2024 National Pollution Prevention Training and Conference

Exploring Alternatives to Methylene Chloride: Paint Stripping, Furniture Refinishing, and More

December 10, 2024
1:00 – 2:15PM ET

Moderated by Joel Tickner, Change Chemistry and UMass Lowell

Speakers:

- **Joel Tickner, Change Chemistry and University of Massachusetts Lowell**
- **Greg Morose, Toxics Use Reduction Institute, University of Massachusetts Lowell**
- **Katy Wolf, Consultant and Former Director of the Institute for Research and Technical Assistance (IRTA)**

December 10, 2024

Advancing safer alternatives to methylene chloride and other chemicals of concern

Joel A. Tickner, ScD

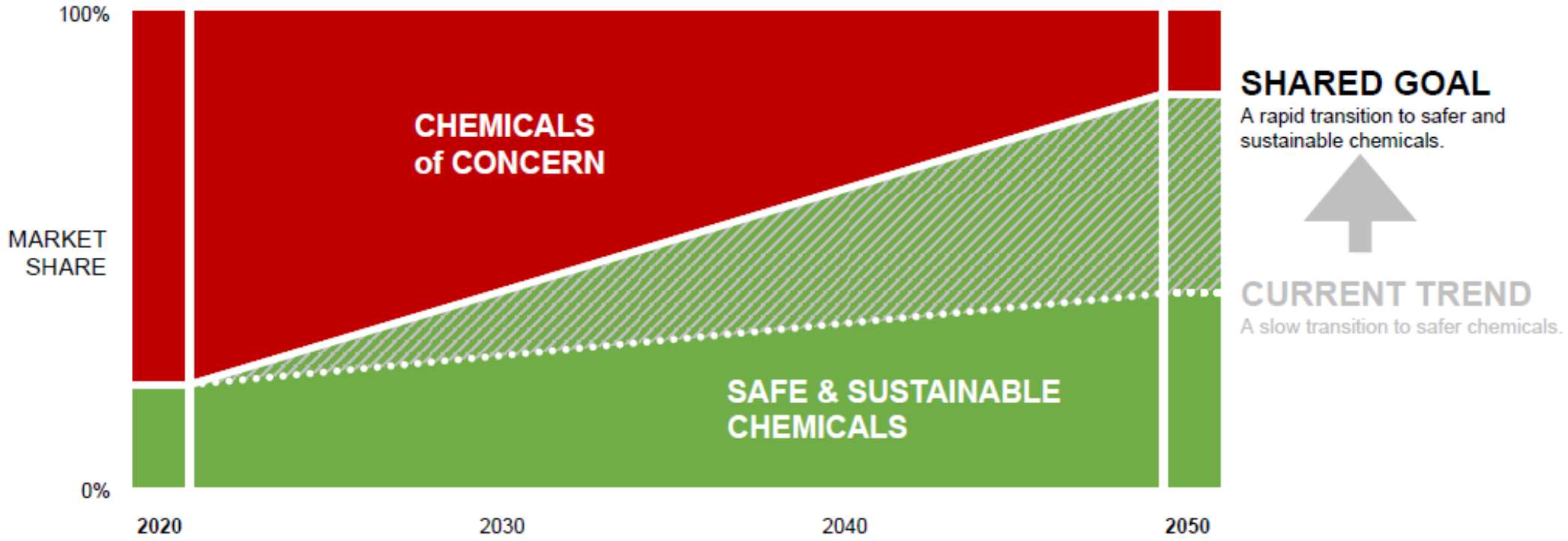
Sustainable Chemistry Catalyst

UMass Lowell

Three take-home points

- Restricting TSCA chemicals requires equal emphasis on supporting safer alternatives.
- Given the limited number of TSCA chemicals that are likely to be regulated, clarity as to what are potentially regrettable and safer substitutes is needed.
- Transitioning to safer chemicals can be complicated and requires a thoughtful approach that addresses needs along the value chain-- adequate timeframes, signaling, incentivization, and support are needed.

We won’t chemicals of concern and their impacts without safer alternatives at scale



FACT SHEET
2024 Final Risk Management Rule for Methylene Chloride under TSCA

EPA

What is methylene chloride?

Methylene chloride – also called dichloromethane or DCM – is a colorless liquid and a volatile chemical with a sweet odor. The solvent is used in a variety of consumer and commercial applications, including adhesives and sealants, automotive products, and paint and coating removers.

In April 2024, EPA issued a final rule regulating methylene chloride under the Toxic Substances Control Act (TSCA) to protect human health from health risks such as neurotoxicity effects and cancer from inhalation or dermal exposures.

Who is subject to the methylene chloride regulation?

Anyone who manufactures (including imports), processes, distributes in commerce, uses, or disposes of methylene chloride or products containing methylene chloride may be impacted by EPA's regulation of the chemical. The table below is a summary of key points; full details are in the final rule.

What is the methylene chloride regulation[1] under TSCA?

Workplace Chemical Protection Program

A workplace chemical protection program (WCPP) is required in order to continue 13 conditions of use of methylene chloride. These uses include:

1. Domestic manufacturing
2. Import
3. Processing as a reactant
4. Processing in incorporation into formulation, mixture, or reaction product
5. Processing in repackaging
6. Processing in recycling
7. Use as a laboratory chemical.
8. Use in paint and coating removers for safety critical, corrosion-sensitive components of aircraft and spacecraft
9. Use as a bonding agent for solvent welding
10. Industrial and commercial use as a processing aid
11. Use for plastic and rubber products manufacturing
12. Use as a solvent that becomes part of a formulation or mixture where the formulation or mixture will be used inside a manufacturing process and the solvent (methylene chloride) will be reclaimed
13. Disposal

The WCPP requires that owners and operators of facilities using methylene chloride take appropriate measures to meet new inhalation exposure limits (including 2 ppm as an 8-hour time weighted average) and develop and implement an exposure control plan, among other requirements.

Prohibitions for Consumer Uses

Distributing methylene chloride for consumer use is prohibited after **May 5, 2025.**

Prohibitions for Commercial Uses[2]

Most commercial uses are prohibited after **April 28, 2026.**

Commercial Furniture Refinishing

Methylene chloride may be used for only very specific furniture refinishing until **May 8, 2029**, with workplace protections. After this date, this use is prohibited.

Recordkeeping and Downstream Notification

Manufacturers, processors, and distributors are required to update Safety Data Sheets to spread awareness throughout the supply chain. Relevant SDS must be updated by **October 7, 2024** for manufacturers and **December 4, 2024** for processors and distributors.

What the final rule covers

- Prohibits manufacturing, processing and distribution of methylene chloride for all consumer uses.
- Prohibits most industrial and commercial uses of methylene chloride, including paint and coating removers. Consumer paint and coating removal was prohibited in 2019.
- Creates strict workplace protections through a Workplace Chemical Protection Program to ensure that for the remaining uses, workers will not be harmed by methylene chloride use.
- *Most prohibited uses will be fully phased out within 2 years.* Alternative products with similar costs and efficacy to methylene chloride products are generally available for most prohibited uses.

What's not included

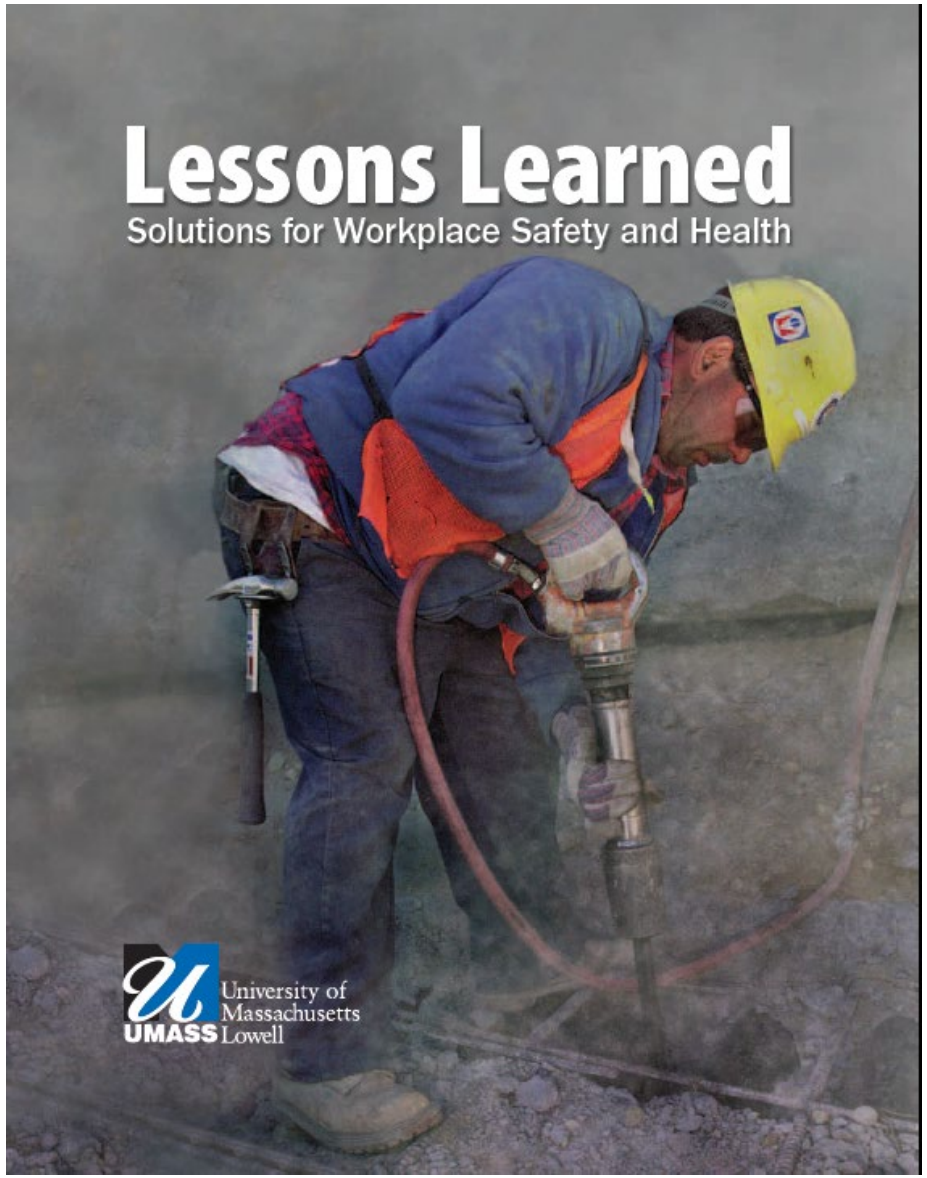
- Use in the production of other chemicals, including chemicals that are important in efforts to reduce global warming outlined in the American Innovation and Manufacturing Act.
- Production of battery separators for electric vehicles.
- Use as a processing aid in a closed system.
- Use as a laboratory chemical.
- Use in plastic and rubber manufacturing, including polycarbonate production.
- Use in solvent welding.
- Specific uses of methylene chloride required by the National Aeronautics and Space Administration, the Department of Defense, and the Federal Aviation Administration.

Not all substitution is equal

Table 1
Notable examples of regrettable substitutes (Harney et al., 2003; Siddiqi et al., 2003; U.S. CDC, 2008; Birnbaum, 2010; ECHA, 2013; National Toxicology Program, 2011; Velders et al., 2012; Ichihara et al., 2012; Eladak et al., 2015; Rochester and Bolden, 2015; CCOHS, 2018).

Chemical of Concern (function)	Hazard	Substitute	Hazard
Bisphenol-A (BPA) (plasticizer)	Endocrine disruption	Bisphenol-S (BPS), Bisphenol-F (BPF)	Endocrine activity
Lead (additive in gasoline)	Neurotoxicity	Methyl tert-butyl ether (MBTE)	Aquatic toxicity
Methylene chloride (solvent carrier in adhesives)	Acute toxicity, carcinogenicity	1-Bromopropane (nPB)	Carcinogenicity, neurotoxicity
Methylene chloride (brake cleaners)	Acute toxicity, carcinogenicity	n-Hexane	Neurotoxicity
Poly brominated diphenyl ethers (PBDEs) (flame retardant)	Persistence, neurotoxicity, reproductive toxicity, carcinogen (penta and deca)	Tris (2,3-dibromopropyl) phosphate	Carcinogenicity, aquatic toxicity
Trichloroethylene (TCE) (metal degreasing)	Carcinogenicity	1-Bromopropane (nPB)	Neurotoxicity, carcinogenicity
Chlorofluorocarbons (CFCs) (refrigerant)	Ozone depletion	Hydrofluorocarbons (HFCs)	Greenhouse gas

https://doi.org/10.1016/j.scp.2019.100161



CASE STUDY 5

Regulating Methylene Chloride:

A Cautionary Tale about Setting Health Standards One Chemical at a Time

Molly M. Jacobs, Joel Tickner, David Kriebel

On June 30, 2000 a 35-year-old female worker from a North Carolina cushion company was carried to the local emergency room because she could no longer walk without assistance.[1] Days before, headaches had progressed into severe numbness and burning sensations in her feet, legs, thighs, and lower back.[1]

Her job at the cushion company was to glue foam cushion pieces together with a spray adhesive containing 55 percent (by weight) 1-bromopropane, which had been introduced into the workplace not long before workers started to get sick.[2]

One case of this neurological illness turned into many as similarly exposed and sick workers from other cushion manufacturing companies were reported.[2] Months and years later, these workers' neurological symptoms still persist.[1,2]

The sad irony: the companies had switched to a 1-bromopropane-based adhesive in place of one containing methylene chloride in response to the Occupational Safety and Health Administration's new methylene chloride standard.

How could a system of regulating toxic hazards to protect workers result in additional sick workers?

SINCE THE EARLIEST DAYS OF THE Occupational Safety and Health Administration (OSHA), the agency has realized the severe limitations of issuing regulations substance by substance, and hazard by hazard. Yet despite this understanding, OSHA regulates exposures to only a small fraction of the tens of thousands of chemicals on the market in the United States today. And the majority of existing health standards allow "acceptable" workplace exposures based on evidence from the 1950s, despite scientific findings that reveal health effects at exposures well below current legal limits.

OSHA's methylene chloride health standard is a success story: it is comprehensive in scope to protect workers, it survived legal challenges and a threatened Congressional review, and it is based on early signs of harm revealed by animal toxicology studies. Yet despite these successes, the methylene chloride standard clearly reveals lessons learned about the politicization of science to delay regulation, the inherent dangers of a substance-by-substance system of regulating toxic hazards, and the missed opportunity for workplace health regulations to stimulate innovation of safer chemistries.

https://www.uml.edu/docs/Lessons%20Learned%20Solutions%20for%20Workplace%20Safety%20and%20Health%2C%20full%20report_tcm18-232340.pdf

INSIDE LOWE'S »

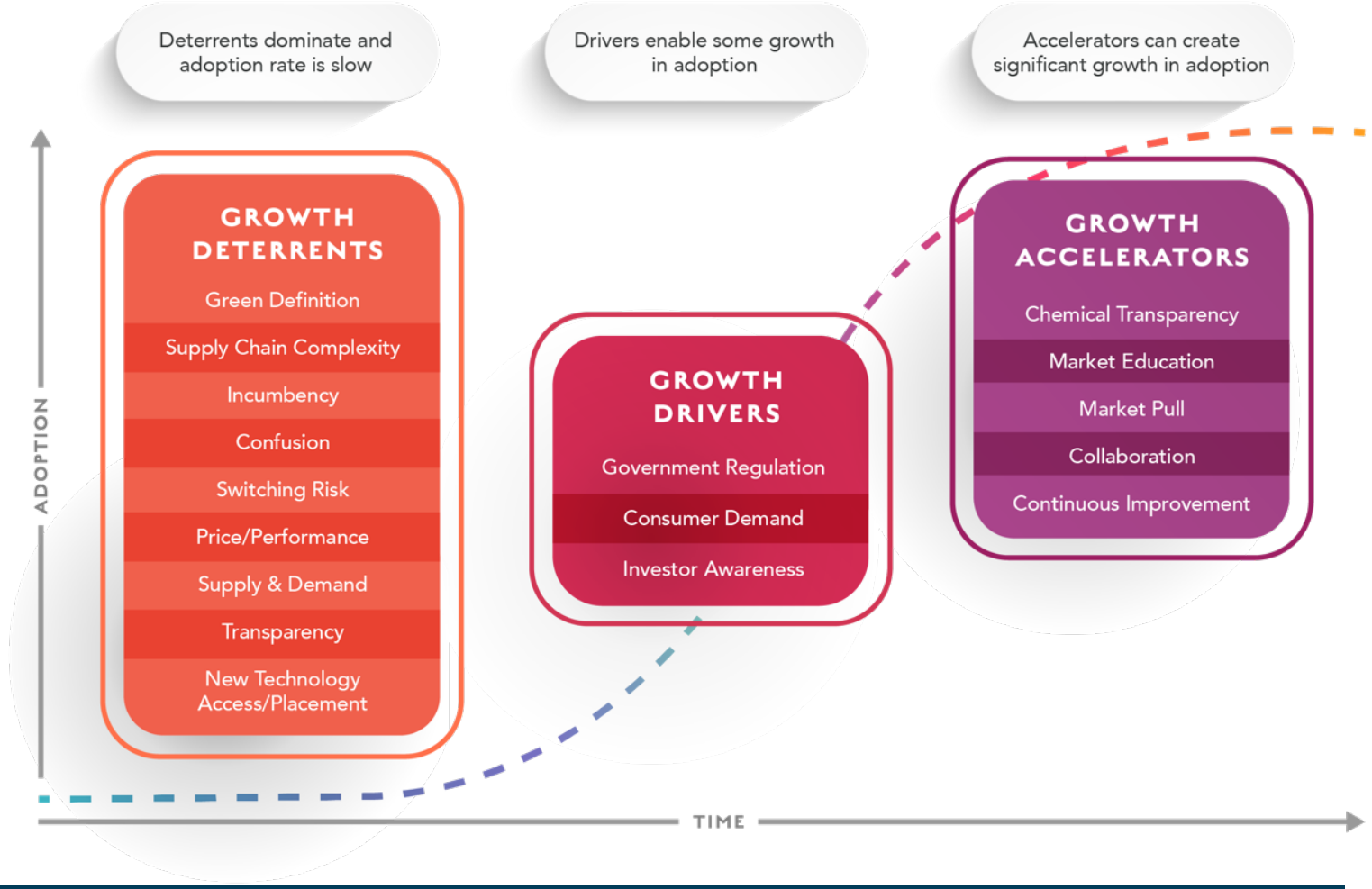
Lowe's commits to phasing out paint removal products with methylene chloride and NMP

Products will be removed from assortment globally by the end of 2018

https://newsroom.lowes.com/inside-lowes/lowes-commitment-methylene-chloride-nmp/

So, what's the challenge?

- The number of growth deterrents exceeds the number of drivers and accelerators
- While government regulations and consumer awareness establish urgency, growth will be accelerated through chemical transparency, enhanced education, market pull, collaboration and continuous improvement



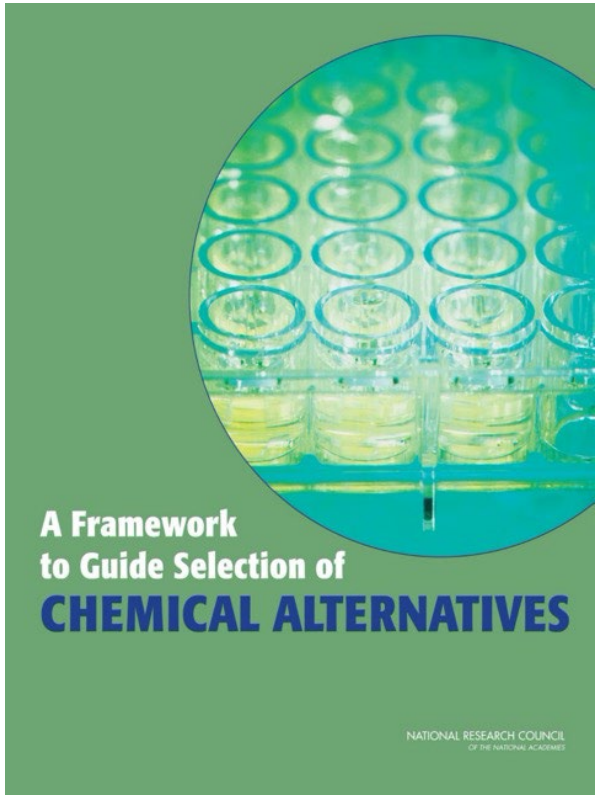
Specific challenges

- Established supplier relationships
- Short timeframes for transition at times
- Lack of willingness to try “out of the box” alternatives – customer acceptance, cost, performance concerns, etc.
- Small businesses often buy from distributors
- Little guidance on safer alternatives
- Companies need to balance multiple sustainability issues when selecting alternatives

The need for alternatives assessment to guide substitution

"A process for identifying, comparing, and selecting safer alternatives to chemicals of concern on the basis of their hazards, comparative exposure, performance, and economic viability."

- NAS 2014



The goal – informed substitution (EPA 2010)

A **considered transition** from a **chemical of particular concern to safer chemicals or non-chemical alternatives**.

The goals of informed substitution are to:

- **Minimize the likelihood of unintended consequences**, which can result from a precautionary switch away from a chemical of concern without fully understanding the profile of potential alternatives, and
- **Enable a course of action based on the best information**—on the environment and human health—that is available or can be estimated.

https://www.canada.ca/en/health-canada/programs/consultation-informed-substitution-canadas-chemical-program.html

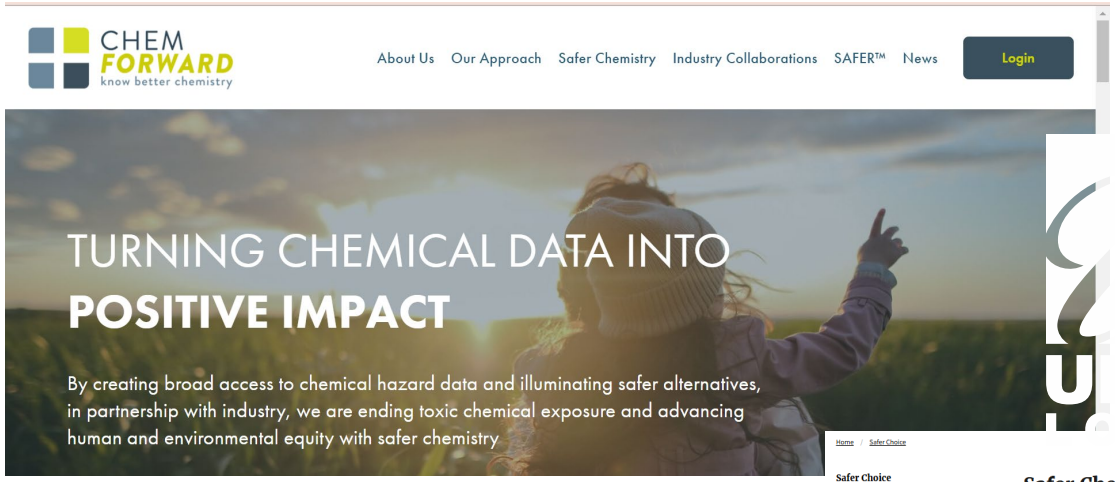
Starting Point: Look at the function needed, not the chemical characteristics

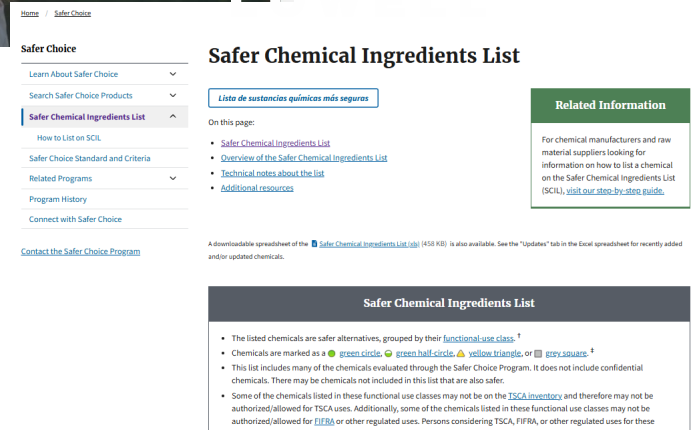
Table 1. Functional Substitution for Chemicals in Products, Chemicals in Processes

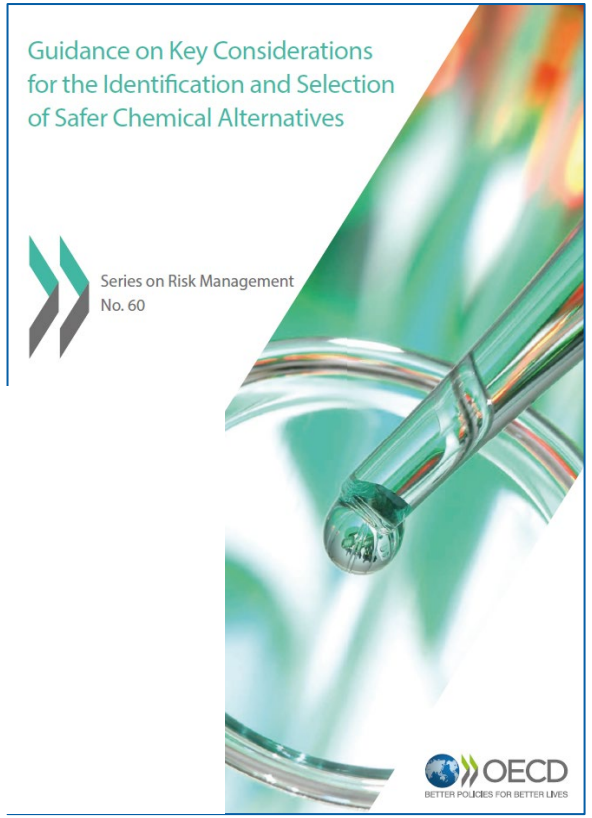
Functional Substitution Level	**Chemical in Product** Bisphenol-a in Thermal Paper	**Chemical in Process** Methylene Chloride in Degreasing Metal Parts
Chemical Function (Chemical Change)	Is there a functionally equivalent chemical substitute (i.e., chemical developer)? **Result: Drop-in chemical replacement**	Is there a functionally equivalent chemical substitute (i.e., chlorinated solvent degreaser)? **Result: Drop-in chemical replacement**
End Use Function (Material, Product, Process Change)	Is there another means to achieve the function of the chemical in the product (i.e., creation of printed image)? **Result: Redesign of thermal paper, material changes**	Is there another means to achieve the function of the process (i.e., degreasing)? **Result: Redesign of the process** (e.g., ultrasonic, aqueous)
Function As Service (System Change)	Are cash register receipts necessary? Are there alternatives that could achieve the same purpose (i.e. providing a record of sale to a consumer)? **Result: Alternative printing systems** (e.g., electronic receipts)	Is degreasing metal parts necessary? Are there other alternatives that could achieve the same purpose (i.e., providing metal parts free of contaminants for other end uses)? **Result: Alternative metal cutting methods**

https://doi.org/10.1021/es503328m

We have increasing knowledge, capabilities, and criteria to understand what's safer







United States Environmental Protection Agency | Science Advisory Board (1400) Washington, DC | EPA-SAB-EEC-95-017 SEPTEMBER 1995

EPA

AN SAB REPORT: IMPROVING THE USE CLUSTER SCORING SYSTEM

RECOMMENDATIONS FOR THE USE CLUSTER SCORING SYSTEM PREPARED BY THE ENVIRONMENTAL ENGINEERING COMMITTEE

We can use that information to compare / rank alternatives for specific chemicals or functions

ABSTRACT

At the request of the Office of Pollution Prevention and Toxics (OPPT), a Subcommittee of the Environmental Engineering Committee (EEC) of the Science Advisory Board (SAB) reviewed the Use Cluster Scoring System (UCSS) which is being developed by OPPT. The primary purposes for clustering chemicals by intended functional use are to: a) efficiently screen large numbers of commercial chemicals; and b) identify opportunities to prevent pollution within the resulting use clusters. Algorithms are used to score chemicals in each cluster according to their health and ecological risks in order to set priorities for future evaluation of

With a functional substitution approach, we can address more chemicals, more quickly leveraging predictive tools

Environmental Science & Technology

Policy Analysis

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Advancing Safer Alternatives Through Functional Substitution

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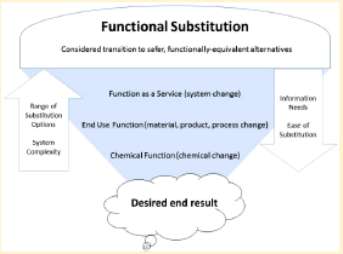
ABSTRACT: To achieve the ultimate goal of sustainable chemicals management policy—the transition to safer chemicals, materials, products, and processes—current chemicals management approaches could benefit from a broader perspective. Starting with considerations of function, rather than characterizing and managing risks associated with a particular chemical, may provide a different, solutions-oriented lens to reduce risk associated with the uses of chemicals. It may also offer an efficient means, complementing existing tools, to reorient chemicals management approaches from time-intensive risk assessment and risk management based on single chemicals to comparative evaluation of the best options to fulfill a specific function. This article describes a functional approach to chemicals management we call "functional substitution" that encourages decision-makers to look beyond chemical by chemical substitution to find a range of alternatives to meet product performance. We define functional substitution, outline a rationale for greater use of this concept when considering risks posed by uses of chemicals, and provide examples of how functional approaches have been applied toward the identification of alternatives. We also discuss next steps for implementing functional substitution in chemical assessment and policy development.



Green Chemistry

PAPER

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Cite this: *Green Chem.*, 2017, **19**,

High-throughput screening of chemicals as functional substitutes using structure-based classification models†

Katherine A. Phillips,*[a,c] John F. Wambaugh,[b] Christopher M. Grulke,[b] Kathie L. Dionisio[c] and Kristin K. Isaacs[c]

Identifying chemicals that provide a specific function within a product, yet have minimal impact on the human body or environment, is the goal of most formulation chemists and engineers practicing green chemistry. We present a methodology to identify potential chemical functional substitutes from large libraries of chemicals using machine learning based models. We collect and analyze publicly available information on the function of chemicals in consumer products or industrial processes to identify a suite of harmonized function categories suitable for modeling. We use structural and physicochemical descriptors for these chemicals to build 41 quantitative structure–use relationship (QSUR) models for harmonized function categories using random forest classification. We apply these models to screen a library of nearly 6400 chemicals with available structure information for potential functional substitutes. Using our Functional Use database (FUse), we could identify uses for 3121 chemicals; 4412 predicted functional uses had a probability of 80% or greater. We demonstrate the potential application of the models to high-throughput (HT) screening for "candidate alternatives" by merging the valid functional substitute classifications with hazard metrics developed from HT screening assays for bioactivity. A descriptor set could be obtained for 6356 Tox21 chemicals that have undergone a battery of HT *in vitro* bioactivity screening assays. By applying QSURs, we were able to identify over 1600 candidate chemical alternatives. These QSURs can be rapidly applied to thousands of additional chemicals to generate HT functional use information for combination with complementary HT toxicity information for screening for greener chemical alternatives.

Received 30th September 2016,
Accepted 20th December 2016

DOI: 10.1039/c6gc02744j

rsc.li/greenchem

With the alternatives assessment and informed substitution lens we can then:

- Compare other critical attributes:
  - Performance
  - Cost
  - Other sustainability attributes
- Identify barriers to transition
- Address barriers and support and incentivize safer substitution
- Advance R&D and interim steps if better alternatives are not currently available

Supporting the transition to safer chemistry through a Center of Excellence for Chemical Alternatives Assessment: Rationale

- Increasing recognition of the need to support the transition to safer, more sustainable chemicals and materials and concerns about:
  - Ensuring safer, feasible alternatives are available
  - Concern about regrettable substitutions and lack of clarity as to what is “better”
- Lack of adequate attention to or information/assessment of substitutes
- Increasing recognition of the importance of industry sectoral pre-competitive collaboration to transition to alternatives
- Lower resources and cost by sharing burden and more likely to identify better options
- Identification of and addressing barriers/challenges to evaluation, commercialization, and adoption
- Increased value chain materials transparency
- Development of consistent and replicable assessment approaches

SETAC Globe 19 Sep 2024

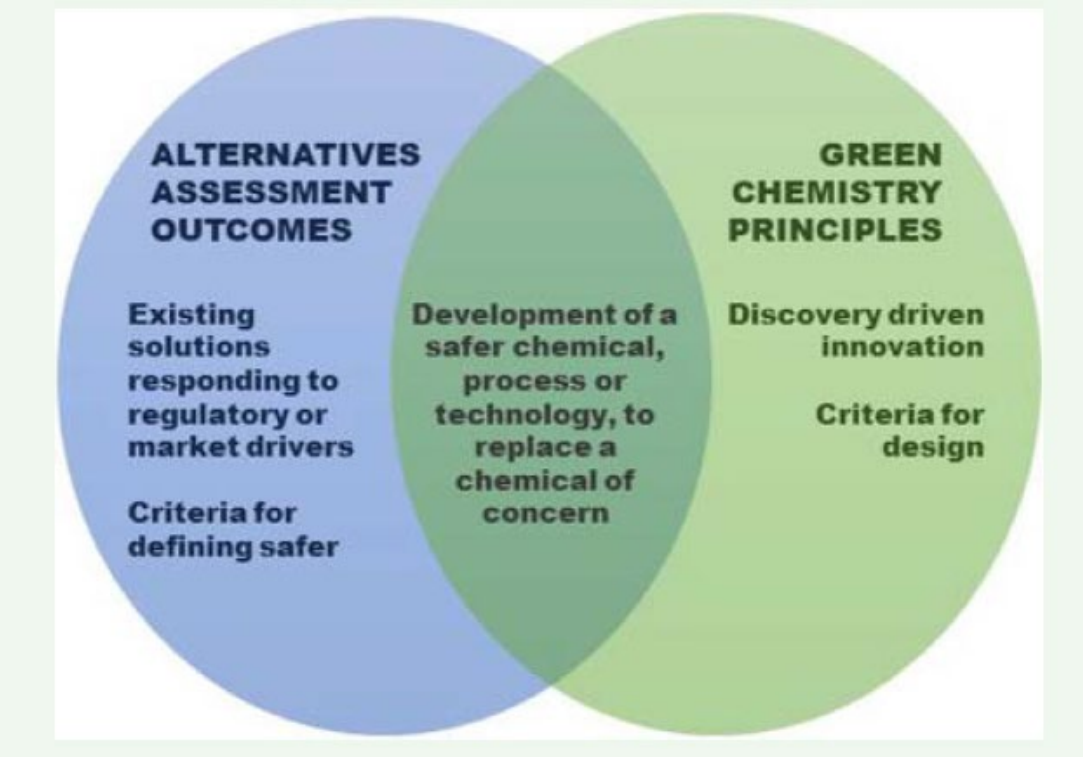
New SETAC Interest Group Launched: The Advancement and Application of Alternatives Assessment (A4)

Lauren Heine, Heine Group, LLC; Timothy Malloy, University of California, Los Angeles; Libby Sommer, Libby Sommer LLC; Joel Tickner, Molly Jacobs and and Jennifer Landry, University of Massachusetts, Lowell; Catherine Rudisill, Safer Chemistry Advisory; and Colleen McLoughlin, Enhesa

Paving the Path Toward Safer, More Sustainable and Functional Substitutes to Chemicals of Concern

https://www.setac.org/group/advancement-and-application-of-alternatives-assessment-a4.html

Where alternatives aren't available, leverage tools of alternatives assessment to design them



Tickner, et al, 2021: DOI: 10.1080/17518253.2020.1856427

Conclusions

- Move from the problem-sphere to the solutions-sphere.
- Alternatives assessment should come in early to support informed substitution when market or other drivers already indicate a problem.
- Need to provide clear guidance in restrictions as to what alternatives could present regrettable substitutions, supporting the broader transition towards safer chemicals.
- Need to support/incentivize the transition to safer alternatives and R&D particularly for exempted uses

Thank you!

Joel Tickner, ScD

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For more information, please visit:

Sustainable Chemistry Catalyst | sustainablechemistrycatalyst.org

Change Chemistry | member.changechemistry.org

Safer Alternatives to Methylene Chloride

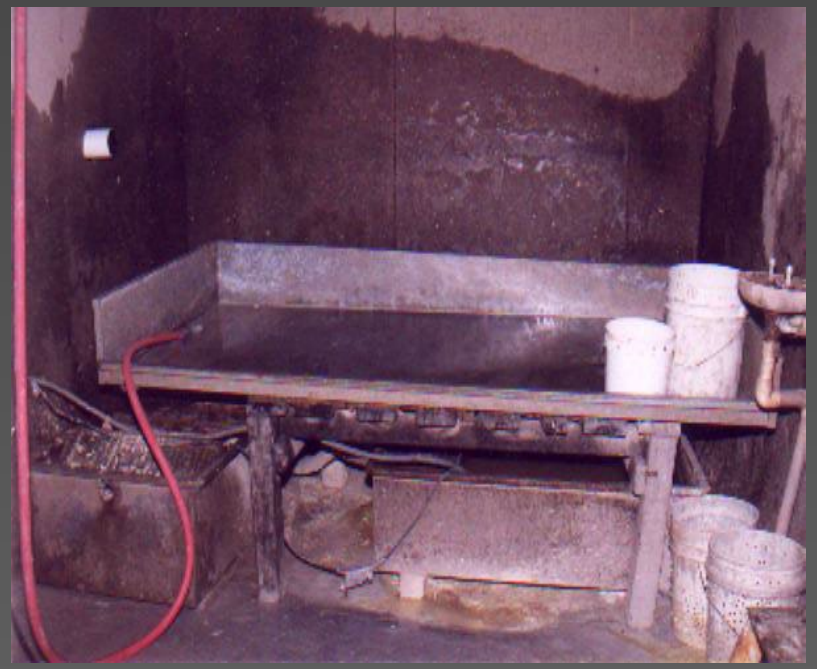
Katy Wolf, Ph.D.
Consultant

Background

- EPA regulated methylene chloride (METH) for consumer use in paint and coating removal in 2019
- EPA expanded this action to other TSCA applications in 2024
- Safer alternatives are available in all applications
- Detailed focus on three applications
- Information on safer alternatives for many other applications

Furniture Stripping

- Furniture stripping companies strip items for consumers
- Large strippers use equipment for stripping
- Smaller strippers use consumer product strippers
- In earlier work, estimated that 80 strippers have equipment and 500 do not in California
- Stripped many items with different coatings at two stripping facilities
  - Project sponsored by Cal/EPA's DTSC
- Developed alternative strippers and one benzyl alcohol stripper worked as effectively as baseline METH stripper



Annualized Cost Comparison for Strippers in Equipment

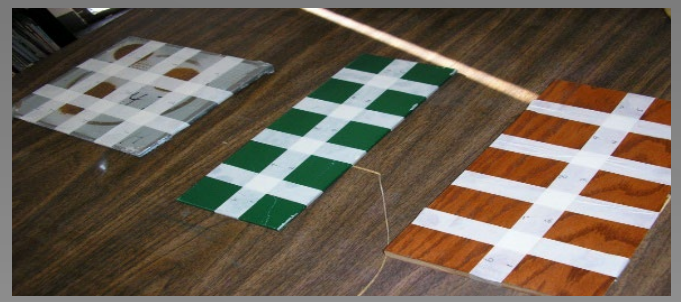
Cost Element	METH Stripper	Benzyl Alcohol Stripper
Capital Cost	-	$217
Stripper Cost	$4,790	$4,250
Rinse Agent Cost	$55	$124
Disposal Cost	$300	$350
Total Cost	$5,145	$4,941

Contractor On-Site Stripping

- Contractors strip items in houses and offices
- Items include cabinets, molding, frames
- Doors and drawers often removed and stripped off-site
- Earlier project involved conducting tests of alternative strippers for cabinet stripping in home
- Tested METH baseline stripper and two alternative benzyl alcohol strippers
- One of alternatives worked nearly as well as baseline stripper

Consumer Product Strippers

- Also tested consumer product strippers on several types of coatings in project
  - Items stripped included doors, door jams, cabinetry, chairs, bed frames, metal patio furniture
- Tested several strippers
- Benzyl alcohol strippers worked best as alternatives



Boat Hull Stripping

- Boat hull stripping alternatives work performed with boatyards as part of project sponsored by EPA and Cal/EPA's DTSC
- Boat hull paints containing copper are used to protect hulls from attachment by marine life and paint needs to be stripped periodically
- Boatyards strip paint using METH chemical stripping or abrasive hand sanding
- Tested three alternative abrasive stripping methods on boat destined for demolition
  - Dry ice, volcanic rock and sodium bicarbonate blasting


www.gotblasted.com
210H


CF 3172 ER

Cost Comparison of Alternative Stripping Methods for 30 Foot Boat

System	Description	Cost
METH Stripping	Baseline	$1,434
Hand Stripping	Hand Abrasion	$1,313
Sodium Bicarbonate Stripping	Media Blasting	$1,075 to $1,276

Anti-Spatter Formulations

- Anti-Spatter products used by industry for welding and laser cutting
  - Prevents deposition of removed metal on parts
- Formulations have traditionally included METH
- More recently, there are some water-based products
- Worked with Exotic Metals Forming

Company to find safer alternative for laser cutting

- Project sponsored by EPA and conducted by PPRC

Alternatives Testing

- Company designed special fixture for testing alternatives
- Company needed to comply with REACH which eliminated many products
- Found one water-based product that worked reasonably well
  - Did not comply with REACH
  - Asked company to reformulate but company declined
- Asked Brulin to develop a water-based product that would comply with REACH
  - Made a low-cost product that worked extremely well


EICN 860
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Annualized Cost Comparison for Exotic for Anti-Spatter Process

Cost Element	Solvent Anti-Spatter	Water-Based Anti-Spatter
Anti-Spatter	$72,000	$8,580
Application Equipment	$1,037	$104
Labor	$19,368	$19,368
PPE	$3,480	-
Total	$95,885	$28,052

Safer Alternative Stripping Methods for Other Applications

- Aircraft stripping
  - Not painting at all
  - Benzyl alcohol strippers and/or abrasive methods like PMB, sodium bicarbonate blasting, wheat starch blasting
  - Laser stripping, flash jet stripping
- Industrial companies with coating operations
  - Strip reject parts before paint is cured or, if the paint is cured, use media blasting cabinets
  - Strip fixtures from conveyor lines with cryogenics, benzyl alcohol or hot alkaline strippers
- Paint tank stripping
  - Strip immediately after manufacture
  - hand sanding or abrasive blasting methods

Alternative Stripping Methods Continued

- Wheel stripping
  - Benzyl alcohol strippers
- Adhesives/adhesive removers
  - Water-based, hot melt, acetone, soy
- Vapor Degreasing and cold cleaning
  - Water-based cleaners
  - Note that the EPA SNAP program still gives METH as an approved alternative
- Ground Vehicle Stripping
  - Media blasting, benzyl alcohol strippers
- Autobody shop stripping
  - Replace parts, hand sanding
- Auto Restoration Stripping
  - Benzyl alcohol strippers

Contact Information

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Safer Paint Strippers without Methylene Chloride and other Chemicals of High Concern

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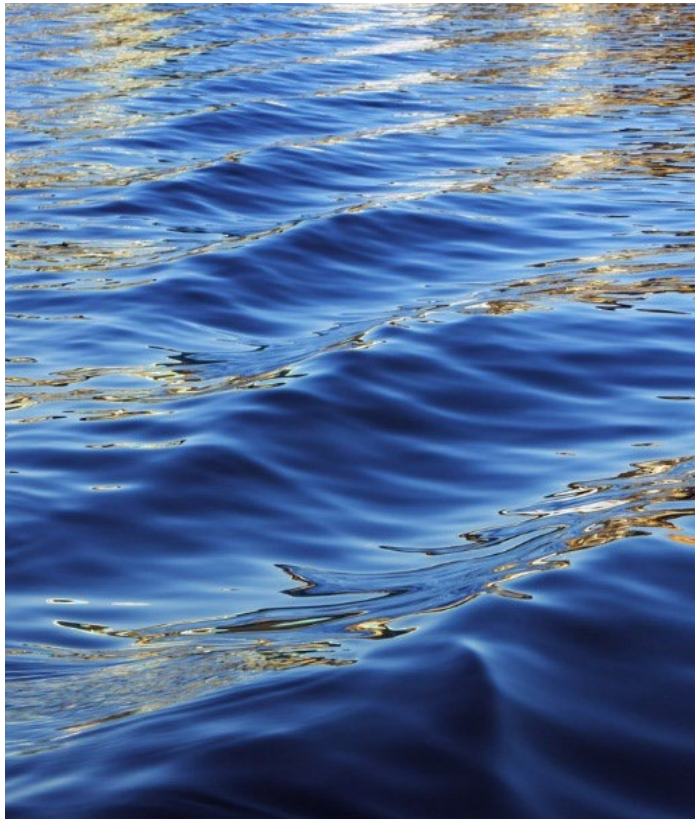
978-934-2954
December 10, 2024



Chemical Paint Stripping Products

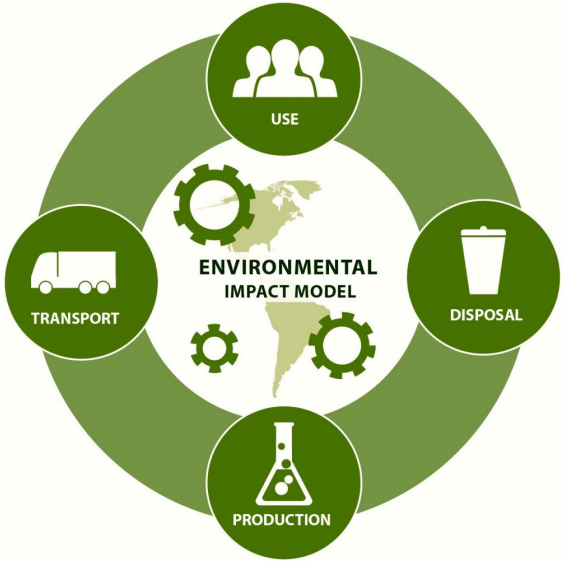
Approx. 2% - 10% Additives: thickener, wetting agent, colorants, rinsing agent, evaporation barriers, etc.

Approx. 90% - 98%
Solvents (chemicals of high concern and safer chemicals)

Exposure to Paint Stripper Solvents

Several of the solvents used in paint stripping products are volatile, rapidly evaporating during manufacture and use. As a baseline for comparison, water has a unit-less relative evaporation rate of approximately 30. DCM used in paint removal products has a relative evaporation rate of 1,450, evaporating approximately 48 times faster than water.

Even when appropriate PPE and emission controls are in place, the potential for failure or misuse exists, so that exposure cannot ever be completely ruled out.



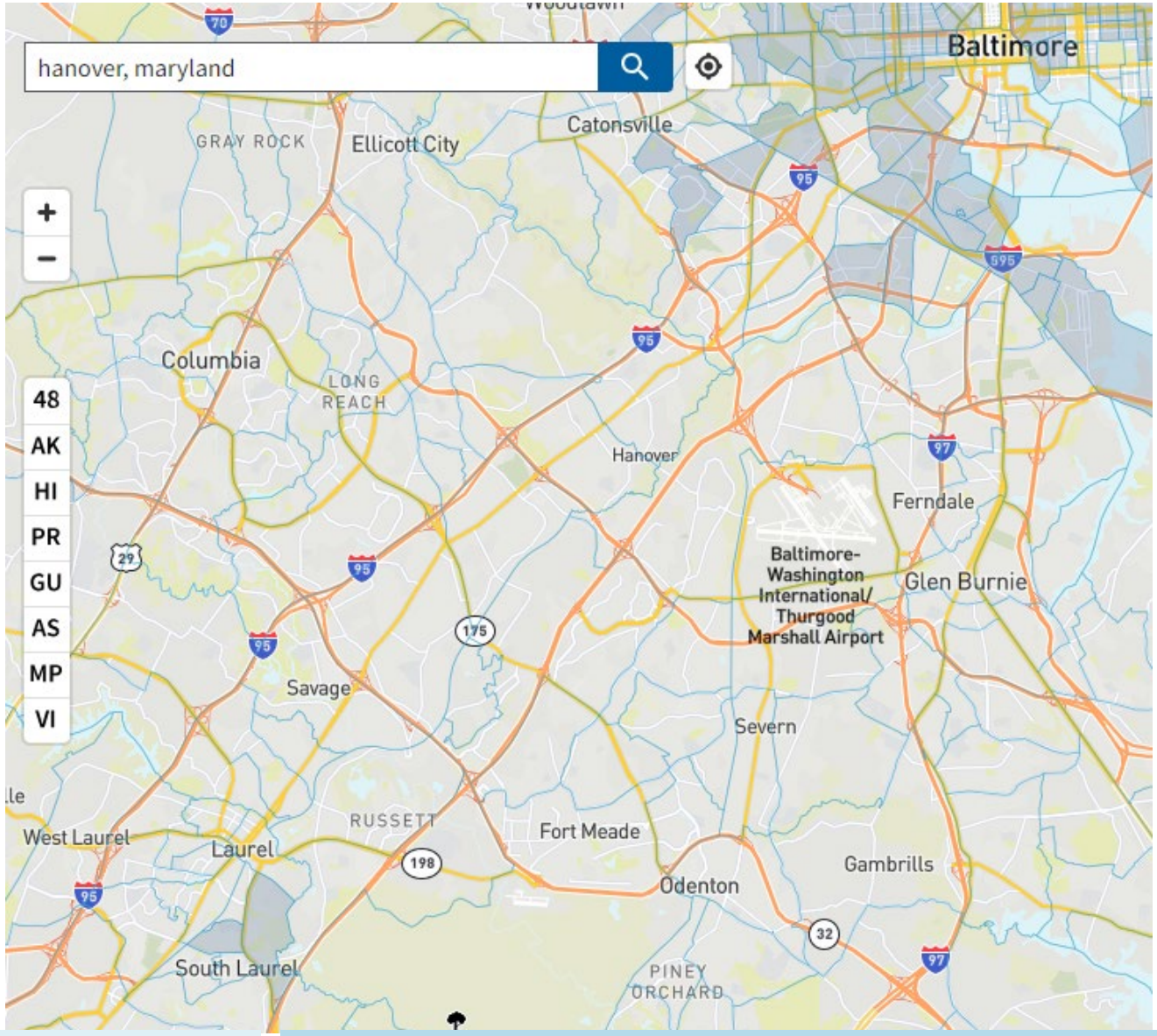
https://news.ucsb.edu/2014/014070/faster-environmental-testing-new-synthetic-chemicals-and-materials

Scope: Number of Product Users Per Year

User Group	Number of Users	Source
Do-it-Yourselfers (DIYers)	1,300,000	EPA, 2017
Painters, construction and maintenance workers	338,900	Bureau of Labor Standards (BLS), 2023
Total	1,638,900	

BLS: Painters apply paint, stain, and coatings to walls and ceilings, buildings, large machinery and equipment, and bridges and other structures. https://www.bls.gov/ooh/construction-and-extraction/painters-construction-and-maintenance.htm

Environmental Justice (EJ)



U.S. EPA Climate and Economic Justice Screening Tool
https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5

A community is highlighted as disadvantaged on the CEJST map if it is in a census tract that is both:

(1) at or above the threshold for one or more environmental, climate, or other burdens, and

(2) at or above the threshold for an associated socioeconomic burden (e.g. housing costs, low income, etc.)

Scope: Paint Stripper Product Manufacturers (using chemicals of high concern ingredients)

Manufacturer	Brands	Location	Proximity to EJ Community
Benco Sales Inc.	Benco	Crossville, TN	Within
Express Chem	Flo Strip, Powder Strip, Accuchem, Mast Away	St. Louis, MO	Less than 1 mile away
Packaging Services	Crown	Pearland, TX	Approximately 1 mile away
Rustoleum	Watco	Vernon Hills, IL	Less than 1 mile away
Sunnyside Corp.	Back to Nature and Savogran	Wheeling, IL	Within
WM Barr	Klean Strip, Kwik Strip, and Jasco	Memphis, TN	Approximately 1 mile away

Source: Climate and Economic Justice Screening Tool
https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5

Chemical Substitution Approaches

1) Green Chemistry (Principles #4 and #5)

*Design chemical products that are fully effective while **reducing** toxicity.*

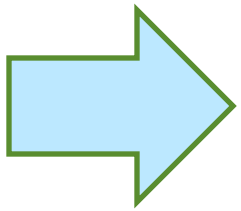
2) Regrettable Substitution

Replacing a chemical of high concern with another chemical of high concern.

Methylene Chloride Substitution

Methylene Chloride

State	Cal Prop 65 (Carcinogen) MA TURA
Fed.	EPA Hazardous Air Pollutant EPA TRI
Global	EU Annex VI CMR IARC Carcinogen



Naphthalene

State	Cal Prop 65 (Carcinogen) MA TURA
Fed.	EPA Hazardous Air Pollutant EPA TRI
Global	EU Annex VI CMR IARC Carcinogen

Green Chemistry or Regrettable Substitution?

How can we distinguish between toxic and safer solvents in paint stripping products and avoid future regrettable substitutions?

Green Screen Chemical Hazard Assessment

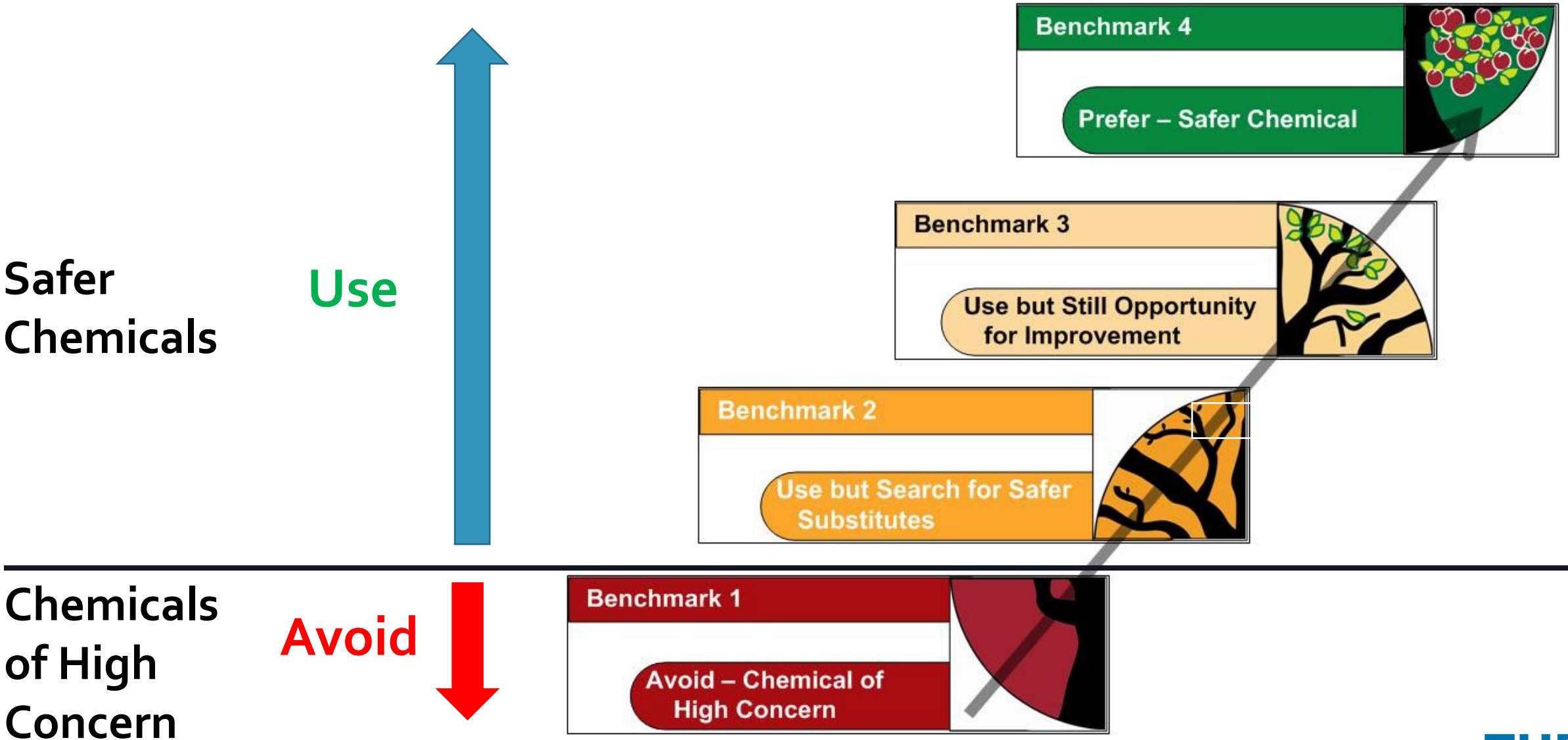
Ecotoxicity and fate in the environment	Toxicity to humans (Group I)	Toxicity to humans (Group II)	Physical hazards
• Acute aquatic ecotoxicity • Chronic aquatic ecotoxicity • Other ecotoxicity studies (if available) • Persistence • Bioaccumulation	• Carcinogenicity • Mutagenicity and genotoxicity • Toxicity for reproduction • Toxicity for development • Endocrine activity	• Acute toxicity • Systemic toxicity and effects on organs • Neurotoxicity • Skin sensitisation • Respiratory sensitisation • Dermal irritation • Eye irritation	• Reactivity • Flammability

Ratings for each hazard endpoint: very low, low, medium, high, very high, data gap

Developed by Clean Production Action

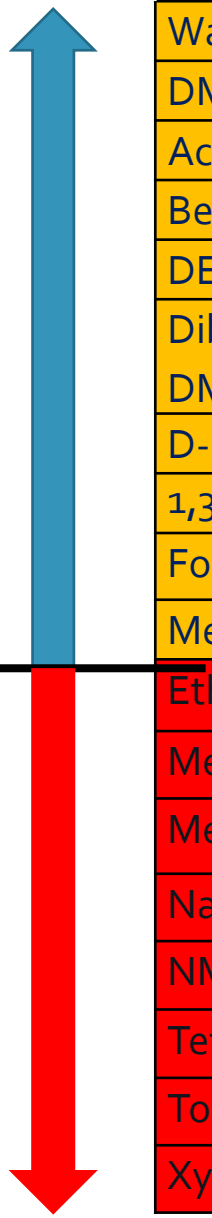
https://www.greenscreenchemicals.org/

Green Screen Benchmark Levels for Chemicals



TURI TOXICS USE REDUCTION INSTITUTE UMASS LOWELL

Chemicals Used in Paint Strippers



Chemical	Green Screen Benchmark	California Prop 65 Listed
Water	4	
DMSO	3	
Acetone	2	
Benzyl alcohol	2	
DEGME	2	
Dibasic esters (DMA, DMG, and DMS)	2	
D-Limonene	2	
1,3 Dioxolane	2	
Formic acid	2	
Methyl acetate	2	
Ethyl benzene	1	✓
Methanol	1	✓
Methylene chloride	1	✓
Naphtha/Naphthalene	1	✓
NMP	1	✓
Tetrahydrofuran	1	✓
Toluene	1	✓
Xylene	1	

Review the product ingredients list on the product container label, or Section 3 of the product Safety Data Sheet (SDS) for the presence of these ingredients.

The presence of a California Prop65 warning label on the product container indicates that a chemical of high concern is likely a product ingredient.

Paint Stripping Product Examples with Chemicals of High Concern (Benchmark 1)

Ethyl benzene (C)
Methanol (R)
Xylene (R)

Toluene (R)
Methanol (R)

Naphtha (C)
Methanol (R)

NMP (R)

Methylene chloride (C)
Methanol (R)

C: Carcinogen: causes cancer

R: Reproductive toxicity: negatively impacts reproductive system of men and women (e.g. infertility) as well as the development offspring

Safer Paint Stripper Product Examples (No Benchmark 1 Chemicals)

Supplier	Product	Chemicals
Dumond	Smart Strip Advanced	Benzyl alcohol
Dumond	Peel Away 1	Calcium hydroxide, sodium hydroxide
EZ Strip	Max Strip Paint & Varnish Stripper	Triethyl phosphate
Franmar	Blue Bear 605PRO with Safenol	Safenol, dibasic ester, ethoxylated alcohols
Motsenbocker	Lift-off Paint & Varnish Remover	Glycol ether, acetone
Packaging Services	Crown STRP Sure	DMSO
Sunnyside	MultiStrip Advanced (no NMP)	Benzyl alcohol, dibasic esters, ethyl 3-ethoxypropionate, formic acid
Super Remover	New Generation	Methyl acetate, DMSO, 1,3 Dioxolane
WM Barr	Citristrip (no NMP)	Benzyl alcohol, DEGME, 2-(2-Aminoethoxy) ethanol, light, distillate
WM Barr	Green Paint & Varnish Stripper	Benzyl alcohol

Paint Stripper Products in U.S. in 2024

Retailer	Total Linear Feet Shelf Space	Number of Products	Products with COC	Linear Feet with COC	Products with no COC	Linear Feet with no COC	Products with ? COC	Linear Feet with ? COC
Ace Hardware	40,395	8	4	20,197	3	15,148	1	5,049
Advance Auto Parts	2,229	1	1	2,229	0	-	0	-
Aubuchon Hardware	292	4	2	146	1	73	1	73
Autozone	7,980	1	1	7,980	0	-	0	-
Benjamin Moore	13,750	2	0	-	1	6,875	1	6,875
Do it Best	1,125	1	1	1,125	0	-	0	-
Dunn Edwards	149	1	1	149	0	-	0	-
Home Depot	14,035	6	3	7,018	3	7,018	0	-
Lowe's	14,733	6	3	7,367	3	7,367	0	-
Menards	8,525	10	3	2,558	5	4,263	2	1,705
NAPA Auto Parts	8,000	2	2	8,000	0	-	0	-
O'Reilly Auto Parts	8,175	3	3	8,175	0	-	0	-
PPG Paint Stores	318	1	0	-	0	-	1	318
Sherwin Williams	16,667	4	0	-	2	8,333	2	8,333
True Value	3,455	6	5	2,879	1	576	0	-
Walmart	12,291	4	2	6,145	2	6,145	0	-
West Marine	1,802	3	3	1,802	0	-	0	-
Total feet	153,918			75,768		55,797		22,353
Total miles	29.2			14.3		10.6		4.2
				49%		**36%**		**15%**

?: trade secret, proprietary ingredient, no SDS

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How can we move forward with safer products with adequate performance?

Solute + Solvent = Solution

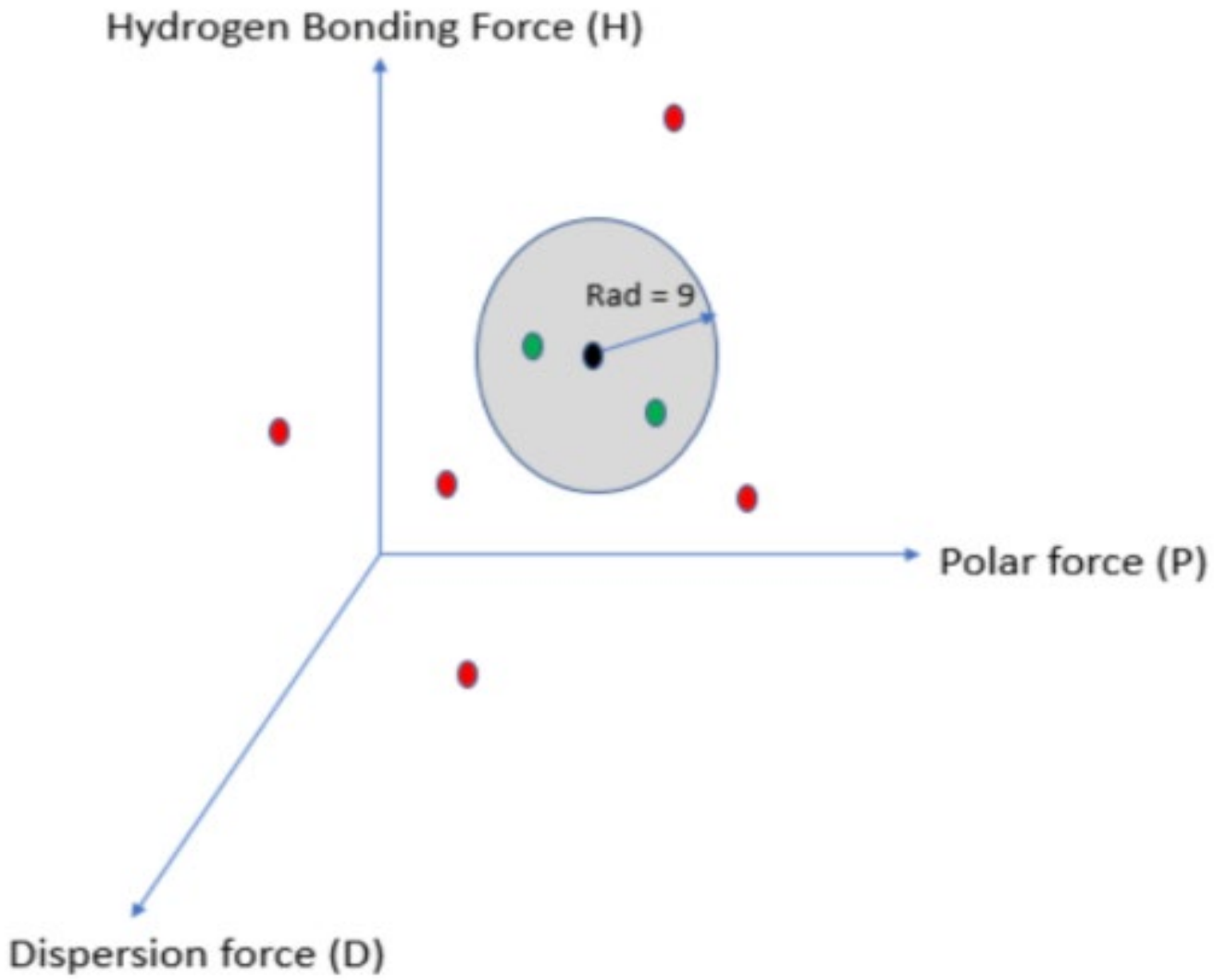
- Solute is the substance being dissolved, solvent is the substance that dissolves it. Both substances must be similar to dissolve.
- The solute is often a polymer.

Hansen Solubility Parameter Approach

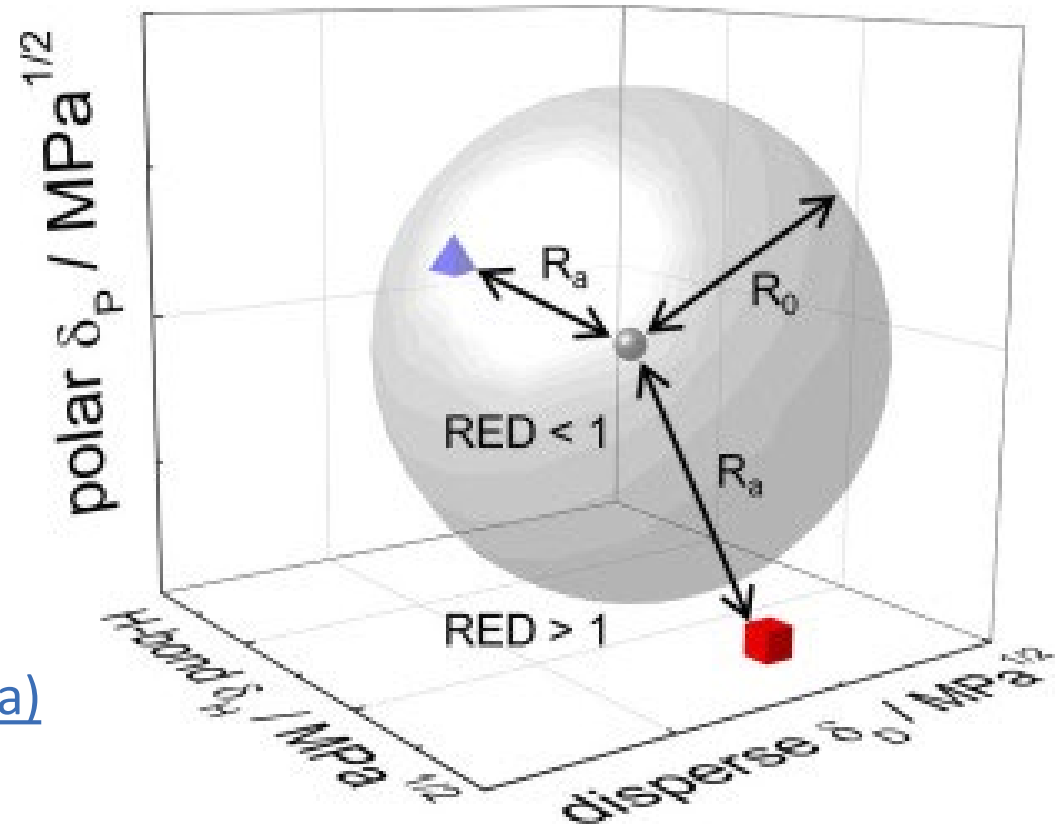
The three parameters (D, P, and H) are plotted in 3D space.

Around the solute center point (D, H, P) is a sphere of solubility, with a unique radius.

Red dots represent solvents outside of the solubility sphere, and green dots are inside the sphere.



Relative Energy Difference (RED)



RED = $\frac{\text{distance of solvent to sphere center (Ra)}}{\text{radius of the sphere (Ro)}}$

A perfect solvent has a RED of 0.

A solvent just on the surface of the Sphere has a RED of 1.

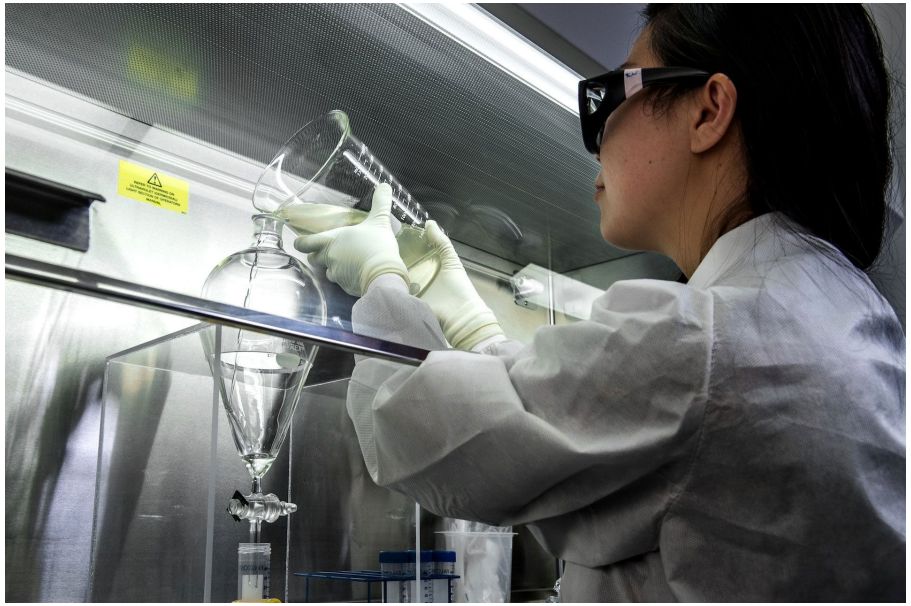
If RED > 1 then solvent will not dissolve the solute, if RED < 1 then it will dissolve.

Safer Pipe and Paint Products Program (SP4)

Problem:
Chemicals of high concern such as methylene chloride, ethyl benzene, toluene, xylene, and several others, are used as ingredients in many paint stripping products. These chemicals can cause cancer, damage the reproductive system, or impair the central nervous system. The use of these products containing these chemicals of high concern by professional painters and do-it-yourselfers increases their risk of exposure.

Solution:
The Safer Pipe and Paint Products Program (SP_4) is funded ($1.18 million) by the U.S. EPA and led by the Toxics Use Reduction Institute (TURI) program to assist retailers and manufacturers to provide safer PVC cement and paint stripping products without chemicals of high concern.

SP4 Process



Reformulation: Provide free technical and financial assistance to manufacturers to reformulate their products with safer ingredients.

Performance: Conduct independent performance testing (ASTM, SCAQMD) of all products to validate product performance.

Safety: Review product ingredients for safety to ensure that chemicals of high concern are not used.

ASTM Performance Testing

- Per ASTM International Standard D6189-97 (Reapproved 2022) “Standard Practice for Evaluating the Efficiency of Chemical Removers for Organic Coatings”
- Each of three layer is a different color (red, white, blue)
- Wood panels: latex paint
- Steel panels: oil based paint
- Measure coating thickness. Wet with thickness gauge (wood and steel) and dry with micrometer (steel only).
- Performance testing to occur November 2024 through January 2025
- All coatings applied and performance testing conducted at IUPAT District Council 35 IFTI facility in Brentwood, NH

Source: IUPAT IFTI, Brentwood, NH

Share Information

	ASTM Oil based	ASTM latex	VOC	Ingredient Safety	Comments
Product 1	✓	✓	✓	✓	
Product 2	x	✓	x	x	
Product 3	✓	x	✓	✓	
Product 4	✓	✓	x	✓	

Share product performance and safety information in a fact sheet format with retailers, national painter's union, and other users to enable them to make informed product purchasing decisions.

2024 National Pollution Prevention Training and Conference

Exploring Alternatives to Methylene Chloride: Paint Stripping, Furniture Refinishing, and More

December 10, 2024
1:00 – 2:15PM ET

Moderated by Joel Tickner, Change Chemistry and UMass Lowell

Speakers:

- **Joel Tickner, Change Chemistry and University of Massachusetts Lowell**
- **Greg Morose, Toxics Use Reduction Institute, University of Massachusetts Lowell**
- **Katy Wolf, Consultant and Former Director of the Institute for Research and Technical Assistance (IRTA)**