

Environmental Assessment and Risk Analysis Element



LITERATURE REVIEW

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Preliminary Assessment of the Toxicity from Exposure to Crumb Rubber: its use in Playgrounds and Artificial Turf Playing Fields

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Abstract

Crumb rubber consists of recycled, destructively chipped/pulverized, used automobile tires. This material is produced by a variety of methods such as grinding, chipping, softening with various agents, freezing, then shredding, chipping, etc. As a result of these processes and various post-production processes, various amounts of the "additives/components" used in the original production of the tire, besides rubber, occur in the crumb rubber.

Crumb rubber has been used in playgrounds because of its ability to minimize impact falls better than wood mulches of various kinds. As may be imagined, there are significant differences in quality and sizes varying from producer to producer depending on the method of production. Various producers make claims that their product is 95% steel free, non-toxic, fade resistant, stable, will not blow away, etc. Many of the claims made for various products containing crumb rubber lack independent substantiation. In addition, some commercial mulch and potting soil products that contain crumb rubber do not mention this ingredient on the label and reportedly there are no requirements for them to do so.

Fractured rubber from tires is high in leachable zinc, a known phytotoxic element that can kill ornamental plants and prevent crops such as peanuts from growing. Rufus Chaney (2005) of the U.S. Department of Agriculture following the research for 20 years says that the majority of research leads to the conclusion that for the zinc factor alone, ground or chipped rubber should never be used in gardens or composts. While phytotoxicity to ornamental plants and crops from high zinc content is known (Chaney, 1993), some producers advertise this fact as an advantage for their product, in that it inhibits weed growth.

Toxicology

There is very limited information available on independent toxicity safety assessment studies (with peer review, not designed or funded by either the rubber or recycled rubber industry) concerning environmental and human safety aspects of crumb rubber products.

A study in the Netherlands examined artificial turf football pitches for the potential effects of components in rubber infill and its distribution in the environment (Verschoor, 2007). It reported the risks of zinc to public health are of no concern: the human toxicity of zinc is low and the World Health Organization drinking water criterion is not exceeded. However, environmental quality standards for zinc in surface and groundwater were exceeded. Zinc from rubber infill is either emitted mainly to the surface water, when a drainage system has been constructed on clay or peat soils, or mainly to groundwater in naturally well-drained sandy soils. Aging of the rubber crumbs appeared to be of major importance for estimating zinc releases.

A field trial was conducted to evaluate the water quality effects of tire shreds placed above the water table (Humphrey and Katz, 2001b). Samples were collected in three 3-meter square geomembrane-lined basins located beneath the shoulder of a road. Two of the basins were overlain by 0.61 meter of tire shreds with a 75-mm maximum size topped by 0.72 to 1.37 meters of granular soil. The basin serving as a control was overlain with 0.72 meter granular soil. Quarterly samples for inorganic constituents were taken from January 1994 through June 1999. Samples were taken for volatile and semivolatile organic

compounds on three dates. Filtered and unfiltered samples were analyzed for the following substances that have a primary drinking water standard: barium, cadmium, chromium, lead, and selenium. There was no evidence that the presence of tire shreds altered the concentrations of the substances from the naturally occurring background levels. There was no evidence that tire shreds increased the levels of aluminum, zinc, chloride or sulfate, which have secondary (aesthetic) drinking water standards. In a few samples, iron levels exceeded the secondary standard. Manganese levels consistently exceeded the secondary standards. Three sets of samples were tested for organics. Negligible levels of organics were found.

In 2005, Sullivan reported that the most significant health effect resulting from direct exposure to tire rubber appears to be either allergic or toxic dermatitis. It is estimated that 6% to 12% of the population is allergic to rubber in some form. The basis of these concerns are from studies that show rubber workers and workers in tire production have greater incidence of chronic cough, chronic phlegm, chronic bronchitis, shortness of breath, and tightness in the chest than unexposed workers.

While this is probably true given the information available at this time on crumb rubber, data gaps do remain in the information available for this product.

Potential exposure pathways

Inhalation exposure

Crumb rubber includes some level of dusts and small particles in the material. As this material is used as intended, due

to impacts and weathering phenomena, additional crumb material, both large and small, will break down producing smaller particles. Particles less than 10 microns mean aerodynamic diameter (PM-10) are able to penetrate to deep lung tissue where they can potentially cause impaired lung function. Thus, inhalation of small particles and dusts of crumb rubber is a realistic pathway for adverse exposure to crumb rubber.

Asthma is a condition marked by recurrent attacks of paroxysmal dyspnea (shortness of breath), with wheezing due to spasmodic contraction of the bronchi. Some cases of asthma are allergic manifestations in sensitized persons (bronchial allergy); others are provoked by a variety of factors including vigorous exercise, irritant particles, psychologic stress, etc. In the case of crumb rubber usage, asthma attacks may be triggered by the physical nature of the particles and dusts themselves, or by an allergic reaction to latex or other chemical components in the product.

Dermal exposure

By the very nature of their intended uses, these facilities provide for rough and tumble activities. There is, therefore, a potential for dermal exposure to unprotected skin surfaces such as hands, arms, legs, and head to crumb rubber.

Individuals vary in their allergic sensitivity to various substances. Individuals very sensitive/allergic to various products are referred to as being a member of a sensitive sub-population. Some members of this sensitive sub-population manifest allergic contact dermatitis due to exposure to a variety of agents, one being latex, as in latex gloves and other products. Such people may have an increased likelihood of exhibiting allergic reactions to components in crumb rubber. While to date no evidence has emerged on this, the appropriate studies have not necessarily been conducted.

Oral exposure

Anyone familiar with young children knows that they frequently place non-food items in their mouths. Thus, there is potential for some limited exposure via the oral route to these children. Older children and adults using facilities treated with crumb rubber can reasonably be expected to get some inadvertent/unintentional oral exposure to crumb rubber from dusts generated in routine use of these facilities. Soil ingestion scenarios linked to criteria for cleanup of contaminated soil can be applied to estimate ingestion exposure on sites using crumb rubber.

Pica is the compulsive eating of nonnutritive substances including dirt (geophagia). Pica also occurs in some patients with iron or zinc deficiencies. Those components of tires that are not affected by the strong acids in the stomach are likely to pass through the digestive tract. A data gap exists for potential effects of other product ingredients that might be digested to some unknown degree. Additionally, any steel shards remaining in the material could possibly cause health problems if they became imbedded in or caused perforation of the digestive tract.

Exposure assessment

Inhalation

Based on the minimal concentrations of chemicals detected

by Humphrey and Katz (2001a) after sampling wells 0.6 to 3 meters from where tire shreds were placed below the water table over a four year period, it is considered very unlikely that any significantly adverse vapor (inhalation) exposures would occur to humans in close proximity to where crumb rubber is used in outdoor applications.

Any low molecular weight volatile organic substances originally present in new tires would probably dissipate during the useful lifetime of the tire prior to being recycled into crumb rubber. This product is made from recycled tires which were used on some sort of motor vehicle at highway speeds for one to two years which would heat the tires to well above ambient temperatures facilitating out-gassing of volatile components. Further, once removed from the vehicle, the tires likely spend an additional one or more years in a scrap pile outdoors, likely in the sun, where further weathering would occur which facilitates further volatilization of low molecular weight compounds. For these reasons when shredded, the tires likely contain only minuscule amounts of volatile organic substances, if any.

Dermal

As crumb rubber contains approximately 14% natural rubber, and 27% synthetic rubber, exposure to these products has a high potential to cause allergic contact dermatitis in the 6% to 12% of the population that is allergic to rubber in some form. This risk is probably highest in children, rather than adults, as they participate in activities more than adults do where dermal exposure is likely to occur.

Oral

While not advocating the deliberate ingestion of crumb rubber there are no indications from the data available at this time that the accidental ingestion of up to 50 to 200 mg/day (the mass of dirt assumed to be ingested in the standard exposure scenario for contaminated sites) of crumb rubber would be the cause of adverse health effects.

Conclusion

Insufficient information was found to perform a complete formal exposure assessment/risk characterization on crumb rubber for the stated outdoor use at this time due to existing data gaps in the available information. After reviewing the information available, with the possible exception of allergic reactions among individuals sensitized to latex, rubber and related products, there was no obvious toxicological concern raised that crumb rubber in its intended outdoor use on playgrounds and playing fields would cause adverse health effects in the normal population. However, due to the natural and synthetic rubber components in the crumb rubber product, there may be some members of a sensitive sub-population who are allergic to latex and/or other components of rubber tires who could exhibit varying degrees of allergic contact dermatitis through dermal contact. Individuals with a known sensitivity to such materials should be advised about the potential for exposures and allergic responses.

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