R-CONTROL SIPs

SIP No. 2013

Subject: **Formaldehyde Levels**

Date: **November 2007**

The Oriented Strand Board (OSB) used as the facings for R-Control SIPs may include very low levels of formaldehyde. The formaldehyde is present in very small amounts due to the adhesive forming the structural bond between the wood strands.

APA, the Engineered Wood Association, has researched this subject thoroughly, and has conducted tests using a large-scale test chamber method for measuring formaldehyde emissions. In this test, OSB is placed within a heated chamber and monitored for formaldehyde emission on both newly produced OSB and OSB several months after production. The OSB concentration within the test chamber was significantly greater than that utilized in a typical structure.

The results of testing by the APA and other laboratories are that less than 0.1 parts per million (ppm) are emitted within the large scale chamber. This is for both new and aged OSB. Formaldehyde that is emitted by OSB is below HUD standards for emissions.

Attached, please find a bulletin authored by the APA concerning the amount of formaldehyde released from an APA-labeled OSB structural panel.

Note: Particle board found in furniture, shelving, cabinets and many other common items often are a greater area of concern for formaldehyde emission.

AFM CORPORATION · R CONTROL · FOAM CONTROL

R-Control SIPs are made exclusively with Foam-Control EPS. R-Control SIPs and Foam-Control EPS are manufactured by AFM Corporation licensees.

TECHNICAL REPORT

Structural Wood Panels and Formaldehyde

By John A. Emery, Ph.D

APA
THE ENGINEERED
WOOD ASSOCIATION

APA – The Engineered Wood Association receives numerous inquiries concerning the release of formaldehyde gas from APA-trademarked structural panel products, which include softwood plywood, oriented strand board (OSB), and composite panels. This report summarizes the results of research on this subject and explains why these products have not caused formaldehyde offgassing problems.

When considering formaldehyde emissions, it is important to understand that different types of adhesives are used in wood products. Some types of wood panel products are manufactured with urea formaldehyde adhesives and others are made with phenol formaldehyde adhesives. Formaldehyde-related problems have been associated with certain urea formaldehyde adhesives but *not* with the phenol formaldehyde adhesives.

Urea formaldehyde adhesives are water resistant, but not waterproof, and they are used in certain products which are normally used indoors where high moisture resistance is not required. Such products include *hardwood* plywood and certain types of particleboards. Hardwood plywood is commonly used for decorative wall paneling and in cabinets and furniture. Urea formaldehyde-bonded particleboards are commonly used for floor underlayment and in shelving and furniture. For further details concerning these products, the following organizations may be contacted:

Hardwood Plywood & Veneer Manufacturers Association
P.O. Box 2789
Reston, Virginia 22090
(Phone: 703/435-2900)

Composite Panel Association
18928 Premier Court
Gaithersburg, Maryland 20879
(Phone: 301/670-0604)

Formaldehyde Adhesives

The only formaldehyde-containing adhesives used in structural panel products which bear the trademark of the APA are phenol formaldehyde (phenolic) adhesives. These glues are highly durable and waterproof; and as explained below, do not release significant amounts of formaldehyde.

The "active ingredient" in phenolic adhesives used in structural panels is a phenol formaldehyde resin, usually supplied to the mills in a water solution. For plywood manufacture, this resin solution is typically mixed with sodium hydroxide and relatively inert materials called fillers and extenders (ground bark and wheat flour, for example) to form the adhesive. In the case of oriented strand board, the resin is normally used without any additives. The adhesive is then applied to the wood and cured under high temperature and pressure in a hot press to bond the wood veneers or strands together. The cured adhesive is a dark-colored rigid plastic.

A Bit of Chemistry

The phenol formaldehyde resins are purchased from a company that manufactures these materials (i.e., the "glue company"). The resins consist of phenol formaldehyde polymers (large molecules) of various molecular weights which are made by reacting measured amounts of phenol and formaldehyde under carefully controlled conditions of temperature, pressure, and rate of chemical addition. These polymers consist of "chains" of phenol and formaldehyde which are chemically linked together to form the polymer molecules. These molecules possess physical and chemical properties which are completely distinct from the properties of either phenol or formaldehyde; that is, the polymers are new chemical entities, and not simply mixtures of phenol and formaldehyde. An analogy can be made between phenol formaldehyde polymers and sodium chloride (table salt). Both compounds are made by reacting potentially toxic materials to produce separate chemical entities which are relatively inert.

Once formed, the phenolic polymers are extremely stable and do not break down into phenol and formaldehyde molecules. Because of their stability, adhesives made from phenolic resins are used to produce the fully-waterproof bonds needed for wood products used in exterior applications.

Measuring Formaldehyde

The resins, as supplied by the manufacturer, normally contain very small amounts – typically less than 0.1 percent – of unreacted or "free" formaldehyde. This free formaldehyde is the source of the trace amounts of formaldehyde that exist in freshly manufactured structural panels.

Although the amount of free formaldehyde in the resin can be measured, this information does not provide the basis for calculating the amount of free formaldehyde in the finished product. Such calculations are not possible because during the curing of the glue in the hot press, some of the free formaldehyde reacts with various chemical constituents of the wood, some is incorporated into the adhesive polymers, some is offgassed into the air, and some is destroyed *via* the Cannizzaro reaction (a chemical reaction that converts formaldehyde into methyl alcohol and formic acid). Consequently, the amount of formaldehyde in structural panels must be determined in some other way.

The most widely accepted method for measuring the formaldehyde emitting potential of wood products is the "Large-Scale Test Chamber" procedure. This method utilizes a test chamber which has a volume of 1,000-2,000 cubic feet and simulates a room in a home. During testing, the air in the chamber is maintained at a constant temperature and humidity, typically 75 degrees Fahrenheit and 50 percent relative humidity. The air in the chamber is replaced with fresh air at a specified ventilation rate, normally one-half air change per hour – a rate which simulates the ventilation in a modern energy-efficient home. A known amount of wood product to be tested is then placed in the chamber, and the formaldehyde levels in the air are measured.

The most comprehensive studies of formaldehyde release from phenolic panels were conducted for *APA – The Engineered Wood Association* using the "Large-Scale Test Chamber" method.[1,2] In these studies, a 2,000-cubic-foot chamber was loaded with a sufficient number of test panels to obtain 0.5 or 1.0 square meter of panel surface area per cubic meter of air volume (most products were tested at both "loading rates"). The chamber was maintained at 75 degrees Fahrenheit and 50 percent relative humidity, and the air within the chamber was replaced at a rate of 0.5 air changes per hour. After equilibrium conditions were established, formaldehyde levels in the air were measured.

Tests were conducted on samples of Douglas-fir and southern pine plywood, waferboard, oriented strand board, composite panels, and a phenolic particleboard. Tests were made soon after these products were manufactured and again after they had "aged" for several months.

Formaldehyde levels in this test chamber were well below 0.1 parts per million (ppm) in air from all tests of fresh panels, and emissions rapidly approached zero as the panels aged. In fact, the levels were so low and so close to the "background" levels in the test chamber that it was not possible to measure them accurately.

The results of these chamber tests agree with those in research reports from the U.S. Forest Products Laboratory (U.S. Department of Agriculture), the Oak Ridge National Laboratory, and from various phenolic panel manufacturers.[1]

Formaldehyde in Perspective

To put the 0.1 ppm emission level in perspective, it might be helpful to realize that formaldehyde is always present in outdoor air.[3] It is produced naturally by many processes, including the combustion of wood, cigarettes, gasoline and other organic compounds; photochemical reactions; and biologic activity. Formaldehyde is present naturally at rather high levels in many foods, including apples and onions; and it is even a natural "chemical building block" in the human body. In fact, human blood normally contains about 3 ppm formaldehyde.[4] Therefore, this chemical is always present to some degree in the environment, and the very low levels which might be associated with phenolic resin-bonded wood panel products should constitute no problem.

APA –The Engineered Wood Association is unaware of any documented evidence which shows any significant adverse health effects of formaldehyde, even in the most sensitive individuals, at levels below 0.1 ppm. The Federal Occupational Safety and Health Administration stated in the preamble to that agency's recent workplace formaldehyde rulemaking[5]: "Sensory irritation has been experienced at levels as low as 0.05 ppm, but effects at levels below 0.1 ppm appear so mild in all reported individuals that acute effects at such exposures would not constitute a significant risk of material impairment of health." (p. 46235).

U.S. Government agencies have generally concluded that phenolic resin-bonded wood products do not cause significant formaldehyde-related problems. For example, the only federal standard which sets limits on formaldehyde release from wood products is the Manufactured Home Construction and Safety Standards promulgated by the Department of Housing and Urban Development (24 CFR Part 3280). This rule requires the use of the Large-Scale Test Chamber described above and requires formaldehyde levels to be less than 0.2 and 0.3 ppm, respectively, for all plywood and particleboard used in manufactured housing. However, because formaldehyde levels associated with phenolic resin-bonded products are so low, HUD exempted these products from all the testing and certification requirements of the standard.

Moreover, in a recent joint publication by the U.S. Consumer Product Safety Commission and the U.S. Environmental Protection Agency,[6] it is stated: "Even if you do not experience such [adverse] reactions [to formaldehyde], you may wish to reduce your exposure as much as possible by purchasing exterior grade products, which emit less formaldehyde." Thus, these governmental agencies endorse the use of phenolic resin-bonded wood products in buildings where low levels of formaldehyde are desired.

In summary, all available scientific data indicate that the maximum formaldehyde levels associated with phenolic resin-bonded wood panel products, even when freshly manufactured, are about the same as background levels present in outdoor air in urban environments. There does not appear to be any evidence that such low levels are causing health problems.

References

(1) Emery, J. A. "Formaldehyde Release from Wood Panel Products Bonded with Phenol Formaldehyde Adhesives." Chapter 3 in **Formaldehyde Release from Wood Products**, American Chemical Society Symposium Series 316, American Chemical Society, Washington, D.C. 1986.

(2) Emery, J. A. "Large-Scale Test Chamber and Two-Hour Desiccator Test Results for Phenolic Panels." American Plywood Association, P.O. Box 11700, Tacoma, WA 98411. 1986.

(3) **Indoor Pollutants.** National Academy Press, Washington, D.C. 1981.

(4) Heck, H. d'A, *et al.* "Formaldehyde (CH20) Concentrations in the Blood of Humans and Fischer-344 Rats Exposed to CH20 Under Controlled Conditions." American Industrial Hygiene Association Journal 46:1-3 (1985).

(5) Federal Register, Dec. 4, 1987. Department of Labor, Occupational Safety and Health Administration, 29 CFR Parts 1910 and 1926, Occupational Exposure to Formaldehyde; Final Rule, pp. 46168-312.

(6) *The Inside Story, A Guide to Indoor Air Quality.* Report by the U.S. Environmental Protection Agency and the U.S. Consumer Product Safety Commission, Washington, D.C., EPA Document #402-K-93-007, April 1995.

We have field representatives in most major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying APA engineered wood products, contact us:

APA – THE ENGINEERED WOOD ASSOCIATION
HEADQUARTERS
7011 So. 19th St. • P.O. Box 11700
Tacoma, Washington 98411-0700
(253) 565-6600 • Fax: (253) 565-7265

(International Offices:
Bournemouth, United Kingdom;
Mexico City, Mexico; Tokyo, Japan.)

www.apawood.org

PRODUCT SUPPORT HELP DESK
(253) 620-7400
E-mail Address: help@apawood.org

The product use recommendations in this publication are based on APA – The Engineered Wood Association's continuing programs of laboratory testing, product research, and comprehensive field experience. However, because the Association has no control over quality of workmanship or the conditions under which engineered wood products are used, it cannot accept responsibility for product performance or designs as actually constructed. Because engineered wood product performance requirements vary geographically, consult your local architect, engineer or design professional to assure compliance with code, construction, and performance requirements.

Form No. SPE-1040D
Revised April 2002

APA
THE ENGINEERED WOOD ASSOCIATION