

Draft on KNHC's criteria of HCHO for building materials

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ABSTRACT

This study has done for setting the criteria for emission from building materials and a method to test for formaldehyde (HCHO). Emission tests from major building products in a controlled small chamber were performed with a field and laboratory emission cell (FLEC) to evaluate the features of chemical pollutants from those coverings. HURI (Housing & Urban Research Institute) proposed the test method and the emission criteria for HCHO, which considered many dimensions including test results and the influence on the building materials market. The criteria are divided into three steps; the second step will be applied in 3 years after the application of the first set of criteria and the third will be applied in 5 years in turn. HURI is also preparing the criteria for VOCs and the test method will be helpful for the next VOCs study.

INDEX TERMS

HCHO; Indoor air quality; Building materials; Emission criteria

INTRODUCTION

As a result of energy-saving policy and the use of a number of chemicals in the recent interior finishing materials, indoor air quality (IAQ) is getting worse and people have been exposed to a lot of risks from pollutants such as HCHO and volatile organic compounds (VOCs). There are many reports indicating that the indoor air problem is more serious than outdoor air pollution and people have started to realize that indoor air quality is more important than the indoor temperature and humidity. As a result, IAQ has become a key issue in the indoor environment for people's health in Korea and the government, public organizations and even the general people take an active interest in IAQ.

Many countries and international organizations have been revising their IAQ guidelines or standards and setting labelling systems such as Indoor Climate Labelling (ICL; Denmark and Norway), EMICODE of GEV (Germany), Green Guard (USA), Eco Mark Program (Japan), Blue Angel (Germany), etc. Even though IAQ has become major issue in the field of indoor environment in Korea, as yet there are no officially fixed standards for testing and analysing finishing materials that contaminate indoor air with a number of chemicals. Fortunately, the Ministry of Environment (MOE) recently revised its IAQ law which mandates control of IAQ in more buildings than the previous law. According to the revised law flat builders should test the new flat's IAQ (HCHO, VOCs) and present the test result to tenants and submit the result to the municipal borough from May 2004. Korea Air Cleaning Association (KACA) is trying to set a new labelling system that would test and evaluate chemicals emitted from building materials and give labels to the products. These are all encouraging signs in achieving good IAQ.

Korea National Housing Corp. (KNHC), as a public flat supplier, has built more than 1 million flat units since its foundation in 1962. In fact, KNHC focused not on the quality of housings but on the number of units built so it needs to consider the quality of flats,

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especially the indoor environment. Therefore, the research body of KNHC, Housing & Urban Research Institute (HURI), began this study so as to improve the IAQ. There are many ways to make the IAQ better: ventilating the indoor air properly, filtering the air, replacing the materials that emit pollutants into the indoor air and reducing the quantity of pollutants from emission sources. It was considered that reducing chemicals that emit pollutants from building materials is the most effective method to improve the IAQ; that is, source controls. Therefore, HURI needed to make its own HCHO criteria of building materials so that low HCHO emission materials can be used.

For the first step guidelines, criteria or standards of other countries were investigated and emission tests were done and then HURI proposed the test method and the emission criteria for HCHO, which considered many dimensions including test results, other countries' standards and influence on the building materials market. There are planning and design departments and construction sites related to them. The planning and design department will consider the proposed criteria carefully and when they apply the criteria to the specification, the construction sites would be able to select the appropriate materials. Figure 1 shows the application procedure of the criteria and the test method; this paper explains the test method and HCHO emission criteria as given below.

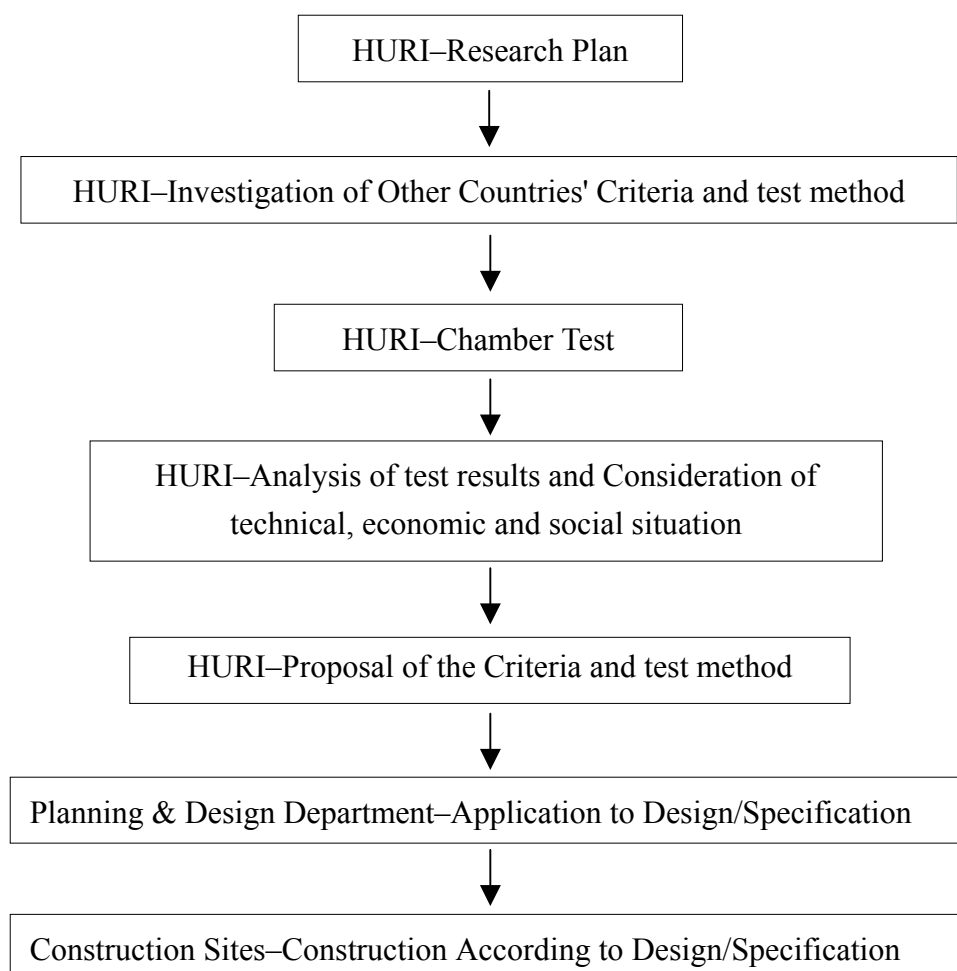


Figure 1 Application procedure of the criteria and the test method.

TEST METHODS

Test Material/Specimen Selection, Handling and Transportation

The test materials need to be selected directly from the production line in factories and packaged immediately in order to ensure the test materials' chemical integrity during transportation. Generally, the size of the materials is enough if it is bigger than FLEC and materials that are normally packed in a container or a package can be sent as it is. Other building materials are packed, to avoid contamination by chemicals or impact on heat and humidity, in a polyethylene bag or a non-polluting bag and are to be sent for emission tests as soon as possible and should be stored in a controlled chamber at the same temperature and humidity as the test condition.

Preparing of Specimens and Conditioning

Specimens for the roll-shaped materials like wall papers and floorings are taken at least 2 m inside from the edge of material. Specimens for panels and boards such as gypsum board are taken from their core and of size 50 cm × 50 cm. Paints and adhesives are prepared quickly from a storage can and put on a circle-shaped window as 250 µm thick and 300 g/m², respectively. The paints are spread evenly with a stainless steel bar and the adhesives are finished with a trowel.

Before the emission tests, all the factors affecting the tests need to be removed; therefore, a FLEC cell is placed in a dry oven at 200°C for an hour or more after cleaning with methanol and the sealing material is washed with thrice-distilled water three times and with HPLC grade water twice and then dried naturally. It is also necessary to exchange water in the air controller once a week to maintain the required humidity.

Chamber Air Sampling

Table 1 shows the air sampling method. Sampling was done with Lp-DNPH cartridges for 1 h at 150 ml flow rate. The duration of the test and sampling time were applied differently according to the characteristics of the material. For solid materials, 10 samplings were totally done for 7 days; for paint two samplings were done for 2 days, which is similar to RAL criteria (RAL, 2000); and for adhesives and glues one sampling was done, which is the same way as the EMICODE criteria (Wolkoff, 1996).

Table 1 Characteristics of chamber test

Test period	Solid materials	1, 3, 5, 7, 9 h after 1, 2, 3, 5, 7 days after
	Paints	1, 24 h after
	Adhesives and glues	10 days after
Sampling flow rates		150 ml/min
Sampling time		1 h
Total air sampling volume		9 l

Analysis

After air sampling the Lp-DNPH cartridges are stored in an incubator before analysis and they are extracted by 5 ml acetonitrile and filtered more than three times through a PTFE filter. This extracted liquid is analysed by high performance liquid chromatograph (HPLC) according to EPA TO-11A (EPA, 1999). The HCHO standard is CARB carbonyl-DNPH Mix 1, which consists of seven standard substances. The injection rate of the extracted liquid into HPLC is 20 µl and the column temperature is 25°C. The flow rate of acetonitrile is 1.2 ml/min and the analysis is done for 45min.

Proposed Criteria and the Test Method

As previously stated, HURI proposed the test method and the emission criteria of HCHO, which was considered in many dimensions including test results, other countries' standards and influence on the building materials market. Improving the IAQ is main aim of this study; on the other hand, preserving the materials market is also important. Therefore many factors should be considered at the same time. It could be said that it is effective to strengthen the criteria step by step in order to achieve the aim, so criteria and the test method were proposed to be applied by stages.

Table 2 Proposed test method

Classification		Step 1	Step 2	Step 3
Wall paper, Flooring, Gypsum board	Test period	7 days	14 days	28–30 days
	Sampling time	1, 3, 5, 7 days after	1, 3, 7, 14 days after	1, 3, 7, 14, 28–30 days after
Paint	Test period	1 day	1 day	1 day
	Sampling time	1, 24 h after	1, 24 h after	1, 24 h after
Adhesive	Test period	10 days	10 day	10 day
	Sampling time	10 days after	10 days after	10 days after

In the first step samplings for solid materials such as wall papers, floorings and gypsum boards are to be done four times for 1 week, like in Japan. In each country, standards and labelling system has its methodology and the length of test duration is different depending on the test purpose and its situation. But 4 weeks is a normal length of the test duration. The test duration is related to the test capability and management cost. There are not many laboratories that can perform the chamber test at the moment and material makers are reluctant to pay a high testing cost, which resulted in a test duration of 1 week in the first step. Four weeks will be applied for the last and third step, similar to what is followed in many other countries. Two weeks as a transition stage was proposed for the second step. Liquid materials are to be tested for a same time in all steps. Paint is to be sampled two times for 2 days and adhesive is to be tested once for 10 days.

Even though there are many results from samplings, the result from the final sampling is compared with the emission limit (criteria) and the others will be used for future data.

In the first step, the emission factor of solid materials such as wall papers, floorings and gypsum board should be less than $0.125 \text{ mg/m}^2/\text{h}$. Adhesives should be less than $0.4 \text{ mg/m}^2/\text{h}$. Paint should be less than $0.5 \text{ } \mu\text{g/m}^2/\text{h}$ at 1 h sampling and $0.125 \text{ } \mu\text{g/m}^2/\text{h}$ at 24-h sampling. In the second step the emission factor is the same as first step but different test conditions such as test duration and sampling time are applied. In the third step, the emission factor of solid materials should be less than $0.05 \text{ mg/m}^2/\text{h}$. Adhesives should be less than $0.125 \text{ mg/m}^2/\text{h}$. Paint should be less than $0.3 \text{ mg/m}^2/\text{h}$ at 1 h sampling and $0.05 \text{ mg/m}^2/\text{h}$ at 24 h sampling.

Table 3 The proposed emission criteria of building materials (mg/m² /h)

Classification	Wall paper	Flooring	Paint		Adhesive			Gypsum board
			1 h	24 h	Glue	Adhesive for wall	Adhesive for floor	
Step 1	Below 0.125	Below 0.125	Below 0.5	Below 0.125	Below 0.4	Below 0.4	Below 0.4	Below 0.125
Step 2	Below 0.125	Below 0.125	Below 0.5	Below 0.125	Below 0.125	Below 0.125	Below 0.125	Below 0.125
Step 3	Below 0.05	Below 0.05	Below 0.3	Below 0.05	Below 0.125	Below 0.125	Below 0.125	Below 0.05

CONCLUSION

After the chamber tests, investigation of other countries' standard and consideration of market situation, HURI presented the test method and the emission criteria for HCHO. Hopefully the criteria will play an important role in reducing the amount of chemicals emitting from building materials and lead manufacturers to develop low HCHO emitting materials and finally improve IAQ in the near future.

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