Formaldehyde: Just the Facts

The Basics Behind this 'Building Block' Chemical

by Mark A. Gruenwald

More than 150 years ago, a discovery made by Russian scientist Alexander Butlerov forever advanced the way we live and how we live. Bulterov's discovery, followed by findings that formaldehyde can act as an antiseptic, propelled formaldehyde into the forefront of medicine. Continuing studies revealed more favorable properties, bringing the chemistry of formaldehyde into mainstream production. Today, formaldehyde is found in products ranging from building materials to pharmaceuticals.

With such a long history of use coupled with its omnipresence in our natural environment, most would believe that formaldehyde has stood the test of time because of its safety and efficacy. However, formaldehyde is one of those "building block" chemicals that continue to attract ongoing regulatory attention. More than 30 years of research has focused on characterizing the safety of formaldehyde. Today scientists have much greater knowledge of where and how both internal and inhaled formaldehyde are distributed at the molecular level. Yet, most of this new knowledge has not been applied in assessments of formaldehyde risk by key regulatory authorities. It is imperative that high quality "Mode of Action" (MOA) data, such as recent molecular distribution studies, be brought into the risk assessment process. This article will provide an update on key aspects of that characterization and illustrate how effective product stewardship and risk management measures by government and industry have lowered risk to a level of insignificance.

General Facts about Formaldehyde

Formaldehyde is natural and widespread in nature. It can be found in every living system - from plants to animals to humans - all which actually produce formaldehyde as a normal part of metabolism. Formaldehyde occurs as a by-product of all combustion processes. It's produced in the smoke from burning wood, combustion engine exhaust and cooking. Of the total atmospheric formaldehyde in the world, 70 to 90 percent comes from mobile sources (e.g., automobiles), power generation and combustion. Only a very small amount is the result of emissions from wood products. Formaldehyde does not accumulate in the environment or within plants and animals. It metabolizes quickly and breaks down readily in the body and in the atmosphere, making it "greener" than one might think. Formaldehyde is one of the most extensively studied chemicals in use today. Its health and safety properties have been researched in depth, and the evidence is reassuring that current standards and safeguards are protective and have resulted in plummeting exposure rates.

The Manufacture, Properties and Use of Formaldehyde

Formaldehyde is produced by passing vaporized methanol and air over a catalyst. The formaldehyde vapors are absorbed into water to produce aqueous solutions. All formaldehyde solutions contain some amount of methanol. Low methanol formaldehyde solutions typically contain between 0.2 percent and 1.5 percent methanol by weight due to the incomplete conversion of methanol.

Formaldehyde is a colorless gas with a distinct pungent odor that can be detected by most people at low levels, with the odor threshold typically ranging from 0.5 to 1 ppm. As with the detection of any odor, some individuals may be more sensitive to the odor of formaldehyde than others. Formaldehyde is very soluble in water, alcohols, ether and acetone.

It is a critical ingredient in thousands of items that shape our everyday lives. Formaldehyde is used as a chemical intermediate in the production of engineered structural wood, plywood, particleboard, adhesives, abrasive materials, insulation, certain wood adhesives, lubricants and some controlled-release fertilizers. In smaller quantities, formaldehyde is used for the preservation and embalming of bodies and biological specimens. It is also used in some permanent-press fabrics. Formaldehyde plays the role of a

germicide, insecticide, and fungicide in some cosmetics such as mascara, cuticle softeners, nail creams and shaving cream, as well as personal hygiene products such as soaps, shampoos, deodorants, sunscreens, lotions and mouthwashes.

Formaldehyde in Engineered Wood Applications

Engineered wood products are high-performance and sustainable building products such as oriented strand board (OSB), I-joists and glue laminated beams. The majority of structural wood panels and other engineered wood products are manufactured with high-performance adhesives based on formaldehyde chemistry. These adhesives are designed to have extremely low formaldehyde emissions. These emissions are similar, or lower than the formaldehyde emissions from raw wood.

Phenolic formaldehyde adhesives have been the technology of choice for wood panel adhesives for the last 70 years. These resins are thermosetting; meaning that once cured, they cannot be softened by heating. They are extremely resistant to water and will not break down in the presence of moisture. The resins used in engineered wood manufacturing are designed to completely cure during the hot pressing operation. Once the resin is cured in the board production process, tests show the panel is virtually free of any residual phenol or formaldehyde.

Agencies' Opinions on Formaldehyde

Formaldehyde is biodegradable and does not persist in the atmosphere. When released to water, formaldehyde biodegrades to low levels in a few days. Even so, disagreement regarding the potential connection between formaldehyde exposure and cancer risk persists.

Although the International Agency for Research on Cancer (IARC) has classified formaldehyde as "carcinogenic to humans," these determinations have been criticized with respect to their methodology and conclusions. The decision by IARC (which was not unanimous), particularly concerning an association with leukemia, has been seriously questioned.

The preliminary determination regarding cancer risks reached by EPA in the June 2010 proposed Integrated Risk Information System (IRIS) assessment of formaldehyde has been criticized on numerous grounds by scientists from other government agencies. In particular, available data cannot explain how a chemical such as formaldehyde, which is naturally present in the body and which does not reach distant sites in the body following inhalation, would be capable of causing leukemia.

The EPA/IRIS assessment of formaldehyde was critically reviewed by a committee from the National Academy of Sciences/National Research Council (NAS/NRC 2011), which found numerous flaws in the document. The NAS is the "gold standard" of science established in 1863 by President Lincoln to "investigate, examine, experiment and report upon any subject of science." This review concluded that the EPA/IRIS assessment failed to support an association between formaldehyde exposure and leukemia or other health problems. In particular, the NAS/NRC committee rebuked the EPA's assessment and methods in reaching its conclusions on formaldehyde.

Most significantly, the National Research Council found insufficient evidence and a biased approach to the EPA's claim that formaldehyde causes leukemia and cancer in the respiratory tract:

> "Conclusions appear to be based on a subjective view of the overall data, and the absence of a causal framework for these cancers is particularly problematic given the inconsistencies in the epidemiologic data, the weak animal data and lack of mechanistic data."

It is expected that the entire document and draft conclusions will be extensively reviewed and modified, given the numerous criticisms and methodological issues concerning the EPA's formaldehyde IRIS assessment as identified in the NAS/NRC review. That said, it is not clear when the EPA expects to release another draft of their assessment for public comment and peer review, but it could occur as early as the end of 2013.

The National Toxicology Program (NTP 2011) has evaluated the carcinogenic potential of formaldehyde, and this evaluation contains many of the same methodological and interpretive flaws that plagued the earlier EPA/IRIS assessment of formaldehyde. Both review processes examined and analyzed the same scientific studies. Despite the fact that the NRC report on the criticism of the draft formaldehyde

IRIS assessment was available before the finalization of the NTP review, it appears the NTP ignored the significant findings by the Academy. Industry representatives expressed their problems with this inconsistency openly in a public statement and writing to Congressional leaders that:

> "By failing to sufficiently reflect the conclusions of the NAS, and by producing a contradictory report, the 12th RoC has created potential for public confusion and alarm."

Without acknowledging the methodological and interpretive flaws, the 12th Report on Carcinogens (RoC) issued in 2011 listed formaldehyde as a known human carcinogen for NPC, sinonasal cancer and leukemia. Given the continuing controversy surrounding the data and the lack of solid scientific review processes upon which formaldehyde is classified as a human carcinogen (particularly for leukemia), a bi-partisan Congressional directive mandated another NAS Committee to review the scientific basis and rationale for the RoC listing. This review begins this month with a final report likely by the end of 2014.

Risk Management and Product Stewardship

Levels of formaldehyde in the workplace have declined over the past few decades due to improved manufacturing practices and advances in resin chemistry. Significant reductions have been made to emissions levels in the workplace, in ambient air and in indoor air. Exposure to formaldehyde in the workplace is subject to a number of established limits. For example, the Occupational Safety and Health Administration (OSHA) established the OSHA Formaldehyde Standard (29CFR 1900.1048) that sets limits on worker exposure at 0.75 ppm time weighted average for eight hours and 2 ppm within a 15-minute time frame.

Good stewardship, better manufacturing technologies and regulatory oversight have resulted in declining formaldehyde emissions in the indoor environment during past decades. A 2005 study of homes around the nation showed an average of 17 ppb, which is well under The World Health Organization indoor air guideline value is 100 ppb.

National and international regulations require that wood products have low formaldehyde emissions. The California Air Resources Board (CARB) Air Toxic Control Measure and the federal Formaldehyde Standards for Composite Wood Products Act of 2010 apply to interior use products, such as hardwood plywood, medium density fiberboard and particleboard. Formaldehyde-based chemistries are providing viable solutions to these challenges.

Structural products used in the construction of a building's frame have low formaldehyde levels and therefore are often exempt from emission requirements. Based on the extensive amount of data, there is widespread recognition that when the chemistry of formaldehyde is handled and used in accordance with government and industry regulations, standards and guidelines, formaldehyde is safe for its intended uses and consumers and workers are appropriately protected. The U.S. forests products industry supports and complies with these established standards.

Formaldehyde: A Proven Track Record of Performance, Safety and Stewardship

The formaldehyde industry has a long history of commitment to research and stewardship of its products based on objective, fact-based science. Formaldehyde and derivative resins and adhesives are used in a wide range of industrial applications. Formaldehyde is a versatile and valuable material with applications that enhance the quality of modern life.

Formaldehyde-based chemistries remain the technology of choice because of their proven performance, safety and cost-effective attributes. As responsible product stewards, North American manufacturers of formaldehyde-based adhesives and other chemical products are committed to continuous improvement, product enhancements and further formaldehyde research that support good public health policy and economic growth.

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