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Effect of some manufacturing variables on formaldehyde release from particleboard: Relationship between different test methods

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ABSTRACT

Different standard methods were used to determine the formaldehyde emission (FE) from particleboard; some of them were defined as European, Japanese and American standards. This study aimed to determine the effect of some manufacturing variables on FE of particleboards produced using melamine–urea–formaldehyde (MUF) adhesive with low content of free formaldehyde. The FE from the two types of particleboard (uncoated and laminated of 16–19 mm thickness) was measured with gas analysis method (EN 717-2) as well as the formaldehyde content (FC) with perforator method (EN 120). The European chamber (EN 717-1), Japanese desiccator method (JIS A 1460) and American large chamber (ASTM E 1333-96) values were measured by the conversion factor. The two types of particleboard studies showed differences in their formaldehyde parameters. It was concluded that the amount of formaldehyde emitted from the most of the manufactured boards resulted in the emission class El. In addition, laminating and decreasing the board thickness had a highly significant effect ($p < 0.001$) on decreasing the formaldehyde parameters. The particleboard E1-emission class had approximately the same value according to the test methods and similar behavior was observed in the relationship between the EN 120 values and EN 717-1, JIS A 1460, the proposed California Air Resource Board (CARB) Phase 1 and 2. This article considers how to estimate the FE values of the international test methods using the conversion factor to eliminate the need for time consuming and expensive equipment.

1. Introduction

Formaldehyde has been linked to human health problems for both short and long-term exposure to the gas. In 1992, the California Air Resource Board (i.e., CARB) identified formaldehyde as a toxic air contaminant, based primarily on the determination that it was a human carcinogen with no known safe level of exposure [1]. Exposure to formaldehyde has both non-cancer, such as eye, nose, and/or throat irritation, and cancer health effects. The International Agency for Research on Cancer (IARC) conducted an evaluation of formaldehyde and concluded that there was sufficient evidence that formaldehyde causes nasopharyngeal cancer in humans [2].

Amino resins such as urea–formaldehyde (UF), melamine–urea–formaldehyde (i.e., MUF) resins, etc. were mainly responsible for the FE from composite wood products. More recently, the MUF resins were shown to yield particleboards with significantly lower FE than the control UF resins [3–5] with good moisture resistance. In accordance with Dunky [6] the stability against hydrolysis that increased in MUF may be due to stabilization of the C–N-bonding resulted from the quasi-aromatic ring structure of the melamine and slower decrease of the pH in the bond line and due to the melamine buffer capacity.

The test methods such as the desiccator method, chamber method or gas analysis method provide different FE values and different formaldehyde content measurements by perforator method for the same wood-based product [7]. The desiccator method has been widely used in countries of Asia-Pacific region, such as Korea, Japan, Malaysia, Indonesia, Australia and New Zealand, while the perforator method (also called the extraction method) has conventionally been used in European countries. By contrast, the large chamber method was standard in North America.

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