

Polycyclic organic matter (POM) ^(A)

The term polycyclic organic matter (POM) defines a broad class of compounds that includes the polycyclic aromatic hydrocarbon compounds (PAHs), of which benzo[a]pyrene is a member. POM compounds are formed primarily from combustion and are present in the atmosphere in particulate form. Sources of air emissions are diverse and include cigarette smoke, vehicle exhaust, home heating, laying tar, and grilling meat. Cancer is the major concern from exposure to POM. Epidemiologic studies have reported an increase in lung cancer in humans exposed to coke oven emissions, roofing tar emissions, and cigarette smoke; all of these mixtures contain POM compounds. Animal studies have reported respiratory tract tumors from inhalation exposure to benzo[a]pyrene and forestomach tumors, leukemia, and lung tumors from oral exposure to benzo[a]pyrene. EPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (4), which contains information on the carcinogenic effects of benzo(a)pyrene including the unit cancer risk for oral exposure, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs). (1)

Uses

- The majority of the polycyclic organic compounds have no commercial uses. (11)
- Solutions containing mixtures of some PAHs are used to treat some skin disorders in humans. (1)

Sources and Potential Exposure

- The primary source of POM is formation during combustion. A less significant formation mechanism is the volatilization of lightweight POM compounds, which occurs in the production and use of naphthalene. (11)
- Polycyclic organic compounds have been detected in ambient air from sources including cigarette smoke, vehicle exhausts, asphalt roads, coal, coal tar, agricultural burning, residential wood burning, and hazardous waste sites. (1,2)
- Benzo[a]pyrene, one of the more commonly monitored PAHs, has been detected in urban air at levels approximately twice as high as those in rural areas (e.g., 0.6 nanograms per cubic meter (ng/m^3) versus $0.3 \text{ ng}/\text{m}^3$). Seasonal variations have also been observed from monitoring in the Northeast U.S. during the early 1980s, with mean benzo[a]pyrene concentrations during the winter more than an order of magnitude greater than during the summer. (11)
- PAHs have been found in some drinking water supplies. (1)
- Cooking meat or other foods at high temperatures increases the amount of PAHs in the food. (1)
- Occupational exposure to PAHs may occur in coal tar production plants, coking plants, coal-gasification sites, smokehouses, municipal trash incinerators, and other facilities. (1)
- POM has been listed as a pollutant of concern to EPA's Great Waters Program due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment (2).

Assessing Personal Exposure

- PAHs or their breakdown products can be measured in urine, blood, or body tissues. (1)

Health Hazard Information

Acute Effects:

- No reports of effects to humans following acute (short-term) exposure to POM are available.
- Acute animal tests in rats have shown benzo[a]pyrene to have high acute toxicity from oral exposure. (3)

Chronic Effects (Noncancer):

- Skin exposures to mixtures of carcinogenic PAHs cause skin disorders in humans and animals, and adverse skin effects have been noted in humans and animals following application of solutions containing benzo[a]pyrene. (1)
- An epidemiological study of workers exposed by inhalation to benzo[a]pyrene and other particulate matter reported some respiratory effects. The role of benzo[a]pyrene in this association, however, is unclear. (1)
- Animal studies have reported effects on the blood and liver from oral exposure to benzo[a]pyrene and a slight hypersensitivity response from dermal exposure to benzo[a]pyrene. (1)
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for POM or for benzo[a]pyrene. (4,5)

Reproductive/Developmental Effects:

- No information is available on the reproductive or developmental effects of POM in humans.
- Animal studies have indicated that benzo[a]pyrene, via oral exposure, induces reproductive toxicity, including a reduced incidence of pregnancy and decreased fertility. Developmental effects, such as a reduced viability of litters and reduced mean pup weight, have also been noted from oral exposure to benzo[a]pyrene in animals. (1,6)

Cancer Risk:

- Epidemiologic studies have reported an increase in lung cancer in humans exposed to coke oven emission, roofing tar emissions, and cigarette smoke. Each of these mixtures contains a number of POM compounds (e.g., certain PAHs). (1,6)
- Animal studies have reported respiratory tract tumors from inhalation exposure to benzo(a)pyrene and forestomach tumors, leukemia, and lung tumors from oral exposure to benzo[a]pyrene. (1,5,7)
- EPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens. (4,5,12-17)
- EPA uses mathematical models, based on animal studies to estimate the probability of a person developing cancer from ingesting water containing a specified concentration of a chemical. EPA has calculated an oral cancer slope factor of $7.3 \text{ (mg/kg/d)}^{-1}$ for benzo[a]pyrene. For a detailed discussion of the confidence in the potency estimates, please see IRIS. (5)
- The California Environmental Protection Agency (CalEPA) has calculated an inhalation unit risk estimate of $1.1 \times 10^{-3} \text{ (}\mu\text{g/m}^3\text{)}^{-1}$ for benzo[a]pyrene. (7)

Physical Properties

- The term polycyclic organic matter (POM) defines a broad class of compounds that generally includes all organic structures having two or more fused aromatic rings (i.e., rings that share a common border), and that have a boiling point greater than or equal to 212°F (100°C). (11)

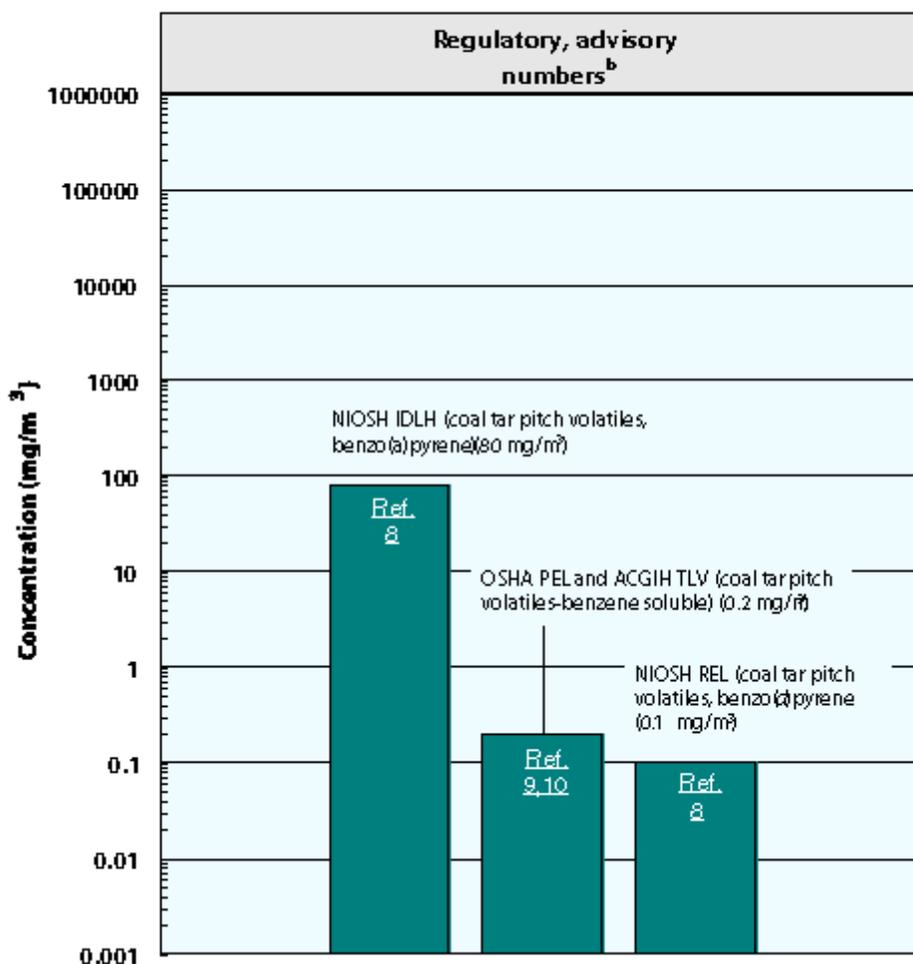
- POM has been identified with up to seven fused rings and, theoretically, millions of POM compounds could be formed; however, only about 100 species have been identified and studied. (11)
 - Eight major categories of compounds have been defined by the EPA to constitute the class known as POM. The most common category is the polycyclic aromatic hydrocarbons (PAHs), also known as polynuclear aromatics, which include benzo[a]pyrene. (11)
 - Most POM compounds are solids with high melting and boiling points, and are extremely insoluble in water. The PAHs are primarily planar, nonpolar compounds with melting points considerably over 212 °F (100 °C). Phenanthrene, with a melting point of 214 °F (101 °C), and benzo[c]phenanthrene, with a melting point of 154 °F (68 °C), are two exceptions. (11)
 - POM is present in the atmosphere predominantly in particulate form. (11)
 - The chemical formula for benzo[a]pyrene is C₂₀H₁₂, and the molecular weight is 252.3 g/mol. (1)
 - The vapor pressures of POM compounds vary, depending upon the ring size and molecular weight, from 6.8 × 10⁻⁴ mm Hg for phenanthrene, to 1.5 × 10⁻¹² for coronene. The vapor pressure for benzo[a]pyrene is 5.6 × 10⁻⁹ mm Hg at 25 °C, and it has a log octanol/water partition coefficient (log K_{ow}) of 6.06. (1,11)
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Conversion Factors:

To convert concentrations in air (at 25°C) from ppm to mg/m³: $\text{mg/m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$. For benzo(a)pyrene: 1 ppm = 10.3 mg/m³. To convert concentrations in air from µg/m³ to mg/m³: $\text{mg/m}^3 = (\mu\text{g/m}^3) \times (1 \text{ mg} / 1,000 \mu\text{g})$.

Health Data from Inhalation Exposure

Polycyclic Organic Matter



ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

NIOSH REL--National Institute of Occupational Safety and Health's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.

NIOSH IDLH--NIOSH's recommended exposure limit; NIOSH-recommended immediately dangerous to health level.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects averaged over a normal 8-h workday or a 40-h workweek.

The health and regulatory values cited in this factsheet were obtained in December 1999.

^a Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

^b Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH and ACGIH numbers are advisory.

Summary created in April 1992, updated January 2000

References

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A. * Polycyclic organic matter consists of polycyclic aromatic hydrocarbons (PAHs), including benzo(a)pyrene (CAS#50-32-8), their nitrogen analogs, and a small number of oxygen-containing polycyclic organic matter compounds.