

Drinking from the firehose: Select thoughts on chemical safety information accretion and dispersion

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President, ILPI and Safety Emporium

Sunday, August 22, 2021

American Chemical Society Division of Chemical Health and Safety
Awards Symposium
Atlanta, GA



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Howard Fawcett Chemical Health And Safety Award

- Presented annually for outstanding contributions to the science, technology, education, and communication of chemical health and safety.

2020 David Finster, Ph.D.	2006 D. Jeff Burton	1993 Howard F. Fawcett
2019 Samuella Sigmann	2005 Edward H. Rau	1992 Kenneth Yoder
2018 Dow Chemical	2004 Thomas Goehl	1991 Jay A. Young
2017 Monona Rossol	2003 Harry J. Elston	1990 Stanley Pine
2016 Lee Latimer	2002 Robert H. Hill Jr.	1989 Douglas B. Walters
2015 Jyllian Kemsley	2001 Eileen Segal	1988 Leslie Bretherick
2014 Sheila Kennedy	2000 Emmett Barkley	1987 Samuel S. Butcher,
2013 P&G Children's Safe	1999 Linda Rosenstock	Dana W. Mayo, Ronald M.
Drinking Water program	1998 Janet Baum	Pike
2012 Robert Emery	1997 Louis DiBerardinis	1986 Blaine C. McKusick
2011 Eugene Ngai	1996 Ralph Stuart	1985 Malcolm Renfrew
2009 US Dept of State	1995 Warren K. Kingsley	1984 Warren Kingsley
2008 US CSB	1994 Daniel Crowl	1983 Herbert House
2007 Salvatore R. DiNardi		



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<https://dchas.org/2016/01/21/howard-fawcett-chemical-health-and-safety-award/>



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My unusual path in safety

- Cornell University – witnessed my first major lab accident.
- MIT – witnessed a major lab accident. And a lot of minor ones. And a lot of near misses.
- (Northwestern U – Solid state chemistry doesn't use solvents)
- University of KY – and some more, major and minor.
- 1995 – First web site devoted to Material Safety Data Sheets.
- 1998 – Becomes part of ILPI. Comprehensive SDS resource. Stopped counting at 100,000,000 page views.
- 2002 – Safety Emporium, online retail lab & safety supplies.



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Ongoing interests

- ILPI hosts the DCHAS-L archives: <http://www.ilpi.com/dchas/>
 - Over 24,000 posts since 2003, including invaluable wisdom from safety pioneers long departed.
- Support for Ralph Stuart's safety headlines project.
- MeOH demo safety <http://www.ilpi.com/safety/demosafety.html>
- ACS Committee on Chemical Safety Safety Advisory Panel.
- Working directly with several NIOSH-approved N95/N99 manufacturers/suppliers, a new segment of safety knowledge for us.



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DCHAS, the S is for Safety

- Hard to write a traditional ACS safety talk when you aren't doing research, aren't part of a safety department, and don't work at a major institution, etc. so here we are...
- Major universities and corporations have programs and mechanisms into place to address safety issues/concerns readily.
 - Safety knowledge codified in Standard Operating Procedures (SOP's), Chemical Hygiene Plans, regulatory compliance and more.
 - Staff knows how find and evaluate authoritative answers.

Preaching to the choir today!



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DCHAS-L, A Safety Peer Group

- The Division of Chemical Health & Safety's email discussion list is a valuable resource for safety peers.

<https://dchas.org/the-dchas-l-list/>

We have an organic research lab that is producing solvent waste mixtures that are about 50% DCM and 50% hexanes and ethyl acetate. Does anyone know where I might find information for this mixture that might tell us whether this should be stored as flammable waste or non-flammable?

Does anyone have any suggestions for a company to supply prescription safety glasses for industry? We are looking to change our supplier and need a variety of different types of safety glasses.

Do you know, or do you know of someone/group I could talk to concerning industry best practices about hydrogenation/open access hydrogenation/methanol/filtration, etc.? We would like to see if there are some practices out there that we haven't considered.



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ACS CENTER FOR Lab Safety

“We support and promote the safe, ethical, responsible, and sustainable practice of chemistry coupled with professional behavior and technical competence...”

Explore RAMP Resources:

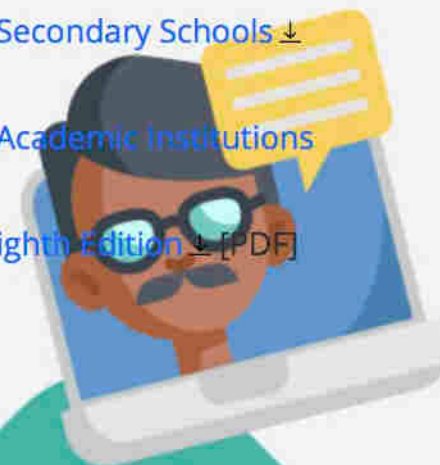
Teaching RAMP

- [Guidelines for Chemical Laboratory Safety in Secondary Schools](#) ↓ [PDF]
- [Guidelines for Chemical Laboratory Safety in Academic Institutions](#) ↓ [PDF]
- [Safety in Academic Chemistry Laboratories, Eighth Edition](#) ↓ [PDF]
 - [Arabic Translation](#) ↓ [PDF]
- [RAMP Poster](#) ↓ [PDF]
- [RAMP Brochure](#) ↓ [PDF]

Hard copies of much of this material may be purchased through the [ACS Store](#).

RAMP in Practice

[Hazard Assessment in Research Laboratories](#) ↓ [PDF]



<https://institute.acs.org/lab-safety.html>



Carefully curated content = “easy” answers

Search Results for acetone 7 Results [+ Submit an Incident](#)

CSL Number	Reagent(s) Name	Warning Message	Source
CSL00009	ACETONE (4468-52-4, 67-64-1) Hydrogen peroxide (7722-84-1)	Formation of acetone peroxides possible. Try to avoid combination or check for peroxides.	ACS Safety Letters
CSL00055	ACETONE (4468-52-4, 67-64-1) NITRIC ACID (52583-42-3, 7697-37-2)	Potentially explosive	User-Reported
CSL00014	ACETONE (4468-52-4, 67-64-1) PHOSPHORUS OXYCHLORIDE (10025-87-3)	Warning - This combination has been documented in the literature to explode when mixed. These two reagents should NEVER come in contact with one another. Ensure that all POCl ₃ is quenched prior to rotary evaporation or any other means of POCl ₃ contacting acetone residues.	User-Reported
CSL00052	ACETONE (4468-52-4, 67-64-1) POTASSIUM HYDROXIDE (1310-58-3) CALCIUM HYDROXIDE (1305-62-0) CHLOROFORM (67-66-3, 8013-54-5)	Chloroform and acetone interact vigorously and exothermally in presence of solid potassium hydroxide or calcium hydroxide to form 1,1,1-trichloro-2-hydroxy-2-methylpropane.	Bretherick's
CSL00003	ACETONE (4468-52-4, 67-64-1) sodium percarbonate (15680-89-4)	can form explosive acetone peroxide compounds.	User-Reported

1 GHS Classification

Showing 1 of 6 [View More](#)

Pictogram(s)	  Flammable Irritant
Signal	Danger
GHS Hazard Statements	H225: Highly Flammable liquid and vapor [Danger Flammable liquids] H319: Causes serious eye irritation [Warning Serious eye damage/eye irritation] H336: May cause drowsiness or dizziness [Warning Specific target organ toxicity, single exposure; Narcotic effects]
Precautionary Statement Codes	P210, P233, P240, P241, P242, P243, P261, P264, P271, P280, P303+P361+P353, P304+P340, P305+P351+P338, P312, P337+P313, P370+P378, P403+P233, P403+P235, P405, and P501 (The corresponding statement to each P-code can be found at the GHS Classification page.)

EU REGULATION (EC) No 1272/2008

<https://safescience.cas.org/results?q=acetone>

<https://pubchemdocs.ncbi.nlm.nih.gov/lcss>



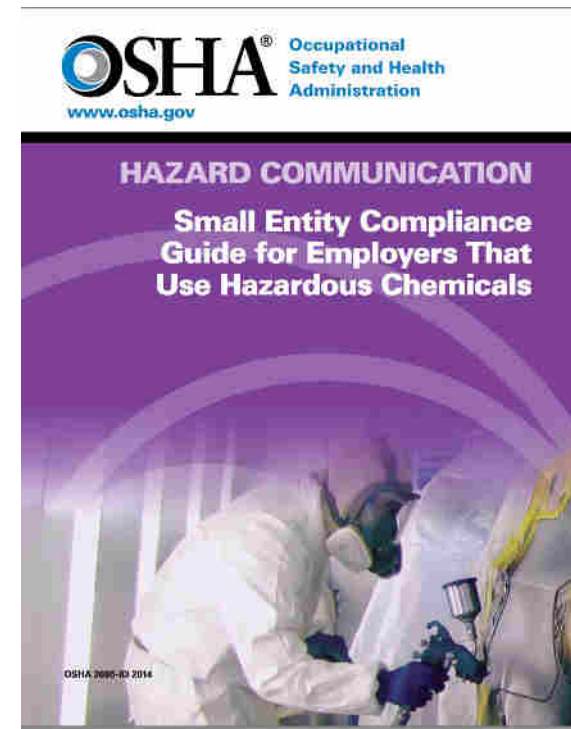
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But how do “regular” people FIND safety info?

- I work with a worldwide audience daily, and they have a LOT of questions about safety.
 - But very few have any idea how to find answers to their specific question.
 - And fewer still know how to gauge the accuracy/validity like DCHAS members do.
- Small businesses, community colleges etc. often have minimal safety competencies or regulatory understanding.



OSHA Publication 3695 is a great starting place.

ILPI's Safety Data Sheet (SDS) Website

- List of 100+ good sites to find SDS's.
- SDS Frequently Asked Questions (FAQ) w/ 58 entries.
- SDS HyperGlossary contains ~300 entries covering 450+ terms. Extensively crosslinked and links to authoritative sources.
- Hypertext-enhanced HazCom Standard 29 CFR 1910.1200, inspection procedures, and 400+ interpretation letters.
- SDS software and suppliers resources.

<http://www.ilpi.com/msds/index.html>



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Doing our part...

What does water reactive mean?

⌵ 🔍

🔍 All 🖼 Images 🛒 Shopping 📺 Videos 📰 News ⋮ More Tools

About 204,000,000 results (0.57 seconds)

<http://www.ilpi.com/msds/ref/waterreactive> ⋮

The MSDS HyperGlossary: Water Reactive

Sep 12, 2018 — **Water reactive** substances are dangerous when wet because they undergo a chemical reaction with **water**. This reaction may release a gas that ...

Who can write an SDS?

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🔍 All 📰 News 🛒 Shopping 🖼 Images 📺 Videos ⋮ More Tools

About 23,500,000 results (0.56 seconds)

<http://www.ilpi.com/msds/faq/part0> ⋮

The SDS FAQ: Content

In theory, anyone **can write an SDS** as long as they are capable of filling out the OSHA-required elements outlined in Appendix D of the Hazard Communication ...

How do I free a stuck ground glass joint?

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🔍 All 📺 Videos 🛒 Shopping 🖼 Images 📰 News ⋮ More Tools

About 21,100,000 results (0.67 seconds)

<http://www.ilpi.com/glassblowing/frozenglass> ⋮

The Scientific Glassblowing Learning Center: Dealing with ...

Another method used to **free frozen glass joints** is the application of heat to the outer **joint**. The outer **glass joint** expands - **freeing** itself from the inner ...

What is evaporation rate?

⌵ 🔍

🔍 All 🖼 Images 📰 News 📺 Videos 🛒 Shopping ⋮ More Tools

About 59,900,000 results (0.52 seconds)

Safety Data Sheets: An evaporation rate is the rate at which a material will vaporize (evaporate, change from liquid to vapor) compared to the rate of vaporization of a specific known material. This quantity is a ratio, therefore it is unitless. Feb 3, 2020

<http://www.ilpi.com/msds/ref/evaporationrate> ⋮

The MSDS HyperGlossary: Evaporation Rate



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ilpi.com is a “respected authority” in Google’s Page Rank algorithm.



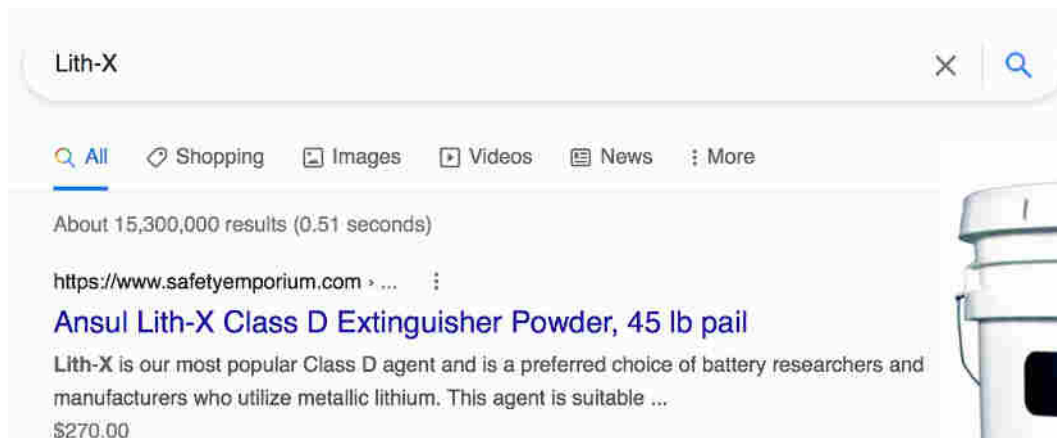
Fine wine versus the firehose

- Someone with readily available expertise can consume technical information this way:
- Someone out of their element runs to the web and gets answers this way:



But even experts drink from the hose

- July 1, 2021. Yet another phone call concerning extinguishing agents for lithium ion battery fires.



Lith-X is an extinguishing agent for lithium metal fires, not lithium ion battery fires.



www.safetyemporium.com



Ansul Lith-X Class D Extinguisher Powder, 45 lb pail

Item #: 09451

Quantity:

\$270.00

- Buy 12 - 23 and get 2% off
- Buy 24 or above and get 5% off

Normal Availability: 1-5 business days

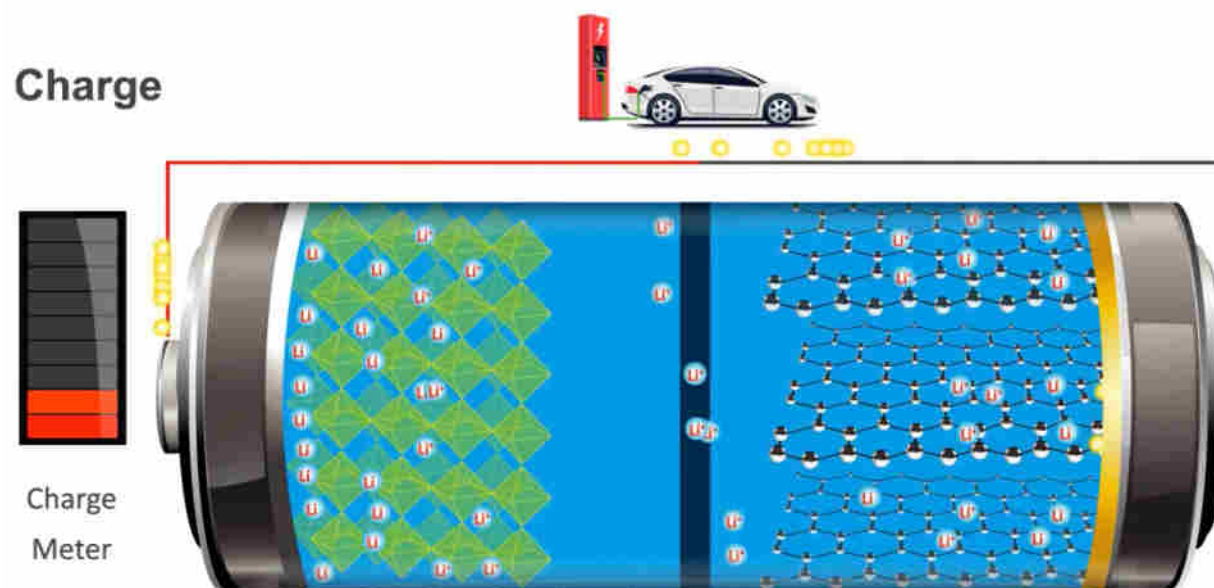
ADD TO CART

ADD TO WISHLIST

<https://www.safetyemporium.com/09451>

Lithium-ion batteries don't contain lithium metal

https://www1.eere.energy.gov/apps/office_eere/lithium/Lithium-Battery-Animation.html



Lithium ions shuttle back and forth through a (flammable) electrolyte).

Analogy: table salt does not contain metallic sodium!

This call was urgent...

- Emergency responder. Fire currently going on.
- “There must” be some lithium metal batteries in there as well. They started blowing up when water was put on the fire.
- Warehouse size fire. Caller said Lith-X recommended.
- Would require tons of Lith-X to fight this (2-3” coverage recommended).
 - The fire had already been going on for 15 hours.
 - Involved approximately 100 tons of Li-ion batteries.
 - Caller called us because we were the first hit on Google.

Lith-X is **not** a Li-ion extinguishing agent and there is never enough of it in stock to deal with something this size.

How not to start your solar energy business

1. Invest life's savings in run-down warehouse, panels and batteries.
2. Fix up warehouse; repair roof leaks.
3. Arrange for insurance coverage.



Curated info is sometimes not enough...

Technical note: Rechargeable lithium ion batteries do not pose a Class D fire threat but typically involve a flammable electrolyte material or casing and should be protected by an appropriate Class ABC or BC dry chemical extinguisher. ABC would be your first choice unless you had other considerations - for example, aircraft or electronic equipment would dictate a Class BC dry chemical or clean agent such as CleanGuard, Halotron, carbon dioxide or water. For a technical report that discusses suppression of lithium ion battery fires see the suppression discussion of [Lithium Ion Batteries Hazard and Use Assessment](#) at the NFPA. Lithium metal batteries (which are single use) **do** pose a Class D threat.

Lithium ion batteries hazard and use assessment

Fire Protection Research Foundation report: "[Lithium Ion Batteries Hazard and Use Assessment - Phase III](#)" (PDF)

Author: R. Thomas Long Jr and Andrew Blum

Date of issue: November 2016

This report is part of a multi-phase research program sponsored largely by the Foundation's Property Insurance Research Group (PIRG) to develop guidance for the protection of lithium ion batteries in storage.

The first two phases of this project addressed a hazard assessment and a large scale flammability characterization, with the initial report completed in 2011 and a [follow-up report completed in 2013](#). The latter of these two earlier efforts provided useful information on the performance of packaged small format batteries in storage. This indicated that a practical sprinkler protection solution, similar to that used for other common stored commodities, will be effective.



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Making it up as you go along

- Ultimately put under control with high flow water followed by smothering with 28 tons of cement.

<https://abc7chicago.com/morris-fire-update-evacuation/10849672/>

- "When we smothered it with the concrete, we're not 100% sure that this thermal runaway is not continuing. It is probably continuing and hopefully it is going to consume what is left of the batteries underneath then it will be over. But there is a possibility that as this continues that it does break through this Portland cement."

RHETORICAL QUESTION: How do you dispose of 28 tons of cement mixed with live/damaged batteries and general warehouse fire debris? **RCRA nightmare.**

Experts can miss existing hazards as well.

2008, UCLA

Sheri Sangji fatally burned in an accident involving *t*-butyllithium.

Internal reviews can be blind to an existing risk/hazard that was not fully understood (or thought to be). Risk audits and assessments are key.

<https://cen.acs.org/articles/87/i31/Learning-UCLA.html>

Expect training to fail

No matter how well-trained someone is, there is a significant probability employees will freeze up in a true emergency.

Plan for the unexpected response.

“We Are Comfortable with Our Current Safety Procedures”:
How Do You Prevent Something You Don’t Recognize?

<https://www.linkedin.com/pulse/we-comfortable-our-current-safety-procedures-how-do-you-palluzi>



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And non-experts?

\$60 Million Awarded to N.Y. Student Engulfed in Flames in Chemistry Accident

Much of a high school student's body was left scarred from third-degree burns when an experiment went awry in 2014.

Arizona (2004) – Middle school teacher builds carbon dioxide bombs as a “demonstration” of sublimation.
Student lost an eye.

Teacher insists he did nothing wrong
and would perform it again for its
“pedagogical value”



U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

INVESTIGATION REPORT

FINAL

WEST FERTILIZER COMPANY FIRE AND EXPLOSION (15 Fatalities, More Than 260 Injured)



WEST FERTILIZER COMPANY

WEST, TX

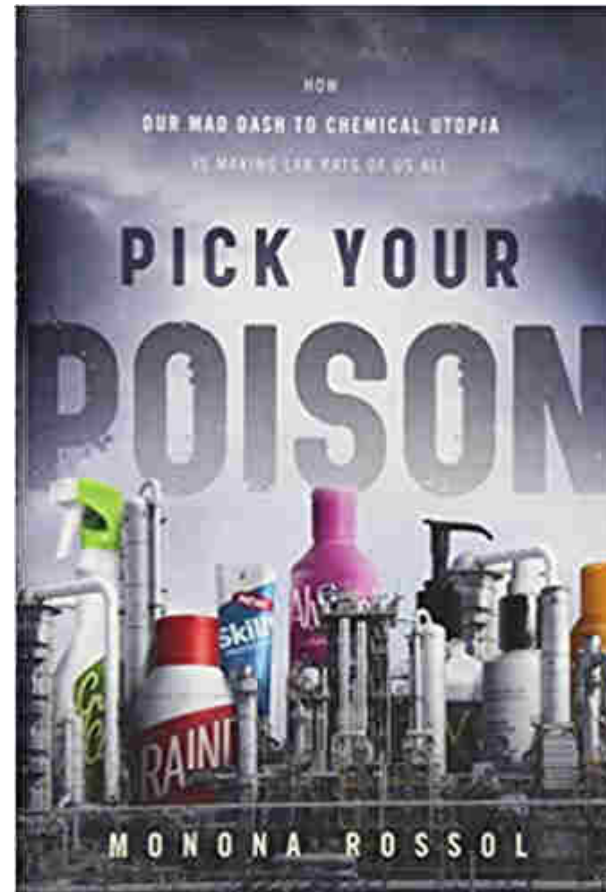
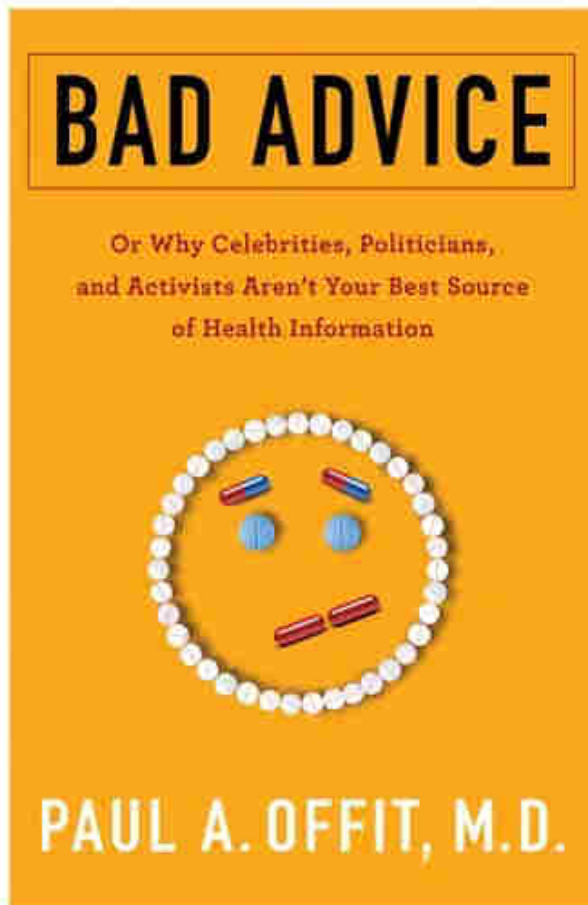
APRIL 17, 2013

Who drinks from the firehose?

- Anyone can. Sometimes experts are faced with having to make it up as they go along.
- So much information is available on-line that it can be difficult to find the “best” information.
 - Chaff:wheat ratio often high.
 - Disinformation or bad information as well. And not just chemistry.

Levine, K., Chaifetz, A. and Chapman, B. (2017), "Evaluating food safety risk messages in popular cookbooks", *British Food Journal*, Vol. 119 No. 5, pp. 1116-1129. <https://doi.org/10.1108/BFJ-02-2017-0066>

Of 1,497 cookbook recipes involving raw animal ingredients, only 123 (8.2 percent) included an endpoint temperature, of which 89...gave a correct temperature...When endpoint temperatures were not included, authors often provided subjective and risky recommendations.



Who should the public trust? Who DO they trust?

FILTERS

But we are making a difference!

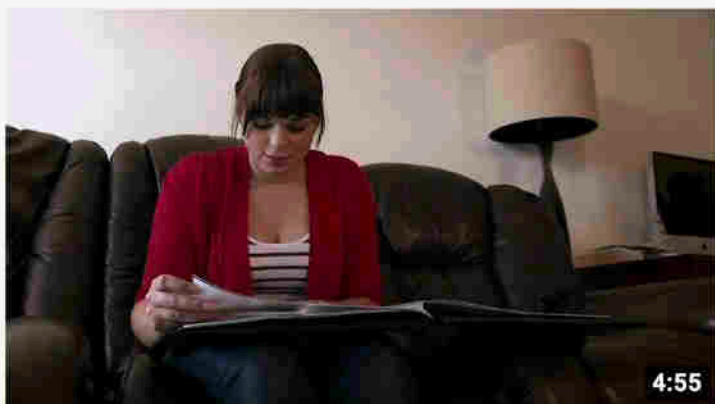
A Safer "Rainbow Flame" Demo for the Classroom

141K views • 5 years ago



American Chemical Society

A chemistry demonstration commonly known as the "rainbow flame" experiment has resulted in a number of serious injuries in ...



After the Rainbow

139K views • 7 years ago



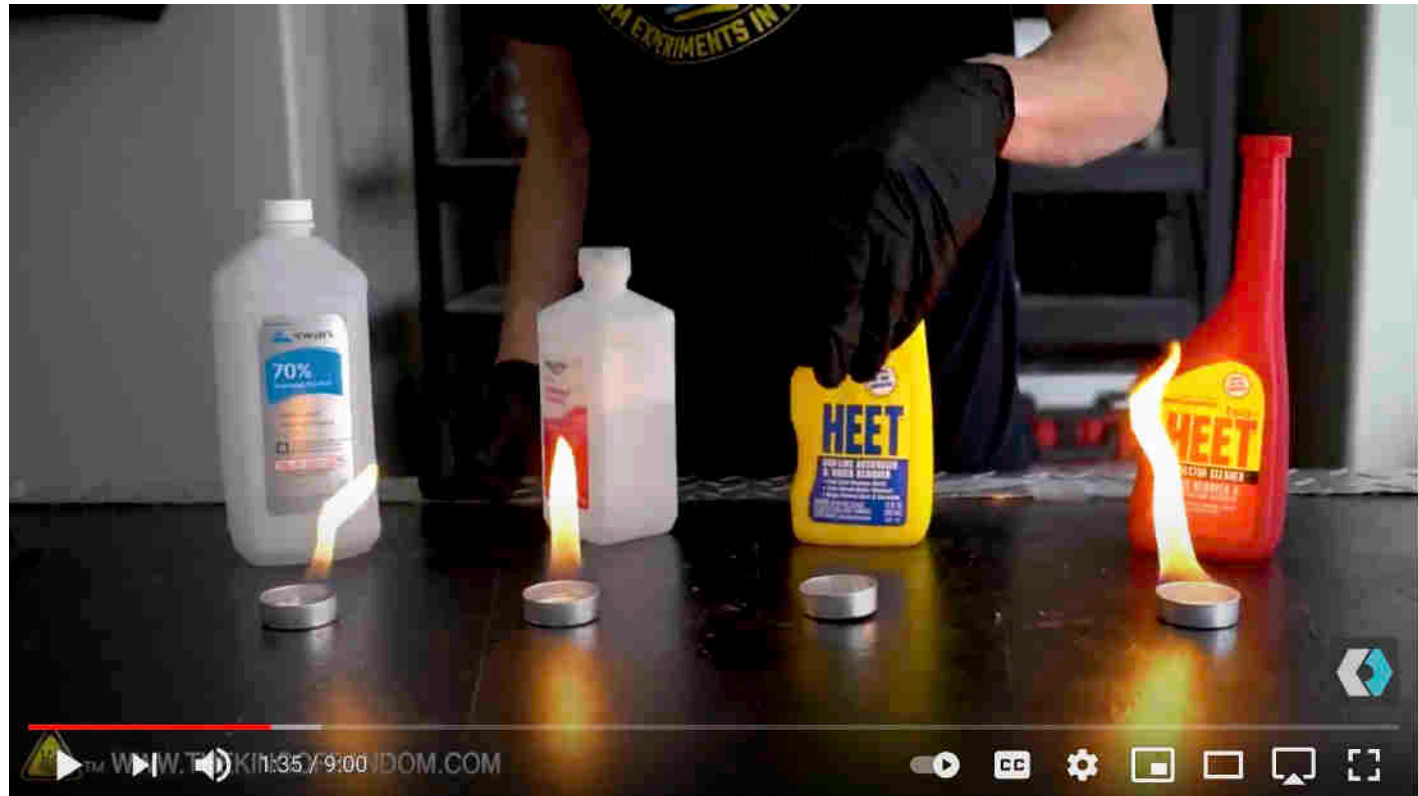
USCSB ✓

"After the Rainbow" is a CSB video safety message focusing on preventing accidents in high school chemistry labs.

CC

Likewise, in time, manufacturers, firefighters and power suppliers will learn how to deal with large scale battery fires. Or make non-flammable batteries.

But the
battle will
continue



SAFETY
Lab and Safety Supplies
EMPORIUM

www.safetyemporium.com

<https://www.youtube.com/watch?v=p2XIMKX3ktg>

ILPI
www.ilpi.com

Great progress...but we aren't done yet.

- The availability, quality, and dissemination of chemical health and safety information has increased dramatically over the past 50 years.
 - Information technology has revolutionized the field
 - Simple example: finding an SDS.
 - Regulatory impacts: OSHA and EPA.
 - Growing awareness of the value of safety culture.
 - ACS embracing safety as a core value.
 - Safety community evangelism.

The future of chemical health and safety

- Provide succinct, understandable, and readily available advice on a variety of safety topics.
 - Requires **CURATION, CURATION, CURATION.**
- ACS as the go-to source for accurate and understandable chemical health and safety information.
 - *C&E News*, CAS has bought in.
- We need to reach beyond our core base.
 - Local section outreach to schools and industry.
 - How do we (re)establish public trust in science/scientists?



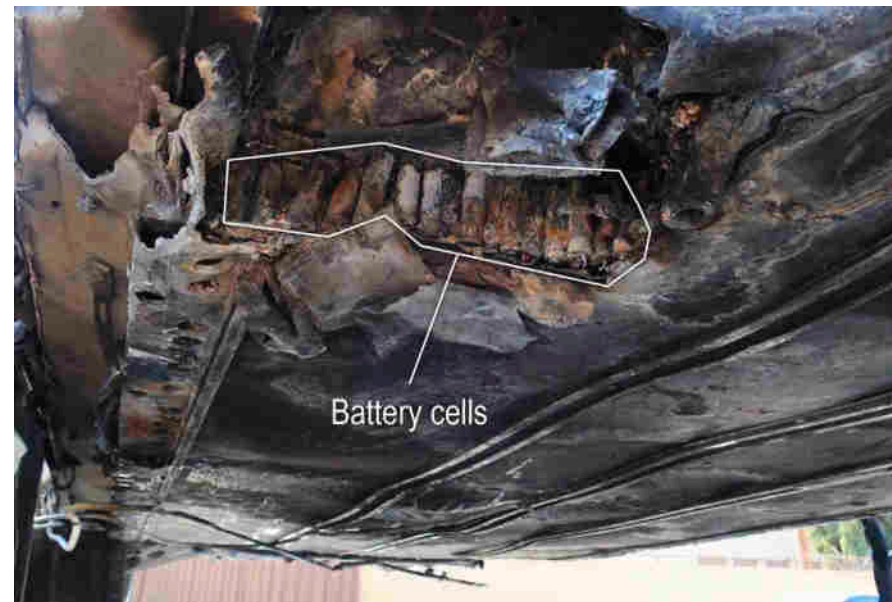
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Li-ion fires are hard to control

- 2017 Tesla Model S P85 has 16 individual battery modules, each with 444 individual battery cells.
- Sealed in epoxy. Waterproof.
- Cathode gives off free oxygen at relatively low T (180 °C).
- Basically all you can do is cool them.
- NTSB report on four electric vehicle crashes – incredible volumes of water needed; can reignite weeks later.

<https://www.nts.gov/safety/safety-studies/Documents/SR2001.pdf>



Li ion vs gasoline

- Energy density
 - Li-ion batteries: (~ 250 Wh/kg) (540 kg) = 135 kWh
 - Gasoline: ($\sim 12,500$ Wh/kg) (57 kg) = 712.5 kWh. Over 5x more energy!
- Firefighter: “once it’s burning, they are extremely hard to put out,” he added. “They’ll reignite... as soon as you stop flowing water and it looks like it’s out, it’ll just reignite.”
- “Normally a car fire you can put out with 500 to 1,000 gallons of water, but Tesla’s may take up to 30,000-40,000 gallons of water, maybe even more, to extinguish the battery pack once it starts burning and that was the case here,” Smith [told CBS Austin](#).
- Tesla Megapack fire involving 2 of 210 units took 150 firefighters **4 days** to put out.

<https://www.businessinsider.com/tesla-megapack-battery-fire-burns-four-days-testing-australia-2021-8>



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