

Research Article

Cause Analysis and Countermeasures of Overproof Formaldehyde of Housing Decoration

¹Wenhua Tang and ²Lianhong Yu

¹School of Environmental Engineering,

²Community Health Service Station, Wuhan Textile University, Wuhan 430073, China

Abstract: In order to understand the level of indoor formaldehyde pollution of newly decorated houses in Wuhan city and preliminarily discuss indoor formaldehyde pollution factors, chose several new residential areas in Wuhan city, 100 houses which are from these residential districts and were decorated not more than 1 year were randomly selected to be measured indoor air formaldehyde content by portable formaldehyde meter and in the meantime, the questionnaire was carried out about formaldehyde concentration influence factors from residents living in those houses. The results show that 26 households reach the standard, 74 households are not up to the standard, including 24 suites of high or more pollution. Analyzed cause of excessive formaldehyde, the conclusion is that among the quality and quantity of decorative materials, the quality and quantity of buying or making furniture, wall treatment mode, decoration complexity level and vacant housing ventilation time, any of these factors are likely to cause high levels of formaldehyde, only each factor is controlled within reasonable limits, formaldehyde may be standard. According to many residents' certain error in decoration housing, some reasonable proposals are given for housing decoration and several effective measures are proposed to control and curb or prevent indoor formaldehyde pollution.

Keywords: Formaldehyde detection, formaldehyde harm, formaldehyde pollution prevention, formaldehyde source, housing decoration, indoor air pollution

INTRODUCTION

With the rising of people's living standards, the residential decoration has become important means to beautify their living environment, at the same time, the indoor air pollution that improper decoration causes has become increasingly serious and its impact on human health has been widely attention (Wang, 2007; Xiao-Cai, 2007; Zhi-Yong, 2007; Song-Wen and Hai-Bing, 2010). The harmful substances which are contained in decoration materials and furniture etc., is an important reason to cause indoor air pollution, formaldehyde is one of them and its harm to the human body has become the focus of attention in recent years (Xue-Chun and Jin-Zhong, 2007). In order to understand the level of indoor formaldehyde pollution of newly decorated houses in several new residential areas in Wuhan, since July 1st, 2012, 100 houses which were decorated not more than 1 year were randomly selected to be measured formaldehyde content and be surveyed formaldehyde concentration influencing factors, our purpose is to remind the public should pay more attention to the related aspects which cause formaldehyde pollution during housing decoration, adequately understand the source of indoor air formaldehyde, correctly recognize the harm from formaldehyde and scientifically decorate housing.

Table 1: The testing results of 100 households housing formaldehyde

The results	Housing number	Formaldehyde concentration range (GB50325-2001) (FC is abbreviation)
Up to standard	26	$FC \leq 0.08 \text{mg/m}^3$
Slight pollution	19	$0.08 < FC \leq 0.25 \text{mg/m}^3$
Moderate pollution	31	$0.25 < FC \leq 0.50 \text{mg/m}^3$
High pollution	18	$0.50 < FC \leq 0.8 \text{mg/m}^3$
Serious pollution	6	$FC > 0.8 \text{mg/m}^3$

THE TESTING RESULTS AND POLLUTION ANALYSIS OF FORMALDEHYDE

Since July 1st, 2012, Wuhan Jubikang Indoor Environment Test Center and we have successively provided the formaldehyde testing service for 100 residents, the results and survey are shown in Table 1 and 2. According to the Code for Indoor Environmental Pollution Control of Civil Building Engineering (GB 50325-2001) (Ministry of Construction of the People's Republic of China, 2006), when samples being collected, doors and windows are closed 12 h.

Seen from Table 2, the preliminary conclusion is that formaldehyde pollution is the result of the integrated effects of many factors: vacant housing ventilation time, decoration modeling style, wall treatment mode and the quantity and quality of various furniture boards; any of these factors are likely to cause

Table 2: Preliminary statistics of formaldehyde concentration influence factors of 100 households housing

The testing results Housing number	Influence factors							
	Vacant housing ventilation time		Wall treatment mode		Quality and quantity of various furniture boards		Decoration complexity level	
	More than six months	Less than six months	Brush latex paint	Paste Wallpaper	Making furniture	Buying furniture	Simple	Complex
Up to standard (26)	14	12	18	8	12	14	21	5
Slight pollution (19)	9	10	14	5	6	13	17	2
Moderate pollution (31)	8	23	24	7	19	12	10	21
High pollution (18)	1	17	6	12	12	6	2	16
Serious pollution (6)	0	6	2	4	2	4	1	5

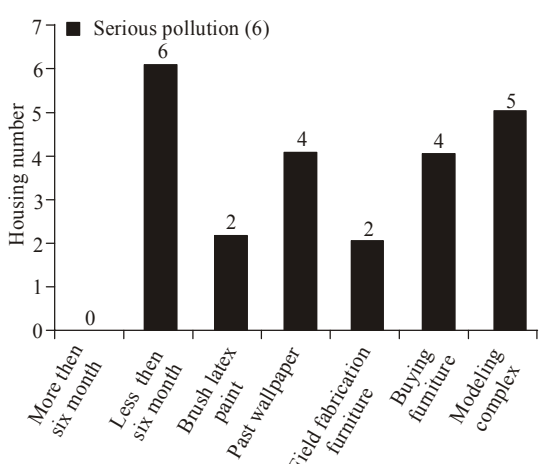


Fig. 1: Preliminary statistics of formaldehyde serious pollution impact factors

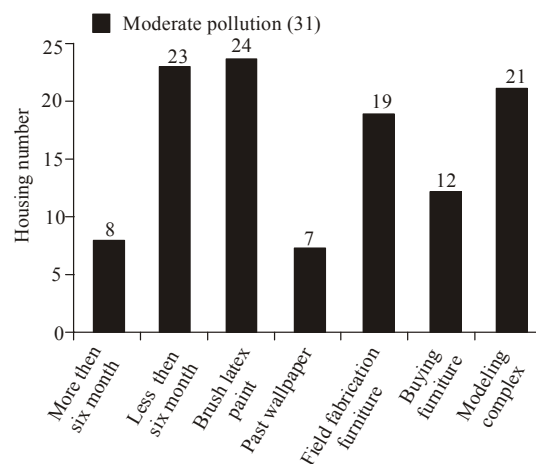


Fig. 3: Preliminary statistics of formaldehyde moderate pollution impact factors

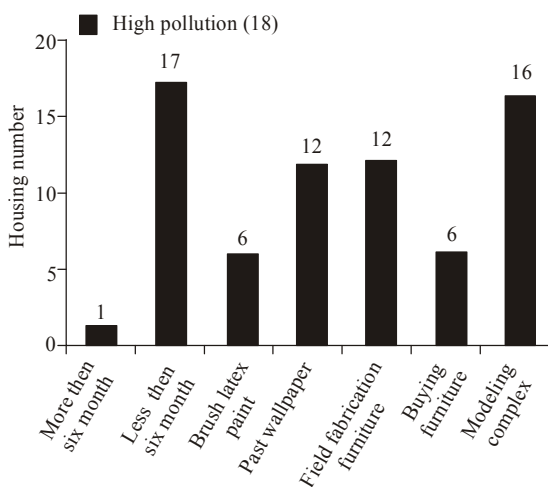


Fig. 2: Preliminary statistics of formaldehyde high pollution impact factors

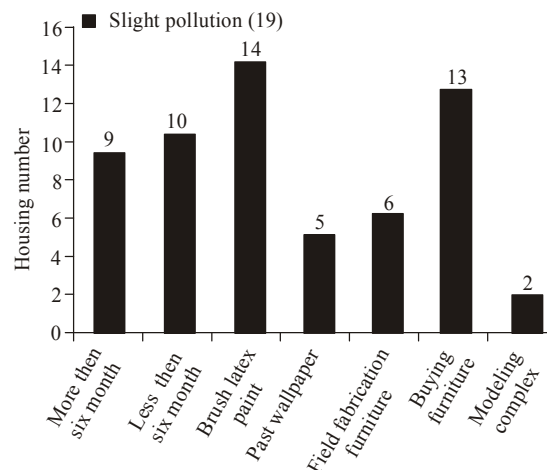


Fig. 4: Preliminary statistics of formaldehyde slight pollution impact factors

high levels of formaldehyde, only each factor is controlled within reasonable limits, formaldehyde may be standard.

Be seen from Fig. 1 to 3, 55 households housing of serious pollution, high pollution and moderate pollution

have obvious characteristic: short vacant housing ventilation time, complex decoration modelling, using blame environmental protection plank to make furniture and partly using toxic glues to paste wallpaper. Among the 24 suites housing of high and serious pollution, 23

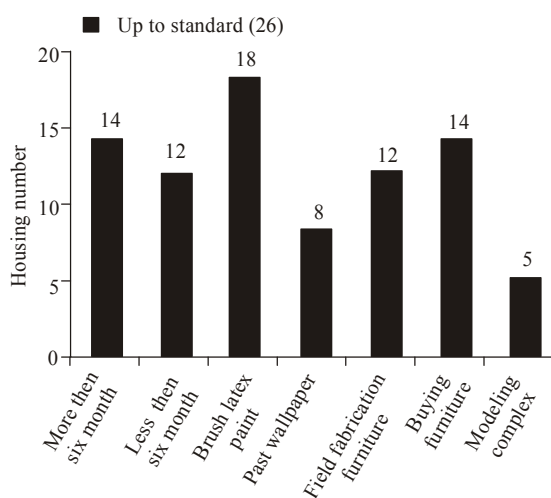


Fig. 5: Preliminary statistics of formaldehyde up to standard impact factors

suites had no more than half a year in vacant housing time, including 8 suites of not more than three months. Obviously, the shorter housing vacancy time is, the easier formaldehyde exceeds bid.

Seen from Fig. 4 and 5, 45 households housing of slight pollution and up to standard have obvious characteristic: longer vacant housing ventilation, simple decoration modelling, mostly buying environmental protection furniture and mostly brushing environment friendly latex paint on wall. According to the survey, among the 26 suites of formaldehyde qualified housing, result is that 21 suites housing was simply decorated, 14 suites had more than half a year in vacant housing ventilation, only 2 suites was decorated less than three months and brushed environment friendly latex paint on wall. It's worth noting that Total Volatile Organic Compound (TVOC) also reached standard in formaldehyde qualified housing. Obviously, the simpler decoration is, the better it is.

THE SOURCE OF FORMALDEHYDE IN INDOOR AIR

Formaldehyde mainly comes from the man-made board of interior decoration, furniture, decoration materials and family adornments, especially in man-made board.

Man-made board: It basically has plywood, joinery board, Medium Density Fiberboard (MDF) and particle board, etc. Man-made board' adhesives is mainly urea formaldehyde resin, which is obtained by formaldehyde and urea' chemical reaction at 120~180°C, because this adhesives has super quality and cheap price, so it is

widely used; Normally, most of the formaldehyde has been reacted, but a small amount still did not participate in the reaction and is free in urea formaldehyde glue, once decoration housing exposes to heat or moisture, formaldehyde will volatilize from these materials. At the same time, chemical stability of urea-formaldehyde resin is poorer, in use process it will slowly release formaldehyde gas for a long time, even about 3~15 years.

Making furniture with man-made board or purchasing artificial board furniture: The formaldehyde pollution is same as above.

Other kinds of decoration materials containing formaldehyde: Such as wall cloth, wallpaper, foam plastic and coating etc. Especially, when pasting wallpaper, using formaldehyde-containing adhesive

Family adornments: Such as curtains, cloth crafts, chemical fiber carpet, clothing, etc. In order to achieve anti-creasing, shrinkproof, or to maintain wear of printing, colored, improvement feel, more need to add formaldehyde in auxiliary.

HOUSING DECORATION PROPOSALS

At normal temperature, formaldehyde is a colorless gas (having strong stimulation smell), soluble in water, often in the form of aqueous solution; The 35%~40% formaldehyde of aqueous solution is called "formalin", its boiling point is 19°C, at room temperature, it is extremely volatile; with the rise of the temperature of the environment, its release is accelerated; When indoor environment humidity increases, the release quantity of formaldehyde rises; When environmental temperature and humidity meanwhile increases, the synergistic effects of release formaldehyde will come into being; When environmental temperature and humidity keep relatively stable state, the indoor formaldehyde concentration gradually reduces with extension of release time (Zhu, 2012; Qiu, 2009).

Scientific design and optimization of the decoration process: The key is to reduce total amount of formaldehyde release. Don't pay special attention to excessive decoration, because formaldehyde release of various materials will have superimposed effect in excessive decorated house; the more complex decoration is, the longer release time is (i.e., to eliminate indoor formaldehyde concentration to the safety range). Even if the building materials are China Environmental Label Products, as long as achieve certain amount, they will produce the superimposed effect, still can cause indoor air pollution.

Carefully choosing qualified decoration materials:

When buying artificial woodiness board, as far as possible choose E0 or E1 level plank, in which formaldehyde-containing are qualified, don't choose E2 level. Especially when buying furniture, don't blindly believe recommended products, salesman often says that particle board, particle board etc are solid wood, the so-called "solid wood furniture" unexpectedly is stunt.

Regulating construction process: To take measures to close the formaldehyde release passage, for example, in the use of artificial wood plate, to avoid small plate assembly, because the more urea formaldehyde resin is used, the more formaldehyde releases, overmuch broken section also can make formaldehyde release too much and too fast, the truncated surface should be sealed with sealing strip or brushing paint.

Strengthening building ventilation: After houses are decorated, vacant ventilation more than six months is advisable, it would be best that houses are vacancy through a summer. Because the summer temperature can make formaldehyde rapidly release, thus through a summer this can greatly reduce the total amount of indoor formaldehyde.

METHODS OF ELIMINATION FORMALDEHYDE

Window ventilation: It is the most economical and most effective method. Slight formaldehyde pollution can be removed through ventilated window. Indoor air circulation can reduce air harmful substance content, thereby lower harm of this kind material to human body. The relevant experimental results show that for general decorated house, after window ventilation six months, the indoor formaldehyde concentration can drop to 0.08 mg/m³, i.e., the qualified standard (Lai and Wang, 2009; Qiu, 2009).

Plant removal method: Appropriately put some plants which have absorption of harmful substance, such as bracketplant, cactus, aloe etc, these broadleaf plants can absorb formaldehyde. On the choice of plants, consider the pollution degree, room area etc factors, in the ordinary circumstances, it is more appropriate to put two basin 1.5 m high plant for 10 m² room. This method can achieve good effect in elimination of slight pollution and moderate pollution. But this method is useless and harmful at night, because plants absorb formaldehyde by photosynthesis, only work during the day and breathe out harmful gas at night, so at nightfall please put the plant into the balcony.

Active carbon adsorption: This method' advantage is easy to use, active carbon not only can absorb formaldehyde, but also can absorb other pollution gas. When using activated carbon, had better choose small grain; The smaller the particle is, the better the adsorption is. This method can achieve best effect in a small scope or a little space, for example, directly put the activated carbon packet in the bedroom closet, shoe cabinet, bookcase, hutch ark and so on. But be careful that it is not obvious that activated carbon adsorb formaldehyde in pollution serious room, because it is easy to reach saturation, so in the use of about five days, activated carbon need regeneration in the sunshine for 3~5 h, generally its adsorption effective period is 5~8 months.

Using formaldehyde catalytic oxidation technology: This method is particularly suitable for the early release of formaldehyde in just right decorative finished house. Catalytic oxidation technology is developed in recent years as air purification technology, it mainly uses TiO₂ light catalytic performance to oxidize formaldehyde into carbon dioxide and water, often in a few hours, can remove more than 95% of the indoor formaldehyde. Its advantages is that processed products will not cause secondary pollution and it remove formaldehyde at a very fast rate. However, how is this technology actually? pending to be tested; Suggesting that homeowners sign a contract involving invalid refund with Formaldehyde Control Agency, in order to avoid the waste of money.

CONCLUSION

In a word, we need to scientifically design and decorate our household environment. First of all, we must have the correct understanding of formaldehyde harm; The second, when decorating, we should choose formal decoration company; The third, we should buy decoration materials which are according with the national safety standards; When buying furniture, we should choose the excellent enterprise product; The fourth, after decorating, we should detect and assess indoor air quality, To seriously polluted room, we should analyze formaldehyde source and take the comprehensive measures to effectively eliminate it.

ACKNOWLEDGMENT

The study was supported by The Ministry of Housing and Urban-Rural Construction 2012 Science and technology projects (project number: 2012-K1-37), Hubei Provincial Department of Housing and Urban-

Rural Construction 2011 science and technology project (project number: 140) and Wuhan Jubikang Indoor Environment Test Center.

REFERENCES

- Lai, C. and D. Wang, 2009. The harm and disposal on room air pollution of formaldehyde. *Inner. Mongolia Environ. Sci.*, 21(3): 83-85. (In Chinese)
- Ministry of Construction of the People's Republic of China, 2006. Code for Indoor Environmental Pollution Control of Civil Building Engineering. The National Standard of the People's Republic of China (GB 50325-2001). (In Chinese).
- Qiu, J., 2009. Indoor formaldehyde pollution situation and control measures. *Chinese Hi-Tech Enterp.*, 10: 129-131. (In Chinese)
- Song-Wen, L. and Y. Hai-Bing, 2010. Investigation on formaldehyde pollution in some indoor air in Suzhou city and its prevention technique. *Occup. Health*, 26(11): 1278-1280. (In Chinese)
- Wang, F., 2007. Investigation of indoor air pollution by formaldehyde in newly decorated rooms. *Chinese J. Health Lab. Technol.*, 17(3): 514-515. (In Chinese)
- Xiao-Cai, F., 2007. Investigation on formaldehyde pollution in decoration of part habitable room in Zhaoqing. *Occup. Health*, 23(22): 2089-2090. (In Chinese)
- Xue-Chun, L. and Z. Jin-Zhong, 2007. Research on formaldehyde in indoor environment pollution. *Stud. Trace Elements Health*, 24(1): 55-56. (In Chinese)
- Zhi-Yong, C., 2007. Monitoring and analysis of the formaldehyde concentration of indoor air in decorated rooms. *Mod. Prev. Med.*, 34(17): 3375. (In Chinese)
- Zhu, G., 2012. Discussion on the indoor formaldehyde pollution and eliminating methods. *Rural Econ. Sci-Technol.*, 23(5): 127-128. (In Chinese)