The Facts About Roofing Asphalt Fumes and Health

Introduction:

Today, paving and roofing applications are the major industrial uses for asphalt. In the U.S., the asphalt roofing industry has grown steadily since its inception in 1893. Three commercially popular roofing products or systems are made from asphalt: (1) asphalt shingles, which are used in residential and steep-slope commercial roofing; (2) built-up roofing, a system of asphalt-impregnated felt plies sealed and surfaced with hot mopping-grade roofing asphalt, which is used in low-slope commercial roofing; and (3) modified bitumen systems, another low-slope commercial product which uses polymer-modified roofing asphalts to impregnate and coat one or more fabric plies. Asphalt is also used in the production of underlayment felts used on shingle roofs, roll goods used in BUR systems and some steep slope applications, and cold-applied roofing materials (e.g., roof coatings, mastics and cements).

In a typical year, about 5 million homes are roofed with asphalt shingles. More than 80 billion square feet of built-up roofing systems are in service on hospitals, office buildings, and schools across the United States.

Because many asphalt products must be heated to be applied, burns are by far the number one health concern. Another potential concern is exposure to tiny droplets called fume, which become airborne when asphalt is heated to elevated temperatures (above 200°F/93°C). As with any industrial material that has the capability of generating airborne fumes or vapors, potential health hazards are a concern.

It is important to recognize that many asphalt roofing products, including shingles and roll goods as well as roof coatings, mastics and cements, are not heated during application and therefore do not release asphalt fumes. In addition, products that are heated during application, such as built-up roofing systems, stop releasing fumes after the material has cooled, which is typically within one hour.

Following are some commonly asked questions covering the possible health effects from exposure to asphalt fumes.

Q&A

What Is Asphalt?

It is a dark brown to black material with cement-like qualities made by refining petroleum crude oils. Asphalt is not a single chemical substance, but a complex mixture containing thousands of different substances, many of them complex organic compounds that are difficult or impossible to identify individually with available analytical techniques. The chemical composition of crude oil varies greatly, and a variety of different refining processes are used to make asphalts that meet the performance specifications and physical properties required for different end-uses. As a result of the complexity and variability of their composition, no two asphalts are exactly the same, and the specific chemical structure of any one asphalt cannot be completely defined.

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What Are Asphalt Fumes?

When asphalt is heated, a small portion of it is released as a vapor. As these vapors cool in the air, some of them condense into a cloud of tiny droplets called "fume". Not every compound that is part of the asphalt becomes part of the fume that is created when asphalt is heated. Quite the opposite – only the chemicals that are more volatile (i.e., are more readily turned into vapors) become part of the fume. It has been estimated that only about 0.0001 % (one-ten thousandths of one percent) of the base asphalt evolves into fume under normal operating conditions.

What Short-Term Health Effects Have Been Observed?

The only established health effects of exposure to asphalt fumes for short periods of time (that is, for a few minutes or hours) are irritation of the eyes and upper respiratory tract (i.e., the nose and throat). According to the medical literature, irritation, if it does occur, is usually mild and temporary. Several types of skin irritation have also been reported among some asphalt workers. Some asphalt workers have also experienced headache, nausea, decreased appetite and fatigue, although the role of asphalt fumes in causing such nonspecific symptoms has not been established.

Are There Long Term Health Effects Caused By Asphalt Fumes?

Asphalt fumes contain trace quantities of substances called polynuclear aromatic compounds (PACs). A few members of this very large class of complex chemicals are considered suspect carcinogens because they have caused tumors in studies on laboratory animals. However, because of limitations in the available analytical techniques for detecting specific PAC compounds in complex materials like asphalt fumes, the existing evidence does not reliably demonstrate that the PACs in asphalt fumes include suspected carcinogenic substances. For example, in the case of roofing asphalt, potentially carcinogenic PACs have been reliably detected in only a few samples of worker exposures in the field. However, the significance of this information to worker health is unknown, because the measured PAC levels were extremely low, were at or near the detection limits of the methods used, and may have been the result of other sources of PACs in the work environment.

In any case, even if low levels of potentially carcinogenic PACs are in fact present in asphalt fumes, the National Institute for Occupational Safety and Health (NIOSH) has determined that such a finding, by itself, would not warrant a conclusion that asphalt fumes pose a cancer hazard to exposed humans.

Have Animal Studies Been Conducted?

A number of laboratory animal studies have been done over the years. The earlier studies, which involved various types of whole asphalt dissolved in solvents, produced mixed results. NIOSH reviewed these studies in 1977 and concluded that they do not support a finding that asphalt fumes pose a cancer hazard.

Only two of the animal studies done to date tested asphalt fumes. The first of these was a 1980 "skin-painting" study of mice exposed to asphalt fumes generated using a unique laboratory procedure specially designed to produce the large quantities of fumes needed for this type of study. The laboratory fumes caused skin tumors in the experimental mice. In the second study, the same laboratory fumes were separated into five fractions labeled A through E, and these fractions were tested alone and in various combinations, again by skin-painting mice. This study showed that only Fractions B and C of the laboratory fumes were carcinogenic.

Subsequent research has revealed that the laboratory-generated fumes used in these mouse skin-painting studies are chemically and physically very different from the fumes created under actual operating conditions in the field. This research also indicated that real-world fumes created in the field closely resemble Fraction A of the laboratory fume. This is a significant finding, because Fraction A showed no evidence of carcinogenicity even though it was tested in twelve different mouse skin-painting experiments in the second study.

Q&A

Have Studies Been Done To Evaluate The Long Term Health Effects Experience Of People Exposed To Asphalt Fumes?

Yes. Because asphalt has been so widely used for such a long time, a considerable number of human studies have been conducted over the years. An authoritative review of these studies was performed in 1994 by the International Agency for Research on Cancer (IARC), whose evaluations of the cancer-causing properties of industrial substances often form the basis for regulatory action in the United States. Although there were excess cancer rates in roofing workers, IARC found that there were serious limitations in the designs of these studies, and that the cancer risk seen in these studies might be the result of exposure to other materials, particularly known carcinogens such as coal tar, asbestos, and tobacco smoking. IARC determined, accordingly, that the studies in humans provide no adequate basis to conclude that exposure to asphalt fumes poses a cancer hazard.

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Is Any Research Being Conducted To Further Study Whether Exposure To Asphalt Fumes Might Cause Long Term Health Effects?

A number of potentially important studies are underway. With regard to studies in humans, two large U.S. asphalt roofing product manufacturers have been tracking the mortality experience of their asphalt workers for many years. In addition, IARC is nearing the completion of an epidemiological feasibility study of asphalt workers in seven [7] European countries to determine if more focused human studies are feasible and are needed. It is expected that IARC will decide to conduct these studies, and if it does, they are expected to be finished in about five years or so.

Several major studies of experimental animals also are in various stages of development. These include a carcinogenicity study in Germany and a series of shorter-term studies being conducted in Morgantown, West Virginia. Both of these studies involve inhalation exposure to asphalt fumes generated using laboratory procedures, although efforts are being made, with the assistance of the U.S. asphalt industry, to develop laboratory methods that better simulate the chemical composition of the fumes that are created in actual field settings. Results from these studies are expected over the next several years.

In addition, scientists from Government, industry and private groups are continuing to work on the difficult problem of developing an adequate characterization of the chemical composition of asphalt fumes as well as the vapors that are also created when asphalt is heated. The focus of these studies is on the complex PACs that are known to be present in fumes as well as the identities of the chemical compounds in asphalt fumes and vapors that may be responsible for irritation effects.

What Do Regulatory Agencies And Advisory Bodies Say About The Possible Long Term Health Effects Of Asphalt Fumes?

As noted above, in 1994 IARC reviewed the available evidence on the potential carcinogenicity of asphalt fumes in humans and found that evidence to be inconclusive. In 1999, the American Conference of Governmental Industrial Hygienists (ACGIH), another group whose worker health recommendations have historically been influential on regulators as well as industry, reaffirmed its consistent view that asphalt fumes are "not classifiable as a human carcinogen."

In December 2000, NIOSH published a "*Hazard Review*" for asphalt and concluded that roofing asphalt fumes are a "potential" occupational carcinogen. NIOSH's review of the underlying scientific evidence in the *Hazard Review* is consistent with the earlier IARC and ACGIH assessments of essentially the same scientific evidence. For example:

- Although finding that suspected carcinogens may be present in asphalt fumes "under some conditions," NIOSH acknowledged that the available evidence is "limited" and that more research is needed;
- NIOSH agreed that questions about the representativeness of laboratory-generated asphalt fumes "limit the usefulness" of the available animal studies in evaluating the possible carcinogenicity of asphalt fumes; and
- Like IARC and ACGIH, NIOSH found that existing studies reveal an excess of lung cancer among roofing workers, but also determined that "it is uncertain whether exposure to asphalt is related to this association", because the workers in these studies were also exposed to "known human lung carcinogens" including coal tar, asbestos and tobacco smoking.

Q&A

Are There Any Legal Or Recommended Exposure Limits For Workers To Asphalt Fumes?

There is no legal standard specifically limiting worker exposure to asphalt fumes in the U.S. In 1992, OSHA proposed a permissible exposure limit (PEL) of 5 milligrams per cubic meter of air (5.0 mg/m3) to protect against potential irritation effects. Final action on this proposal was suspended due to an intervening court decision, and OSHA has not scheduled any further action.

No consensus has yet emerged on an appropriate and protective limit on worker exposures to asphalt fumes, in part because the existing recommendations are inconsistent with respect to both the numerical limit on exposure and the method for measuring exposure. The pending OSHA proposal of 5.0 mg/m3, for example, measures exposure as a time-weighted average of "total particulate" collected over an eight-hour shift. In contrast, NIOSH's recent Hazard Review continues in effect the existing NIOSH Recommended Exposure Limit (REL) of 5.0 mg/m3, measured as total particulate. Like OSHA's proposed PEL, the NIOSH REL is intended to protect against irritation effects. However, unlike the OSHA proposal, the REL is measured as a 15-minute ceiling concentration.

The ACGIH recently revised its recommended "threshold limit value" (TLV) for asphalt fumes to 0.5 mg/m3, measured as the time-weighted average of "benzene-extractable inhalable particulate" over a full work shift, to prevent irritation effects. Because the new TLV calls for the development of a new measurement method, the asphalt roofing industry is working with Government, organized labor and other groups to expeditiously develop a standard method and to conduct research to evaluate how measurements taken with the new method compare with the methods historically used by industrial hygienists in the asphalt industry. At the present time, it is believed that average exposures in asphalt roofing manufacturing operations are generally near or below the new TLV. The same conditions apply in many hot asphalt roofing application operations, although it is known that higher exposures can occur in these operations when poor work practices such as overheating the asphalt are used.

Although TLVs are often influential in the development of regulatory and industrial standards, the credibility and longevity of the new TLV for asphalt fumes has been drawn into question as a result of NIOSH's recently published *Hazard Review*. The *Hazard Review* does acknowledge the new TLV, but concludes that the existing data are insufficient for deriving appropriate exposure criteria to protect workers from the irritation effects of asphalt fume exposures. NIOSH decided, accordingly, to leave in effect the REL it set in 1977.

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How Are These Health Issues Being Addressed By The Roofing Industry?

The asphalt roofing industry has formed a group of technical, scientific and medical representatives to research the health issues associated with the use of asphalt, develop effective methods to control exposures to asphalt fumes, and address other important issues such as the need for a reliable method to measure exposures in a way that is both accurate and relevant to potential health effects. The four organizations sponsoring this effort are: the Asphalt Institute (refiners of asphalt); the Asphalt Roofing Manufacturers Association (manufacturers of roofing materials and systems); the National Roofing Contractors Association (applicators of roofing products and systems); and the Roof Coatings Manufacturers Association (manufacturers of cold-applied roofing materials and systems).

With regard to potential health effects, this group has been working for more than a decade with scientists from Government agencies, organized labor, other asphalt industry groups and independent bodies to support and sponsor research designed to develop a scientifically sound characterization of the potential health effects of asphalt fume exposures. These initiatives have included the development of new analytical techniques and laboratory protocols for generating fumes that are chemically similar to real world exposures, conducting studies to characterize worker exposures, and providing assistance in connection with ongoing health studies sponsored by other groups, including the studies currently underway in Europe (the IARC human study and the Germany animal study) and the U.S. (the NIOSH Morgantown study, among others). In addition, as noted above, two asphalt roofing manufacturers are conducting long-term surveillance of the health of their workers, and the results of one of these studies is expected to be released in the near future.

Q&A

What Measures Has The Asphalt Roofing Industry Taken To Reduce Exposures?

Asphalt fume exposure levels have been declining in the roofing application industry because of the increasing availability of low-fuming asphalt products as well as improved work practices and kettle design advances. In roofing manufacturing operations, changes in process equipment together with the increased use of more effective engineering controls have led to large reductions in measured exposure levels.

Looking to the future, the asphalt roofing industry is developing, in cooperation with NIOSH and the United Union of Roofers, Waterproofers and Allied Workers, a suite of resources for employers to use in order to achieve continued progress in reducing worker exposures to asphalt fumes and keeping such exposures to a minimum. In the roofing manufacturing sector, a NIOSH technical document describing available state-of-the-art engineering controls and work practices for controlling exposures is nearing completion, and will soon be made available industry-wide.

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For roofing application operations, work is continuing on a comprehensive education and training program that will be disseminated throughout the industry to ensure that contractors, supervisors and workers are fully informed on the available engineering controls, work practices and other measures to minimize exposures. In addition, the asphalt roofing industry has supported the development of new technologies for controlling emissions from roofing kettles, including: (i) low-fuming asphalt products which have yielded reductions of more than 80 percent in exposures to kettle operators; and (ii) promising improvements in kettle afterburner controls that may reduce some of the serious safety hazards associated with earlier designs.

What Steps Should Be Taken To Control Worker Exposures To Asphalt Fumes?

In roofing manufacturing operations, a number of effective engineering controls and work practices have been identified, as just mentioned. Additional information about these controls is available from the Asphalt Roofing Manufacturers Association.

In roof installation operations, the asphalt roofing industry's joint effort with the Roofers Union and NIOSH has identified effective practices for controlling exposures. In addition to utilizing highly effective low-fuming asphalt products, the key procedures are these: (i) selecting the right size kettle for the job and situating the kettle properly; (ii) identifying and maintaining the appropriate kettle temperature (it is especially important to avoid overheating the asphalt); (iii) keeping the lids on kettles and other containers closed whenever possible, and holding to a minimum the number of times these lids must be opened; and (iv) avoiding the fume cloud whenever possible.

Available engineering controls for roofing application work, in addition to the recently introduced kettle emission controls mentioned above, include: (i) kettles equipped with thermostatic controls, insulation, and more powerful pumps; (ii) insulated supply lines; and insulated and covered rooftop containers, such as luggers, mechanical spreaders and felt-laying machines. Contact the National Roofing Contractors Association for additional information.

What Protective Measures Are Recommended For Building Occupants?

Because of the diluting effects of distance and air currents, the exposure to building occupants near a roofing job would in most cases be many times lower than that of roofing workers, though an odor may on occasion be present.

Although building occupant exposure is likely to be very low, the asphalt roofing industry supports several common-sense precautions to further minimize fume exposure, including these:

Air intakes and windows that are downwind from where the asphalt is being heated and applied should be closed if practicable. The roofing kettle should be placed downwind of occupied buildings whenever possible. Further, building occupants (workers, students, etc.) should be told about the re-roofing job, informed that they may notice a petroleum-type odor as the work is performed, and provided with the latest available information on health effects. In addition, several of the recommended practices for controlling worker exposures will also reduce potential exposures to building occupants. These practices include the use of low-fuming asphalts, kettle emission and temperature controls, and work practices that prevent the unnecessary release of fumes and keep kettle temperatures as low as possible consistent with the maintenance of recommended asphalt application temperatures.

ADDITIONAL INFORMATION

If there are any further questions or concerns, please feel free to contact us:

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