Wood Dust

CAS No.: none assigned

Known to be a human carcinogen

First listed in the *Tenth Report on Carcinogens* (2002)

Carcinogenicity

Wood dust is *known to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in humans.

Cancer Studies in Humans

Many case reports and epidemiological studies (including cohort studies and case-control studies that specifically addressed nasal cancer) have found a strong association between exposure to wood dust and cancer of the nasal cavity. Strong and consistent associations with cancer of the nasal cavity and paranasal sinuses were observed both in studies of people whose occupations were associated with wood-dust exposure and in studies that directly estimated wood-dust exposure. Cancer risks were highest for adenocarcinoma, particularly among European populations. Studies of U.S. populations showed similar significant positive associations between wood-dust exposure and adenocarcinoma of the nasal cavity. A pooled analysis of 12 case-control studies found a very high estimated relative risk of adenocarcinoma (45.5) among men with the greatest exposure, and the risk increased with increasing duration of exposure (Demers *et al.* 1995). The association between wood-dust exposure and elevated risk of nasal cancer (adenocarcinoma) in a large number of independent studies and in many different occupations in many countries strongly supports the conclusion that the increased risk is due to wood-dust exposure, rather than to simultaneous exposure to other substances, such as formaldehyde or wood preservatives (IARC 1995, NTP 2000).

Other types of nasal cancer (squamous-cell carcinoma of the nasal cavity) and cancer at other tissue sites, including cancer of the nasopharynx and larynx and Hodgkin disease, have been associated with exposure to wood dust in several epidemiological studies. However, these associations were not found in all studies, and the overall epidemiological evidence is not strong enough or consistent enough to allow firm conclusions to be drawn about the role of wood-dust exposure in the development of cancer at tissue sites other than the nasal cavity (IARC 1995, NTP 2000).

Studies on Mechanisms of Carcinogenesis

Polar organic solvent extracts of some hardwood dusts were weakly mutagenic in *Salmonella typhimurium,* and two chemicals found in wood, delta-3-carene and quercetin, also were mutagenic in *S. typhimurium*. *In vivo* exposure of mammals and *in vitro* exposure of mammalian cells to organic solvent extracts of some wood dusts (beech and oak) caused DNA damage, micronucleus formation, and chromosomal aberrations (primarily chromatid breaks). Elevated rates of DNA damage (primarily single-strand breaks and DNA repair) and micronucleus formation were observed in peripheral-blood lymphocytes from people occupationally exposed to wood dust (IARC 1995, NTP 2000).

The roles of specific chemicals found in wood dust (either naturally in the wood or added to it in processing) in causing cancer are not clear. The particulate nature of wood dust also may contribute to wood-dust-associated carcinogenesis, because a high proportion of dust particles generated by woodworking typically are deposited in the nasal cavity. Some studies of people with long-term exposure to wood dust have found decreased mucociliary clearance and enhanced inflammatory reactions in the nasal cavity. Also, cellular changes (metaplasia and dysplasia) observed in the nasal mucosa of woodworkers and of laboratory animals may be precancerous (IARC 1995, NTP 2000).

Cancer Studies in Experimental Animals

The evidence from studies in experimental animals is inadequate to evaluate the carcinogenicity of wood dust. No tumors attributable to beech wood-dust exposure were found in rats exposed by inhalation or intraperitoneal injection. Inhalation exposure to wood dust also did not significantly affect the incidence of tumors caused by simultaneous exposure to other compounds (known to be carcinogenic in humans or experimental animals), including formaldehyde or sidestream cigarette smoke in rats and *N*-nitrosodiethylamine in hamsters. However, each of these studies was limited by such factors as small numbers of animals or exposure groups, short study duration, or inadequate data reporting. In female mice, dermal exposure to a methanol extract of beech wood dust resulted in significant dose-related increases in the incidence of skin tumors (squamous-cell papilloma and carcinoma) and mammary-gland tumors (adenocarcinoma, adenoacanthoma, and mixed tumors) (IARC 1995).

Properties

Wood is an important worldwide renewable natural resource. Forests cover about one third of the earth's total land mass (about 3.4 million square kilometers). An estimated 12,000 species of trees each produce a characteristic type of wood, and the species of trees harvested vary considerably among different countries and even among different regions of a country. However, even in countries with high domestic production of wood, some wood may be imported for specific uses, such as furniture production (IARC 1995).

Most of the 12,000 tree species are broad-leaved deciduous trees, or hardwoods, principally angiosperms. Only about 800 species are pines, firs, and other coniferous trees, or softwoods, principally gymnosperms. The terms "hardwood" and "softwood" refer to the species, and not necessarily the hardness of the wood. Although hardwoods generally are denser than softwoods, the density varies greatly within each group, and the hardness of the two groups overlaps somewhat. The composition of softwood tissue is simpler than that of hardwood, consisting of mainly one type of cells, tracheids. Hardwoods show more detailed differentiation among stabilizing, conducting, and storage tissue. Although most trees harvested worldwide are hardwoods (58% of volume), much of the hardwood is used for fuel. Softwood is the major wood used for industrial purposes (69%); however, the percentage varies from region to region (IARC 1995).

Wood dust is a complex mixture generated when timber is processed, such as when it is chipped, sawed, turned, drilled, or sanded. Its chemical composition depends on the species of tree and consists mainly of cellulose, polyoses, and lignin, plus a large and variable number of substances with lower relative molecular mass. Cellulose is the major component of both softwood and hardwood. Polyoses (hemicelluloses), which consist of five neutral sugar units, are present in larger amounts in hardwood than in softwood. The lignin content of softwood is higher than that of hardwood. The lower-molecular-mass substances significantly affect the properties of wood; these include substances extracted with nonpolar organic solvents (fatty acids, resin acids, waxes, alcohols, terpenes, sterols, steryl esters, and glycerols), substances extracted with polar organic solvents (tannins, flavonoids, quinones, and lignans), and water-soluble substances (carbohydrates, alkaloids, proteins, and inorganic material). Wood dust is also characterized by its moisture content: "dry" wood has a moisture content of less than approximately 15%, and "moist" wood has a higher moisture content. Woodworking operations using dry wood generate more total dust and a larger quantity of inhalable dust particles than do those using moist wood (IARC 1995).

Use

Wood dust is produced in woodworking industries as a by-product of the manufacture of wood products; it is not usually produced for specific uses. One commercial use for wood dust is in wood composts (Weber *et al.* 1993). "Industrial roundwood" refers to categories of wood not used for fuel, which include sawn wood (54%), pulpwood (21%), poles and pit props (14%), and wood used for other purposes, such as particle board and fiberboard (11%) (IARC 1995).

Production

Wood dust is created when machines or tools are used to cut or shape wood materials. Industries in which large amounts of wood dust are produced include sawmills, dimension mills, furniture industries, cabinetmaking, and carpentry (IARC 1995). In 1990, total estimated production of wood used in U.S. industry was 311.9 million cubic meters of softwood and 115 million cubic meters of hardwood (Demers *et al.* 1997).

Exposure

Exposure to wood dust occurs when individuals use machinery or tools to cut or shape wood. When the dust is inhaled, it is deposited in the nose, throat, and other airways. The amount of dust deposited within the airways depends on the size, shape, and density of the dust particles and the strength (turbulence and velocity) of the airflow. Particles with a diameter larger than 5 μm (inspirable particles) are deposited almost completely in the nose, whereas particles 0.5 to 5 μm in diameter (respirable particles) are deposited in the lower airways (IARC 1981, 1995).

Wood dust usually is measured as the concentration of airborne dust, by particle size distribution, by type of wood, and by other characteristics of wood. Total airborne dust concentration is reported as mass per unit volume (usually milligrams of dust per cubic meter of air). Wood dust generally is collected by a standard gravimetric method, whereby a sampling pump is used to collect a known volume of air through a special membrane filter contained in a plastic cassette. Some sampling studies reported that the particle size distribution varied according to the woodworking operation, with sanding producing smaller particles than sawing, but others found no consistent differences (IARC 1995). The majority of the wood-dust mass was reported to be contributed by particles larger than 10 μm in aerodynamic diameter; however, between 61% and 65% of the particles by count measured between 1 and 5 μm in diameter (IARC 1995).

Exposure to wood dust also occurs through handling of compost containing wood dust. One study measured dust concentrations resulting from handling of compost material consisting of successive layers of chopped leaves, bark, and wood; visible clouds of fine particles were easily generated when the compost material was agitated. The reported background concentration of respirable dust sampled upwind of the compost pile was 0.32 mg/m^3. During loading and unloading of compost, samplers in the breathing zone detected inspirable dust at 0.74 mg/m^3 and respirable dust at 0.42 mg/m^3. Samples collected directly from the visible clouds of particles generated by compost agitation contained inspirable dust at 149 mg/m^3 and respirable dust at 83 mg/m^3 (Weber *et al.* 1993).

The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that nearly 600,000 workers were exposed to woods (NIOSH 1990). Teschke *et al*. (1999) analyzed 1,632 measurements of personal time-weighted-average airborne wood-dust concentrations in 609 establishments on 634 inspection visits that were reported to the Occupational Safety and Health Administration Integrated Management Information System between 1979 and 1997. Exposures ranged from less than 0.03 to 604 mg/m^3, with an arithmetic mean of 7.93 mg/m^3 and a geometric mean of 1.86 mg/m^3. Exposure levels decreased significantly over time; the unadjusted geometric mean was 4.59 mg/m^3 in 1979 and 0.14 mg/m^3 in 1997. Occupations with high exposure to wood dust included sander in the transportation equipment industry (unadjusted geometric mean = 17.5 mg/m^3), press operator in the wood products industry (12.3 mg/m^3), lathe operator in the furniture industry (7.46 mg/m^3), and sander in the wood cabinet industry (5.83 mg/m^3). High exposures occurred in the chemical, petroleum, rubber, and plastics products industries, in sanding, pattern making, and mill and saw operations. The lowest exposures occurred in industrial pattern-making facilities, paper and paperboard mills, schools and institutional training facilities, and veneer and plywood mills.

Use of hand-held electric sanders has been identified as a particularly dusty process that leads to dust exposure. Wood-dust concentrations vary with type of dust extraction, amount of wood removed, and type of sander (Thorpe and Brown 1994). For electric belt sanders used to sand dowels, total dust concentrations ranged from 0.22 mg/m^3 with external dust extraction to 3.74 mg/m^3 without extraction, and concentrations of respirable dust ranged from 0.003 mg/m^3 with extraction to 0.936 mg/m^3 without extraction. Rotary sanders tested with flat wood samples produced total dust concentrations ranging from 0.002 mg/m^3 with extraction to 0.699 mg/m^3 without extraction; concentrations of respirable dust ranged from 0.001 mg/m^3 with extraction to 0.088 mg/m^3 without extraction. Comparable decreases in dust concentration were observed when dust extraction was used with electrical orbital sanders.

Regulations

Occupational Safety and Health Administration (OSHA)

This legally enforceable PEL was adopted from the 1969 United States Department of Labor regulation *Safety and Health Standards for Federal Supply Contracts* shortly after OSHA was established. The PEL may not reflect the most recent scientific evidence and may not adequately protect worker health.

Permissible exposure limit (PEL) = 15 mg/m^3 total fibers; = 5 mg/m^3 respirable fibers (based on the standard for "particles not otherwise regulated").

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 0.5 mg/m^3 for western red cedar; = 1 mg/m^3 for all other species.

National Institute for Occupational Safety and Health (NIOSH)

Recommended exposure limit (REL) = 1 mg/m^3.

Listed as a potential occupational carcinogen.

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