

# Performance and application of Tiger Hi-Clean Board

## Introduction

The amended building standard law was executed on July 1, 2003, which includes the newly introduced measures against sick building syndrome. The law prohibits the use of building materials containing chlorpyrifos and also restricts the use of building materials containing formaldehyde. “Tiger Hi-Clean Board” (hereinafter called “Hi-Clean Board”), which has the ability to absorb and decompose formaldehyde, has increasingly received public attention and widely been used recently due to growing concerns about indoor air environment. This technical report introduces the performance of “Hi-Clean Board”.

### (1) Outline of the amended building standard law

The guideline value for formaldehyde concentration of 0.08ppm determined by the Ministry of Health, Labour and Welfare is employed as an assessment guide of indoor air pollution under the amended building standard law. Regulations with regard to building materials and ventilation equipment are stipulated in order to achieve the guideline value.

The object of regulation is to maintain the indoor formaldehyde concentration to be no more than the guideline value under the following condition; Surface area of furniture is about 3 times larger than that of floor and a room temperature is set to be 28°C, which is approximately equivalent to a temperature of summer season when formaldehyde emission reaches maximum amount.

The outline of the amended building standard law is as follows.

#### 1) Measures against formaldehyde

① Classification of interior finishing materials according to the amount of formaldehyde emission

The area for use of formaldehyde-emitting materials is restricted.

F☆☆☆☆ (The 1st grade)

No restriction on areas for use of materials

F☆☆☆ (The 2nd grade)

Areas for use of materials is up to twice the area of floor

\*The classification will follow with F☆☆ and F☆.

② Imposition of installation of ventilation

③ Restrictions for ceiling cavities

#### 2) Measures against chlorpyrifos

The use of building materials containing chlorpyrifos is prohibited in buildings which include habitable areas.

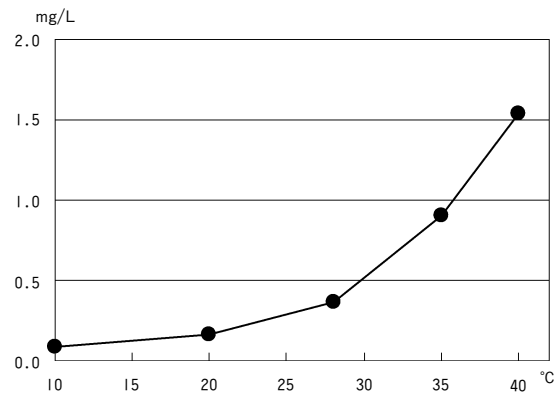
### (2) Future Issues

It is believed that indoor air quality will be improved due to the amendment of building standard law. However, all problems cannot be solved by the law and the following problems can be predicted in the future.

① The amended building standard law does not always guarantee that indoor formaldehyde concentration is no more than 0.08ppm. The law restricts only areas for use of building materials containing formaldehyde. Therefore, a small amount of formaldehyde could be still emitted from building materials. For example, when a room temperature is over 28°C, more formaldehyde is emitted than the estimated amount. It is necessary to be aware that some formaldehyde might be emitted even if interior finishing material is graded as F☆☆☆☆. Also, the amount of formaldehyde emission increases substantially as temperatures rise.

<Measurement Example>

The amount of formaldehyde emitted from Company A's standard plywood which conforms to F☆☆☆☆ was measured at different temperatures. The result was that the amount of formaldehyde emission increased as



The amount of formaldehyde emission increases dramatically at high temperatures.

Fig.1 Amount of formaldehyde emission with varied temperatures

temperatures rose as shown in Figure 1.

② The ventilating effect is not always same because the efficiency of ventilation equipment may vary depending on occupants' life styles. Room occupants may turn off ventilation equipment for many reasons, e.g., "Air conditioning does not work properly", "Electricity expense becomes too high", or "Air outside is not clean".

③ There are so many sources of formaldehyde other than building materials. Formaldehyde is also emitted from furniture, open stove, cigarette smoke and many others. The restriction on interior building materials has been added to the newly amended building standard law. However, there is no restriction on furniture which building occupants use in buildings. According to the official survey conducted by the Tokyo metropolitan government, plywood which emits a substantial amount of formaldehyde is often used for furniture even today.

### (3) Positioning of gypsum building materials and "Hi-Clean Board" in the amended building standard law

The building materials with the limitation of use under the amended building standard law are stipulated in the notification of the National Land and Transportation Ministry as "Formaldehyde emitting Building Materials". Our gypsum products are made from safe mineral based materials which do not emit any formaldehyde, such as gypsum and paper. Therefore, our gypsum products do not correspond to the formaldehyde emitting building materials stipulated in the notification. Our gypsum products can be used as non-regulated materials without limitation of area for use. In addition, "High-Clean Board" strongly supports the amended building standard law which aims for contribution of safe indoor air quality due to its excellent ability to absorb and decompose formaldehyde.

### (4) Accreditation of "Hi-Clean Board"

"Hi-Clean Board" is certified as "building material with the ability to reduce volatile organic compounds in a room" for the first time in the operation of approving new building techniques under the responsibility of the Building Centre of Japan. (Fig. 2) "Hi-Clean Board" is highly evaluated for the ability to absorb and decompose indoor formaldehyde chemically, which results in substantial reduction of concentration of airborne contaminant.

### (5) Performance of "Hi-Clean Board"

"Ventilation" (To open the window to introduce fresh air into a room and let bad air out from a room) is commonly used in order to decrease the concentration of formaldehyde in a room. "Amount of Ventilation" is a frequently used term for "Ventilation".

◆Amount of Ventilation: amount of indoor air ventilated per hour = Volume (m<sup>3</sup>/h)

The performance of functional building materials, which have the ability to reduce the concentration of



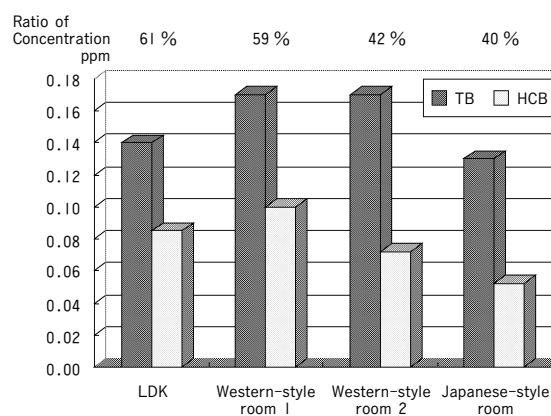
Fig. 2 Certificate of “Hi-Clean Board”

formaldehyde, can be represented by “Amount of Ventilation”. Incidentally, it is accepted that the use of “Hi-Clean Board” for an area of 1m<sup>2</sup> can reduce indoor formaldehyde concentration corresponding to Amount of Ventilation of 1.5m<sup>3</sup>/h. In the case of a class room in school, the effect is same as when fresh air which volume is the same as a class room is let into a room for 2 hours to decrease formaldehyde concentration. This is the most outstanding performance for building materials. (For further information, see (6) Particular Performance Measurement Case 4) Measures for Sick School Building by using “Hi-Clean Board”) In addition, the performance of “Hi-Clean Board” with regards to “Amount of Ventilation” was demonstrated through the performance evaluation test conducted by the Building Centre of Japan.

## (6) Specific Measurement Example

### 1) Comparative examples for apartments (Fig. 3)

Comparison measurement was conducted for two housings which were located in the same apartment building and had same floor plans. Standard plasterboard (hereinafter, called TB) was employed for one housing and “Hi-Clean Board” (hereinafter, called HCB) was employed for the other housing.



The concentration of formaldehyde in a room was reduced to be from 40% to 60% of initial concentration by using “Hi-Clean Board”. The similar result can be obtained even if walls in a room are decorated with vinyl wallpaper.

Fig. 3 Comparative measurement examples for apartments

- LDK : All walls were decorated with vinyl wallpaper.

The concentration of formaldehyde in a room was reduced to be 61% of initial concentration when HCB was used.

- Western-style 1 : All walls were decorated with vinyl wallpaper.  
The concentration of formaldehyde in a room was reduced to be 59% of initial concentration when HCB was used.
- Western-style 2 : Breathable wallpaper was used only for ceiling.  
The concentration of formaldehyde in a room was reduced to be 42% of initial concentration when HCB was used.
- Japanese-style room : HCA\* was used for an area of 10m<sup>2</sup> in closet.  
The concentration of formaldehyde in a room was reduced to be 40% of initial concentration when HCB was used.

\* ) HCA: “Hi-Clean Board Art Type” is wallpaper-decorated version of HCB.

The result shows that the house where HCB was used for all rooms had lower formaldehyde concentration. Thus, it is proven that both HCB and HCA can absorb and decompose formaldehyde in a room effectively. This is a case example which approves that the concentration of formaldehyde in a room can be decreased by about 40% by using HCB even though walls are decorated with vinyl wallpaper.

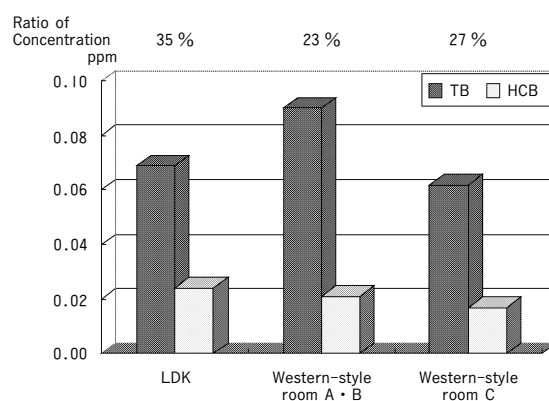
## 2) Comparative examples for wooden detached house (Fig. 4)

Comparative measurement was conducted for two wooden detached houses which had the exactly same floor plan. One employed TB and the other employed HCB.

Walls consist of plasterboards (TB or HCB) decorated with vinyl wallpaper.

Ceilings consist of plasterboards (TB or HCB) and rock wool acoustic boards.

HCB, which is used as base layer boards, considerably absorbs and decomposes indoor formaldehyde permeated through rock wool acoustic boards.



The formaldehyde concentration of wooden detached house consisting of walls decorated with vinyl wallpaper was decreased by from 27% to 35% by using “Hi-Clean Board”. The same effect can be obtained for houses which ceilings consisting of plasterboards and rock wool acoustic boards.

Fig. 4 Comparative measurement examples for detached houses

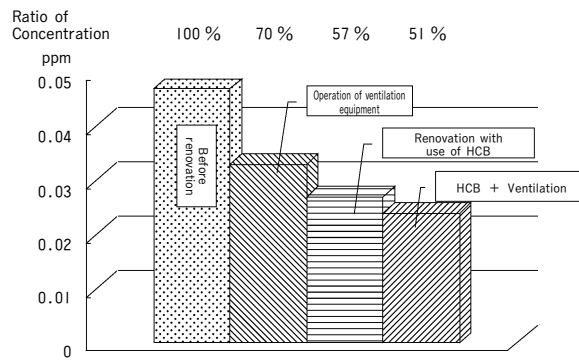
## 3) Renovation examples for detached houses (Fig. 5)

This is an example case of refurbished detached house where HCB was additionally applied to existing walls. Breathable wallpaper was used for finishing for HCB. The concentration of formaldehyde in a room was reduced to be 70% of initial concentration when ventilation equipment had been operated before the renovation work. The concentration of formaldehyde in a room was reduced to be 57% or less of initial concentration when HCB was applied additionally to existing walls even though ventilation equipment was not operated. The concentration of formaldehyde in a room was reduced to be 51% of initial concentration when HCB was additionally applied to existing walls and also ventilation equipment was operated.

Thus, HCB can decrease indoor formaldehyde concentration equivalent to ventilation.

## 4) Example of measure against sick school syndrome by using “Hi-Clean Board” (Fig. 6)

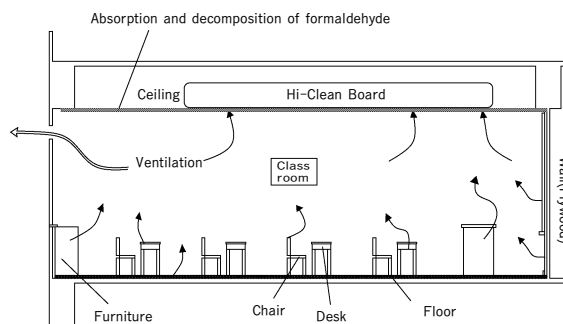
Sick school syndrome which is mainly caused by formaldehyde is a big issue for construction of new school



The concentration of formaldehyde in a room was substantially decreased when “Hi-Clean Board” was applied to existing walls. Further reduction in formaldehyde concentration in a room can be obtained by ventilating a room.

Fig. 5 Renovation examples for detached house

buildings and its renovation work. Therefore, certain measures for sick school syndrome are urgently required. The health effects caused by harmful chemical products are estimated mainly for adults. It is believed that chemical products would give more harmful effect on growing children than adults. Extra consideration for chemical products should be given to children in school environment as they have difficulties in avoiding risks by themselves. Therefore, standards for school environmental sanitation specify the obligation to check regularly if indoor formaldehyde concentration and indoor air quality are maintained well. The following figure shows an example of how HCB is used for ceiling of class room.



(↔ represents emission and absorption of contaminant.)

Significant effect was obtained when “Hi-Clean Board” was used for ceiling.

Fig. 6 The way how formaldehyde in a class room is emitted, absorbed and decomposed

The effect of decreasing indoor formaldehyde concentration when using HCB is evaluated as a ventilation capacity. For example, if HCB is used only for ceiling, the effect of decreasing indoor formaldehyde concentration is equivalent to a ventilation frequency of about 0.6 times/h (“ventilation frequency of 0.5 times/h in habitable rooms in houses”, which is stipulated by the Building Standard Law). (Fig. 7) Therefore, the effect of decreasing indoor formaldehyde concentration by using HCB only for ceilings is equal to the ventilation frequency of 0.5 times/ h. In addition, if “Hi-Clean Board” is used for walls additionally, even greater effect of decreasing indoor formaldehyde concentration can be achieved.

- 1) Value is obtained by dividing volume of air which can be ventilated within an hour by volume of room.
- 2) Ventilation frequency in habitable rooms in houses is 0.5 times/h (Article 20-6, The Building Standard Law Enforcement Order).

HCB's ability to decrease the concentration of formaldehyde in a room .....1.5 m<sup>3</sup>/h·m<sup>2</sup>\*\*

※) HCB's ability to decrease the concentration of formaldehyde in a room is represented as the ventilation capacity per hour and per unit area.

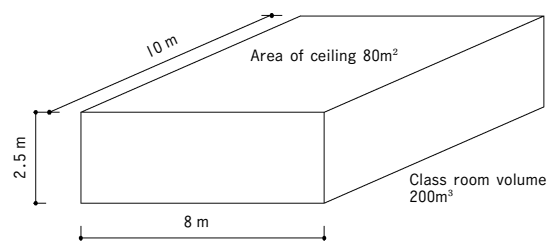
This performance value was obtained through the performance evaluation test conducted by the Building Centre of Japan, which certified HCB as "building material with the ability to reduce indoor volatile organic compound".

Ceiling area.....10×8=80m<sup>2</sup>

Room volume.....80×2.5=200m<sup>3</sup>

Total ventilation achieved by using HCB for ceiling: .....80m<sup>2</sup>×1.5m<sup>3</sup>/h·m<sup>2</sup>=120m<sup>3</sup>/h

Total ventilation achieved by HCB is calculated to ventilation frequency: .....120m<sup>3</sup>/h÷200m<sup>3</sup>=0.6times/h



When "Hi-Clean Board" is used for ceiling of a class room, the effect is the same as when fresh air, which volume is equivalent to a class room, is let into a room for 2 hours to decrease formaldehyde concentration.

Fig. 7 Example calculation of the effect of "Hi-Clean Board"

## Summary

The most important thing for housing occupants is not how the building standard law is put in practice, but how housing occupants can live in a healthy environment.

The amount of formaldehyde emission may vary widely depending on the number of furniture and type of furniture that building occupants bring in buildings. Some people may be very sensitive to even small amount of formaldehyde. Therefore, at a time of construction, it is necessary that the formaldehyde concentration in a room should be decreased as low as possible even when it is lower than 0.08ppm. We recommend "Tiger Hi-Clean Board" as a leading product for reducing the concentration of formaldehyde in a room.