

Definition: **dioxin** from *Collins English Dictionary*

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1 any of a number of mostly poisonous chemical by-products of the manufacture of certain herbicides and bactericides, esp the extremely toxic 2,3,7,8-tetrachlorodibenzo-para-dioxin

Summary Article: **Dioxin**

From *Green Energy: An A-to-Z Guide*

Dioxin refers to a large group of halogenated organic compounds that are polychlorinated dibenzodioxins. They are commonly called “dioxins” because they all contain the p-dioxin skeleton consisting of two benzene rings joined by two oxygen bridges. A variable number of chlorine atoms are attached to the benzene ring at any of eight possible sites on the benzene rings. The locations of the chlorine attachments impact the toxicity of the dioxin. The most infamous of the dioxins is 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD), which was a contaminant in Agent Orange, which was used as an herbicide in the Vietnam War.

Dioxins are produced in a variety of chemical reactions. In the 1980s, nearly 80 percent of dioxins entering the atmosphere were the result of burning organic materials in the presence of chlorine. Because chlorine is present in many settings, combustion of various kinds produced a small amount of dioxins that, in the aggregate, created significant pollution and environmental burden. Coal-fired utilities and municipal waste incinerators were two large sources of environmental dioxins. Diesel truck exhaust, metal smelting, application of sewerage sludge, burning of trash, and burning of treated wood were other significant sources. To some extent, new emission requirements implemented in the United States over the past two decades have significantly reduced, but not eliminated, dioxin emissions. At this time, in the United States, only 3 percent of all dioxin emissions come from these traditional sources. However, burning of residential trash, especially if not equipped with emission control methods, continues to be a large source of dioxin production in the United States. In other countries, burning of a variety of organic materials for heating, cooking, or power continues to be a source of dioxins. Other sources of dioxin include paper mills that use chlorine bleaching in producing paper, production of polyvinyl chloride plastics, and manufacture of pesticides. Cigarette smoke produces a small amount of dioxins.

Although great strides have been made in reducing the production of dioxins, there still remains a great deal of dioxin produced decades ago because dioxins decompose very slowly in the environment. Dioxins are also very widespread because when released into the air, as in burning, they can travel long distances. In water, they settle into sediments, where they can be ingested by fish or other aquatic organisms and travel long distances both geographically and up the food chain.

Dioxins are absorbed through dietary intake of fat and are stored in fatty tissues. Ninety-five percent of the human intake of dioxins occurs through dietary intake of animal fats. Only a small amount comes from breathing air containing dioxins or from skin contact. One way to reduce intake of dioxins is to reduce intake of animal fat.

Dioxins are not readily metabolized or excreted in the human body. Half-life in humans ranges from

eight years to over a hundred years, depending on the specific dioxin. Dioxins cross the placenta, and thus pose risk to developing fetuses. Dioxins are excreted in human milk, and thus also can be toxic to developing infants.

Not all dioxins have the same toxicity. The 2,3,7,8 Tetrachlorodibenzo-p-dioxin (or TCDD) form is the most toxic. Toxicity of a given dioxin is measured in terms of its relationship to this form. The toxicity is measured in Toxic Equivalent by relating to the 2,3,7,8 TCDD form and summing the toxicities. Thus, a dioxin with half the toxicity of 2,3,7,8 TCDD would add a half Toxic Equivalent to the overall toxicity of the mixture.

There are several fairly well-agreed-upon toxic effects of dioxin. One is chloracne, which is a particularly severe skin disease with acne-like lesions. Chloracne occurs with high levels of dioxin exposure. A particularly notable case was the poisoning of a Ukrainian politician, Victor Yushchenko, in 2004. Chloracne can also be seen in workers in some chemical plants in which dioxin levels are high. Other well-agreed-upon health effects of high levels of dioxin exposure include other skin rashes, skin discoloration, excessive body hair, and possibly mild liver damage.

Cancer is a much-debated toxicity of dioxin. There are several studies that do suggest that workers exposed to high levels of dioxins at their workplace have a higher incidence of cancer. Animal studies have shown a cancer risk. The International Agency for Research on Cancer considers 2,3,7,8 TCDD to be a known carcinogen. However, despite no clear consensus on the cancer risk of most other dioxins, all dioxins have been considered to be cancer-causing by many scientists and advocates. These advocates are often very vocal in their beliefs.

A major concern regarding dioxins is their ability to act as “endocrine disruptors.” This has been the concern of a number of jurisdictions including the European Union. Concern that dioxins can cause endocrine problems such as thyroid disease, endometriosis, and immune compromise has been the source of much discussion and strong feelings among certain advocate groups. Studies of Vietnam-era military personnel involved with handling Agent Orange have shown a possible increase in the risk of diabetes. Further, these endocrine-disruptor effects are felt to affect reproductive capability and the development of infants. California lists dioxins in its proposition 65, which is a list of such agents. However, the science is far from settled on these issues, with emotions running high on both sides.

Several well-known dioxin exposure cases have received much publicity. Times Beach, Missouri, was the site of roads coated with dioxin (and other chemicals)-containing materials causing dioxin contamination of the surrounding soil. Eventually, the U.S. Environmental Protection Agency called for the evacuation of the area. Love Canal in Niagara Falls, New York, was another site of dioxin (and other chemical) contamination resulting in evacuation of the residents of the area.

The importance of dioxin in the framework of “green energy” is twofold. First, as traditional methods of energy production look at more efficient ways of producing energy, care must be taken to continue to control the emissions of dioxins in the combustion process. Second, alternative sources of energy generation that do not involve combustion (e.g., solar, wind, and tidal) should help to further reduce emissions. However, in considering such alternatives, it is important to be aware of the potential generation of other pollutants or by-products of the materials needed to produce such forms of energy. Even if all industrial sources of dioxin can be eliminated (which is not a realistic expectation), there will remain the production of dioxins through natural processes such as forest fires. The potential for human exposure also will still remain from the “reservoir” sources in the environment.

Unfortunately, the environmental burden of dioxins will be with us for generations to come because of their slow degradation in the environment. A concern that needs careful attention is remediation. Because of the high emotions and concerns regarding the risk of dioxins, there is a tendency to call for removal of the dioxin-containing material from particular areas. However, this may actually release dioxins that are trapped in sediment back into the food chain.

See Also:

Alternative Energy, Coal, Clean Technology, Power and Power Plants, Waste Incineration.

Further Readings

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