

# VINYL CHLORIDE

## Exposure | Hazards | Regulation

### What is Vinyl Chloride?

Vinyl Chloride (VC) is a colorless, highly flammable gas. The majority of vinyl chloride in the U.S. is synthesized with additives like BPA, certain metals, and plasticizers like phthalates in order to produce polyvinyl chloride, or PVC<sup>1</sup>. PVC is a plastic that, depending on its final composition, can be both hard and flexible. This makes it perfect for use in a wide range of applications. Some of its uses may include: construction materials such as pipes, flooring, siding, cable coatings, and door and window frames; medical devices such as intravenous bags, blood and respiratory tubing, dialysis equipment, and feeding tubes; and consumer products, like garden tools, toys, furniture, plastic bags, curtains, and credit cards<sup>1</sup>. PVC is everywhere.

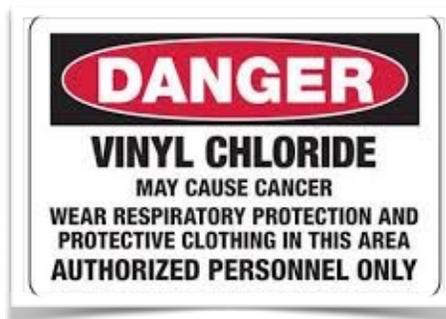


### Exposure to VC: Who and How

- Exposure to high levels of VC (<100 parts per million) may occur in places that manufacture, process, transport, store, or dispose of VC or PVC. VC has been a known occupational health hazard since the 1960s.<sup>2</sup>
- Concentrations of VC in ambient air are usually low, but higher local exposure can occur through release of VC from factories that make or process it, or evaporation from areas where VC, or VC wastes, are stored.<sup>2</sup>
- Enclosed places with lots of new plastic, like new cars, may have higher levels of vinyl chloride concentrations in the air.<sup>2</sup>
- Drinking water may be contaminated by VC through the use of PVC pipes.<sup>1</sup>
- PVC additives may leach into the environment through landfills, through incineration, or through consumer use (such as through food or cosmetic packaging).<sup>3</sup>

### Short-Term Hazards and Outcomes

Short-term exposure to high levels of vinyl chloride gas results in dizziness, sleepiness, and headaches. Acute short-term exposure can result in loss of consciousness and even death.<sup>4</sup>



<sup>1</sup>Anon. 2017. "Tox Town - Polyvinyl Chloride (PVC) - Toxic Chemicals And Environmental Health Risks Where You Live And Work - Text Version." *Toxtown.nlm.nih.gov*. Retrieved November 27, 2017

<sup>2</sup>U.S. Department of Health and Human Services. 2006. *Toxicological Profile For Vinyl Chloride*. Washington, D.C.: U.S. Department of Health and Human Services; Agency for Toxic Substances and Disease Registry.

<sup>3</sup>Schierow, Linda-Jo, and Margaret Mikyung Lee. 2017. "Phthalates In Plastics And Possible Human Health Side Effects.."

<sup>4</sup>U.S. Department of Health and Human Services. 2006. *Toxicological Profile For Vinyl Chloride*. Washington, D.C.: U.S. Department of Health and Human Services; Agency for Toxic Substances and Disease Registry. (page 27-29)

## Regulation:

VC is regulated in drinking water, food, air, and workplace environments.

- In 1975, OSHA set a limit of permissible workplace VC exposure at 1 ppm average over an 8 hour work day.<sup>1</sup>
- Each VC-related business must set up a program monitoring occupational exposure levels, and offer medical surveillance if workers are exposed.<sup>1</sup>
- VC is listed as a Hazardous Air Pollutant under the Clean Air Act, and its emissions are regulated as such.<sup>2</sup>
- EPA requires reporting of any releases of VC into the environment exceeding 1 pound.<sup>3</sup>
- FDA regulates the VC content of various plastics that carry food and beverages.<sup>3</sup>
- EPA has set a safe level limit for VC in drinking water at 0.002 mg/L.<sup>3</sup>
- On California's Prop 65 list.<sup>4</sup>

## So why is PVC—and by default, VC—used?

PVC is used because it is cheap and effective. Its physical properties can be changed with hundreds of different additives, allowing manufacturers to perfectly meet their requirements. The synthesis of PVC, and all of its potential properties are well-understood, and switching from a material so ubiquitous would require time, research, development, testing, and would cost a lot of money. There many alternatives on the market, for various PVC products (including wood, polyolefin, and rubber) , but sticking with PVC remains the most cost-effective option to the industry.

## Long-Term Hazards and Outcomes

- Long-term exposure to vinyl chloride gas, through inhalation or oral exposure, results in damage of the liver, lungs, nerves, and kidneys, as well as brain, blood, lung cancer, and a rare form of liver cancer.<sup>5,6</sup>
- A small percentage of occupational exposures result in “vinyl chloride disease”, whose symptoms include shrinking of finger bones, joint and muscle pain, and thickening of the skin.<sup>7</sup>
- Epidemiological studies have found associations with birth defects, miscarriages, and decreased male fertility and VC.<sup>7</sup>
- The EPA, National Toxicology Program, and the International Agency for Research on Cancer have classified VC as a human carcinogen.<sup>8</sup>
- During the production, use, and disposal of PVCs, bio-accumulative toxins that are added to PVCs such as dioxins and phthalates can be released into the environment. Dioxins are classified as human carcinogens by World Health Organization, International Agency for Cancer Research, and the U.S. National Toxicology Program.<sup>9</sup> Phthalates are potential endocrine disruptors and carcinogens, and are linked to obesity, diabetes, and altered reproductive development.<sup>10</sup>

## Data Gaps and Conflicts of Interest: Who is Doing the Science?

The biggest point of contention in VC research is whether or not it causes forms of cancer other than liver cancer. Industry-funded studies in the 1950s and 60s concluded that there was no clear causal relationship between VC exposure and cancers of the lung, brain and blood.<sup>11</sup> Other, independent researchers since have concluded that there is a slight correlation between VC exposure and other cancers.<sup>12</sup> The EPA, arguably due to pressure by the industry, does not allude to a causal relationship between VC and these other cancers in its formal VC assessment.<sup>13</sup>

There is also a lack of information about the toxicology and exposure hazards of PVC, which is made with additives that have known carcinogenic and reproductive health effects. Billions of pounds of this substance are produced, used, and disposed of across the world, and yet there have been relatively few studies on how PVC products could be affecting consumers or the environment.

<sup>1</sup>U.S. Department of Health and Human Services. 2006. *Toxicological Profile For Vinyl Chloride*. Washington, D.C.: U.S. Department of Health and Human Services; Agency for Toxic Substances and Disease Registry.

<sup>2</sup>Anon. 2017. "Clean Air Act Standards And Guidelines For Chemical Production And Distribution | US EPA." *US EPA*. Retrieved December 7, 2017 (<https://www.epa.gov/stationary-sources-air-pollution/clean-air-act-standards-and-guidelines-chemical-production-and>)

<sup>3</sup>U.S. EPA Toxicity and Exposure Assessment for Children's Health. 2007. *Vinyl Chloride TEACH Chemical Summary*. Washington, D.C. (Page 8-9)

<sup>4</sup>Anon. 2017. "The Proposition 65 List." OEHHA. Retrieved December 7, 2017 (<https://oehha.ca.gov/proposition-65/proposition-65-list>).

<sup>5</sup>International Agency for Research on Cancer. 2007. Vinyl Chloride. IARC.

<sup>6</sup>Kielhorn, J., Melber, C., Wahnschaffe, U., Aitio, A., & Mangelsdorf, I., 2000. Vinyl chloride: still a cause for concern. *Environmental Health Perspectives*, 108(7), 579-588.

<sup>7</sup>U.S. Department of Health and Human Services.

<sup>8</sup>Anon. 2017. "Known And Probable Human Carcinogens." *Cancer.org*. Retrieved December 7, 2017 (<https://www.cancer.org/cancer/cancer-causes/general-info/known-and-probable-human-carcinogens.html>).

<sup>9</sup>Anon. 2017. "Tox Town - Polyvinyl Chloride (PVC) - Toxic Chemicals And Environmental Health Risks Where You Live And Work - Text Version." *Toxtown.nlm.nih.gov*. Retrieved November 27, 2017

<sup>10</sup>U.S. Environmental Protection Agency. 2012. *Phthalates Action Plan*. Washington, D.C.: U.S. EPA

<sup>11</sup>Doll R, 1988. Effects of exposure to vinyl chloride. An assessment of the evidence. *Scandinavian Journal of Work, Environment, and Health*, 61-78 (INDUSTRY)

<sup>12</sup>International Agency for Research on Cancer. 2007. Vinyl Chloride. IARC.

<sup>13</sup>Sass, Jennifer Beth, Barry Castleman, and David Wallinga. 2005. "Vinyl Chloride: A Case Study Of Data Suppression And Misrepresentation." *Environmental Health Perspectives* 113(7):809-812.