Power Plants and Mercury

Mercury exists in the environment in many forms, in many different compounds, and behaves in complex ways.

Beyond the familiar silvery column in thermometers, the chemical element mercury is ever-present in the environment in vaporous, solid, and liquid forms. It occurs in numerous chemical forms, and may change from one form to another. In lakes and wetlands, natural processes can convert certain chemical forms of mercury to methylmercury—an organic form considered more toxic than other mercury compounds. Methylmercury accumulates in fish muscle tissue and can enter the bodies of people who eat the fish, though the levels of exposure for U.S. citizens are not considered dangerous.

Trace amounts of mercury are present in coal and oil. Consequently, whenever these fuels are used, such as in the generation of electricity, some of this mercury is emitted into the air along with exhaust gases.

A variety of sources release mercury into the environment. Natural sources, such as volcanic eruptions, the world's oceans, and soil erosion (especially around abandoned metal mines), account for about two-thirds of the world's mercury emissions. The other third comes largely from industrial sources, including the burning of municipal and medical waste, fossil fuel combustion, cement production, manufacturing of pesticides and chlorine-based industrial products, and motor vehicles.

Power plant emissions account for about one-third of the mercury emitted to the air from industrial sources in the United States, but only about 2% of total industrial mercury emissions globally. After power plants release mercury, much of it becomes part of a global cycle. The behavior of mercury in this cycle depends on its chemical form. Oxidized mercury (also called ionic or divalent mercury) falls or washes out of the air and returns to the earth more readily than other forms. Elemental mercury usually travels farthest in the atmosphere, where it may remain for months or years. Eventually, it too returns to the earth. These deposited forms of mercury may enter bodies of water and soils. Interestingly, for most of the U.S., over half of the mercury deposited on land or water originates outside the U.S.

EPRI and other researchers estimate that about 60% of the mercury released by U.S. power plants overall is elemental. About 40% is oxidized, the form that may be most readily converted to methylmercury in aquatic environments. Researchers are trying to determine how much mercury from power plants actually enters aquatic environments and whether any significant amount is transformed to methylmercury. Yet because it is difficult to track the path of elemental mercury—as it can travel around the world—and because mercury exists in so many forms, in so many environments, determining the role of the various sources of mercury has remained elusive.

Existing controls for power plant emissions may already capture some mercury, but research is under way to identify cost-effective options.

Measurements at a variety of U.S. power plants suggest that existing emission control devices for particulates (including fly ash) and sulfur dioxide (SO_2) capture, on average, 40% of the mercury present in the coal being burned. Mercury removal rates, however, vary from 0% to over 90% among power plants tested. Reliable, cost-effective control technologies designed specifically for capturing mercury have neither been fully developed nor demonstrated. EPRI and other researchers are investigating several potential technologies: One option is to inject materials into the flue gases to absorb or react with mercury and produce solids that can subsequently be captured by particulate control devices; another method is to inject materials that produce compounds of mercury that can more easily be captured by SO_2 controls. The cost of applying such controls will likely range from 1-3 tenths of a cent per kWh. Due to remaining uncertainties on control technology performance and its potential impacts on power plant operation and by-product utilization, the predicted cost range is very large. Best current estimates are $1 to $3 billion *annually* above the cost of other emission controls.

Most Americans have minimal exposure to methylmercury. Some women, while pregnant, may consume large amounts of mercury-tainted fish. This may expose their developing fetuses to subtle health risks.

There have been three major accidental mercury poisoning incidents—two in Japan in the 1950s, and one in Iraq in the 1970s—where people ate massive amounts of methylmercury in contaminated food. Their exposure levels were hundreds of times higher than current mercury exposure in North America today. In these cases, the children and adults exposed to the highest amounts of mercury experienced kidney, brain, and nerve damage, or even died.

Researchers studying the after-effects of the Iraq accident observed that it took less methylmercury to affect fetuses than it did to affect adults. Consequently, it's particularly important for women of childbearing age to limit their exposure to mercury. Excess amounts of mercury consumed by women during pregnancy may heighten their developing babies' risk of delayed starts in walking and talking, slow responses to stimuli, and cause other subtle effects.

Everyday exposure to mercury in the United States today is low. It comes primarily from methylmercury via fish consumption, and does not appear to pose a health threat for U.S. consumers. The U.S. Environmental Protection Agency (EPA) and the U.S. Food and Drug Administration (FDA) believe that eating 1 to 4 meals per week of most commercial fish is not likely to pose risks of adverse health effects for any individual, including pregnant women and their young children.

The scientific and regulatory communities remain unclear about the level at which mercury exposure begins to constitute a health threat. This makes setting allowable emissions levels problematic.

Because the body naturally eliminates mercury, researchers believe that occasional exposure to the relatively small amounts of mercury in the environment has no effect on human health. The EPA has set a maximum safe level of mercury exposure largely based on a recent study in the Færoe Islands in the North Atlantic, where the predominant food sources are locally caught fish with very low mercury and pilot whale, the primary source of mercury. Researchers tested nearly 1000 seven-year-old children who were routinely exposed to mercury prior to their birth via their mothers' diet. Under the test protocols used, some of the children with greater mercury exposure performed less well on tests measuring subtle behavioral and developmental differences.

However, in addition to mercury, the pilot whale contained other pollutants, including large amounts of polychlorinated biphenyls (PCBs), which mimic the effects of mercury on child development. Similar studies in the Seychelles Islands, where fish consumption is also high but where PCB levels are extremely low, have shown no effect of mercury exposure from fish consumption in children who have been tested several times up to the age of nine years. EPRI and other researchers continue studies to determine the levels at which mercury exposure becomes a health threat, to refine our understanding of the prevailing levels of mercury exposure in the U.S., and to determine the extent to which fish consumption may affect young children and pregnant women. Recent studies by EPRI have shown that significant reductions in utility mercury emissions of up to 70% appear to result in only slight lowering of the amount of mercury consumed by the most sensitive U.S. residents, in most states less than 2%, and thus only slight reductions in exposure. The maximum exposure reduction to the most highly exposed women was about 6.5%.

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