IC2 Webinar: Safer Alternatives to Perchloroethylene in Garment Care

2018-04-03
Webinar Logistics

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• Attendee lines muted during presentation; I will unmute for Q&A
• You may also submit questions using GoToWebinar’s questions interface at any time
• Webinar slides will be posted on http://theic2.org/events
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Today’s Presenters

• Joy Onasch, Business & Industry Program Manager, TURI
• Ashley Pedersen, Policy Liaison, King County LHWMP
• Steve Whittaker, Ph.D.; Research Services Program Manager; King County LHWMP
Upcoming IC2 Webinars

IC2-BizNGO Webinar: The Chemical Hazard Data Commons
Wednesday, April 18, 1:00 - 2:00 PM EDT/10:00 - 11:00 AM PDT
https://attendee.gotowebinar.com/register/5690285324587364097
Alternatives to Perchloroethylene In Garment Care

IC2 Webinar - April 3, 2018

Joy Onasch, P.E.
Business & Industry Program Manager
What is Perc and Why is it a Problem?

Able to dissolve most organic materials, perchloroethylene (PCE or perc) is the most widely used dry cleaning solvent in Massachusetts and nationally.

A typical dry cleaning machine...

Throug perc machines have improved emissions over time, there is still exposure to workers and the public through co-located residences and clothes taken home.
Short and long term health effects linked to use of perc include:

- Dizziness, confusion
- Damage to liver & kidneys
- Neurotoxicity
- Reproductive toxicity
- Developmental toxicity
- Cancer

Misuse of perc can lead to soil and groundwater contamination.

75% of drycleaner sites in the US are contaminated.

Many are Superfund sites.
Alternatives Studied

- Wet cleaning
- CO$_2$
- High flash point hydrocarbons
- Acetals
- Propylene-glycol ethers
- Volatile methyl siloxanes
- n-Propyl bromide
Key Criteria – 1st set

Technical/Performance
- Cycle time and load capacity
- Difficult materials
- Pretreatment and finishing requirements

Economic
- Equipment costs
- Chemical costs
- Energy costs
<table>
<thead>
<tr>
<th>Key Assessment Criteria</th>
<th>Perc (reference)</th>
<th>Wet Cleaning</th>
<th>Carbon Dioxide</th>
<th>Flashpoint Hydrocarbons</th>
<th>Acetal</th>
<th>Propylene Glycol Ethers</th>
<th>Siloxane</th>
<th>n Propyl Bromide</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common Trade Names / Manufacturers of Equipment or Solvents</strong></td>
<td>Wascomat, Miele, Continental, HwaSung, Aquasolo</td>
<td>Cool Clean Technologies, Solvair®</td>
<td>DF2000™ Fluid, EcoSolv®, ShellSol D60, Caled Hydroclene</td>
<td>Solvair®, Rynex 3®, Impress®, Gen-X®</td>
<td>Green Earth® DS solvent</td>
<td>Drysolv®, Fabrisolv™ XL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Technical/Performance² | Cycle time (min) | 45 | 20-40 | 35-45 | 60-75 | 60-65 | >45 | 53-58 | 45 |
| Load capacity (lb) | 50 | 20-75 | 60 | 35-90 | 40-90 | 43 | 55 | 50 |
| Materials system may have difficulty with | Leather, suedes, beads, delicates | Leather, suede and fur | Triacetates, specially dyed acetates | Vinyl appliqués | Appliques or decorations glued to fabric | None identified | None identified | Leather, suedes, beads, delicates |
| Spotting requirements | Moderate | Low | High | Moderate | Low | Low | High | Low |
| Equipment | $40,000 - $65,000 | $36,000 - $61,000 | $100,000 - >$150,000 | $38,000 - $75,000 | $50,000 - $100,000 | $56,000 | $30,500 - $55,000 | $40,000 - $60,000 or retrofit costs |
| Chemical cost per gallon | $17 | $0.007/gal (water); $25-$31/gal (detergent) | $0.18/lb (CO₂); $40/gal (detergent) | $14-$17 | $28-$34 | $25-$30 | $22-$28 | $40-$64 |
| Electricity usage³ (kWh/100 lb) | 26.6 | 9.3 | 30.9 | Similar to hydrocarbon | Unavailable | 54.2 | Unavailable |
| Typical cost per pound cleaned⁴ | $0.63-$1.94 avg. $1.02 | $0.57-$1.32 avg. $1.10 | $1.40 | $0.73-$1.02 avg. $0.88 | Unavailable | $1.14 | $1.08-$2.33 avg. $1.71 | Unavailable |
Are Alternatives Effective and Affordable?

**All** options are technically feasible
Some may have impact on throughput
Some have limitations on the fabrics they can handle

**Most** options are affordable
$\text{CO}_2$-based options not economically feasible
(for majority of smaller MA shops)
Key Criteria – 2nd set

Environmental
- Persistence
- Bioaccumulation
- Aquatic Toxicity

Health and Safety
- Exposure limits
- CNS effects
- Carcinogenicity
- Repro/developmental toxicity
- Flammability
<table>
<thead>
<tr>
<th>Key Assessment Criteria</th>
<th>Perc</th>
<th>Wet Cleaning</th>
<th>Carbon Dioxide</th>
<th>Flashpoint Hydrocarbons</th>
<th>Acetal</th>
<th>Propylene Glycol Ethers</th>
<th>Siloxane</th>
<th>n-Propyl Bromide</th>
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</thead>
<tbody>
<tr>
<td><strong>Environmental</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistence&lt;sup&gt;5&lt;/sup&gt; (water, soil, sediment, air)</td>
<td>M (water), H (soil, sed, air)</td>
<td>L (water, soil, air), M (sed)</td>
<td>NA</td>
<td>L (water, soil, air), M (sed)</td>
<td>L (water, soil, air), M (sed)</td>
<td>L (water, soil, air), M (sed)</td>
<td>L (water, soil, air), M (sed)</td>
<td>L (water, soil, air), M (sed), H (air)</td>
</tr>
<tr>
<td>Bioaccumulation&lt;sup&gt;6&lt;/sup&gt;</td>
<td>Low</td>
<td>Low</td>
<td>NA</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Aquatic Toxicity&lt;sup&gt;7&lt;/sup&gt;</td>
<td>Moderate</td>
<td>Low to Moderate&lt;sup&gt;8&lt;/sup&gt;</td>
<td>Low</td>
<td>High</td>
<td>Moderate&lt;sup&gt;9&lt;/sup&gt;</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Recommended Exposure limits&lt;sup&gt;10&lt;/sup&gt;</td>
<td>25 ppm</td>
<td>NE</td>
<td>5000 ppm</td>
<td>100 ppm&lt;sup&gt;11&lt;/sup&gt;</td>
<td>NE</td>
<td>NE</td>
<td>10 ppm&lt;sup&gt;12&lt;/sup&gt;</td>
<td>10 ppm</td>
</tr>
<tr>
<td>Central Nervous System Effects</td>
<td>Yes</td>
<td>No&lt;sup&gt;13&lt;/sup&gt;</td>
<td>No&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Yes</td>
<td>No data available</td>
<td>Yes</td>
<td>Some evidence</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Human Health</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Carcinogenicity</td>
<td>IARC Probable human carcinogen</td>
<td>Not classified by IARC</td>
<td>Not classified by IARC</td>
<td>Not classified by IARC</td>
<td>Not classified by IARC</td>
<td>Not classified by IARC</td>
<td>Some evidence</td>
<td>Clear evidence in animal studies by NTP</td>
</tr>
<tr>
<td>Reproductive / Developmental Toxicity</td>
<td>Yes</td>
<td>Negligible&lt;sup&gt;15&lt;/sup&gt;</td>
<td>No data available</td>
<td>No data available</td>
<td>No data available</td>
<td>No data available</td>
<td>Studies indicate concern</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Point/Flammability</td>
<td>NA / Not Flammable</td>
<td>NA / Not Flammable</td>
<td>NA / Not Flammable</td>
<td>140-145°F / Combustible liquid</td>
<td>144°F / Combustible liquid</td>
<td>160-212°F / Combustible liquid</td>
<td>171°F / Combustible liquid</td>
<td>NA&lt;sup&gt;17&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Are the Alternatives Safer than Perc?

All are less persistent; HC and Siloxanes are more bioaccumulative and toxic in aquatic environment

Most are safer to humans ... **EXCEPT** ...
- nPB is carcinogenic, reproductive toxic and neurotoxic – **NOT** a safer alternative
- **Data gaps** present concern for alternatives that are new to the market (e.g., Solvon K4 acetals)
Key Criteria – 3rd set: Applicable Regulations

- Hazardous Air Pollutants
- Designated VOCs
- Massachusetts regulations
  - Listed toxics under TURA
  - Environmental Results Program
- Hazardous waste disposal issues
- Wastewater discharge restrictions
<table>
<thead>
<tr>
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<th>n-Propyl Bromide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Air Act Hazardous Air Pollutant (HAP)</td>
<td>Yes, HAP</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Clean Air Act NAAQS VOC</td>
<td>No, Exempt</td>
<td>No</td>
<td>No</td>
<td>VOC</td>
<td>VOC</td>
<td>VOC</td>
<td>No, Exempt</td>
<td>VOC</td>
</tr>
<tr>
<td>Massachusetts regulated (TURA, ERP)</td>
<td>TURA Higher Hazard Substance, ERP</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>TURA</td>
</tr>
<tr>
<td>Hazardous waste disposal required</td>
<td>Yes - Listed hazardous waste</td>
<td>No</td>
<td>No</td>
<td>Yes Waste Oil = Hazardous Waste in MA</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Wastewater discharge restrictions</td>
<td>No</td>
<td>Discharge to sewer or holding tank</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Are the Alternatives More Regulated than Perc?

- **Most** options are combustible or flammable, requiring additional control for safety.

- **Several** options are VOCs.

- **Most** options involve industrial waste disposal, though not hazardous waste disposal.

- **Wet Cleaning** poses issues for facilities on septic.

- **nPb** newly regulated under TURA and is a higher hazard substance!
Wet Cleaning and CO2 are considered the most environmentally friendly options. Wet Cleaning technology is the more affordable of the two.

Washer and dryer use biodegradable detergents and conditioners

Finishing equipment re-shapes and dries the slightly damp clothes
MA Conversions to Wet Cleaning

From 2008 through 2018 TURI has given 19 grants to dry cleaners to eliminate the use of perc and switch to dedicated professional wet cleaning

- Cleaners save money on solvent, waste, water, and electricity
- Cleaners are fully satisfied with the process and product; there is less regulatory oversight and risk of contamination
- The work environment is greatly improved
- Customers are very pleased with quality
KMK Cleaners in Walpole Creates Healthier Workplace

- 40% reduction in electricity costs
- Greater than 50% drop in water use
- Saving about $1,500 per month in operating costs

“As a family run business, we’ve been interested in getting away from perc for quite a while, and professional wet cleaning was the right answer. It makes the shop a healthier place for my Dad and me, our employees, and for future generations.” – Kristy Mead, Manager, KMK Cleaners
AB Cleaners in Westwood Creates Safer Work Environment with Improved Quality

- Reduced electric use by almost 30%
- Reduced water use by over 50%
- Saving over $400 per month in operating costs

“We knew that perc was not good for us. I was concerned for the health of my pregnant wife and baby and also for my employees. With wet cleaning, there has been a huge improvement in the way the air smells and the clothes come out cleaner without any shrinkage or the feel of chemicals.” – Joon Han, owner of AB Cleaners
Business & Industry Program Manager: Joy Onasch
Phone: 978-934-4343
Email: joy@turi.org
Web: www.turi.org/drycleaning
Helping dry cleaners switch from PERC to professional wet cleaning

Ashley Pedersen, Policy Liaison
Local Hazardous Waste Management Program in King County, WA

IC2 Presentation
April 3, 2018
# Federal Changes = Local Opportunities

<table>
<thead>
<tr>
<th>Federal Changes</th>
<th>Local Risks</th>
<th>Local Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>New chemical review process</td>
<td>Insufficiently protective regulations</td>
<td>Local review, prioritization, and action on key chemicals of concern</td>
</tr>
<tr>
<td>EPA’s final decisions will preempt local and state regulations</td>
<td>Regrettable substitution (chemical &quot;whack-a-mole&quot;)</td>
<td>EPA creates the ‘sticks’ and LHWMP creates the ‘carrots’ for positive change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LHWMP is uniquely positioned to work with businesses and residents</td>
</tr>
</tbody>
</table>

Graphic: [nrdc.org](http://nrdc.org)
### Chemicals being reviewed by EPA

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Health impacts</th>
<th>Examples of uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,4-dioxane</td>
<td>Cancer</td>
<td>Dyes, varnishes, waxes</td>
</tr>
<tr>
<td>1-bromopropane</td>
<td>Cancer, developmental and reproductive effects</td>
<td>Foam cushions, dry cleaning</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Cancer</td>
<td>Insulation, brake pads</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>Cancer</td>
<td>Industrial uses</td>
</tr>
<tr>
<td>Cyclic Aliphatic Bromide Cluster</td>
<td>Developmental effects</td>
<td>Flame retardant, insulation</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>Cancer, developmental effects</td>
<td>Paint stripper</td>
</tr>
<tr>
<td>N-methylpyrrolidone</td>
<td>Developmental and reproductive effects</td>
<td>Paint stripper</td>
</tr>
<tr>
<td>Pigment Violet 29</td>
<td>Harms aquatic organisms</td>
<td>Dye for paints and plastics</td>
</tr>
<tr>
<td><strong>Perchloroethylene (PERC)</strong></td>
<td>Cancer</td>
<td>Dry cleaning, spot removers</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>Cancer, developmental and reproductive effects</td>
<td>Dry cleaning and degreasers</td>
</tr>
</tbody>
</table>
EPA Scope of Risk Evaluation

2020:
PERC dry cleaning machines prohibited from co-location in residential buildings.

2021:
EPA is expected to ban or restrict PERC usage in dry cleaning facilities.

The problem with PERC

- probable human carcinogen
- contaminates groundwater, surface water, and soil
By the Numbers: PERC in King County

~90 PERC dry cleaners

15 years
recommended life span of PERC machines

18 years
median age of PERC machines in King County

189 sites
contaminated by PERC
Professional Wet Cleaning

- effective
- safer for workers
- safer for the environment
- uses less energy
- saves money

Washer Machine

Metering System
<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Jurisdiction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrations</td>
<td>Educational or pilot programs that target local businesses</td>
<td>California, New York, Massachusetts, South Coast Air Quality Mgmt. Distr. (SCAQMD)</td>
</tr>
<tr>
<td>Financial Assistance</td>
<td>Grants intended to help dry cleaning shops switch to alternative solvents</td>
<td>California, New York, Massachusetts, SCAQMD, City of Philadelphia</td>
</tr>
<tr>
<td>Ban</td>
<td>Phase-out or complete ban of PERC at different levels of jurisdiction</td>
<td>California, SCAQMD, Philadelphia, Minneapolis</td>
</tr>
<tr>
<td>Signage</td>
<td>“Right to know” legislation requiring signage of chemical usage in dry cleaning businesses.</td>
<td>New York, Massachusetts</td>
</tr>
</tbody>
</table>
Grant Program

Goal: A PERC-free King County

- 2017 Research
- 2018 Pilot
- Review and revise
- 2019 Launch

Thinking about buying new dry cleaning equipment?

WE ARE OFFERING $20,000 in grants to help you replace your perchloroethylene (PERC) dry cleaning machine with professional wet cleaning equipment.

Grant Recipients Must

- Be located in King County and use a PERC dry cleaning machine
- Clean out and dispose of your PERC machine safely
- Buy and install a professional wet cleaning system, including new detergents and spot cleaners
- Dispose of your old detergents, spot cleaners, and other chemicals you used with your PERC machine (we can help you dispose of these for free)
- Allow us to verify that you have disposed of your old machine and chemicals properly and that your new chemicals are relatively safe

Wet Cleaning Benefits

- Safer for the environment
- Safer for worker health
- Savings in utility costs

For more information contact Patrick Hoermann:

206-263-1658  Patrick.Hoermann@kingcounty.gov

We made the switch to wet cleaning and are very happy with the results. There has been a huge improvement in the way the air smells and the clothes come out cleaner without any shrinkage or the feel of chemicals.

-John Hen, Owner, AB Cleaners, Westwood, Massachusetts

82% of people in King County prefer environmentally-friendly businesses

Eligibility for Environmentally-friendly businesses

Alternative Formats Available

206-263-1650  TTY Relay: 711
Thank You!

Ashley Pedersen
Local Hazardous Waste Management
Policy Liaison

ashley.pedersen@kingcounty.gov | 206.477.3761
www.hazwastehelp.org
What do we know about “hydrocarbon” dry cleaning solvents?

Steve Whittaker, Ph.D.
Research Services Program Manager
Local Hazardous Waste Management Program in
King County, WA

IC2 Presentation
April 3, 2018
Outline

• LHWMP’s survey & field work
• What are “hydrocarbons”?
• Hazard evaluation
• Classification systems
• Manufacture
• Specifications
• Chemical analysis
• The Good and The Bad
LHWMP’s survey & field work (2010-2012)

- 69% dry cleaners in King County using PERC
- 21% using “hydrocarbon”:
  - The alternative of choice
  - Usage increasing
  - Separator water may be discharged to sewer (with permit)
- Still bottoms are Dangerous Waste (DW) in WA (but not EHW)
What are “hydrocarbon” dry cleaning solvents?

- C10-C13 isoparaffinic naphthas / isoalkanes
- Class IIIA liquids (flash point 140-150 °F)
- Products:
  - Exxon Mobil DF-2000 – most common in WA & MA
  - Chevron Philips EcoSolv
  - Technichem Calypsol
  - Others – but not available in King County
Hazard evaluation of “hydrocarbon” solvents

DF-2000:
CAS# 64742-48-9
How toxic are “hydrocarbon” solvents?

• Mckee et al. (2015):
  • 64742-48-9: “...consists of hydrocarbons having carbon numbers predominantly in the 6–13 range and boiling in the range of approximately 65 to 230°C.”

  • “The composition and physical properties of this substance can vary considerably, depending on the raw material and the production processes”

• Official Journal of the EU (2006):
  • “The classification as a carcinogen need not apply if it can be shown that the substance contains less than 0.1% w/w benzene”
Classifying products: CAS# vs. EC#

- **CAS#**
  - Non-specific
  - May reflect feedstock, *not product*

- **EC#**
  - Designed by API for EU REACH
  - Specific to final product
  - EC# 920-901-0 = Hydrocarbons, C11-C13, isoalkanes, <2% aromatics
Manufacturing Isoalkane Dry Cleaning Solvents (High Flash “Hydrocarbons”)

- Petroleum distillate feedstock
- OR
- “Synthetic” olefin feedstock (aromatic-free)

Oligomerization of lower olefins, followed by fractionation

Hydrogenation

Aromatic-free intermediate

Fractionation

C10-C12 Isoalkanes
C11-C13 Isoalkanes
C12-C16 Isoalkanes
# DF-2000™ Fluid

Dry Cleaning Fluid

<table>
<thead>
<tr>
<th>Properties</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Unit</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Pass</td>
<td></td>
<td>-</td>
<td>VISUAL</td>
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<tr>
<td><strong>Aromatic Content</strong></td>
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<td>0.02</td>
<td>wt%</td>
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<td>Odor, Bulk</td>
<td>Pass</td>
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<td>BTQAL 018</td>
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<td>Color, Saybolt</td>
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<td></td>
<td>-</td>
<td>ASTM D6045</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ASTM D156</td>
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<tr>
<td>Flash Point</td>
<td>60</td>
<td></td>
<td>°C</td>
<td>ASTM D56</td>
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<tr>
<td>Specific Gravity @ 15.6/15.6 °C</td>
<td>0.760</td>
<td>0.775</td>
<td>-</td>
<td>ASTM D4052</td>
</tr>
</tbody>
</table>
**Name of Product**
ECOSOLV DRY CLEANING FLUID

**Revision Date**
3/26/2012

Chevron Phillips Chemical Company LP
10001 Six Pines Drive
The Woodlands, TX 77380
800-858-4327
Technical Service: 882-813-4862

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+32 (0) 2 699 12 11

Chevron Phillips Chemicals Asia PTE Ltd.
5 Temasek Boulevard
06-01 Suntec Tower Five
Singapore 038985
+65 6337 9700

<table>
<thead>
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<th>Test</th>
<th>Units</th>
<th>Method</th>
<th>Typical</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Qualitative</th>
<th>Note</th>
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<tbody>
<tr>
<td>Acidity of Dist Residue</td>
<td>---</td>
<td>ASTM D-1093</td>
<td>Neutral</td>
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<td>---</td>
<td>Neutral</td>
<td>---</td>
</tr>
<tr>
<td>Appearance</td>
<td>---</td>
<td>Visual</td>
<td>Clear with no particulate matter</td>
<td>---</td>
<td>---</td>
<td>Clear with no particulate matter</td>
<td>---</td>
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<tr>
<td>Aromatics</td>
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<td>---</td>
<td>100</td>
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<td>Distillation - DP</td>
<td>FAH</td>
<td>ASTM D-86</td>
<td>406</td>
<td>410</td>
<td>---</td>
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<tr>
<td>Distillation - IBP</td>
<td>FAH</td>
<td>ASTM D-86</td>
<td>374</td>
<td>355</td>
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<tr>
<td>Flash Point, TCC</td>
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<td>ASTM D-56</td>
<td>145</td>
<td>142</td>
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<tr>
<td>Odor</td>
<td>---</td>
<td>Smell</td>
<td>Pass</td>
<td>---</td>
<td>---</td>
<td>Pass</td>
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</tr>
<tr>
<td>Saybolt Color</td>
<td>SAY</td>
<td>ASTM D-6045</td>
<td>30</td>
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<tr>
<td>Specific Gravity 60/60</td>
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<td>ASTM D-4052</td>
<td>0.7635</td>
<td>0.7580</td>
<td>0.7680</td>
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## TECHNICAL DATASHEET: CALYSOLV™ HC

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Method</th>
<th>Value</th>
<th>Qualitative/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>---</td>
<td>Visual</td>
<td>---</td>
<td>Clean with no particular matter</td>
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<tr>
<td>Paraffins</td>
<td>%</td>
<td>GC</td>
<td>&gt;99</td>
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<tr>
<td>Aromatics</td>
<td>ppm</td>
<td>ASTM E169</td>
<td>40</td>
<td>Typical</td>
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<tr>
<td>Benzene</td>
<td>ppm</td>
<td>GC</td>
<td>&lt;3</td>
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<tr>
<td>Sulfur</td>
<td>ppm</td>
<td>ISO 20846</td>
<td>&lt;0.5</td>
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<td>Bromine Index</td>
<td>mg Br/100g</td>
<td>ASTM D1159</td>
<td>0.01</td>
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<td>Corrosion (3hrs@ 100 °C)</td>
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<td>ASTM D130</td>
<td>1A</td>
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<tr>
<td>Distillation, Initial Boiling Point</td>
<td>c°/°F</td>
<td>ASTM D86</td>
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<td>Distillation, Dry Point</td>
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<td>ASTM D86</td>
<td>210/410</td>
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<td>Aniline Point</td>
<td>c°/°F</td>
<td>ASTM D611</td>
<td>85/185</td>
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<tr>
<td>Odor</td>
<td>---</td>
<td>Smell</td>
<td>---</td>
<td>Pass</td>
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<tr>
<td>Color</td>
<td>Saybolt</td>
<td>ASTM D156</td>
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<td>Relative Evaporation Rate (nBuAc=1)</td>
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<td>ASTM D3539</td>
<td>0.08</td>
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<tr>
<td>Vapor Pressure @20 °C</td>
<td>kPa</td>
<td>Calculated</td>
<td>0.11</td>
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<tr>
<td>Kauri-Butanol Value</td>
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<td>ASTM D1133</td>
<td>26</td>
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<tr>
<td>Viscosity @ 25 °C</td>
<td>mm²/s</td>
<td>ASTM D445</td>
<td>1.9</td>
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<tr>
<td>Specific Gravity</td>
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<td>ASTM D4052</td>
<td>0.7632</td>
<td>Typical</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>g/mol</td>
<td>Calculated</td>
<td>171</td>
<td>---</td>
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</tbody>
</table>
Chemical analyses (2018)

- Purchased multiple 5-gallon lots of DF-2000 and EcoSolv from local supplier
- One sample of Calypsolv donated
- EPA Method 624 - GC/MS for VOCs
  - Determine presence of BTEX (MDL = 1 µg/L)
  - Identify isoalkane peaks
Chevron Phillips Ecosolv

- Ethylene (16 mins)
- Xylenes (16-17 mins)
- Toluene (13 mins)
- Ethylbenzene (16 mins)
- 2,4-Di-tert-butyltoluene
- n-Butylbenzene
- p-tert-butyltoluene
- m-tert-butyltoluene
- Benzene (9 mins)
- n-Heptane
- n-Pentane

Isoalkanes
The Good

- Sampled solvents BTEX-free
- Manufacturers specify low aromatic hydrocarbon content, including benzene
- Not toxic to fish
- Largely immiscible with water
- Separator water may be discharged to sewer in King County (with permit)
- Filtration (rather than distillation) available
- Cleans well – less aggressive than PERC
- Low odor
- Very low airborne exposures
- Community acceptance
The Bad

- They are petroleum hydrocarbons
- Flammable (Class IIIA solvent)
  - Fire suppression systems may be needed
- Bacterial growth
- Used with PERC spot cleaning products
- Occasionally use PERC process chemicals
- Generate a hazardous waste (still bottoms)
- Volatile Chemical Products - air quality impacts
- Expensive (compared to wet cleaning)
- Greenwashing
Contributors

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• Myles Perkins – Department of Ecology
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• Steve Whittaker – LHWMP Research Services Team
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• Industry representatives who requested anonymity
Dry cleaners

We work with King County dry cleaners to help them use fewer toxic chemicals. Dry cleaners use many chemicals that can harm the people who use them as well as the environment.

- Spot cleaning products can contain powerful acids and hazardous organic solvents.
- The most commonly used dry cleaning solvent is perchloroethylene (or "PERC").
- PERC is believed to cause cancer and can harm the nervous system, the liver, and the thyroid.

Survey results

In 2010, we sent a questionnaire to every dry cleaner in King County. Here are highlights of the survey. Of the people who filled out the questionnaire:

- 88% were Korean.
- 81% wanted technical information in Korean.
- 69% used the chemical perchloroethylene (PERC) and 21% used an alternative hydrocarbon solvent.
- 75% did not know that PERC is harmful to their health.
- 78% of those who used PERC machines said costs prevent them from replacing their PERC machines.
- 61% did not adequately protect their lungs when cleaning out still bottoms.
- Of PERC machine users, less than 40% used a leak detector. Environmental Protection Agency regulations require the use of a leak detector.
- 60% disposed of their still bottoms as hazardous waste. This suggests that most comply with hazardous waste regulations.
- 85% shared a business with a business that sells or serves food. This is a concern because fatty foods absorb PERC.
References


Fish bioassays: LC50s (2018)

- DF2000: >5,000 mg/L
- Ecosolv: >100 mg/L
- Calypsolv: >100 mg/L

(PERC: 3.6 mg/L)
(Solvon K4: 46 mg/L)
Exposure monitoring with NIOSH (2013)

Table E4. Results of personal air samples collected over the work shift, DF-2000 drycleaning shop A, May 2–3, 2013

<table>
<thead>
<tr>
<th>Main tasks</th>
<th>DF-2000 concentration (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner/Operator</td>
<td>Unloading and loading</td>
</tr>
<tr>
<td>Day 1</td>
<td>1.4</td>
</tr>
<tr>
<td>Day 2</td>
<td>0.99</td>
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</tbody>
</table>

Table E5. Results of personal air samples collected during short-term work tasks, DF-2000 drycleaning Shop A, May 2–3, 2013

<table>
<thead>
<tr>
<th>Main tasks</th>
<th>Duration of task (minutes)</th>
<th>DF-2000 concentration (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner/Operator</td>
<td>Loading, washing cycle, and unloading Cleaning still</td>
<td>235</td>
</tr>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employee A</td>
<td>Pressing and ironing shirts</td>
<td>Day 1</td>
</tr>
<tr>
<td>Day 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*For this sample, the MDC was 3.8 mg/m³.

Occupational Exposure Limit: 300 mg/m³ (DFG MAK)
The Training Workgroup continues to plan additional webinars intended to inform and engage. Let us know if you have ideas for future webinar topics or presenters.

Please give us your feedback through the post-webinar survey.
Thank you for attending.