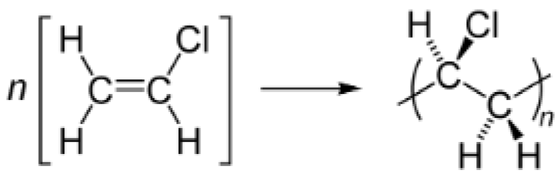
A STUDY ON PVC

History



PVC was accidentally discovered first in 1835 by Henri Victor Regnault and in 1872 by Eugen Baumann. On both occasions the polymer appeared as a white solid inside flasks of vinyl chloride that had been left exposed to sunlight. In the early 20th century the Russian chemist Ivan Ostromislensky and Fritz Klatte of the German chemical company Griesheim-Elektron both attempted to use PVC (polyvinyl chloride) in commercial products, but difficulties in processing the rigid, sometimes brittle polymer blocked their efforts. Waldo Semon and the B.F. Goodrich Company developed a method in 1926 to plasticize PVC by blending it with various additives. The result was a more flexible and more easily processed material that soon achieved widespread commercial use.

Lifecycle of Pollution of PVC

Chlorine Production

- PVC is the largest production-volume organochlorine.
- Organochlorines are known human and environmental toxins.
- Use of chlorine in the production process of PVC creates toxic by-products including dioxins, a known toxin and carcinogen.
- "Severe contamination of fish and sediments with (octachlorostyrene) OCS—an extremely persistent, bioaccumulative POP—has been documented near eight North American chlorine producers."
- "Vinyl manufacture in the United States alone is associated with the release of more than 35,000 pounds (about 16 metric tons) of mercury into the environment each year."
- "Based on an attributable fraction of 40 percent of chlorine demand, the chlorine consumed in vinyl production is associated with electricity consumption of approximately 47 billion kilowatt-hours per year."

Feedstock Production and Polymerization

- Ethylene Dichloride (EDC) and * Vinyl Chloride Monomer (VCM) are created to form polyvinyl chloride.

- Researchers estimate that 100,000 tons of EDC and VCM are released into the air every year along with 20 tons of each into surface water.
- VCM is a known carcinogen.
- EDC is a probable carcinogen
- Both EDC and VCM exposure are linked to liver, testicular, and DNA damage, neurological toxicity, and weakened immune system response.
- Manufacturing of EDC and VCM produces organochlorines and PCBs as by-products. PCB production is estimated at a rate of 20,000 pounds per year from EDC manufacturing.
- PCBs are both a carcinogen and toxin, posing threats to human and environmental health. They are extremely persistent remaining in air, water, and soil for long periods of time.
- Areas around EDC/VCM manufacturing plants have found high levels of toxic organochlorines.
- Creates dioxins as a by-product.
- Samples taken from areas around EDC/VCM plants have found high levels of dioxins in nearby streams, sediments, and fish.

Recycling and Disposal

- "Recycling postconsumer PVC is extremely difficult because vinyl products are mixtures of PVC and additives, and each specific formulation is uniquely suited to its application."
- PVC placed into a landfill can extend its lifecycle of pollution as toxic additives will continue to leach out. 11

All information in this section that does not have an endnote is from the following source:

Thornton, Ph.D., Joe. Environmental Impact of Polyvinyl Chloride Building Materials. Publication. Washington, D.C.: Healthy Building Netword, 2002.

Chemicals found in PVC

- Arsenic
- Bromine
- Calcium
- Chlorine
- Copper
- Iron
- Lead
- Manganese
- Silver
- Strontium
- Tin
- Titanium
- Zinc

Hazardous Chemicals and their Impacts on Aquatic Ecosystems and the Environment

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Greenpeace states that "additives (to PVC) are not bound to the plastic and leach out." 11

"PVC and PE pipes have increased contamination potential once organic chemicals have permeated. The organics cause the pipes to swell allowing a higher rate of diffusion." 12

In a laboratory study, small crustaceans fed phytoplankton that were cultured with silver, zinc, copper, and nickel, experienced negative impacts on their reproduction. 15

"Most heavy metals are effective at very low concentrations, so even low assimilation rates (reflected by small transfer factors) are sufficient to attain biologically significant or harmful concentrations (of fish)." 22

Arsenic

- Several aquatic plants have been shown to accumulate arsenic at extremely high rates. If these plants are a food source to either humans or other aquatic organisms they could pose a threat to their health. 1
- When levels of phosphorous are low arsenic is very toxic to algae. 2
- Water fleas are extremely sensitive to arsenic. 2
- Juvenile mummichogs, a small fish similar to a minnow, whose parents were exposed to arsenic experienced an increased rate of curved or stunted tails. 3
- Researchers found that juvenile mummichogs whose parents were exposed to arsenic had 13 genes with altered expressions. These genes are important in embryo development and could be the cause of structural deformities. 3
- Arsenic, even at very low concentrations, is toxic to the immune system of fish. 4
- Arsenic can accumulate most rapidly in aquatic habitats and proceed to move up the food chain, eventually to humans. 5
- Fish have been found to contain extremely high levels of arsenic. 5
- Inorganic arsenic is more toxic than its organic form. 5
- Arsenic is known to inhibit more than 200 enzymes found in fish and interfere with their function. 5
- In fish, arsenic has been shown to inflame the liver and gall bladder. 5
- In fish, arsenic has been shown to disrupt reproductive processes by disrupting ovarian cell cycles, inhibiting ovarian follicle development, impairing spermatogenesis, and changing testicular architecture. 5
- In birds, arsenic exposure can impact immune responses. 5

Chlorine

- Larger fish are more susceptible to death from chlorine exposure than smaller fish. 9
- At certain levels, exposure to residual chlorine can inhibit the growth of phytoplankton. 9

- Several studies have concluded that salmonoids are the most sensitive fish species to residual chlorine. 9
- "Chronic toxicity effects on growth and reproduction occur at much lower concentrations than acutely lethal concentrations." 9
- In experiments, salmon avoided sea water contaminated with chlorine. 10
- Mussels exposed to chlorine experienced reductions in physiological activities such as filtration rate and foot activity. 19
- Several species of fish, including coho salmon, have been found to avoid water contaminated with chlorine. 20

Copper

- Exposure to low levels of copper can negatively affect the olfactory system in Coho salmon. 13
- Disruption of the olfactory system inhibits the salmon's natural predator avoidance responses. 13
- Copper has been shown to have similar impacts on the olfactory system of chinook salmon, rainbow trout, brown trout, fathead minnow, and tilapia. 13
- Copper exposure to larval fish can interfere with behavior such as schooling, maintaining position in currents, and other behaviors that are integral to migration and survival. 14
- Copper has been shown to cause respiratory stress in spiny dogfish. 16
- Water fleas fed a diet of algal food contaminated with copper experienced reduced growth and reproduction. 17

Lead

- "Lead is known to leach into water carried in PVC pipes that contain lead stabilizers."
- Several types of tested were able to survive in water with high concentrations of lead for extended periods of time. 6
- High concentrations of lead adversely affected survival and reproductive cell production in female sea urchins. 7
- Similar concentrations were found to be toxic to early life stages of sea urchins. 7
- Researchers have found that lead exposure in fish at levels that do not cause death are linked to adverse behavioral effects. 8
- These effects last even when fish are placed in lead free water. 8
- Deposit feeding bivalves have been shown to bioaccumulate lead.
- While acute and chronic toxicity of lead to bivalves need further investigation, eating bivalves with high levels of lead can pose threats to human health. See Health Effects of Lead for more information. 21

Zinc

- In experiments, water fleas subjected to chronic exposure to zinc experienced a decrease in calcium intake leading to reduced movement and filtration, ending in decreased food uptake. 18
- Once exposure ended, water fleas were able to return to normal calcium intake and feeding. 18

Source : http://www.toxipedia.org/display/toxipedia/PVC