2007 report. Another industry certification group, America's Best Cleaners, counts CO_2 cleaners among its members. Machinery is expensive—up to $90,000 more than a perc machine, making affordability difficult for small businesses. Some cleaners with these machines keep traditional machines on-site for the heavier soiled textiles, but others find plant enzymes to be equally effective and more environmentally sustainable. CO_2-cleaned clothing does not off-gas volatile compounds. CO_2 cleaning is also used for fire- and water-damage restoration due to its effectiveness in removing toxic residues, soot and associated odors of fire. The environmental impact is very low. Carbon dioxide is almost entirely nontoxic, it does not persist in clothing or in the environment, and its greenhouse gas potential is lower than that of many organic solvents.

Wet cleaning

is a system that uses water and biodegradable soap. Computer-controlled dryers and stretching machines ensure that the fabric retains its natural size and shape. Wet cleaning is claimed to clean a majority of "dry clean only" garments safely, including leather, suede, most tailored woolens, silk, and rayon. Most perc cleaners use wet cleaning on some garments, but there are only about 20 exclusive wetcleaners in the United States

European study evaluates drycleaning solvents

Developments in solvents, machine technology and detergents have given the drycleaning industry many good alternatives to perchloroethylene, according to a European study published by the International Committee of Textile Care (CINET), an umbrella organization that pools resources of national textile care associations.
The study, conducted by TKT, the Dutch technical center for the textile care industry, compared the cleaning performance of eight alternatives to perc. Although perc remains the most widely used drycleaning solvent in Europe and North America, CINET noted that "the pressure worldwide on the use of perchloroethylene is increasing more and more… therefore, the developments of good alternatives for perchloroethylene are of the utmost importance for the drycleaning industry."

Included in the "real-life testing" were perc, HCS (hydrocarbon), siloxane D5 (GreenEarth), liquid CO2, professional wetcleaning, dibutoxymethane (SolvonK4), glycol ether (Rynex) and the iPura processes that use D5 and hydrocarbon. N-Propyl Bromide, marketed in the U.S. as DrySolv and Fabrisolv, was not included in the European study.

The tests involved cleaning a mix of newly purchased garments and fabrics, each cleaned three times at drycleaning plants during regular working hours along with normal cleaning loads from customers. The garments were examined for shrinkage, pilling, stain removal and graying after cleaning.

Stain removal was evaluated strictly by solvent performance in the cleaning system; there was no pre- or post-spotting. These evaluations were rated on a 140-point scale with hydrocarbon set as the benchmark at 100. Perc topped the scale with a score of 140 and Rynex was a close second. SolvonK4 topped hydrocarbon with a 120 rating. GreenEarth and wetcleaning scored about the same as hydrocarbon. Of the iPura systems, the hydrocarbon one fared somewhat better than the GreenEarth version, scoring about 70 and 50 respectively. At the low end of the scale was CO2 with a score of about 20.
"We clearly see that perchloroethylene is still the best cleaning system with respect to stain removal," the study said. "The scores of wetcleaning and the two-bath processes of siloxane D5 and HCS are not too far apart, with a slight advantage for the two-bath processes of HCS and siloxane D5 over wetcleaning.
While CO2 lagged in the stain removal, it gave the best results for shrinkage after three cleaning cycles of test fabrics, showing less then .5 percent for both wool and cotton. At the other end of the scale was wetcleaning, showing nearly 5 percent shrinkage on wool and 3.5 percent on cotton.
Among the other processes, the scores were within a range of .5 percent to just over 1 percent on cottons and .5 percent to 2.5 percent on wools.

When shrinkage of test garments was evaluated, CO2 again came out on top with wetcleaning showing the highest shrinkage at 2 percent. The higher shrinkage score for wetcleaning was largely attributable to a 100-percent wool sweater in the garment mix, the report said. Without that, its results would have been closer to the others which were all less than 1 percent.

Shrinkage was evaluated directly after the cleaning process and without a finishing step which could affect results, particularly in wetcleaning.
Wool and cotton test fabrics were also examined for graying. The results were generally similar. The iPura hydrocarbon system showed the most greying; wetcleaning showed the least.

Wrinkling was reported as problematic only with the men's suit in the wetcleaning process. However, the wrinkles were "shallow" and easily removed in finishing.

"Pilling and roughening are difficult to measure, so one has to rely on visual observations," the report said. "As to be expected, some pilling and roughening was seen on the sweater (100 percent wool) in the wetcleaning process. Due to the long drying times, a slight roughening was seen after the siloxane D5 process. With all other cleaning processes, no pilling was observed."

The study found no changes in color for all tested solvents and machine technologies. A decrease in shine was noted on the men's suit after wetcleaning.
Zippers were more difficult to open and close after cleaning in K4 and Rynex, the report noted.

And as for odor? "There was hardly any scent detectable on the garments at the time of analyzing the results (several days after cleaning and finishing the garments)," the report said. "If we put the results in a historical context, it is to be expected that the results for perc (and to a lesser extent for hydrocarbon) have not changed dramatically over the last 15 years as they are mature cleaning technologies," the report said. "These two are the well-established cleaning technologies with which we have compared wetcleaning and the solvent-based alternative technologies."

In its overview of the newer technologies, the CINET report said the following:

Glycol ether (Rynex) showed good results with respect to stain removal and graying, but somewhat more graying than with perc and hydrocarbon. The stain removal is very close to that of perc and shrinkage with test fabrics was comparable to perc and hydrocarbon. Hardly any pilling or roughening was seen on the test fabrics.
"It must be noted that this solvent was tested on a somewhat older multisolvent machine where the drying process was not optimized," the report cautioned.

Siloxane D5. Further improvements might be expected. Due to the nature of the solvent, which is less volatile than perc and hydrocarbon, improvements of the drying process could help.
"The long drying times tend to damage the textiles slightly more than with perc or hydrocarbon. The overall performance of the siloxane D5 bath process with respect to shrinkage and stain removal are on a good level and are comparable to perc and hydrocarbon."

The iPura processes using D5 and hydrocarbon "are interesting from a technological point of view, due to low solvent amounts in the machine and claimed energy savings," the report said.

Both iPura processes show shrinkage that is comparable or less compared to perc and hydrocarbon, the report noted, but the stain removal of both iPura processes "clearly lags behind the bath processes with the same solvents." Also, the study shows that the iPura hydrocarbon process has "rather high graying values."

CO2 "needs strong improvement of detergents, as the stain removal and the graying, which is the job of the detergent, clearly lag behind the other technologies. With respect to the care aspect for the garments, liquid carbon dioxide gives excellent results."

Dibutoxymethane (Solvon K4) shows good stain removal almost on the same level as perc. The shrinkage with test fabrics was somewhat higher with cotton compared to perc and hydrocarbon but was lower with wool. With garments, the average shrinkage is comparable to that of perc and hydrocarbon. Graying was comparable to that of perc and hydrocarbon with cotton and somewhat higher with wool. Hardly any pilling or roughening was seen on the test cloths.
"Interesting is the claimed biodegradability of the solvent, which is a novelty," the report noted.

Wetcleaning has seen many improvements in machine technology, drying technology and detergents over the last 20 years. Its stain removal shows a different profile compared to the non-polar solvents, yet the overall score is comparable to hydrocarbon. This means that different stains need pre- or post-spotting compared to the solvent-based technologies. Knitted woolen articles are not suited for wetcleaning due to shrinkage and pilling/roughening, the report said, but other articles that show somewhat more shrinkage directly after the cleaning process compared to solvent based cleaning can be resolved by the finishing process.

Conclusion
Drycleaning industry can choose from many good alternatives for perc, the report concluded. "The alternative solvents and machine technologies cover the entire spectrum of textiles that the drycleaner receives from customers and show a much more favorable environmental profile compared to perc whereas the performance is comparable to perc. This offers many chances to improve the sustainability and the image of the sector without jeopardizing the quality and service."