Marine Product and Dioxins

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General Information about Dioxins

Dioxins are environmental contaminants persistent in a variety of environmental media and refers to a group of chemical compounds that share certain similar chemical structures and biological characteristics.

These compounds are classed to three similar chemical classes as following to the polychlorinated dibenzo-p-dioxins (PCDDs or PCDDs), polychlorinated dibenzofurans (PCDFs or PCDFs) and certain polychlorinated biphenyls(PCBs).

The PCDDs include 75 individual compounds, and PCDFs include 135 different compound. Theses individual compounds are technically referred to as congeners. The same as that in case of PCBs have 209 congeners. Sometimes the term dioxins is also used to refer to the most well-studied and one of the most toxic dioxins 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD).

The dioxin compounds are often found in complex mixture. For risk assesment purposes, a toxicity equivalency procedure was developed to describe the cumulative toxicity of these mixtures. This procedure involves assigning individual toxicity equivalency factors (TEFs) to the 2,3,7,8 substituted Dioxins congeners.

TEFs are estimates of the toxicity of dioxin compounds relative to the toxicity of 2,3,7,8-TCDD, which is assigned a TEF of 1.0. Calculating the toxic equivalency (TEQ) of a mixture involves multiplying the concentration of individual congeners by their respective TEF. The sum of the TEQ concentrations for the individual congeners is the TEQ concentration for the mixture.

In 1998, the WHO re-evaluated the previously established TEFs for dioxins, furans and dioxin-like (co-planar PCBs; Non-ortho PCBs, and Mono-ortho PCBs). Changes were made to the 1989

International TEFs for PCDDs/DFs and co-planar PCBs.

The changes to the TEFs for PCDDs/DFs and co-plarna PCBs are follows;

- For 1,2,3,7,8-PeCDD, the new WHO TEF is 1 and the I-TEF was 0.5;
- For OCDD, the new WHO TEF is 0.0001 and the I-TEF was 0.001
- For OCDF, the new WHO TEF is 0.0001 and the I-TEF was 0.001
- For PCB 77 (i.e., 3,3',4,4'-TeCB), the new TEF is 0.0001
- The addition of PCB 81 (i.e., 3,4,4',5-TCB) the new TEF is 0.0001
- For the two di-ortho substituted HpCBs in the 1994 TEF scheme (i.e., PCBs 170 and 180), TEFs of zero have been assigned in the new WHO TEF scheme.

These effects include thermal toxicity, immunotoxicity, reproductive effects and teratogemicity, endocrine disruption and carcinogenicity.

Sources of Dioxins

Dioxins are released into the environmental from combustion processes such as commercial or municipal waste incineration and from burning fuels.

Dioxins can also be formed when car exhaust and household trash is burned and during forest fires.

Chlorine bleaching of pulp and paper, and other industrial processes all can create small quantities of dioxins. In addition, cigarette smoke also contains small amounts of dioxins.

The main source of Dioxins release into the environment have been found to be the following.

- Chemical manufacturing processes.
  - Use of contaminated chemicals
  - Improper disposal of contaminated production wastes
- Burning and high temperature processes.
  - Municipal, industrial and chemical waste.
  - Natural materials.
  - Fires involving PCBs.

Environmental Fate of Dioxins

Dioxins are distributed in the environment via air, water and soil. Although dioxins are poorly soluble in water, they strongly adsorb to soil and airborne particulates. As a result of wind and erosion, surface soil contaminated with dioxins is either swept away by air, buried or washed into rivers, streams and oceance.

Once released into the environment, dioxins follow a range of familiar routs. In the atmosphere try exist in both the gasous phase and bound to particles, depending upon the environmental conditions, and are deposited on soil, vegetation and water bodies by wet and dry deposition or in mist. Dioxins have been measured in areas with no local sources and it can, thus, be deduced that they are available for long-range transport over a scale of 1000s of kilometers.

Soil run-off can transfer dioxins from land to water and, in water bodies, dioxins rapidly adsorb to organic matter and they tend to settle into sediments where they can be further transported or ingested by fish and other aquatic organisms.

Dioxins may be concentrated in the food chain so that animals have higher concentrations than plants, water, soil or sediments. Water animals, dioxins tend to accumulate in fat.

Exposure of Trends

It was recognized that a major source of human exposure to dioxins is thought to be through the diet.

The primary source of exposure to the general public is from food, especially meat, milk and fish, which account for well over 90% of the dioxins found in humans.

Small amounts of exposure occur from breathing air containing trace amounts of dioxins on particulate and in vapor form, from inadvertent ingestion of soil containing dioxins and from absorption through the skin contacting, soil or water containing minute levels.

Variations in exposure within countries have been considered in three dimensions, where are available; by age; through time; and for specific population subgroups or at risk groups. In general, total exposure increases with age in childhood and stabilizes in adults of about 20 years of age. However, the intake on a per kilogram basis decreases in this period due to the increasing body weight.

Recent studies from EU countries which started to implement measures to reduce dioxins emissions in the late 1980s,. Such as EU countries, clearly show decreasing dioxins levels in food.

For example, In the united kingdom exposure has fallen by 71% between 1982 and 1992 (equivalent to 12% per year) and in Germany it has fallen by 45% between 1989 and 1995 (9% per

year).

Bioaccumulation in Aquatic Organisms

Most Dioxins entering the aquatic environment are associated with particulate matter (i.e., dry and wet deposition of atmospheric particles, eroded soil/stormwater runoff solids, and solids in municipal and industrial discharges) and likely to remain sorbed the particulate matter once in the aquatic environment.

In the various studies in which dioxin compounds concentration in aquatic sediments studies;

- Dioxin congeners distribution patterns in sediment generally follow these exhibited by the contaminant source.
- The concentration of dioxin congeners in sediment generally increases with the degree of chlorination, but decrease uniformly with distance from the source.

In MRI study (1992) in an effort to determine whether incineration of municipal waste influenced dioxin levels in the immediate area of waste incineration facilities, fish samples were measured from surface water nea cities with and without, operating incinerators throughout connecticut.

The total PCDDs/DFs concentrations for pre-operational and operational status were 28.44 pg/g and 58.38 pg/g, respectively.

Copper et al. (1995) and Fiedler et al. (1997) collected fish samples from in southern Mississippi. All samples had detectable concentrations fo PCDDs/DFs. High TEQ concentrations were observed in farm-raised catfish nugget (mean = 2.1 ppt/sample I-TEQ) and in the parts of the crustacea containing the digestive gland.

The congener profile for the shellfish samples was similar to that observed for sediments collected in the same area and, reported sewage sludge patterns.

In recent study, Ok et al.(2001) analyzed fish samples collected directly from markets in Pusan cities, Korea.

For fish samples, PCDFs account for a higher percentage of the total 2,3,7,8-substituted PCDFs than PCDDs and OCDD is the dominant congener for fish samples with 2,3,7,8-TCDF accounting for the second highest percentage.

Based on I-TEQ, fish samples showed the levels range of 0.013~0.577 pg I-TEQ/g wet weight; mean 0.134 pg I-TEQ/g wet weight).

The estimated intake of PCDDs/DFs by fish for a general population of Korea was about 10.03 pg I-TEQ/day.

References

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