



FOOD TECHNOLOGY FACT SHEET

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December 2018

Basics of Formaldehyde Emission from Wood Composite Panels

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Formaldehyde is a colorless flammable and smelly gas at room temperature. It is also a volatile organic compound, which vaporizes and becomes a gas at ambient temperature. Formaldehyde can be manufactured in the form of liquid or solid. It is one of the most widely used chemical in production of numerous materials such as paints, textile, carpets and household cleaners.

When it is combined with other chemicals including phenol and urea different types of adhesives can also be manufactured. Urea formaldehyde (UF) and phenol formaldehyde (PF) are most commonly used binders in production of wood-based composites, namely particleboard, fiberboard, oriented strand board, laminated veneer lumber and plywood. Plywood was probably the first wood-based composite panel commercially manufactured in 1860 until particleboard and fiberboard were developed in 1950s and 1960s, respectively. Majority of plywood is manufactured for structural use for the construction industry.

After oriented strand board was developed in the 1980s, plywood lost a significant market share within the structural composite panel production. Most of the plywood and oriented strand board panels are manufactured using PF, which is an exterior type of resin having a great resistance against water exposure.

On the other hand, interior panels such as particleboard and fiberboard at different density levels are two prime products manufactured using UF, which have been on commercial market not only in the USA but also in Europe and Asia for decades. As mentioned, both UF and PF are most widely used two types of adhesives in composite panels production and having formaldehyde

in their chemical structure also creates an important environmental and health issues.

Possible carcinogenic characteristics of formaldehyde were brought to our attention in the early 1980s. Over the years its significant health concern was more emphasized, strict rules and regulations for formaldehyde emission limits were developed and enforced for any industry using such raw material including wood composite manufacturers. In particular within the last decade, the issue is getting more serious and being vigorously addressed by industry as well as government agencies. Environmental Protection Agency and the International Agency for Research on Cancer classified formaldehyde as possible human carcinogen. Many studies were carried out, and the results revealed long exposure to formaldehyde emission could be linked to serious health problems including throat cancer, significant decrease in lung function including shortness of breath, respiratory problems, eye and nose irritation, chronic headache and increased allergic propensity in children.

In 2007, the California Air Resource Board approved Airborne Toxic Control Measure to reduce formaldehyde emission from wood-based composite products. Certain standards and emission limits from different composite panels were determined. In 2010, the Congress also passed the Formaldehyde Standards for Composite Wood Product Act into law. The main objective of such act is to reduce formaldehyde exposure and eliminate its harmful health effects. These standards are applicable to panel manufacturers or companies dealing with value-added products from wood composites and a majority of U.S. panel producers to comply such standards under

the rules. Emission limits vary for different products. Medium density fiberboard (MDF), particleboard, thin MDF have emission limit values of 0.11 ppm, 0.09 ppm and 0.13 ppm, respectively. It is also important that formaldehyde emission from high-quality composite panels is very low and dissipates over time. Therefore, it is suggested newly purchased furniture or any products made from wood-composite panels manufactured having formaldehyde-base adhesive should be kept where there is good air circulation for sometime. For example, typical laminated flooring usually has less than 0.03 ppm formaldehyde emission, which should not create any important concern.

There are two most commonly used methods to determine formaldehyde emission from composite panels. These are the desiccator method and chamber method. The desiccator method requires 7 to 10 samples that are 70 mm by 150 mm in size, having their edges sealed with paraffin located in a desiccator. The desiccator also has 300 ml water underneath the samples. This set-up is kept at a temperature of 20 degrees Celsius for 24 hours before the formaldehyde amount in the water is determined photometrically.

In chamber method a small stainless steel temperature-controlled climate chamber is used to determine emission value. The stainless steel seal box is used, which allowed chemical emission only from one side surface of the test piece. Purified air is also used for ventilation in the chamber. Figures 1 and 2 shows typical desiccator and chamber method setups, respectively.

Although chemistry of the adhesive is one of the main parameters determining level of the emission from finished products, press cycle, amount of unreacted formaldehyde during the press, amount of adhesive content and conditioning of the panels prior the shipping

are some of the other variables that need to be taken into consideration. For example, some manufacturers in developing countries use higher percent of adhesive in their products to enhance overall strength and dimensional stability of finished panel. However this causes not only higher cost of the final products but also a higher magnitude of formaldehyde emission.

One of the recent and most effective approaches would be using non-formaldehyde-based adhesive such as tannin, soybean or modified starch in the panels. In a recent study, particleboard panels were manufactured from eastern redcedar using mixture of only 2 percent UF and 15 percent modified starch as binder. These panels had 0.07 ppm formaldehyde emission, which is extremely low.

Further information on formaldehyde emission from wood-based composites can be found in following literature.

- <https://www.epa.gov/formaldehyde/formaldehyde-emission-standards-composite-wood-products>
- <https://www.epa.gov/formaldehyde>

References

- Myers, G. 1983. Formaldehyde emission from particleboard and plywood paneling: measurement, mechanism, and product standards. *Forest Products Journal* 33(5): 27-37.
- Frihart, C, J.M.Wescott, T.Cheffe, K Gonner. 2012. Formaldehyde emission from urea formaldehyde and no formaldehyde bonded particleboard as influenced by temperature and relative humidity. *Forest Products Journal*. 67(7/80): 551-558.



Figure 1. Desiccator formaldehyde emission test setup.



Figure 2. Chamber formaldehyde emission test setup.